CAMBODIAN AGRICULTURE IN TRANSITION: OPPORTUNITIES AND RISKS

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
CARDI	Cambodian Agricultural Research and Development Institute
CCSF	Cambodian Community Savings Federation
CDRI	Cambodia Development Resource Institute
CICP	Cambodian Institute for Cooperation and Peace
CPI	Consumer price index
DAP	Diammonium phosphate
DRC	Domestic resource cost
EBA	Everything but Arms
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FGD	Focus group discussion
FO	Farmers' organization
FWUC	Farmer Water User Communities
GDP	Gross domestic product
ha	Hectares
IFC	International Finance Corporation
IRR	Internal rate of return
MAFF	Ministry of Agriculture, Forestry, and Fisheries
MFI	Microfinance institution
MOWRAM	Ministry of Water Resources and Meteorology
NGO	Nongovernmental organization
NIS	National Institute of Statistics, Cambodia
NPV	Net present value
O&M	Operation and maintenance
PDA	Provincial Departments of Agriculture
PPP	Purchasing power parity
RGC	Royal Government of Cambodia
SOWS-REF	Secretariat of One Window Service for Rice Export Formality
SNEC	Supreme National Economic Council
TFP	Total factor productivity
TOT	Terms of trade
tph	Tons per hour
USAID	United States Agency for International Development
WDI	World Development Indicators
WRS	Warehouse Receipt System

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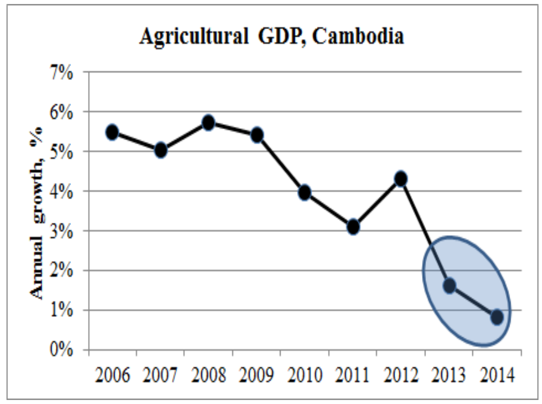
EXECUTIVE SUMMARY



This report seeks to understand the successes, challenges and opportunities of Cambodia's agricultural transformation over the past decade to derive lessons and insights on how to maintain future agricultural growth, and particularly on the government's role in facilitating it. It is prepared per the request of the Supreme National Economic Council and the Ministry of Agriculture Forestry and Fisheries and is based on the primary farm data surveys from 2005 and 2013, and the secondary data from various sources. In 2013-2014, the agricultural growth slowed down to 1 percent from its average of 5.3 percent over 2004-2012. Is the country in transition to a slower agricultural growth? Cambodia can ill afford it because agricultural growth will be critical to continued poverty reduction in the country, given its large size in the economy. Market and private investment friendly policies and targeted public sector investments in irrigation, extension, and other "public good" agricultural services, as feasible within the government's total budget, can help secure continued robust agricultural growth.

KEY FINDINGS

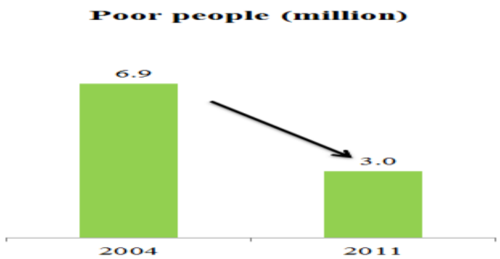
THE PAST DECADE'S AGRICULTURAL GROWTH IS A STORY OF MANY SUCCESSES

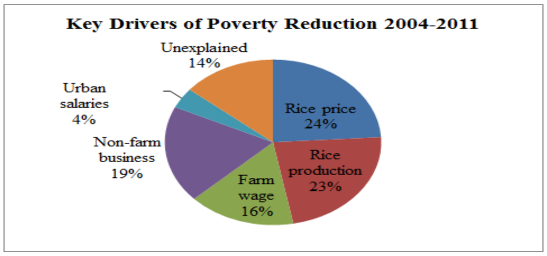
In the last decade, Cambodia's agriculture sector has undergone significant structural transformation. Although still playing a large role, the agriculture sector became relatively less "important" in overall GDP and the total labor force, but more "productive", i.e. agricultural land and labor productivity has increased. This transformation was driven by vibrant and pro-poor agricultural growth.

The agricultural growth in Cambodia was high. During 2004-2012, the annual growth in agricultural gross production was 8.7 percent. Agricultural value added[1] grew by 5.3 percent during this period. This exceptional growth, among the highest in the world, was driven by crop production, mainly of paddy rice (annual growth of 9 percent), but also maize (20 percent), cassava (51 percent), sugarcane (22 percent), and vegetables (10 percent). The growth in livestock and fisheries was modest.

The agricultural growth was also pro-poor. Cambodia's poverty headcount declined from 50 percent in 2007 to 21 percent in 2011, with the number of poor declining from 7 million to 3 million. Most poverty reduction took place in rural areas. More than 60 percent of the poverty reduction was attributed to the agriculture sector: higher rice prices stimulated the larger rice production that increased farm wages. Further poverty reduction will continue to depend on the success of agriculture for many years to come, due to its large role in the labor force, value added, and exports, as well as the fact that many farmers are among the poor and vulnerable.

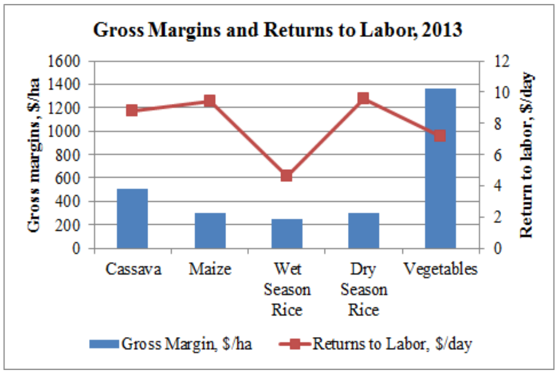
[1] The agricultural value added is defined as the value of gross production *less* the value of intermediate farm inputs.





Agricultural wages have been converging with nonagricultural wages. Agricultural wages grew by 206 percent between the surveys conducted in 2005 and 2013, while nonfarm wages increased by 60 percent. As a result, the ratio between per worker nonagricultural to agricultural valued added in current prices fell to 2.1 in 2012 from 3.2 in 2004. Returns to farm labor have been increasing.

The diversification of crop production has started. Although crop production is still mainly focused on paddy, the crop mix has been changing, driven by higher profitability of non-rice crops. In 2013, average farm gross margins (and returns to labor) were $506/ha ($9.4/day) for cassava, $303/ha ($8.8/day) for maize, and $1,393/ha ($7.2/day) for vegetable production, compared to $245/ha ($4.6/day) for wet season rice and $296/ha ($9.6/day) for dry season rice. Dry season rice competes with non-rice crops in terms of returns to labor but its expansion is constrained by limited irrigation. The share of total area planted under paddy declined from 86 percent in 2002 to 74 percent in 2011, while the share of planted area for maize and cassava production increased significantly.



Even the paddy sector has started to diversify. Triggered by the demand from modernized rice mills, more farmers grow more profitable aromatic paddy, estimated at 10 percent of rice cultivated area and 30 percent of total production. Further expansion of farmland under aromatic paddy is possible with improvements in quality seed supply, agricultural extension, and irrigation.

Yields increased for most crops. With the annual growth in cultivated land areas at 4.7 percent and agricultural gross production at 8.7 percent, the average growth of yields was 4 percent during 2004-2012. This growth in yields was triggered by wide adoption of improved technologies, expanded (yet still limited) irrigation, more use of modern inputs, and better access to mechanized services, pointing to the advances in commercialization. Farmers also have better access to markets.

Cambodian farm products remain price competitive at farm gate. A domestic resource cost analysis of competitiveness shows that despite rising labor costs and prices of farm inputs, the value added generated by farmers exceeds the costs of domestic factors of production (land, labor, and capital). This high competitiveness explains the large increase in agricultural exports in the recent decade. However, the competitiveness of ordinary rice produced during the wet season has worsened in recent years and many small farmers producing ordinary rice started to lose their competitive edge.

Past agricultural growth was driven by several factors. Among the major ones were open trade and, in general, market-oriented agricultural policy. Cambodia was one of the few developing countries that did not overact to the 2008 global food price spike but actually saw higher food prices as an opportunity to leverage agricultural growth. Other net-exporting countries such as India and Vietnam used export restrictions to limit transmission of the global food price spike into their markets. Higher agricultural prices in Cambodia made farmland expansion profitable. In addition, the agriculture sector benefited from: (i) improved access to overseas markets through the Everything but Arms Agreement with the European Union and open cross-border trade with neighbors; (ii) better availability and wider use of mechanization services triggered by the higher cost of rural labor; (iii) better farm access to finance; and (iv) the private sector investments in rice mills.

BUT THERE ARE CHALLENGES

A large share of the past agricultural growth was driven by farmland expansion. The average contribution (weighted by crop areas) of land expansion to the change in farm gross margins in real terms between 2005 and 2013 was about 60 percent. Farmland expanded annually by 4.7 percent, with very large increases (128 percent) for cassava. This farmland expansion has contributed to accelerated deforestation, especially in upland areas.

The average increase in per hectare gross margin[2] **was good, at 3.4 percent per year**. But it varied between 2.1 percent for dry season rice to 44.5 percent for vegetables. Maize's per hectare margin even declined. In many cases, farmers who expanded their land areas received higher incomes, but farmers with unchanged land areas were not able to substantially increase their incomes. The period of relatively high food prices was largely used to expand land areas rather than to build a strong foundation through productivity increases.

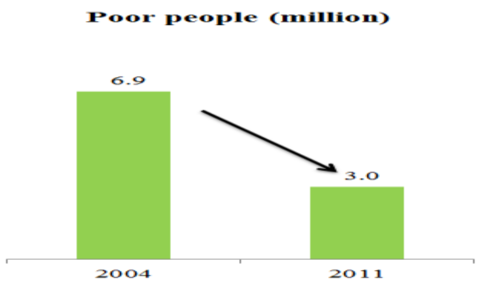
Changes in farm gross margins, real terms, 2005-2013, %

	Change in Cultivated Area	Change in Gross Margin per Hectare	Change in Total Gross Margin
Wet season rice	2.1	2.4	4.5
Dry season rice	6.7	2.1	8.8
Cassava	128.1	15.1	143.2
Maize	17.2	-10.3	6.9
Vegetables	6.4	44.5	50.9
Weighted average	**4.7**	**3.4**	**8.1**

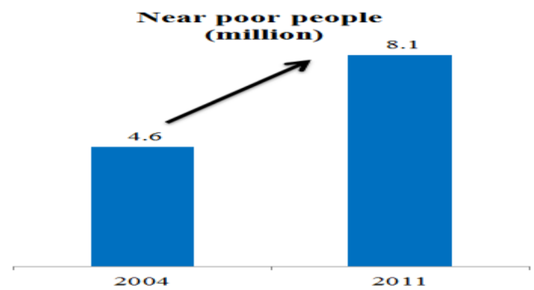
Source: 2005 and 2013 surveys.

While poverty reduced significantly, the number of vulnerable people also increased significantly. Most people who escaped poverty did so by a small margin. The loss of only 1,200 Riels per day (the cost of two small water bottles) would cause Cambodia's poverty rate to double to 40 percent. This high rate of vulnerability is the sign of still modest agricultural productivity increases. Nutritional security has also lagged behind the reduction in poverty: although the prevalence of stunting among children under five has declined by 7 percent between 2010 and 2014, it remained at the high rate of 33 percent.

[2] Gross margin is defined as gross revenue *less* intermediate inputs, including hired labor. The farm gross margin estimated in this report includes major, but not all crops, i.e. rice, cassava, maize, and vegetables.



Poor are those living below $1.15 per day (poverty line)



Near poor or vulnerable are those living above $1.15 per day, but below $2.30 per day

Vulnerability is greatest among the smallest farms. Small farmers, with land area less than a hectare, reported finding it difficult to expand and integrate into the emerging modern food value chains. The share of such farms in total number of rural households owning land was 48 percent in 2011. In the last decade, there has been the trend in Cambodia for large farms (above 3 ha) to become larger and small farms (less than 1 ha) to become smaller.[3] The average size of the interviewed farms[4] with less 1 ha declined from 0.99 ha in 2008 to 0.88 ha in 2012, while the average size of medium farms (between 1 and 3 ha) increased from 1.55 ha to 2.38 ha and the larger farms (above 3 ha) from 3.61 ha to 7.03 ha. In spite of the productivity improvements of some small farms in the past, the productivity of most small traditional farms has remained low, as agricultural extension and other public services have not reached them at a large scale. It appears that the income increase for this group of farmers in the last decade largely came from higher production values, driven by high agricultural prices, and the sale of their labor to larger farms at higher wages, rather than higher land and labor productivity.

Except for rice, the agroprocessing industry has played a limited role in agricultural growth. Almost all crops were exported to neighboring countries unprocessed. This indicates serious weaknesses in the value chain, particularly in the post-harvest system of supply chain management (collection of raw material, storage, finance, logistics, transportation, and information).

What Worked in the Past Will not be Sufficient in the Future

With global food prices declining and the land frontier diminishing, Cambodian agriculture is losing its two major growth drivers. Moreover, agricultural labor is becoming scarcer and more expensive, adding to production costs. Global agricultural prices are projected to continue their decline in the next decade, and selling low-quality ordinary rice on domestic and foreign markets will be less and less profitable. Relying on higher domestic demand driven by the increase in GDP and higher import demand alone, without more efficient use of resources, will not be enough to maintain the high rate of past growth. Cambodia would need to find other drivers of growth to help maintain agricultural growth at or near 5 percent and make it more sustainable.

The recent slowdown in agricultural growth in Cambodia may signal a potential longer-term decline. As global food prices gradually declined and the global rice market became more competitive with the reentry of Thailand and Myanmar, rice production in Cambodia stalled. And with it, total crop value added declined, from 4.9 percent in 2012 to 0.6 percent in 2013. The

[3] This change in distribution of farmland is occurring independently of economic land concessions.
[4] The farm survey was carried out for this report in 2013, see *Annex 2* for details.

growth in agricultural value added slowed down to 1.6 percent in 2013 after average growth of 5.3 percent between 2004 and 2012.

Returning to a high agricultural growth rate is important. Agriculture still maintains a large share in GDP, trade, and the labor force, which means that it will remain the key to further reduction in poverty and vulnerability in the upcoming decade. If Cambodia's structural transformation continues, with agricultural growth averaging 5 percent, by 2030 Cambodia will have relatively smaller but more productive agriculture sector. The agriculture's share in GDP and total labor force are projected to go down respectively to 17 percent and 31 percent in 2030, from 26 percent and 51 percent in 2012, while land productivity would increase from $1,300/ha to $2,700/ha and labor productivity would rise from $1,200/person to $3,700/person (Table 1).

By contrast, the cost of slow agricultural growth would be huge. If average agricultural growth is only 3 percent between 2012 and 2030, agricultural value added would be 29 percent lower by 2030 compared with a 5 percent growth scenario, slicing overall GDP by 18 percent, keeping more people in agriculture, reducing agricultural labor productivity by 34 percent, and slowing any further income convergence between farmers and nonfarmers. Lower agricultural growth would also lead to a much slower reduction in poverty.

Table 1: Impact of lower agricultural growth on selected agriculture sector indicators, Cambodia

Indicators	2012	2030	
		3% Ag GDP growth	5% Ag GDP growth
Share of agriculture in GDP, %	26	15	17
Share of agriculture in labor force, %	51	34	31
Agricultural labor productivity, $/person	1,200	2,450	3,700
Agricultural land productivity, $/ha	1,300	1,900	2,700
Labor productivity ratio of agricultural to nonagricultural workers	2.1	2.1	1.6

A long-term vision for Cambodian agriculture would need to encompass elements of sustainability, productivity, competitiveness, and income growth, shifting from still strong focus on production. Simulation of different scenarios for future agricultural development reveals that a rise in farm productivity would have the largest positive effect on farm incomes, especially if the shift from traditional to modern technologies is accompanied by higher efficiency of modern input use and irrigation. Farmers producing fragrant rice, processing cassava into dry chips, and undertaking other value addition activities can further increase their incomes, illustrating the importance of the agroprocessing industry. Lowering production costs through better use of existing resources (e.g., productivity increase) and minimizing drops in farm output prices through lower logistics costs are the keys to maintaining farm competitiveness. Continued land expansion also provides additional income but sustainability considerations will limit large expansions in the future. This constraint makes agricultural productivity, commercialization, and diversification even more critical for ensuring future agricultural growth that reduces poverty and boosts shared prosperity in Cambodia.

RECOMMENDATIONS

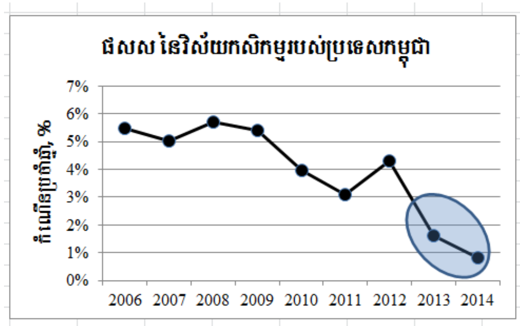
Continued rapid agricultural growth and further structural transformation in the agriculture sector are possible in Cambodia. Four sets of policies together can help support such continued agricultural growth during the next five years (short-to medium run). The first is maintaining a private sector friendly agricultural policy environment, with added attention to lower the regulatory burden in farm input sectors. The second is strengthening the environmental sustainability of agricultural production. The third is improving the quality of agricultural public programs and, as feasible within Cambodia's total government budget, increasing allocations to more effective programs. And the fourth is helping develop the agribusiness and agroprocessing industry.

Investments and policy improvements are needed immediately but not all will show immediate results. For some of them, more time and effort are required to have an impact on the ground. Table 2 summarizes key policy recommendations that need to be set in motion immediately to produce impacts in the short to medium run that would help reverse the recent slowdown in agricultural growth and help fully utilize the significant potential of Cambodia's agriculture.

Table 2: Summary of the report's key policy recommendations based on the time of impacts' realization

Policy recommendations	Impacts realizable in Short Run	Impacts realizable in Medium-to-Long Run
Maintaining a private sector friendly agricultural policy environment		
Continue the open trade policy and non-distortive agricultural policy	X	
Reduce the regulatory costs of importation of fertilizers	X	
Open up seeds sector for private investments through deregulation and institutional strengthening		X
Strengthening the environmental sustainability		
Improve land use planning and better enforce land laws/regulations		X
Strengthen land tenure security		X
Promote sustainable land management practices	X	
Promote the safe use of agricultural chemicals	X	
Improving agricultural "public good" investment programs		
As feasible within Cambodia's total government budget, increase the budget for core agricultural public goods, especially irrigation, applied research, extension, soil nutrient management, input quality control, food safety, vocational training, and rural roads	X	
In irrigation, pay more attention to upgrades and rehabilitation of existing systems and participatory management of irrigation infrastructure	X	
Improve the quality of agricultural public programs		X
Facilitate integration of small farms into food value chains		X
Helping develop agribusiness and agroprocessing industry		
Improve access to and reduce electricity costs		X
Invest in food safety public infrastructure		X
Improve rice trade logistics, including cost reduction		X
Remove barriers for introduction of warehouse receipts		X

សេចក្តីសង្ខេបរួម



របាយការណ៍នេះ បានព្យាយាមស្វែងយល់ពីជោគជ័យ បញ្ហាប្រឈម និងកាលានុវត្តភាពនៃ បម្លាស់ប្តូរក្នុងវិស័យកសិកម្ម នៅកម្ពុជា នៅក្នុងទសវត្សរ៍កន្លងទៅនេះ ដើម្បីទាញ បានជាមេរៀន និងគំនិតសំខាន់ៗ សម្រាប់រក្សាកំណើនកសិកម្ម នាពេលអនាគត ជាពិសេស តួនាទីរបស់រដ្ឋាភិបាល នៅក្នុងការបង្កលក្ខណៈ ឱ្យមាន កំណើនបែបនេះ។ របាយការណ៍នេះត្រូវបានរៀបចំឡើង ទៅតាម ការស្នើសុំរបស់ ឧត្តមក្រុមប្រឹក្សាសេដ្ឋកិច្ចជាតិ និងក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ ដោយផ្អែកទៅតាមការអង្កេតប្រមូលទិន្នន័យផ្ទាល់ពីកសិដ្ឋាន ពីឆ្នាំ២០០៥ ដល់២០១៣ និងទិន្នន័យដែលបានពីប្រភពផ្សេងៗ។ នៅកំឡុងឆ្នាំ ២០១៣–២០១៤ កំណើនកសិកម្មមានការថមថយមកនៅត្រឹម ១ភាគរយ ពីកំណើនជាមធ្យម ៥,៣ភាគរយ នៅកំឡុងឆ្នាំ ២០០៤–២០១២។ តើប្រទេសកម្ពុជា ស្ថិតនៅក្នុងអន្តរកាលទៅរកកំណើនសេដ្ឋកិច្ចយឺតជាងមុនឬ? ប្រទេសកម្ពុជាមិនអាចបណ្តោយឱ្យមាន បញ្ហាបែបនេះ បន្តកើតមានឡើងឡើយ ដោយហេតុថាកំណើនក្នុងវិស័យកសិកម្មមានសារៈសំខាន់ សម្រាប់បន្តការកាត់ បន្ថយភាពក្រីក្រនៅក្នុងប្រទេសនេះ និងដោយសារតែកសិកម្មមានសមាសភាគធំ នៅក្នុងសេដ្ឋកិច្ចរបស់ប្រទេសកម្ពុជា។ គោលនយោបាយ ដែលបង្កភាពងាយស្រួលដល់ទីផ្សារ និងការវិនិយោគឯកជន និងការវិនិយោគក្នុងវិស័យសាធារណៈ ដែលផ្តោតទៅលើគោលដៅដូចជា វិស័យធារាសាស្ត្រ ផ្សព្វផ្សាយបច្ចេកទេសកសិកម្ម និង សេវាកសិកម្មជា "ប្រយោជន៍សាធារណៈ" ដទៃទៀត ទៅតាមលទ្ធភាពដែលអាចធ្វើបាន ក្នុងរង្វង់លទ្ធភាពថវិកាសរុបរបស់រដ្ឋាភិបាល អាចនឹងជួយរក្សាឱ្យវិស័យកសិកម្មនៅតែបន្តកំណើនរឹងមាំបាន។

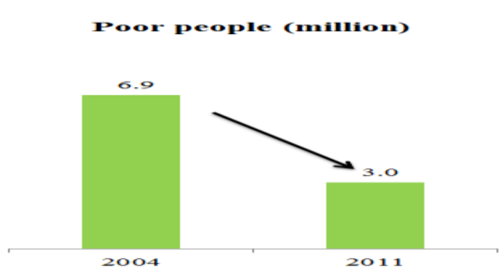
លទ្ធផលរកឃើញសំខាន់ៗ

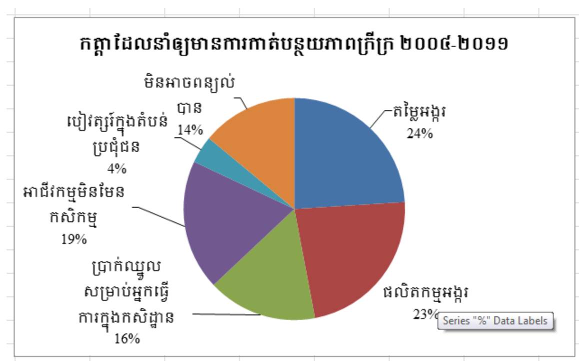
កំណើននៃវិស័យកសិកម្មនៅក្នុងទសវត្សរ៍កន្លងទៅ បានបង្ហាញពីជោគជ័យជាច្រើន

នៅក្នុងទសវត្សរ៍ចុងក្រោយនេះ វិស័យកសិកម្មរបស់ប្រទេសកម្ពុជា បានឆ្លងកាត់បម្លាស់ប្តូររចនាសម្ព័ន្ធសំខាន់ៗ គួរឱ្យកត់សម្គាល់។ បើទោះបីជានៅមានតួនាទីដ៏ធំយ៉ាងណាក៏ដោយ វិស័យកសិកម្មមិនសូវមាន "សារៈសំខាន់" នៅក្នុង **ផសស** និងកម្លាំងពលកម្មសរុបឡើយ ប៉ុន្តែមាន "ផលិតភាព" ជាងមុន ពោលគឺផលិតភាពរបស់ដីកសិកម្ម និងកម្លាំងពលកម្ម មានការកើនឡើង។ បម្លាស់ប្តូរនេះត្រូវបានជម្រុញ ដោយសារតែកំណើនក្នុងវិស័យកសិកម្ម ដែលគាំទ្រដល់ជនក្រីក្រ។

កំណើនវិស័យកសិកម្ម នៅក្នុងប្រទេសកម្ពុជាមានកម្រិតខ្ពស់។ ចន្លោះពីឆ្នាំ២០០៤ ដល់២០១២ កំណើន ប្រចាំឆ្នាំនៃផលិតកម្មកសិកម្មសរុបមាន ៨,៧ភាគរយ។ តម្លៃបន្ថែមរបស់វិស័យកសិកម្ម[5] មានការកើន ៥,៣ភាគរយ នៅក្នុងរយៈពេលនេះ។ កំណើនពិសេស ដែលស្ថិតនៅក្នុងចំណោមកំណើនខ្ពស់ជាងគេ នៅក្នុងពិភពលោកនេះ ត្រូវបាន ជម្រុញដោយផលិតកម្មដំណាំ ជាពិសេសស្រូវ (កំណើនប្រចាំឆ្នាំ ៩ ភាគរយ) និងពោត (២០ ភាគរយ) ដំឡូងមី (៥១ ភាគរយ) អំពៅ (២២ ភាគរយ) និងបន្លែ (១០ ភាគរយ)។ កំណើននៅក្នុងវិស័យបសុសត្វ និងនេសាទ មានកម្រិតមធ្យម។

កំណើនក្នុងវិស័យកសិកម្មនេះ ក៏គាំទ្រដល់ប្រជាពលរដ្ឋក្រីក្រផងដែរ។ អត្រានៃភាពក្រីក្ររបស់ប្រទេស កម្ពុជា មានការថយចុះពី ៥០ភាគរយ នៅក្នុងឆ្នាំ២០០៧ មកនៅ ២១ភាគរយ នៅក្នុងឆ្នាំ២០១១ ដោយចំនួន ប្រជាជនក្រីក្រថយចុះពី ៧លាននាក់ មកនៅ ៣លាននាក់។ ការកាត់បន្ថយភាពក្រីក្រភាគច្រើន កើតមានឡើងនៅតាមតំបន់ជនបទ។ ការកាត់បន្ថយ ភាពក្រីក្រជាង ៦០ភាគរយ កើតឡើងដោយសារវិស័យកសិកម្ម៖ តម្លៃអង្ករខ្ពស់ជាងមុន បានជម្រុញឱ្យផលិតកម្មស្រូវ កើន ឡើង ដែលជួយបង្កើនប្រាក់ចំណូលដល់អ្នកដែលធ្វើស្រែ និងកសិដ្ឋានស្រូវនានាដែរ។ ការកាត់បន្ថយភាពក្រីក្របន្ថែមទៀត នៅបន្តពឹងអាស្រ័យលើជោគជ័យនៃ វិស័យកសិកម្មច្រើនឆ្នាំទៅមុខទៀត ដោយសារតែតួនាទីដ៏ធំរបស់វិស័យនេះ ចំពោះ កម្លាំងពលកម្ម តម្លៃបន្ថែម និងការនាំចេញ ក៏ដូចជាដោយសារតែកសិករជាច្រើនស្ថិតនៅក្នុងចំណោមអ្នកដែលក្រីក្រ និង ងាយរងគ្រោះជាងគេ។





ប្រាក់ឈ្នួលក្នុងវិស័យកសិកម្ម កើនឡើងទៅកៀកនឹងប្រាក់ឈ្នួលក្នុងវិស័យមិនមែនកសិកម្ម។ ប្រាក់ឈ្នួលក្នុង វិស័យកសិកម្មមានការកើនឡើង ២០៦ភាគរយ នៅក្នុងការអង្កេតដែលធ្វើឡើងចន្លោះ ឆ្នាំ២០០៥ និង២០១៣ ខណៈពេល ដែលប្រាក់ឈ្នួលក្នុងវិស័យមិនមែនកសិកម្ម មានការកើនឡើង ៦០ភាគរយ។ ដូច្នេះ ផលធៀបរវាងតម្លៃបន្ថែម សម្រាប់អ្នក ធ្វើការក្នុងវិស័យមិនមែនកសិកម្មម្នាក់ ធៀបជាមួយនឹងអ្នកធ្វើរបរកសិកម្ម គិតជាតម្លៃបច្ចុប្បន្ន មានការថយចុះពី ៣,២ នៅក្នុងឆ្នាំ២០០៤ មក ២,១ នៅក្នុងឆ្នាំ២០១២។ ចំណូលដែលបានមកពីការធ្វើការងារនៅក្នុងកសិដ្ឋាន មានការកើនឡើង។

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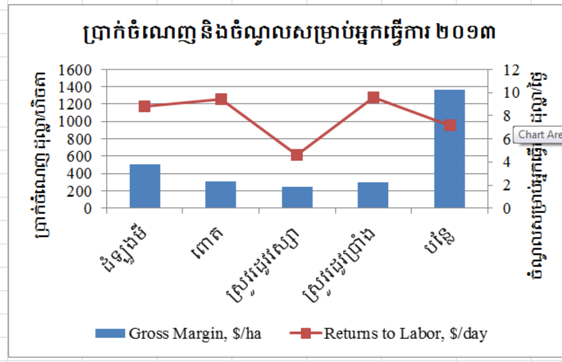
5 តម្លៃបន្ថែមក្នុងវិស័យកសិកម្ម ត្រូវបានគេកំណត់និយមន័យឱ្យថាជាតម្លៃសរុបរបស់ផលិតកម្ម ដកតម្លៃធាតុចូលកសិកម្មចេញ។

ពិពិធភាពផលិតកម្មដំណាំបានចាប់ផ្តើមនិងកំពុងបន្ត។ បើទោះបីជាផលិតកម្មដំណាំ ផ្តោតជាចម្បងលើដំណាំស្រូវក្តី មុខដំណាំកំពុងមានការប្រែប្រួល ដោយសារតែលទ្ធភាពចំណេញ ខ្ពស់នៃប្រភេទដំណាំក្រៅពីស្រូវ។ នៅឆ្នាំ២០១៣ ផលចំណូល សរុបគិតជាមធ្យម (រួមទាំងកំរៃពលកម្ម) របស់កសិដ្ឋាន រួមមាន ៥០៦ដុល្លារ/ហិចតា (៩,៤ដុល្លារ/ថ្ងៃ) សម្រាប់ដំឡូងមី, ៣០៣ ដុល្លារ/ហិចតា (៨,៨ដុល្លារ/ថ្ងៃ) សម្រាប់ពោត និង ១៣៩៣ ដុល្លារ/ហិចតា (៧,២ដុល្លារ/ថ្ងៃ) សម្រាប់ដំណាំបន្លែ បើធៀប ជាមួយនឹង ២៤៥ដុល្លារ/ហិចតា (៤,៦ដុល្លារ/ថ្ងៃ) សម្រាប់ស្រូវ វស្សា និង ២៩៥ដុល្លារ/ហិចតា (៩,៦ដុល្លារ/ថ្ងៃ) សម្រាប់ស្រូវប្រាំង។ ស្រូវរដូវប្រាំងត្រូវប្រជែងជាមួយនឹងដំណាំមិនមែន ស្រូវដទៃទៀត បើគិតពីចំណូលរបស់កម្លាំងពលកម្ម ប៉ុន្តែការពង្រីកផលិតកម្មស្រូវរដូវប្រាំងត្រូវជួបឧបសគ្គ ដោយសារតែ ប្រព័ន្ធធារាសាស្ត្រនៅមានកម្រិតនៅឡើយ។ ភាគរយនៃផ្ទៃដីសរុបដែលប្រើប្រាស់ សម្រាប់បង្កបង្កើនផលស្រូវ មានការ ថយចុះពី ៨៦ភាគរយ នៅក្នុងឆ្នាំ២០០២ រហូតដល់ ៧៤ភាគរយ នៅក្នុងឆ្នាំ២០១១ ខណៈពេលដែលភាគរយនៃផ្ទៃដីសម្រាប់ដាំពោត និងដំឡូងមី មានការកើនឡើងគួរឱ្យកត់សម្គាល់។



ស្ទើរតែវិស័យស្រូវក៏ចាប់ផ្តើមធ្វើពិពិធកម្មផងដែរ។ ដោយសារតែមានតម្រូវការពីរោងម៉ាស៊ីនកិនស្រូវទំនើប កសិករកាន់តែច្រើនជាងមុននាំគ្នាបង្កើនការផលិតស្រូវក្រអូបដែលផ្តល់ប្រាក់ចំណេញខ្ពស់ជាងមុន ប្រមាណជា១០ភាគរយ នៃផ្ទៃដី ដាំស្រូវសរុប និងប្រមាណជា ៣០ភាគរយនៃផលិតកម្មសរុប។ ការពង្រីកដីស្រែបន្ថែមទៀត សម្រាប់ស្រូវក្រអូបនេះ គឺអាច ធ្វើទៅបាន ជាមួយនឹងការកែលំអការផ្គត់ផ្គង់គ្រាប់ពូជប្រកបដោយគុណភាព ការផ្សព្វផ្សាយកសិកម្ម និងប្រព័ន្ធធារាសាស្ត្រ។

ទិន្នផលមានការកើនឡើង សម្រាប់ដំណាំភាគច្រើន។ ជាមួយនឹងកំណើនប្រចាំឆ្នាំនៃផ្ទៃដីដាំដុះ ៤,៧ភាគរយ និងផលិតកម្មកសិកម្មសរុប ៨,៧ភាគរយ ទិន្នន័យមានកំណើនជាមធ្យមប្រចាំឆ្នាំ ៤ភាគរយ ចន្លោះពីឆ្នាំ២០០៤ ដល់២០១២។ កំណើនទិន្នផលទាំងនេះត្រូវបានជម្រុញ ដោយការប្រើប្រាស់បច្ចេកវិទ្យាថ្មីៗច្រើនជាងមុន ការពង្រីកប្រព័ន្ធធារាសាស្ត្រ (បើទោះបីជានៅមានកម្រិតនៅឡើយក៏ដោយ) ការប្រើប្រាស់ពូជនិងជីរកសិកម្មល្អៗកាន់តែច្រើនជាងមុន និងលទ្ធភាពទទួលបានសេវាគ្រឿងយន្តល្អប្រសើរជាងមុន ដែលទាំងនេះសុទ្ធតែបង្ហាញពីភាពឿនលឿននៃពាណិជ្ជនីយកម្ម។ កសិករ ក៏មានលទ្ធភាពទទួលបានទីផ្សារកាន់តែប្រសើរជាងមុនផងដែរ។

តម្លៃផលិតផលកសិកម្មរបស់កម្ពុជានៅមាន ភាពប្រកួតប្រជែងនៅនឹងកសិដ្ឋានផ្ទាល់។ ការវិភាគលើភាពប្រកួត ប្រជែងនៃតម្លៃផលិតផលក្នុងស្រុក បង្ហាញថាបើទោះបីជាតម្លៃកម្លាំងពលកម្ម និងតម្លៃធាតុចូលដែលប្រើប្រាស់សម្រាប់ដាំដុះមានការកើនឡើងយ៉ាងណាក្តី តម្លៃបន្ថែមដែលគិតដោយកសិករនៅខ្ពស់ជាងតម្លៃ នៃកត្តាផលិតកម្មក្នុងស្រុក (ដី ពលកម្ម និងដើមទុន)។ ភាពប្រកួតប្រជែងខ្ពស់នេះ អាចជាមូលហេតុនាំឱ្យមានការកើនឡើងការនាំចេញកសិផលដ៏ច្រើន នៅក្នុង ទសវត្សរ៍កន្លងទៅនេះ។ ប៉ុន្តែភាពប្រកួតប្រជែងនៃស្រូវធម្មតាដែលផលិតនៅរដូវវស្សា មានការថយចុះក្នុងរយៈប៉ុន្មានឆ្នាំ ចុងក្រោយនេះ ហើយ កសិករខ្នាតតូចជាច្រើនដែលផលិតស្រូវធម្មតា បានចាប់ផ្តើមបាត់បង់ភាពប្រកួតប្រជែងរបស់ខ្លួន។

កំណើននៅក្នុងវិស័យកសិកម្មកន្លងមក ត្រូវបានជម្រុញដោយកត្តាជាច្រើន។ ក្នុងចំណោមកត្តាធំៗ រួមមានការ បើកចំហរការធ្វើពាណិជ្ជកម្ម និងគោលនយោបាយកសិកម្មផ្តោតលើទីផ្សារជាទូទៅ។ ប្រទេសកម្ពុជា ជាប្រទេសមួយ ក្នុងចំណោមប្រទេសកំពុងអភិវឌ្ឍន៍ ដែលមិនបានប្រតិកម្មជ្រុលខ្លាំងពេកទៅនឹងការលោត ឡើងនូវតម្លៃស្បៀងអាហារ ជាសកលនៅក្នុងឆ្នាំ២០០៨ ប៉ុន្តែចាត់ទុកការឡើងថ្លៃស្បៀងអាហារនេះ ថាជាឱកាសមួយដើម្បីទាញប្រយោជន៍ សម្រាប់ កំណើនវិស័យកសិកម្ម។ ប្រទេសនានាដែលមានការនាំចេញច្រើនជាងការនាំចូល ដូចជាឥណ្ឌា និងវៀតណាម ជាដើម បានដាក់កំហិតលើការនាំចេញ ដើម្បីទប់ឥទ្ធិពលនៃការឡើងថ្លៃស្បៀងអាហារជាសកល មកលើទីផ្សាររបស់ពួកគេ។ តម្លៃ ផលកសិកម្មខ្ពស់នៅក្នុងប្រទេសកម្ពុជា បានធ្វើឱ្យការពង្រីកដីកសិកម្ម ផ្តល់ផលចំណូលមកវិញខ្ពស់។ លើសពីនេះ វិស័យកសិកម្មបានទទួលប្រយោជន៍ពី (i) ការទទួលបានទីផ្សារនៅបរទេសច្រើនជាងមុន តាមរយៈកិច្ចព្រមព្រៀងទំនិញគ្រប់បែបយ៉ាងលើកលែងតែអាវុធចេញ ជាមួយនឹងសហភាពអឺរ៉ុប និងការបើកចំហពាណិជ្ជកម្មឆ្លងដែនជាមួយនឹងប្រទេស ជិតខាង (ii)ការទទួលបាន និងការប្រើប្រាស់យ៉ាងទូលាយនូវសេវាគ្រឿងយន្ត ជំនួសអោយការចំណាយកាន់តែខ្ពស់លើកម្លាំងពលកម្មនៅជនបទ (iii)ការទទួលបានឥណទានប្រសើរជាងមុន និង (iv)ការ វិនិយោគរបស់វិស័យឯកជន លើម៉ាស៊ីន កិនស្រូវខ្នាតធំ។

បញ្ហាប្រឈមនានា

ភាគរយដ៏ខ្ពស់នៃកំណើនក្នុងវិស័យកសិកម្មកន្លងទៅនេះ ត្រូវបានជម្រុញដោយសារតែការពង្រីកផ្ទៃដីដាំដុះ។ ការរួមចំណែកជាមធ្យម នៃការពង្រីកផ្ទៃដីដាំដុះ ចំពោះការប្រែប្រួលអត្រាចំណូលសរុបរបស់កសិកម្ម គិតជាតម្លៃពិត ចន្លោះពីឆ្នាំ២០០៥ ដល់២០១៣ គឺប្រហែលជា ៦០ភាគរយ។ ដីកសិកម្ម ត្រូវបានពង្រីកប្រមាណជា ៤,៧ភាគរយ ក្នុងមួយឆ្នាំ ដោយមានការកើនឡើងយ៉ាងច្រើន(១២៨ភាគរយ) សម្រាប់ដំឡូងមី។ ការពង្រីកដីកសិកម្មបែបនេះ បានរួមចំណែក ធ្វើឱ្យមានការបាត់បង់ព្រៃឈើកាន់តែលឿន ជាពិសេស នៅតំបន់ខ្ពង់រាប។

កំណើនជាមធ្យមនៃអត្រាចំណេញក្នុងមួយហិចតា[6] មានកម្រិត ល្អប្រសើរ គឺ៣,៤ភាគរយក្នុងមួយឆ្នាំ។ ប៉ុន្តែ វាមានការប្រែប្រួលចន្លោះពី ២,១ភាគរយ សម្រាប់ស្រូវរដូវប្រាំង ទៅ៤៤,៥ភាគរយ សម្រាប់បន្លែ។ អត្រា ចំណេញសម្រាប់ពោតក្នុងមួយហិចតាមានការថយចុះ។ នៅក្នុងករណីជា ច្រើន កសិករដែលបានពង្រីកផ្ទៃដីរបស់ខ្លួន បានទទួលប្រាក់ចំណូលខ្ពស់ ជាងមុន ប៉ុន្តែកសិករដែលរក្សាផ្ទៃដីដាំដុះដដែលមិនអាចបង្កើនប្រាក់ចំណូលរបស់ខ្លួនឱ្យបានច្រើនឡើយ។ កំឡុងពេលដែល តម្លៃស្បៀងឡើងខ្ពស់ ត្រូវបានជំរុញលើការពង្រីកផ្ទៃដី ជាជាងការកសាងមូលដ្ឋានរឹងមាំ តាមរយៈការបង្កើនផលិតភាព។

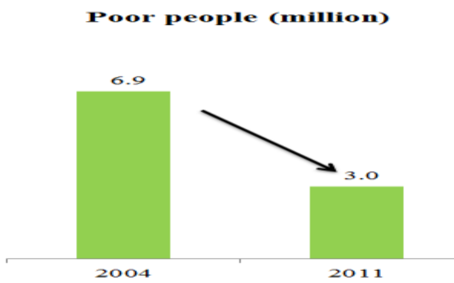
Changes in farm gross margins, real terms, 2005-2013, %

	Change in Cultivated Area	Change in Gross Margin per Hectare	Change in Total Gross Margin
Wet season rice	2.1	2.4	4.5
Dry season rice	6.7	2.1	8.8
Cassava	128.1	15.1	143.2
Maize	17.2	-10.3	6.9
Vegetables	6.4	44.5	50.9
Weighted average	**4.7**	**3.4**	**8.1**

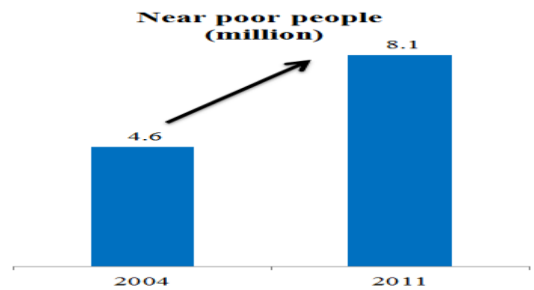
Source: 2005 and 2013 surveys.

ពេលដែលភាពក្រីក្រមានការថយចុះគួរឱ្យកត់សម្គាល់ ចំនួនប្រជាជនដែលងាយរងគ្រោះក៏មាន ការកើនឡើង ច្រើនផងដែរ។ ភាគច្រើននៃប្រជាជនដែលងើបចេញពីភាពក្រីក្រ នៅមិនទាន់ទៅផុតឆ្ងាយពីវានៅឡើយ។ ការបាត់បង់ ចំណូលត្រឹមតែ១២០០រៀល ក្នុងមួយថ្ងៃ (តម្លៃទឹកសុទ្ធពីរដបតូច) នឹងធ្វើឱ្យអត្រា នៃភាពក្រីក្ររបស់ប្រទេសកម្ពុជា កើនឡើង ទ្វេដងដល់៤០ភាគរយ។ អត្រានៃភាពងាយរងគ្រោះដ៏ខ្ពស់បែបនេះ គឺជាសញ្ញាដែលបង្ហាញថា កំណើនផលិតភាពកសិកម្ម នៅមានកម្រិតតិចតួចនៅឡើយ។ សន្តិសុខអាហារូបត្ថម្ភ ក៏នៅមានល្បឿនយឺតជាងការកាត់បន្ថយភាពក្រីក្រផងដែរ៖ ទោះបីជាប្រេវ៉ាឡង់នៃភាពក្រិនរបស់កុមារអាយុក្រោម៥ឆ្នាំ បានថយចុះ៧ភាគរយ នៅចន្លោះពីឆ្នាំ២០១០ និង២០១៤ក្តី អត្រា នេះនៅតែមានកម្រិតខ្ពស់ (៣៣ ភាគរយ) នៅឡើយ។

6 អត្រាចំណូលសរុប ជាចំណូលសរុប ដកធាតុចូលប្រយោលចេញ រាប់ទាំងពលកម្មដែលត្រូវបានជួលផង។ អត្រាចំណេញរបស់កសិដ្ឋាន ដែលត្រូវបានប៉ាន់ប្រមាណនៅក្នុងរបាយការណ៍នេះ រាប់បញ្ចូលតែដំណាំសំខាន់ៗ ដូចជា ស្រូវ ដំឡូងមី ពោត និងបន្លែ ជាដើម។



ប្រជាជនក្រីក្រ ដែលកំពុងរស់នៅក្រោម ១,១៥ ដុល្លារ ក្នុងមួយថ្ងៃ (បន្ទាត់នៃភាពក្រីក្រ)



ប្រជាជនដែលជិតក្រ ឬងាយរងគ្រោះ គឺជាអ្នកដែលរស់ នៅលើ ១,១៥ ដុល្លារ ក្នុងមួយថ្ងៃ ប៉ុន្តែក្រោម ២,៣០ ដុល្លារ ក្នុងមួយថ្ងៃ

ភាពងាយរងគ្រោះមានកម្រិតខ្ពស់ជាង ក្នុងចំណោមកសិដ្ឋានដែលមានទំហំតូចៗ។ កសិដ្ឋានតូចៗ ដែលមានទំហំដី តិចជាង១ហិចតា ត្រូវបានរកឃើញថាជួបនឹងការលំបាក ដើម្បីពង្រីកខ្លួននិងធ្វើសមាហរណកម្ម ចូលទៅក្នុងខ្សែសង្វាក់ផ្គត់ផ្គង់អាហារដែលមានលក្ខណៈទំនើប។ នៃកសិដ្ឋានទាំងនេះ គិតជាចំនួនគ្រួសារសរុបដែលមានដីជាកម្មសិទ្ធិផ្ទាល់ខ្លួនគឺ ៤៨ភាគរយ នៅក្នុងឆ្នាំ២០១១។ នៅក្នុងទសវត្សរ៍ចុងក្រោយនេះ នៅក្នុងប្រទេសកម្ពុជា មាននិន្នាការដែលកសិដ្ឋានធំៗ (លើស៣ហិចតា)កាន់តែរីកធំទៅៗ ហើយកសិដ្ឋានតូចៗ (តិចជាង១ហិចតា)កាន់តែរួញតូចទៅៗ។[7] ទំហំមធ្យមរបស់កសិដ្ឋាន ខ្នាតតូច[8] បានថយចុះពី០,៩៩ហិចតាក្នុងឆ្នាំ២០០៨ មកនៅ០,៨៨ហិចតាក្នុងឆ្នាំ២០១២ ហើយក្នុងពេលជាមួយគ្នានោះ ទំហំ ជាមធ្យមរបស់កសិដ្ឋានខ្នាតមធ្យម (ចន្លោះពី១ទៅ៣ហិចតា) បានកើនឡើងពី១,៥៥ហិចតា ដល់២,៣៨ហិចតា ហើយកសិដ្ឋានធំៗ (លើសពី ៣ហិចតា) បានកើនឡើងពី ៣,៦១ហិចតា ដល់៧,០៣ហិចតា។ បើទោះបីជាផលិតភាពរបស់កសិដ្ឋានតូចៗមានការកើនឡើងខ្លះក្តី ក៏នៅមានកំរិតទាបដោយភាគច្រើននៃកសិដ្ឋានតូចនៅមិនទាន់បានទទួល សេវាផ្សព្វផ្សាយ កសិកម្ម និងសេវាសាធារណៈដទៃទៀត ក្នុងទ្រង់ទ្រាយធំឡើយ។ ការកើនឡើងនូវប្រាក់ចំណូលរបស់កសិករក្នុងក្រុមនេះ នៅក្នុងទសវត្សរ៍ចុងក្រោយនេះ ហាក់បីដូចជាកើតឡើងដោយសារតែតម្លៃផលិតកម្មខ្ពស់ជាងមុន និងការលក់ពលកម្មអោយ កសិដ្ឋានធំៗបានប្រាក់ឈ្នួលខ្ពស់ជាងមុន ជាជាងដោយសារការកើនឡើងនៃផលិតភាពដី និងគុណភាពពលកម្ម។

លើកលែងតែអង្ករចេញ ឧស្សាហកម្មកែច្នៃកសិផលបានបំពេញតួនាទីតិចតួច នៅក្នុងកំណើនវិស័យកសិកម្ម។ កសិផលស្ទើរតែទាំងអស់ត្រូវបាននាំចេញទៅប្រទេសជិតខាង ដោយពុំមានការកែច្នៃ។ នេះបង្ហាញពីចំណុចខ្សោយធ្ងន់ធ្ងរ នៅក្នុងខ្សែសង្វាក់តំលៃ ជាពិសេសនៅក្នុងប្រព័ន្ធគ្រប់គ្រងខ្សែសង្វាក់ផ្គត់ផ្គង់ក្រោយប្រមូលផល (ការប្រមូលកសិផល មិនទាន់កែច្នៃ ការរក្សាទុក ការផ្តល់ហិរញ្ញប្បទាន ភស្តុភារ ការដឹកជញ្ជូន និងព័ត៌មាន)។

អ្វីដែលមានប្រសិទ្ធភាពកន្លងមក នឹងមិនគ្រប់គ្រាន់ សម្រាប់អនាគតឡើយ

ជាមួយនឹងតម្លៃស្បៀងអាហារមានការថយចុះ ហើយផ្ទៃដីដាំដុះលែងកើនឡើង វិស័យកសិកម្មនៅកម្ពុជា កំពុង បាត់បង់ កត្តាជម្រុញកំណើនធំៗរបស់ខ្លួនចំនួនពីរ។ លើសពីនេះ កម្លាំងពលកម្មក្នុងវិស័យកសិកម្មកាន់តែខ្សត់ទៅៗ និងមាន តម្លៃកាន់តែខ្ពស់ ដែលនាំឱ្យចំណាយថ្លៃដើមផលិតកម្មកាន់តែកើនឡើង។ តម្លៃកសិផលជាសកល ត្រូវបានគេព្យាករថានឹង បន្តថយចុះនៅក្នុងទសវត្សរ៍ខាងមុខនេះ ហើយការលក់អង្ករធម្មតាដែលមានតម្លៃទាប នៅក្នុងទីផ្សារក្នុងប្រទេស និងអន្តរជាតិ នឹងទទួលបានចំណេញតិចជាងមុន។ ការពឹងអាស្រ័យលើតម្រូវការក្នុងស្រុកដែលកើនឡើង ដោយសារតែកំណើននៃ ផសស និងកំណើនតម្រូវការនៃការនាំចូល ដោយមិនមានការប្រើប្រាស់ធនធានឱ្យកាន់តែមានប្រសិទ្ធភាពទេនោះ នឹងមិនគ្រប់គ្រាន់ ដើម្បីរក្សាកំណើនខ្ពស់ដូចពេលកន្លងឡើយ។ ប្រទេសកម្ពុជាចាំបាច់ត្រូវតែស្វែងរក កម្លាំងចលករកំណើនផ្សេងទៀត ដើម្បី ជួយរក្សាកំណើនក្នុងវិស័យកសិកម្មឱ្យបានស្មើ ឬកៀកនឹង៥ភាគរយ និងធ្វើឱ្យកំណើននេះមាននិរន្តរភាពបន្ថែមទៀត។

ការថមថយនូវកំណើនក្នុងវិស័យកសិកម្មរបស់កម្ពុជាកាលពីពេលថ្មីៗនេះ អាចជាសញ្ញាបង្ហាញពីការថយចុះ ដែល អាចកើតឡើងក្នុងរយៈពេលវែង។ ខណៈពេលដែលតម្លៃស្បៀងអាហារមានការថយចុះជាបន្តបន្ទាប់ ហើយទីផ្សារអង្ករ សកលោក កាន់តែមានការប្រកួតប្រជែងជាមួយនឹងការចូលមកក្នុងទីផ្សារសារជាថ្មីរបស់ប្រទេសថៃ និងមីយ៉ាន់ម៉ា ផលិតកម្ម ស្រូវនៅក្នុងប្រទេសកម្ពុជានៅទ្រឹង។ ជាមួយគ្នានេះ តម្លៃបន្ថែមសរុបរបស់ដំណាំមានការថយចុះពី ៤,៩ភាគរយ នៅក្នុងឆ្នាំ ២០១២ មក០,៦ភាគរយ នៅក្នុងឆ្នាំ២០១៣។ កំណើននៃតម្លៃបន្ថែមរបស់វិស័យកសិកម្មបានថយមកនៅ ១,៦ភាគរយ នៅក្នុងឆ្នាំ ២០១៣ ក្រោយពេលដែលមានកំណើនជាមធ្យម ៥,៣ ភាគរយ ចន្លោះពីឆ្នាំ ២០០៤ ដល់ ២០១២។

ការវិលត្រលប់ទៅរកអត្រាកំណើនកសិកម្មកម្រិតខ្ពស់ មានសារៈសំខាន់យ៉ាងខ្លាំង។ វិស័យកសិកម្ម នៅតែរក្សា ចំណែកមួយដ៏ធំនៃ **ផសស** ពាណិជ្ជកម្ម និងកម្លាំងពលកម្ម ដែលមានន័យថា វិស័យនេះនៅតែមានសារៈសំខាន់ចំពោះ ការកាត់បន្ថយភាពក្រីក្រ និងភាពងាយរងគ្រោះ ក្នុងទសវត្សរ៍ខាងមុខនេះ។ ប្រសិនបើបម្រែបម្រួលក្នុងប្រទេសកម្ពុជា នៅតែបន្តមានទៀត ជាមួយនឹងកំណើនជាមធ្យមក្នុងវិស័យកសិកម្ម៥ភាគរយ ត្រឹមឆ្នាំ២០៣០ ប្រទេសកម្ពុជានឹងមាន វិស័យកសិកម្ម ដែលមានទំហំតូចជាងនេះ ប៉ុន្តែមានផលិតភាពខ្ពស់ជាងមុន។ ចំណែកនៃវិស័យកសិកម្ម នៅក្នុង **ផសស** និង កម្លាំងពលកម្មសរុប ត្រូវបានព្យាករថាថយចុះមកនៅត្រឹម ១៧ភាគរយ និង ៣១ភាគរយ នៅក្នុងឆ្នាំ ២០៣០ ពី ២៦ភាគរយ និង ៥១ភាគរយ នៅក្នុងឆ្នាំ២០១២ ខណៈពេលដែលផលិតភាពដីធ្លីនឹងមានការកើនឡើងពី ១៣០០ដុល្លារ/ហិចតា ដល់ ២៧០០ដុល្លារ/ហិចតា ហើយផលិតភាពពលកម្មនឹងមានការកើនឡើងពី ១២០ ដុល្លារ/នាក់ ដល់ ៣៧០០ដុល្លារ/នាក់ (តារាង ទី ១)។

ផ្ទុយទៅវិញ ការខាតបង់ដោយសារតែកំណើនកសិកម្មមានល្បឿនយឺត នឹងមានទំហំធំផង។ ប្រសិនបើ កំណើន ជាមធ្យមនៃវិស័យកសិកម្មមានត្រឹមតែ ៣ភាគរយ ចន្លោះពីឆ្នាំ២០១២ ដល់២០៣០ នោះតម្លៃបន្ថែម នៃវិស័យកសិកម្ម នឹងមានការថយចុះជាងមុន២៩ភាគរយ នៅឆ្នាំ២០៣០ បើធៀបជាមួយនឹងសេណារីយ៉ូ កំណើន៥ភាគរយ ដែលធ្វើឱ្យ ផសស ជារួមថយចុះត្រឹម១៨ភាគរយ ហើយទន្ទឹមគ្នា នៅតែរក្សាប្រជាជាជន ច្រើននាក់នៅក្នុងវិស័យកសិកម្ម ផលិតភាពពលកម្មក្នុងវិស័យកសិកម្មថយចុះ៣៤ភាគរយ និងធ្វើឱ្យការខិតមកជិតគ្នានៃចំណូលរវាងកសិករ និងអ្នកមិនប្រកបរបរកសិកម្ម កាន់តែមានភាពយឺតយ៉ាវ។ កំណើនក្នុងវិស័យកសិកម្មទាបជាងមុន នឹងនាំឱ្យការកាត់បន្ថយភាពក្រីក្រមានល្បឿនយឺតខ្លាំង។

តារាងទី ១ ៖ ផលប៉ះពាល់នៃកំណើនកសិកម្មទាបមកលើសូចនាករវិស័យកសិកម្មមួយចំនួន ប្រទេសកម្ពុជា

សូចនាករ	២០១២	២០៣០	
		៣% នៃកំណើន ផសស ក្នុងវិស័យកសិកម្ម	៥% នៃកំណើន ផសស ក្នុងវិស័យកសិកម្ម
សមាសភាគនៃកសិកម្មនៅក្នុង ផសស គិតជា %	២៦	១៥	១៧
សមាសភាគនៃកសិកម្មនៅក្នុងកម្លាំងពលកម្ម គិតជា %	៥១	៣៤	៣១
ផលិតភាពកម្លាំងពលកម្មក្នុងវិស័យកសិកម្ម គិតជា ដុល្លារ/នាក់	១២០០	២៤៥០	៣៧០០
ផលិតភាពដីកសិកម្ម គិតជា ដុល្លារ/ហិចតា	១៣០០	១៩០០	២៧០០
ផលធៀបនៃផលិតភាពកម្លាំងពលកម្មរវាង អ្នកធ្វើការងារ ក្នុង វិស័យកសិកម្ម ជាមួយនឹងអ្នកធ្វើការងារក្នុងវិស័យផ្សេងទៀត	២,១	២,១	១,៦

7 ការប្រែប្រួលរបាយដីកសិកម្មនេះ កើតឡើងដោយមិនពាក់ព័ន្ធជាមួយនឹងសម្បទានដីសេដ្ឋកិច្ចឡើយ។

8 ការអង្កេតលើកសិដ្ឋានត្រូវបានធ្វើឡើង នៅក្នុងឆ្នាំ ២០១៣ សម្រាប់របាយការណ៍នេះ។ សូមមើលឧបសម្ព័ន្ធទី ២ សម្រាប់ព័ត៌មានលំអិត។

ចក្ខុវិស័យរយៈពេលវែងសម្រាប់វិស័យកសិកម្មនៅកម្ពុជា ចាំបាច់ត្រូវក្តោបលើសមាសធាតុនៃ និរន្តរភាព ទិន្នផល ភាពប្រកួតប្រជែង និងកំណើនប្រាក់ចំណូល ដោយសំរាលពីការផ្តោតខ្លាំងពេកតែលើផលិតកម្ម។ ការគណនាប៉ាន់ស្មានតាម សេណារីយ៉ូផ្សេងៗ សម្រាប់ការអភិវឌ្ឍវិស័យកសិកម្មនាពេលអនាគត បង្ហាញថាការកើនឡើងនូវផលិតភាពកសិកម្ម នាពេល អនាគត នឹងមានផលជាវិជ្ជមានខ្លាំងមកលើចំណូលរបស់កសិករ ជាពិសេស ប្រសិនបើមានការផ្លាស់ប្តូរពីការដាំដុះតាមបែប ប្រពៃណី ទៅជាការប្រើប្រាស់បច្ចេកវិទ្យាទំនើប ដោយអមជាមួយនឹងការកើនឡើងនូវប្រព័ន្ធធារាសាស្ត្រ និងការប្រើប្រាស់ សំភារៈកសិកម្មថ្មីៗដែលមានប្រសិទ្ធភាពខ្ពស់។ កសិករដែលដាំស្រូវក្រអូប កែច្នៃដំឡូងមីជាចំណិតដំឡូងមីក្រៀម និងធ្វើ ការបន្ថែមតម្លៃផ្សេងទៀតលើកសិផល នឹងអាចទទួលបានចំណូលខ្ពស់ជាងមុន និងបង្ហាញច្បាស់ពីសារៈសំខាន់នៃ ការកែច្នៃ កសិផល។ ការកាត់បន្ថយចំណាយផលិតកម្ម តាមរយៈការប្រើប្រាស់ឱ្យបានប្រសើរជាងមុន នូវធនធានដែលមានស្រាប់ (តាមរយៈការបង្កើនទិន្នផល) និងការកាត់បន្ថយការធ្លាក់ចុះតម្លៃកសិផល តាមរយៈការកាត់បន្ថយតម្លៃដឹកជញ្ជូន គឺជាគន្លឹះ សម្រាប់រក្សាភាពប្រកួតប្រជែងនៃកសិផលនានា។ ការបន្តពង្រីកផ្ទៃដី ក៏ផ្តល់នូវចំណូលបន្ថែមផងដែរ ប៉ុន្តែភាពកំណត់នៃ ធនធានដី នឹងកាត់បន្ថយការពង្រីកដីក្នុងទ្រង់ទ្រាយធំនាពេលអនាគត។ បញ្ហាប្រឈមនេះ ធ្វើឱ្យការបង្កើនទិន្នផលកសិកម្ម ពាណិជ្ជូបនីយកម្ម និង ការធ្វើពិពិធកម្ម រឹតតែមានសារៈសំខាន់ខ្លាំងឡើង ក្នុងការធានាឱ្យមានកំណើនកសិកម្ម កាត់បន្ថយភាព ក្រីក្រ និងលើកកម្ពស់វិបុលភាពរួម នៅក្នុងប្រទេសកម្ពុជា នាពេលអនាគត។

អនុសាសន៍

ការបន្តកំណើនកសិកម្មយ៉ាងលឿន និងការផ្លាស់ប្តូរធនាសម្ព័ន្ធនៃវិស័យកសិកម្មបន្ថែមទៀត គឺអាចធ្វើទៅបាន សំរាប់ប្រទេសកម្ពុជា។ សំណុំគោលនយោបាយរួមគ្នាចំនួន៤ អាចជួយផ្តល់ការគាំទ្រដល់ការបន្តកំណើនកសិកម្មបែបនេះ នៅក្នុងរយៈពេល៥ឆ្នាំខាងមុខ (រយៈពេលខ្លី និងមធ្យម)។ ទី១ គឺត្រូវរក្សាបរិយាកាសគោលនយោបាយកសិកម្ម ដែលបង្កភាព ងាយស្រួលដល់វិស័យឯកជន ដោយផ្តោតការយកចិត្តទុកដាក់បន្ថែមលើការកាត់បន្ថយបន្ទុកផ្នែកនិតិកម្ម នៅក្នុងវិស័យ សំភារៈកសិកម្ម។ ទី២ គឺការពង្រឹងនិរន្តរភាពបរិស្ថាន សម្រាប់ផលិតកម្មកសិកម្ម។ ទី៣ គឺការបង្កើនគុណភាព កម្មវិធី ផ្សព្វផ្សាយកសិកម្មសាធារណៈ និងវិភាជន៍ថវិកាបន្ថែមដល់កម្មវិធីទាំងឡាយដែលមានប្រសិទ្ធភាពខ្ពស់ ទៅតាមលទ្ធភាព នៃ ថវិកាសរុបរបស់រដ្ឋាភិបាលកម្ពុជា។ ទី៤ គឺការជួយអភិវឌ្ឍវិស័យកសិពាណិជ្ជកម្ម និងឧស្សាហកម្មកែច្នៃកសិផល។

ការបង្កើនទុនវិនិយោគ និងកែលំអគោលនយោបាយ ចាំបាច់ត្រូវធ្វើជាបន្ទាន់ ប៉ុន្តែនឹងមិនបានឃើញលទ្ធផល ភ្លាមៗឡើយ។ សម្រាប់ការកែលំអមួយចំនួន ចាំបាច់ត្រូវមានការចំណាយពេល និងកិច្ចប្រឹងប្រែងបន្ថែមទៀត ដើម្បីឱ្យឃើញ ផលជាក់ស្តែងនៅនឹងមូលដ្ឋាន។ តារាងទី២ សង្ខេបពីអនុសាសន៍គោលនយោបាយសំខាន់ៗ ដែលចាំបាច់ត្រូវអនុវត្តភ្លាមៗ ដើម្បីបានទទួលលទ្ធផលក្នុងរយៈពេលខ្លីទៅមធ្យម ហើយដែលនឹងជួយទប់និន្នាការថយចុះ នៃកំណើនវិស័យកសិកម្ម បច្ចុប្បន្ននេះ ព្រមទាំងជួយ ប្រើប្រាស់សក្តានុពលនៃវិស័យកសិកម្មរបស់ប្រទេសកម្ពុជាឱ្យបានពេញលេញ។

តារាងទី២៖ សង្ខេបអនុសាសន៍សំខាន់ៗនៃរបាយការណ៍ ដោយផ្អែកទៅតាមពេលវេលា ដើម្បីសម្រេចលទ្ធផល

អនុសាសន៍គោលនយោបាយ	លទ្ធផលដែល សម្រេចបាន ក្នុងរយៈពេល ខ្លី	លទ្ធផលដែល សម្រេចបាន ក្នុងរយៈពេលពី មធ្យម ទៅវែង
រក្សានូវបរិយាកាសគោលនយោបាយកសិកម្ម ដែលបង្កភាពងាយស្រួលដល់វិស័យឯកជន		
បន្តគោលនយោបាយពាណិជ្ជកម្មបើកចំហរ និងគោលនយោបាយកសិកម្មដែលមិននាំឱ្យខូចទ្រង់ទ្រាយរបស់វិស័យ	X	
កាត់បន្ថយចំណាយលើបែបបទការនាំចូលជីកសិកម្ម	X	
បើកចំហរវិស័យគ្រាប់ពូជ សម្រាប់ការវិនិយោគពីវិស័យឯកជន តាមរយៈការធ្វើ បដិប្បញ្ញត្តិកម្ម និងការពង្រឹងស្ថាប័ន		X
ពង្រឹងនិរន្តរភាពបរិស្ថាន		
កែលំអការរៀបចំផែនការប្រើប្រាស់ដីធ្លី បង្កើនប្រសិទ្ធភាពការអនុវត្តច្បាប់ដីធ្លី និងបទដ្ឋាន គតិយុត្តិពាក់ព័ន្ធនានា		X
ពង្រឹងសិទ្ធិកាន់កាប់ដីធ្លី		X
លើកកម្ពស់ការគ្រប់គ្រងដីធ្លីប្រកបដោយនិរន្តរភាព	X	
លើកកម្ពស់ការប្រើប្រាស់ជីនិងថ្នាំគីមីកសិកម្មប្រកបដោយសុវត្ថិភាព	X	
កែលំអកម្មវិធីវិនិយោគលើ "ទ្រព្យសាធារណៈ" នៃវិស័យកសិកម្ម		
បង្កើនថវិកាសម្រាប់ទ្រព្យសាធារណៈកសិកម្មសំខាន់ៗ ទៅតាមលទ្ធភាពថវិកា របស់រដ្ឋាភិបាល ជាពិសេស លើប្រព័ន្ធធារាសាស្ត្រ ការសិក្សាស្រាវជ្រាវ ការផ្សព្វផ្សាយ ការគ្រប់គ្រងជីជាតិដី ការត្រួតពិនិត្យគុណភាពសំភារៈកសិកម្ម សុវត្ថិភាពចំណីអាហារ ការបណ្តុះបណ្តាលវិជ្ជាជីវៈ និងផ្លូវជនបទ។	X	
សម្រាប់វិស័យធារាសាស្ត្រ ផ្តោតការយកចិត្តទុកដាក់ឱ្យបានកាន់តែច្រើនជាងមុន លើការកែលំអ និងការស្តារប្រព័ន្ធដែលមានស្រាប់ និងការគ្រប់គ្រងហេដ្ឋារចនាសម្ព័ន្ធធារាសាស្ត្រ ដោយមាន ការចូលរួម។	X	
បង្កើនគុណភាពនៃកម្មវិធីកសិកម្មសាធារណៈ		X
សម្របសម្រួលការធ្វើសមាហរណកម្មកសិដ្ឋានតូចៗ ចូលទៅក្នុងខ្សែសង្វាក់តំលៃនៃស្បៀង		X
ជួយអភិវឌ្ឍកសិពាណិជ្ជកម្ម និងឧស្សាហកម្មកែច្នៃកសិផល		
បង្កើនលទ្ធភាពទទួលបានអគ្គិសនីប្រើប្រាស់ និងកាត់បន្ថយចំណាយលើការប្រើប្រាស់អគ្គិសនី		X
វិនិយោគលើហេដ្ឋារចនាសម្ព័ន្ធសាធារណៈ ដែលពាក់ព័ន្ធជាមួយនឹងសុវត្ថិភាពចំណីអាហារ		X
ធ្វើឱ្យកាន់តែប្រសើរនូវសេវាដឹកជញ្ជូននៃជំនួញស្រូវអង្ករ រួមទាំងកាត់បន្ថយចំណាយ		X
លុបចោលរបាំងនានា ដើម្បីដាក់ឱ្យប្រើប្រាស់នូវប្រព័ន្ធទទួលយកទំនិញក្នុងឃ្លាំងជាវត្ថុបញ្ចាំ (warehouse receipts)		X

1. INTRODUCTION

1. **Cambodian agriculture is in the midst of a rapid transformation**. Its annual production growth during 2002-2012 averaged 9.6 percent, far exceeding agricultural production growth in Asia and around the world. This high agricultural growth has greatly contributed to poverty reduction, exports, agribusiness development, and farm commercialization in the last decade. While the Royal Government of Cambodia (RGC)'s agricultural policy focus has mainly been on rice production and exports, it is increasingly recognized that the current rice-based traditional agriculture would need to transform into modern, diversified agriculture to generate the returns necessary to keep farming an attractive source of income and a contributor to economic development. Cambodian agriculture is still a long way from being an economic activity indistinguishable from other sectors, at least in terms of productivity of labor and capital or in the location of poverty, which would be the final outcome of a structural transformation. The agricultural growth has recently slowed down to about 1 percent, from 5.3 percent during 2004-2012. Still, the last decade has seen significant positive changes.

2. **How can Cambodia build on this positive development?** While there is a wealth of literature on smallholder farming systems in Cambodia and sectoral information from the national accounts, the existing analytical work lacks a systematic analysis of changes in farming systems. Combined with the lack of information on related changes in farm versus nonfarm incomes, this has limited Cambodia's ability to have an informed agricultural policymaking process and has hampered efforts to compare and contrast the impacts and effectiveness of alternative policies and programs for long-term agricultural development.

3. **Further, little empirical knowledge has been generated about past and future sources of agricultural growth and the government's role in facilitating growth**. Why did agriculture grow so rapidly and will this growth last? What made that growth pro-poor and how can Cambodia keep its strong pro-poor impact? How would farming systems need to look to ensure continuation of the 5 percent growth in agricultural value added? What forces will shape an enabling environment for agriculture in the future and how different will they be from those that drove development in the past? And how can the government facilitate future growth, helping farmers overcome challenges and capitalize on opportunities?

4. **This report addresses this knowledge gap**. It was requested by the Supreme National Economic Council (SNEC) and the Ministry of Agriculture Forestry and Fisheries (MAFF). The report uses primary data on farming systems collected in 2013, and compares them to comparable data from 2005. It also uses evidence from interviews with villages and experts, discussions with government staff, and analytical work carried out by the World Bank Group and other development partners in the recent decade, including the analytical work resulting from the five-year collaboration between the World Bank and Australian Aid under the Cambodia Food Crisis Capacity Support Partnership Trust Fund (*Annex 1*).

5. **The report covers the main crops with the largest changes in the past decade and focuses on smallholders, including small farms (up to 1 hectare), medium farms (from 1 to 3 hectares), and large farms (above 3 hectares)**. It does not cover the livestock and fisheries sector, nor does it cover in detail economic land concessions.

6. **The remaining report is organized as follows**. Chapter 2 presents key facts about Cambodia's recent agricultural development using data from national accounts and various

reports. Chapter 3 provides evidence from the field that explains the changes observed in the national accounts. Chapter 4 illustrates developments in farming systems, farm budgets, and farm incomes compared to nonfarm incomes. Chapter 5 presents a farm competitiveness analysis. Chapter 6 discusses the sources of past growth and their limitations and presents an analysis of (likely) future sources of agricultural growth. Chapter 7 presents a long-term vision for the sector, while Chapter 8 simulates policies and the changes in farm incomes needed to realize this vision. Chapter 9 discusses the policy agenda, with implementation details based on national and global experiences. Chapter 10 concludes with a summary of the report and policy recommendations. Annexes present the methodology of the 2013 farm survey, detailed farm budgets by crop, projections of selected indicators, and results of the policy simulations.

2. A DECADE OF AGRICULTURAL TRANSFORMATION IN CAMBODIA

7. **The story of agriculture in Cambodia over the past decade is one of rapid growth and of the profound transformation of a rural society**. The sector has been growing in absolute terms but its relative share in the economy is on the decline, giving room to manufacturing and services. Agricultural exports have increased. Agricultural labor has been migrating to other sectors and outside of the country and is becoming increasingly scarce. Farmers use more inputs and more modern machinery to substitute for scarcer labor and respond to market incentives.

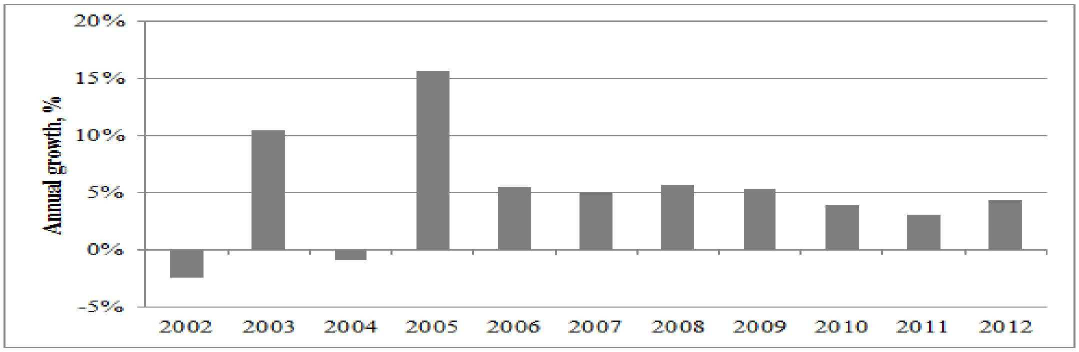
8. **Agricultural policy has in general been conducive for non-distortive growth, i.e., there are no output and input subsidies and no significant market distortions**. However, in addition to the high costs of doing business in the country overall, regulatory weaknesses exist, especially in the seed industry, which deters private investments. The weak land tenure security and poor land administration and governance deter private investments further and lead to unsustainable land use and farmland expansion. Yet, in spite of these issues, the rural poverty declined in the past decade and agricultural growth played the key role in that poverty reduction.

9. **The structural transformation is still occurring, and Cambodian agriculture is in the midst of rapidly transitioning from a traditional subsistence to a modern commercial sector**. This Chapter summarizes the key facts of this transformation using information from MAFF, the Cambodian National Institute of Statistics (NIS), the World Development Indicators (WDI), World Bank reports, the Corporate Statistical Database of the UN's Food and Agriculture Organization (FAOSTAT), and other sources.

2.1. Agricultural Growth

10. **Cambodian agriculture's growth over the past decade is impressive**. Real agricultural GDP grew by 5.1 percent annually between 2002 and 2012 (Figure 1). The average annual growth was 5.3 percent during 2004-2012, the period mostly analyzed in this report. Agricultural value added per worker grew from $700 in 2004 to $1,210 in 2012 (Table 13). The ratio of value added per worker in nonagriculture to agriculture fell from 3.2 in 2004 to 2.1 in 2012, implying a narrowing income gap between agriculture and the rest of the economy.

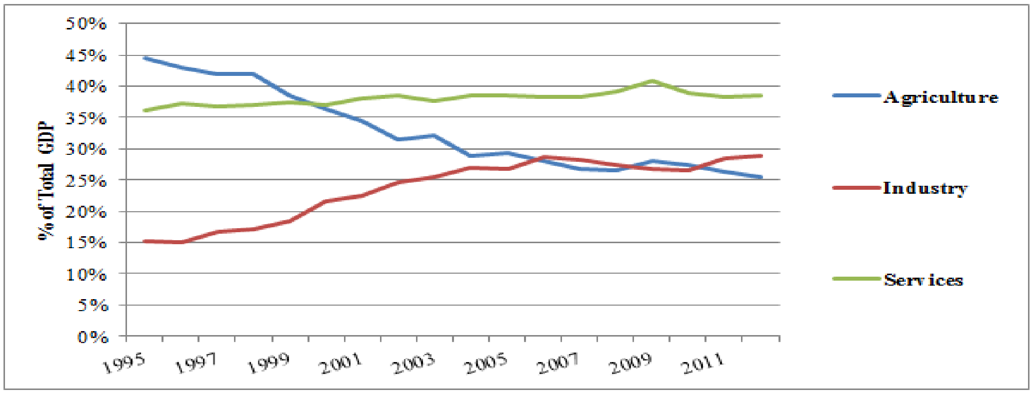
Figure 1: Agricultural GDP growth (constant prices), Cambodia, 2002-2012



Source: World Bank 2014c.

11. **Taking a longer-term perspective, the composition of Cambodia's economy has changed dramatically, reducing agriculture's share and increasing industry's role**. A structural transformation has been taking place. Despite the high growth in agricultural value added, agriculture's share in GDP steadily decreased from 45 percent in 1995 to 26 percent in 2012, with most of the gains captured by the garment industry (Figure 2). The share of agriculture in GDP, however, has stayed unchanged since 2008. In 2011, the share of industry (28 percent) exceeded the share of agriculture (26 percent) for the first time in the modern history of Cambodia.

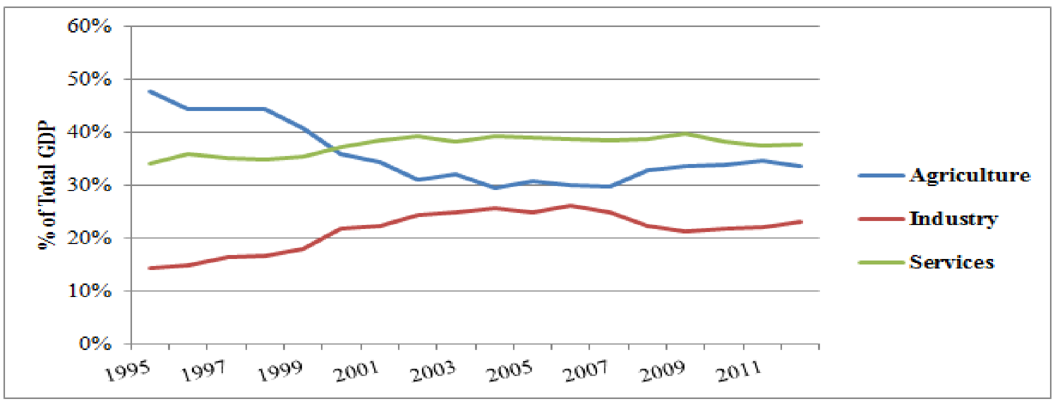
Figure 2: GDP composition by sector (constant prices), Cambodia, 1995-2012



Source: World Bank 2014c.

12. **The analysis in current prices shows a slightly different picture**. Calculated in current prices, the share of agriculture in total GDP decreased less, from 48 percent in 1995 to only 34 percent in 2012 (Figure 3). Between 2002 and 2012, the share of agriculture in GDP actually grew, from 31 percent to 34 percent. The difference between the shares of agriculture in GDP measured in current (34 percent) and constant (26 percent) prices implies that agricultural prices grew faster than nonagricultural prices, triggering the high rate of growth of agricultural production.

Figure 3: GDP composition by sector (current prices), Cambodia, 1995-2012



Source: World Bank 2014c.

13. **This high growth in agricultural production is shown in Table 3.** During 2002-2012, the rate of gross agricultural production growth in Cambodia was 10 percent per year, one of the highest in the world. Gross per capita agricultural production growth was 8 percent, also among the highest.

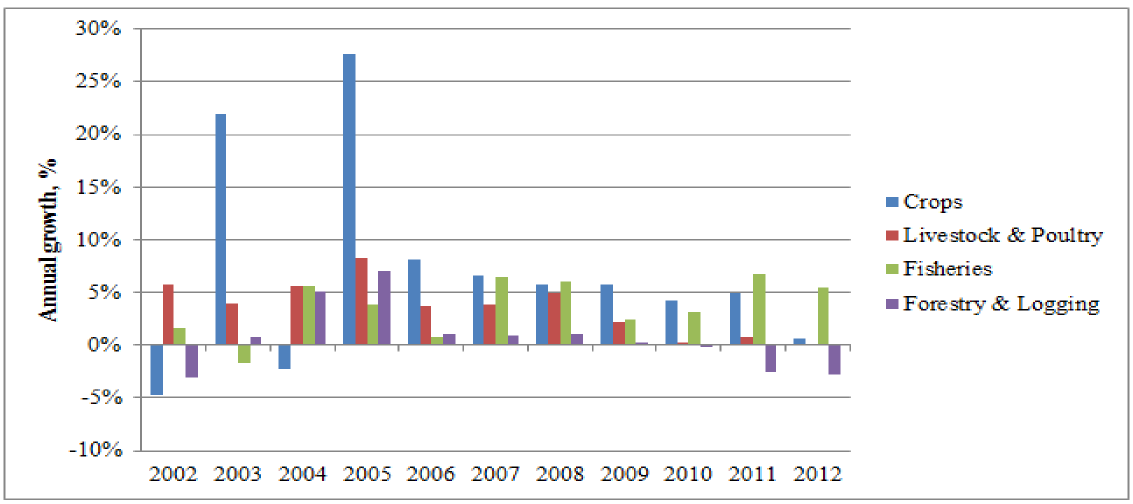
Table 3: Gross agricultural production, annual growth, selected countries, 2002-2012

Country/Region	Average Annual Growth (%)
Bangladesh	2.0
Thailand	2.6
China	3.5
Vietnam	4.1
India	4.3
Indonesia	4.4
Lao PDR	5.3
Cambodia	**9.6**
Asia	3.4
European Union	-0.3
World	2.5

Source: FAOSTAT 2014.

14. **Cambodia's agricultural growth was driven by crops, which are dominated by paddy rice**. The average growth of crops' value added was 7.8 percent (Figure 4). Livestock's value added increased by 3.6 percent per year. The average growth in the fisheries and forestry subsectors was 3.7 percent and 0.7 percent, respectively.

Figure 4: Growth of agricultural subsectors (constant prices), Cambodia, 2002-2012

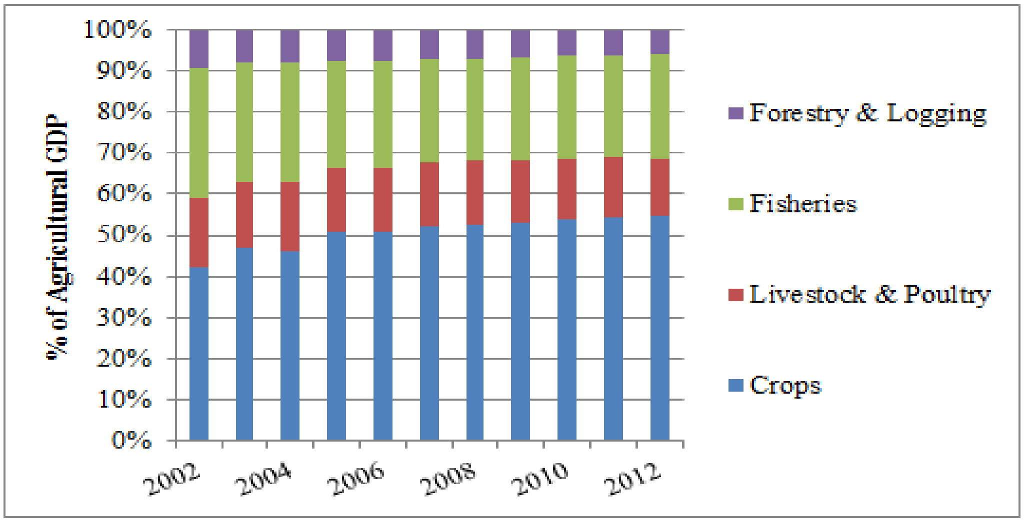


Source: NIS 2014.

15. **Crops remain the major agricultural subsector**. Due to their high rate of growth, the share of crops in agricultural value added increased from 43 percent in 2002 to 54 percent in 2012 (Figure 5). Cereals, especially paddy rice, accounted for the majority of the crop production value,

but the production of non-cereals grew faster than paddy in the last decade (Table 4). The importance of livestock production in agricultural value added declined from 17 percent in 2002 to 14 percent in 2012. Because of its dominance in agricultural value added, this report focuses on crop production.

Figure 5: Share of subsectors in agricultural GDP, Cambodia, 2002-2012



Source: NIS 2014.

16. **Over the past 10 years, rice production more than doubled through a combination of land expansion and yield increase**. In 2002, paddy production was 3.8 million tons (Table 4). In 2012, it reached 9.3 million tons. The annual growth rate was 9.3 percent. The wet season accounts for 75 percent of total paddy production. As just 8 percent of Cambodia's arable land is estimated to be irrigated during the dry season (the lowest rate in Asia; see Table 5), the country's agriculture is still largely dependent on rainfall and quite vulnerable to climatic events.[9]

[9] The share of dry season output, however, has been steadily growing, driven by irrigation investments. In 2008, the planting area for the dry season crop accounted for 13 percent of total planting rice area. In 2013, it increased to 17 percent.

Table 4: Production, area, yields, and growth of major crops, Cambodia, 2002-2012

	2002			2012			Annual Average Growth Rate (%)		
Crop	**Production (ton)**	**Cultivated Area (ha)**	**Yield (ton/ha)**	**Production (ton)**	**Cultivated Area (ha)**	**Yield (ton/ha)**	**Production (ton)**	**Cultivated Area (ha)**	**Yield (ton/ha)**
Rice	3,822,509	1,994,645	1.916	9,290,940	2,980,297	3.117	9.3%	4.1%	5.0%
Maize	148,897	80,470	1.850	950,909	215,442	4.414	20.4%	10.3%	9.1%
Cassava	122,014	19,563	6.237	7,613,697	337,800	22.539	51.2%	33.0%	13.7%
Vegetables	163,175	34,433	4.739	411,435	54,155	7.597	9.7%	4.6%	4.8%
Soybean	38,661	33,438	1.156	120,165	70,972	1.693	12.0%	7.8%	3.9%
Sugarcane	173,105	9,581	18.068	1,220,255	36,722	33.230	21.6%	14.4%	6.3%

Source: MAFF 2014b.

Table 5: Irrigated areas, selected countries

Country	Actually Irrigated Areas (ha) 2011-2012	Arable Land (ha) 2011	Share of Irrigated Areas in Arable Land (%)
Cambodia	317,225	4,000,000	7.9
China	54,218,976	111,598,500	48.6
Indonesia*	6,722,299	23,500,000	28.6
Malaysia*	340,717	1,800,000	18.9
Myanmar*	2,083,000	10,786,000	19.3
Philippines*	1,879,084	5,400,000	34.8
South Korea	880,400	1,492,000	59.0
Thailand	5,059,914	15,760,000	32.1
Vietnam*	4,585,500	6,500,000	70.5

Note: *Equipped full control irrigation areas as data on actually irrigated areas are not available.
Source: World Bank 2014g for data on arable land and World Bank 2014c for data on irrigated areas.

17. **Growth in the crops subsector was not limited to rice**. Production of several other important crops increased even more than that of rice (Table 4). The most spectacular cases are cassava, sugarcane, and maize, which have all grown more than 20 percent per year. This growth is the result of both area and yield increases. Current yields are still low but their annual growth over the last 10 years was steady, varying between 3.9 percent for soybeans to 13.7 percent for cassava.

18. **The rubber subsector has also witnessed remarkable growth**. Planted areas increased by 16 percent annually (Table 6) and when these areas go into production, rubber output will likely triple over the next 10 years.

Table 6: Production, area, yield, and export of rubber, Cambodia, 2002-2011

Year	Total Planted Area (ha)	Immature (ha)	Mature (ha)	Production (tons)	Yield (kg/ha)	Export (tons)
2002	55,582	18,809	36,773	32,384	880	36,774
2003	53,527	19,831	33,696	32,382	960	32,764
2004	54,209	22,619	31,590	33,770	1,060	33,558
2005	60,406	30,004	30,402	29,464	960	29,950
2006	69,994	37,604	32,390	32,077	990	31,184
2007	82,059	51,568	30,491	32,975	1,080	33,121
2008	108,510	74,197	34,313	37,050	1,080	36,000
2009	129,920	95,785	34,135	37,380	1,095	36,500
2010	181,433	143,027	38,406	42,466	1,100	45,000
2011	213,104	167,942	45,162	51,339	1,137	44,969
Annual growth (%)	16%	28%	2%	5%	3%	2%

Source: MAFF 2014b.

19. **Most crop products are exported**. Rice, cassava, and other cereals are the major agricultural export items. In 2011, formal cereal exports were estimated at 180,300 tons, a five-fold increase compared to 2006 (Table 7). The largest increase in exports was for rice. But the informality of cross-border trade does not allow estimation of the true extent of agricultural exports. In 2013, for example, the formal export of rice was 378,850 tons (Table 9). At the same time, informal cross-border trade of rice is estimated to have been 1,536,000 tons, or five times larger. Most exports of cassava, maize, and vegetables also take place via cross-border trade. Official statistics do not properly capture this information, including imports of vegetables in apparently large volumes.

Table 7: Evolution of formal trade of select commodities, Cambodia, 1996-2011

	Quantity ('000 tons)				Annual Growth Rate (%)		
Commodity	1996	2001	2006	2011	1996-2001	2001-2006	2006-2011
Cereals exports	10.4	7.1	38.0	180.3	-7.4	39.9	36.5
Rice exports	5.6	7.0	5.2	174.0	4.6	-5.8	101.8
Coarse grain exports	4.8	0.0	32.6	6.3	-100.0	n/a	-28.0
Cereals imports	41.8	59.8	65.2	44.4	7.4	1.7	-7.4

Source: NIS 2014 based on FAOSTAT 2014.

2.2. Agribusiness Development

20. **Despite this impressive growth of the primary agriculture, Cambodia's agribusiness remains weak**. Agroindustry is basic and most commodities (paddy, cassava, maize, cashews, cattle, and soy bean) are exported in raw form. A modern agroindustry is emerging for rice, but this is a very recent phenomenon, stimulated by the RGC's "Promotion of Paddy Production and Rice Export" policy in 2010 and favorable world rice price trends.

21. **Agribusiness covers several industries**. It includes food, beverages, tobacco, and rubber plants. Transport and trade sectors also generate some income from moving/trading agricultural products, estimated at 50 percent and 30 percent of the sectoral value added respectively.[10] When added, the agribusiness accounted for 10 percent of GDP and 31 percent of agricultural GDP in 2002 (Table 8). In 2012, these shares were 9 percent and 27 percent.[11]

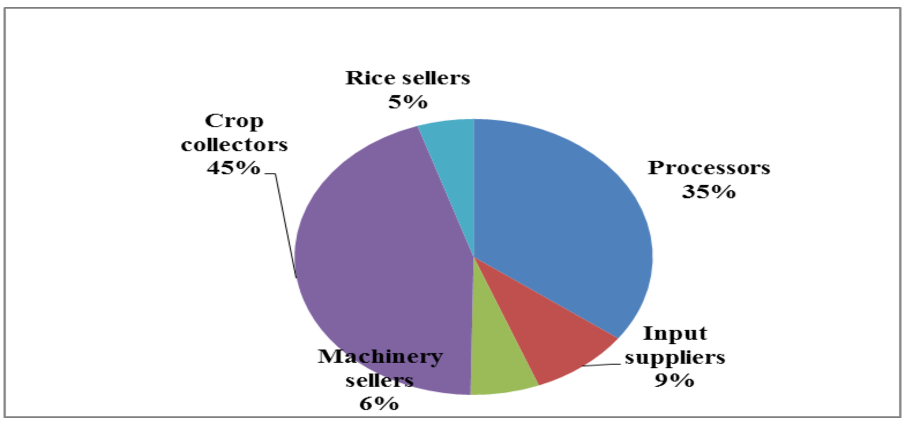
Table 8: Agribusiness industry in Cambodia, 2002-2012

	2002	2012
Agribusiness GDP (billion Riels, current prices)	5,224	19,000
Share of agribusiness in agricultural GDP (%)	30.8	27.4
Share of agribusiness in total GDP (%)	9.6	9.2

Source: World Bank 2014c.

22. **The agribusiness sector consists mostly of small traders and informal agro-enterprises** (Figure 6). Even though a modern sector is emerging (e.g., processors, input suppliers, and machinery suppliers), less than half of the agroenterprises have some degree of formality (e.g., registration and accounting systems).

Figure 6: Contribution to turnover of different types of agribusinesses, Cambodia, 2011



Source: World Bank and AusAid 2013.

23. **The recent expansion of the rice milling industry has been exemplary**. In 2010, the RGC issued a policy on "Promotion of Paddy Production and Rice Export," aiming to export one million ton of milled rice by 2015. Major features of that policy are a strong commitment to open trade,[12] reduction of costs of doing business, and protection of foreign investors' rights. As a result, formal exports of milled rice increased from 12,600 tons in 2009 to over 205,000 tons in 2012, and 378,850 tons by the end of 2013 (Table 9). The "One Window Service" (or one-stop service)

[10] There are no official estimates of these shares for Cambodia. These estimates are based on the experiences of the team producing this report.

[11] These data are presented in nominal prices, which are not very different from the results in constant prices.

[12] Before 2010, only 9 companies had export licenses. The 2010 Rice Policy liberalized exports, and in 2014, 86 companies were already exporting milled rice from Cambodia. Most export is still paddy, across the border to Thailand and Vietnam, but the export of milled rice picked up significantly after the removal of the export licensing restriction.

was established in November 2011 to reduce bureaucratic obstacles and export costs to process export documents (such as sanitary and phytosanitary certificates, customs documents, and CAMCONTROL quantity and quality certificates). This reduced the export approval period from 10 days in 2011 to 4-5 days in 2013 (World Bank 2014b). In 2013, 378,850 tons of milled rice were exported to over 50 countries, 91 percent of which went to the EU and Asian countries. About half of formal milled rice exports consist of high-value fragrant rice. The Federation of Cambodian Rice Exporters was created and the industry is becoming increasingly organized.

Table 9: Rice commodity balance (‘000 tons), Cambodia, 2008-2013

	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Total rice production, in paddy	7,175	7,586	8,250	8,779	9,291	9,389
Total rice production, in milled equivalent	4,305	4,552	4,950	5,267	5,575	5,633
Domestic utilization[13]	2,862	2,937	3,039	3,126	3,212	3,256
Total rice surplus	1,443	1,614	1,911	2,142	2,368	2,378
Total formal export of milled rice	1.5	12.61	105.26	201.89	205.71	378.85
Estimated informal paddy export in milled equivalent	100	200	350	1,472	1,600	1,536

Source: World Bank 2014b .

24. **New actors in the milling industry have emerged since 2010**. In 2009, only two rice milling companies existed with a capacity of 20 tons per hour (tph). By mid-2012, milling capacity had increased to 322 tph (paddy), and to over 700 tph in 2013 (World Bank 2014b). The polishing capacity of mills also jumped, from 72 tph in 2009 to 520 tph in 2013. Additionally, three rice polishing factories have a combined capacity of 44 tph. This increase in polishing capacity enabled low-quality milled rice from thousands of small mills[14] to be upgraded for export. Most new mills are equipped with modern milling and drying facilities, polishing equipment with color sorters, and large warehouses for storing paddy at harvest time (Slayton and Muniroth 2009; 2012).

25. **But even this success story has its limits**. Most rice is still exported in the form of paddy to Vietnam and Thailand. In 2013, informal export volumes were estimated at 1.7 million tons of paddy to Vietnam and 250,000 tons of paddy and 450,000 of milled rice to Thailand, compared to only 379,000 tons of formal rice exports (Table 9). Most mills continue to have low capacity utilization as a result of underdeveloped supply chain management, poor access to skilled labor, food safety-related services, proper business management and working capital, and infrastructure and logistics weaknesses. They operate on one shift per day, for a limited number of days per year. Consequently, Cambodian mills are less profitable than Vietnamese and Thai mills, where two to three shifts per day and almost a full year of operating days are the norm.

2.3. Agricultural Growth and Poverty Reduction

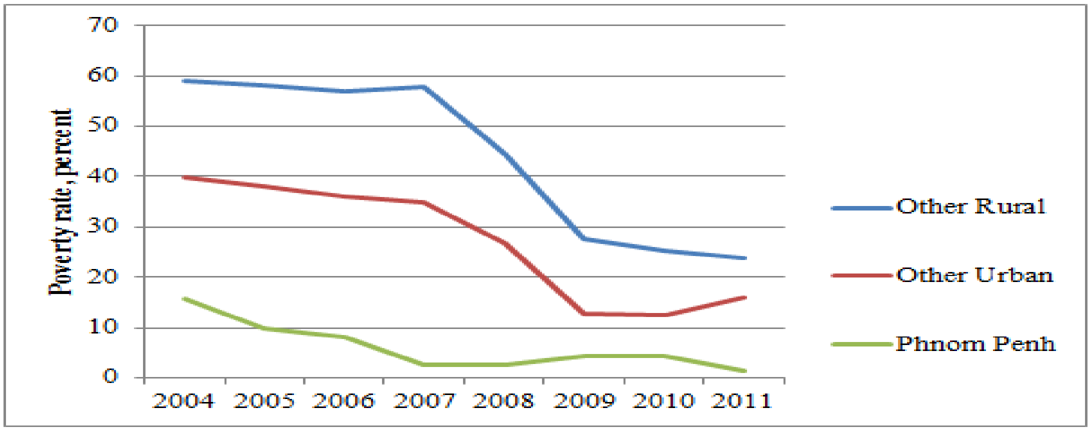
26. **The impressive agricultural growth in the last decade has contributed to significant poverty reduction in Cambodia**.[15] From 2007 to 2011, the overall poverty headcount fell from

[13] Domestic food consumption and other utilization on estimated basis.
[14] According to the Ministry of Industry, there were 28,474 rice mills in Cambodia in 2011, of which 16,326 run with less than $3,000 capital.

[15] This section is based on World Bank (2013b).

50.1 percent to 20.5 percent. During this period, most of the poverty reduction came from improving rural households' conditions. From all poverty reduction, 3.6 percent was in Phnom Penh, 8.1 percent was in other urban areas, and the remaining 88.3 percent was in rural Cambodia (Figure 7). Furthermore, most of the poverty reduction (80.0 percent) occurred between 2007 and 2009.

Figure 7: Poverty rate by region, Cambodia, 2004-2011



Source: World Bank 2013b.

27. **The growth elasticity of poverty in Cambodia was among the largest in Asia**. Measured in the 2005 purchasing parity power (PPP) for the poverty at $1.25 a day, the growth elasticity of poverty was 5.2, implying that for every 1 percent increase in GDP per capita, poverty fell by 5.2 percent. Among selected countries presented in Table 10, for which most recent poverty data is available, only Thailand had the larger impact of economic growth on poverty.

Table 10: Growth elasticity of poverty, selected countries in Asia

Country	Poverty rate (PPP 2005 $1.25/day)	Growth elasticity of poverty (PPP 2005 $1.25/day)	Annualized per capita GDP growth rate
Lao PDR	28.8	0.5	5.9
Philippines	17.8	0.8	4.2
Indonesia	9.7	2.4	4.5
Vietnam	2.9	3.5	4.6
Cambodia	**7.2**	**5.2**	**3.3**
Thailand	0.1	7.5	1.4

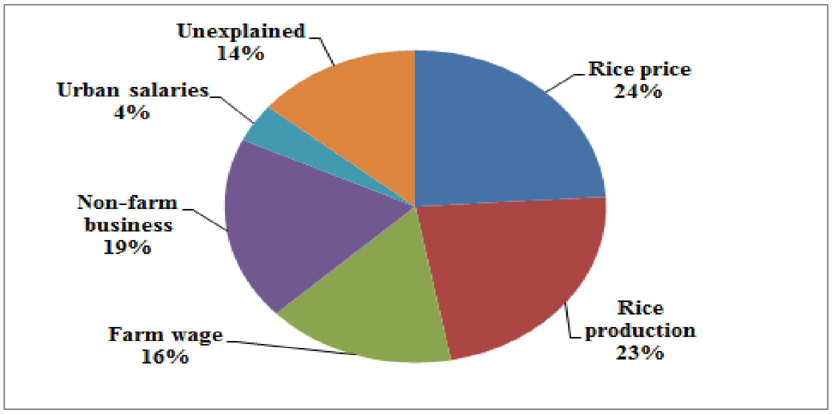
Source: World Bank 2013g.

28. **The first factor explaining the reduction in rural poverty is the price of rice**. There are more net sellers of rice than net buyers in Cambodia (Ivanich and Martin 2014). The global rice price spike in 2008 was permitted to fully pass through to local prices in Cambodia. As a result, many households improved their income, most of them smallholders. Better prices had two direct effects on household income. First, the value per unit of production increased. And second, total production increased due to more planted area and increased use of inputs (Figure 8).

29. **The second factor explaining the reduction in poverty is higher agricultural wages**. Because of data limitations, it was not possible to differentiate the sources of wages from different

agricultural activities, but there is no doubt that an important share of the wage increases was related to rice production. For example, rice represents about 80 percent of the total planted area in Cambodia (Table 4), and about 80 percent of rural households reported growing rice. Moreover, rice experienced the highest price increase (39 percent) from 2007 to 2009 compared to all other locally produced food products: beef – 25 percent, chicken –24 percent, fish and seafood – 24 percent, fresh eggs – 14 percent, fresh fruits – 27 percent, and vegetables – 22 percent. From 2004 to 2009, agricultural income from wage labor increased 49 percent.

Figure 8: Drivers of poverty reduction in Cambodia, 2004-2011



Source: World Bank 2013b.

30. **Overall, the direct impact of higher rice prices and the increase in rice production were responsible for almost half of the reduction in poverty**. Agricultural wages – also closely related to rice – contributed to 16 percent of total reduction in poverty. At the same time, improved income from nonfarm business was responsible for one-fifth of all poverty reduction. Increases in salaried employment in urban areas accounted for 4 percent of the decline in poverty. Finally, the remaining 14 percent of the reduction was unexplained and occurred mainly between 2009 and 2011 (Figure 8).

31. **Despite the significant reduction in poverty headcounts, the vulnerability or the risk of sliding back into poverty remains high in Cambodia**. The recent poverty reduction was augmented substantially by the high concentration of people just below the poverty line in 2004 and people just above the poverty line in 2011. Most people who escaped poverty did so by a small margin. It is estimated that a loss of only 1,200 Riels ($0.30) per day would cause Cambodia's poverty rate to double to 40 percent. Continuation of agricultural and nonagricultural growth and their higher resilience to shocks are needed to reduce that vulnerability in the future.

32. **Nutritional security has also lagged behind the progress in poverty reduction**. The prevalence of stunting of children under five in 2005 was 44 percent, according to the World Bank. In 2010, it declined to 40 percent and in 2014 to 33 percent, according to the results of the Cambodian Demographic and Health Survey 2014, but it remains high in regional comparison.[16] Stunting remained above 40 percent in four provinces: Kampong Chhnang, Kompong Speu, Preah Vihear, and Stung Treng. Stunting is caused not only by lack of food intake but also poor sanitation

[16] In Vietnam, the stunting of children under five was 23 percent in 2011. In Thailand, it was 16 percent in 2012.

and health care. Yet, irrespective of the multidimensional nature of malnutrition, agriculture can do more to address it.

2.4. Agricultural Transformation

33. **Structural transformation is a defining characteristic of the development process, both the cause and effect of economic growth**. According to Timmer and Akkus (2008), four quite relentless and interrelated processes define structural transformation: (i) a declining share of agriculture in GDP and employment; (ii) migration from rural to urban areas and a rapid process of urbanization; (iii) the rise of a modern industrial and service economy; and (iv) a demographic transition from high rates of birth and death (common in underserved rural areas) to low rates of birth and death (associated with better health standards in urban areas). The final outcome of structural transformation, already visible on the horizon in rich countries, is an economy and society where agriculture as an economic activity has no distinguishing characteristics from other sectors, at least in terms of the productivity of labor and capital or the location of poverty.

34. **Structural transformation clearly took place in Cambodia over the last decade**. The share of agriculture in GDP measured in constant prices declined from 28.8 percent in 2004 to 25.6 percent in 2012, while the share of industry in total GDP increased from 26.9 percent to 29.0 percent (Table 11).[17] The agricultural labor force decreased by 6 percentage points.[18] Both birth and death rates declined, and the urbanization process started. Urbanization has been very slow, however; in 2012, 78 percent of Cambodians still lived in rural areas (**Error! Reference source ot found.**).

Table 11: Indicators of structural transformation, Cambodia, 2004 and 2012

Indicators	2004	2012
Agricultural GDP as % of total GDP	28.8	25.6
Ag. employment as % of total labor force	57.4	51.0
Industrial GDP as % of total GDP	26.9	29.0
Rural population as % of total population	81.0	78.0
Birth rate, crude (per 1,000 people)	26.6	25.9
Death rate, crude (per 1,000 people)	7.8	6.0

Source: NIS 2014 for GDP, employment, and populationand WDI 2014 for birth and death rates.

[17] Reliable labor statistics starts only from 2004, collected through the Social Economic Surveys by NIS. This is why the indicators of transformation also start with the year 2004 not 2002 as in the earlier analysis.
[18] According to MAFF, the share of agricultural labor in the total labor force increased from 60 percent in 2004 to 71 percent in 2012. This increase contradicts the evidence-based analysis carried out in this report and the results of the NIS Socioeconomic Surveys, which are considered the most accurate and up-to-date in Cambodia. The report uses the NIS data on labor statistics. The ADB also used the NIS labor statistics in its reports prepared in 2014.

Box 1: Rural Population in Cambodia

In 2012, Cambodia's rural population was 11.1 million people, or 78 percent of the total population. At the same time, the agricultural labor force accounted for 51 percent of the total labor force. How does the "low" 51 percent agricultural labor share reconcile with the "high" 78 percent of the rural population? What do rural people do if not farming? The answer is that there is a difference between population and labor force, as the latter does not include children, seniors, and the unemployed. According to the socioeconomic surveys of the NIS, in 2012 about 62 percent of the rural population was of working age; i.e., the remaining 38 percent were children younger than 15 years and seniors older than 65 years. The labor participation rate of the rural population was 86 percent, with 91 percent for men and 80 percent for women. And the share of agricultural labor in the total rural labor force was 66 percent. Out of 2,393 rural households in 2012, 1,877 were recorded as farming households in the 2013 Agricultural Census of Cambodia. This means that not all rural households are agricultural and not all members of households participate in the labor market.

35. **Where does Cambodia stand in the process of structural transformation in a global comparison?** Countries can be divided into groups by their dependence on the role of agriculture. One such grouping was done by the agribusiness team of the World Bank Group (World Bank 2014a), using the framework developed by the *2008 World Development Report*. Countries were divided into five groups, from agri-based to most developed (Table 12). In 1980, 41 countries were considered agri-based economies and only 18 countries were considered developed. By 2012, the number of agri-based economies declined to 28 while the number of developed economies increased to 50.

Table 12: Country groups based on the role of agriculture in the economy

Indicators	Agri-Based	Pre-Transitioning	Transitioning	Urbanizing	Developed
Ag. value added as % of total GDP	40%	11%	12%	9%	2%
Ag. employment as % of total labor force	72%	59%	40%	19%	4%
Ag. value added per capita, in PPP $	387	521	514	682	519
Non-ag. value added per capita, in PPP $	588	4,369	3,836	6,577	27,467
Total GDP per capita, in PPP $	975	4,879	4,350	7,256	27,986
Ag. value added per ag. worker, in PPP $	1,236	1,727	2,868	8,770	30,588
Ag. capital stock per ag. worker, in PPP $	715	658	1,408	5,436	37,711
% people below the $2 international poverty line	36%	32%	14%	6%	0%

Source: World Bank 2014a.

36. **In 2012, Cambodia was still an agri-based economy, but it came close to being a pre-transitioning country**. Considering the share of agricultural labor in its total labor force and its poverty rates, Cambodia is rapidly approaching the status of a pre-transitioning country (Table 13). The agricultural value added in purchasing power parity (PPP) actually exceeds the average for this group of countries. But for other indicators, such as the share of agriculture in GDP and nonfarm incomes, Cambodia is still very much an agri-based economy.

37. **The process of structural transformation in Cambodia will continue**. Agriculture is likely to play a larger role in Cambodian economic growth and job creation than it does in neighboring countries at the same stage of development given the agriculture sector's strong comparative advantages. Agricultural growth can provide excellent opportunities for income generation and poverty reduction for many years to come.

38. **Yet future transformation may take different pathways depending on which policy decisions are made now**. Cambodia may follow the positive example of *Thailand*.[19] In this neighboring country, agricultural growth during 1960s and 1970s was driven largely through expansion of the land frontier and cheap labor, similar to the current Cambodian situation. Agricultural land per worker increased steadily, which was subsequently converted into productivity improvements through farm mechanization and public spending on infrastructure and human capital. In turn, all of these contributed to significant farm productivity increases, critical for the production of exportable surpluses. Farming systems during that period were largely dominated by traditional smallholders and the export was raw materials of lower-value product segments. But the end of this period also saw the emergence of sophisticated private sector value-added processing.

Table 13: Selected economic indicators, Cambodia, 2004 and 2012

Indicators	2004	2012
Ag. value added as % of total GDP	28.8	25.6
Ag. employment as % of total labor force	57.4	51.0
Ag. value added per capita, current $	120	318
Ag. value added per capita, in PPP $	447	955
Non-ag. value added per capita, in PPP $	1,074	1,896
Total GDP per capita, in PPP $	1,516	2,839
Ag. value added per ag. worker, in PPP $	1,672	3,600
% people below the $2 international poverty line	60.5	32.6

Source: NIS 2014, WDI 2014, and East Asia Poverty Portal, the World Bank.

39. **Thai agriculture lost its competitiveness in the late 1980s due to underinvestment in agricultural public goods and worsening agricultural terms of trade (TOT)**.[20] Exhaustion of the land frontier and an increasing farm population led to a period of declining agricultural land per worker, while the competitiveness of agricultural exports was affected by an overvalued national currency caused by the influx of short-term capital and maintenance of a fixed exchange rate. By the beginning of the early 1990s, Thai farmers were experiencing rising labor costs and shortages of family labor due to increasing rural-urban migration of young agricultural workers to

[19] The analysis of the structural transformation of the Thai agriculture is based on Nippon (2013).
[20] Agricultural TOT is defined as the ratio of prices of agricultural commodities to the prices of farm inputs.

the urban-based manufacturing and service sectors. Average annual agriculture growth rates hovered just over 4 percent throughout the 1980s, dropping to 3.1 percent during 1990-1996.

40. **The government and private sector responded to that economic decline**. In the 1990s, they invested in productive infrastructure and a system of food quality standards, which triggered the next wave of structural transformation. These investments, coupled with more open agricultural trade policy, made an important contribution to the shift towards mechanized farming and higher-value food processing and exports during this period. Labor use per hectare in rice cultivation declined from 58 person-days in 1987 to just 8-10 person-days according to Isvilanonda *et al*. (2000) and Bordey *et al*. (2014). Thai food exports shifted from commodities to higher-value, processed or final products. Between 1992 and 2011, the share of processed food and agricultural products in total agricultural exports increased from 20 percent to 26 percent. For example, most fishery products are now exported in the form of processed products, while that of rice and cereal are exported as small, packaged, uncooked rice and cereal-based finished products, rather than in 100 kg bags. Among rice products, there have been increasing exports of fragrant rice (Hom Mali) and parboiled rice, as opposed to lower-value white rice. The share of processed cassava exports (i.e., starch and modified starch) jumped from 20 percent to 60 percent in the same period. This implies that Thailand is able to obtain more value added from agricultural and food exports as its composition has shifted to more high-value products, supporting further transformation of its agriculture sector.[21]

41. **Yet there are also examples of less successful agricultural transformation in Asia**. In *the Philippines*, for example, the structure of agricultural production and farm labor use have hardly changed over many decades, with traditional low-value crops continuing to dominate. Rice accounted for 16 percent of agricultural value added in 2005, slightly more than in 1980-1990. Its share in total agricultural production has not changed in recent years. The importance of bananas, mango, pineapple, and other tropical crops, in which the Philippines has strong comparative advantage and which are major agricultural export items, has hardly changed over three decades (World Bank 2007). Rice production continues to be labor intensive, with the same labor use in Central Luzon in 2011/12 as was seen in 1966/67, especially for wet season rice (Table 14). The limited dynamism and innovation in the sector hamper agricultural transformation.

Table 14: Labor use for rice production in Central Luzon, Philippines (man-days/ha), 1966/67-2011/12

	1966/67	1970/71	1974/75	1986/87	1990/91	1994/95	2003/04	2007/08	2011/12
Wet season	69	68	85	71	74	71	61	66	71
Dry season	70	76	98	67	59	68	52	53	57

Source: Central Luzon Loop Survey, 19960-2012, IRRI.

42. **Many reasons explain such divergent performance between Thai and Philippine agriculture, but the main ones related to land, farm protection, and the quality of public expenditures**. Farmland tenure security is strong in Thailand, while the Philippines' farmland market is paralyzed by very slow implementation of its land redistribution program (the

[21] In the 2010s, however, Thai agricultural policy has become less conducive to structural change. The controversial rice pledge scheme has led to a large budget drain, neglected spending on core public goods, and significant economic distortions on the rice market. This policy has heavily slowed down the successful agricultural transformation. To avoid this trap, Cambodia should not follow this example.

Comprehensive Agrarian Reform Program). Delays and legal uncertainties over program implementation have led to disinvestment in the sector, especially in capital-intensive tropical crops and mechanization, thereby promoting farmers' investments into less profitable, annual crops such as rice. The Philippines also carries out highly protectionist farm policy, in contrast to Thailand, where farm protection is a recent phenomenon. In the Philippines, the agricultural sector has been subject to high import protection and domestic monopolies for decades. Prices of rice, maize, sugar, and poultry are among the highest in the world. This protection keeps many farmers inefficient, allowing them to maintain their incomes at the expense of consumers. Poor quality of agricultural public expenditure and their bias towards the provision of subsidies and other private goods instead of public goods have further hampered agricultural transformation in the Philippines (World Bank 2007).

43. **This brief dive into international experience is an important reminder for Cambodia**. Future agricultural transformation depends on policy decisions made today. For Cambodia to shape its policy agenda and move to the next level of agricultural transformation, a thorough analysis is required of the past development of the agricultures sector, the drivers of past growth, and the potential drivers of future growth, complemented by lessons from global successes and failures. This analytical work contributes to this analysis.

3. CHANGES IN AGRICULTURE: EVIDENCE FROM THE FIELD

3.1. Introduction

44. **The agricultural growth of the last decade represented in the national accounts (as presented in Chapter 2) is also evident in the field**. Significant changes have occurred in the structure of Cambodia's farming systems, as revealed through a combination of primary data collection, key informant interviews, and focus group discussions (FGDs). In 2013, 36 FGDs were conducted in 24 villages and interviews held with 179 farmers in 6 provinces and 12 districts, 12 commune councils, and dozens of representatives from MAFF and the Ministry of Land at the district and regional levels.[22]

45. **To ensure the robustness of the results, information from different sources was triangulated**. In other words, data from FGDs and individual farm surveys, as well as information collected from farm budgets, were used together to assess the status of agricultural production in Cambodia and to elicit the perspectives of sector stakeholders. This approach allowed better verification and cross-checking of data for farm enterprises and drivers of change. The details of the methodology for primary data collection and interviews are provided in Annex 2 and described briefly below.

46. **Rice, cassava, maize, and vegetables best characterize the changes in Cambodia's farming systems since the mid-2000s**. In addition to significant changes in production growth over the past 10 years, each product had specific defining characteristics: (i) rice is the most important crop in terms of GDP contribution, employment, food security, and exports; (ii) maize is characterized by its rapid adoption of improved seeds and integration with the feed industry; (iii) cassava growth is exceptional but its development is subject to intense discussion related to sustainability and biodiversity conservation; and (iv) vegetables are related to nutrition and food safety, and are a good candidate for import substitution.

47. **Qualitative methods were used to collect data for the 2013 survey,[23] including key informant interviews and FGDs, complemented by quantitative data collection on farm budgets**. Data were collected at the national, provincial, district, commune, village, and individual farm level. Structured survey tools were used to gather data from individual farmers for the financial analysis of farm enterprises. A brief discussion of the 2013 survey follows.

48. **Provinces, districts, and communes for the 2013 survey were selected based on their contribution to the production of the four commodities**. Those visited in the 2005 survey were included in the sample if they fit the purpose of the current research questions. The selection sequence was: (i) selection of provinces; (ii) selection of two districts within each province; (iii) selection of one commune within each district; and (iv) selection of one village within each commune. The six sampled provinces accounted for 46 percent of the national production of rice in 2013,[24] 83 percent of maize production, 57 percent of cassava production, and 60 percent of vegetable production.

49. **At the national, provincial, district, and commune level, key informant interviews were conducted with experts in the field of agriculture, rural development, and land**

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[22] The survey for the World Bank was designed and implemented by Agrifood Consulting International.
[23] The survey covered the 2012 wet season and the 2013 dry season, or the 2012/13 marketing season.
[24] Broken down by 44 percent of wet season rice production and 53 percent of dry season rice production.

management, using: (i) purposive sampling based on information from initial meetings with MEF, SNEC, and MAFF and an initial identification of respondents; and (ii) snowball sampling, which consists of interviewing key informants identified by the respondents themselves. Information was elicited from key informants on: (i) changes in the past 10 years in the agriculture sector, their driving forces, key constraints to improved productivity, and stakeholders' perspectives for the next five years; and (ii) prices, farmers' use of inputs including land, and agricultural production.

50. **At the village level, one FGD was conducted for each selected crop**. The FGD questionnaire elicited: (i) the same information collected from key informants but at the village and farm level, and the impact of changes on farm activities; and (ii) more detailed questions on prices, yields, and use of inputs for agricultural production. At the farm level, data were collected from individual farmers on: farm budgets for the selected crops; qualitative information on changes observed by farmers in the past 10 years on their farms; their perspectives for the next five years; and farm and farmers' characteristics.

3.2. Crop Production

51. **Cambodia's agricultural landscape diversified over the past 10 years**. The cultivated crop area under paddy increased from 2.14 million ha in 2002 and 2.97 million in 2011 (Table 15). But the cultivated area under other crops, especially cassava, increased even more (recall Table 4), resulting in the relative decline of the area under paddy in total cultivated area, from 86 percent in 2002 to 74 percent in 2011 (Table 15).[25] Thus, increasingly more farmers are growing non-rice crops compared to the situation 10 years ago.

Table 15: Diversification in cultivated area, Cambodia, 2002-2011

Indicators	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Cultivated crop area ('000 ha)	2,473	2,718	2,823	2,939	3,111	3,199	3,321	3,519	3,730	3,990
Cultivated area under paddy ('000 ha)	2,137	2,314	2,374	2,444	2,541	2,586	2,616	2,719	2,796	2,969
Share of paddy in total cultivated area (%)	86	85	84	83	82	81	79	77	75	74

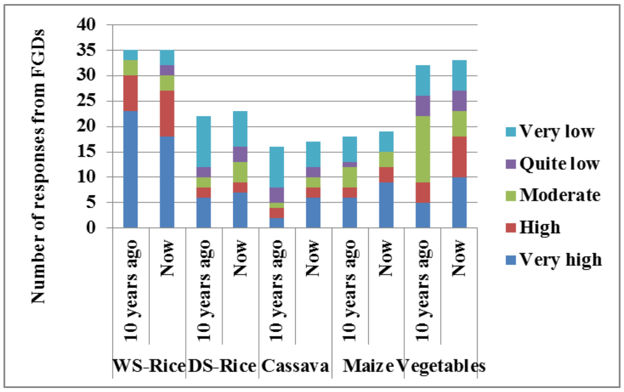
Source: MAFF 2014b.

52. **More generally, there is strong evidence that Cambodian agriculture is both specializing and diversifying**. As Figure 5 shows, agricultural GDP is increasingly dominated by crops. At the same time, within crops there is diversification away from paddy towards other crops. The FGDs reported that the number of wet season rice producers had reduced in 5 villages among the 36 visited (Figure 9.1). Non-paddy crops grew faster than paddy. A shift toward vegetables and upland crops such as maize and cassava was reported by several villages. In one case, a vegetable crop grown 10 years ago was abandoned by farmers.

[25] Note that FAOSTAT reports a larger cultivated area in 2002 and a much lower rate of land expansion. Total cultivated area in 2002 was 3,700,000 ha and it grew to 4,000,000 ha in 2011, according to FAOSTAT.

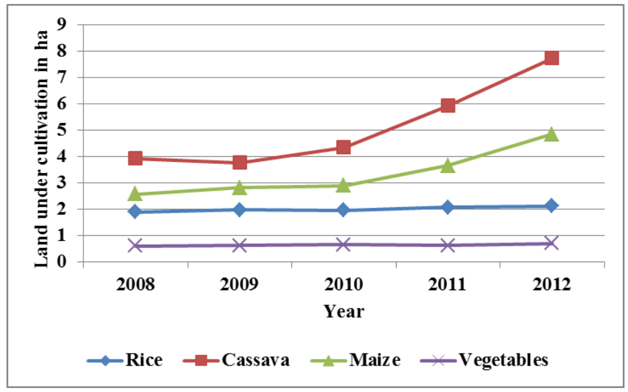
Figure 9: Crop production and cultivated land areas, Cambodia

1. Likelihood of changing crops produced in each village



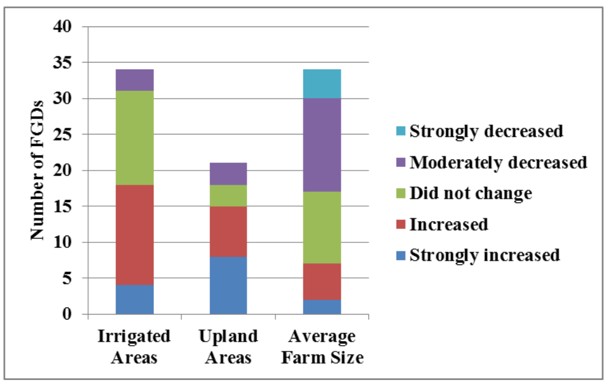
Source: FGDs.

2. Change in the average cultivated area, 2008-2012

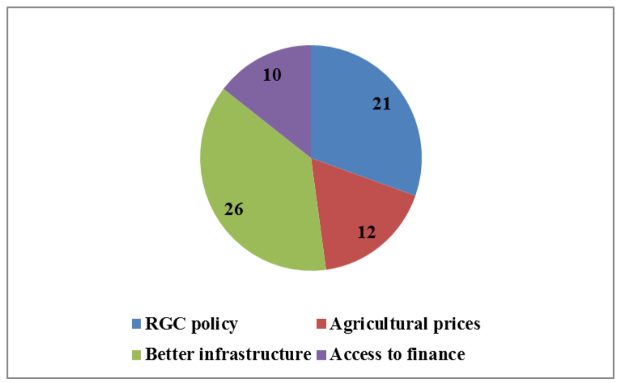


Source: Individual farmers' surveys.

3. Change in the area of cultivated land and average farm size



4. Reasons for the change in cultivated land area



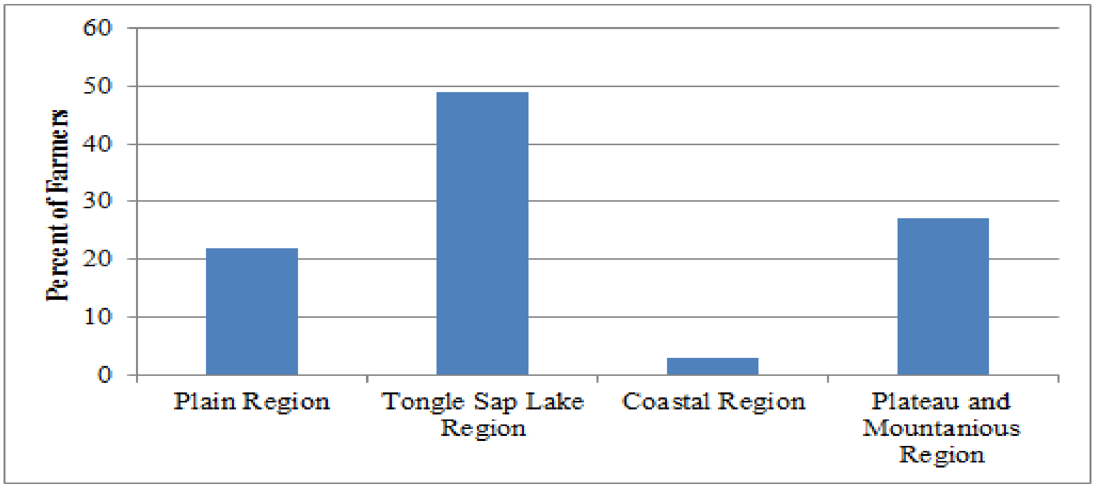
Source: FGDs.

53. **Farmers diversify towards different crops because of higher profitability, existence of a stable market, cultural reasons, and ripple effects**. Indeed, farmers' reasons for diversifying depend on the type of crop. For example, two out of three farmers chose to grow vegetable and cassava and, to a lesser extent, maize because they were profitable. This finding is supported by the results of the farm budget analysis: farmers had gross margins of up to $505/ha for cassava, $303/ha for maize, and $1,393/ha for vegetable production compared to $295/ha for dry season rice and $245/ha for wet season rice (Table 26). According to the FGD results, more than 80 percent of farmers grew rice for cultural reasons: they were used to doing it and their parents grew rice. Ripple effects were also identified as a reason to diversify to other crops or to adopt new technologies such as improved varieties. Analysis of the data from the FGD shows that regardless of farm size and level of technology use, the reasons to diversify remained similar.

54. **Farmers are increasingly moving from the production of nonaromatic to aromatic rice**. The 2013 Agricultural Census estimates that one out of ten farmers in Cambodia plants his/her land with aromatic paddy rice. Yet several years ago this share was much smaller. Geographically, aromatic paddy is mostly produced in the Tonle Sap, Plain, and Plateau regions

(Figure 10). Meanwhile, traders and MAFF officials estimate that about 30 percent of the wet and dry season crops are of fragrant rice.

Figure 10: Regional distribution of aromatic paddy production (% of farmers), 2013



Source: NIS 2014.

55. **An important source of growth in agricultural production, irrespective of crop, is land expansion**.[26] According to MAFF, land expansion contributed to 42 percent of the increase in rice production from 2003 to 2012 (Figure 11). The contribution of land expansion for vegetables, maize, and cassava was 37 percent, 76 percent, and 84 percent, respectively. Cultivated maize areas grew two-fold, from 93,000 ha to 215,000 ha, and production increased three-fold, from 314,000 tons to 950,000 tons. The changes were even more spectacular for cassava: its cultivated areas multiplied by 13 times, from 25,000 ha to more than 337,000 ha, corresponding to a 23-fold increase in production, from 330,000 tons to more than 7.65 million tons.

56. **This large agricultural land expansion shown in the national statistics is confirmed by the 2013 farm survey**. It indicates that cultivated areas especially increased for upland crops (cassava and maize) (Figure 9.2). This result, combined with the change in the proportion of farmers growing non-rice crops, led to a boost in upland production.

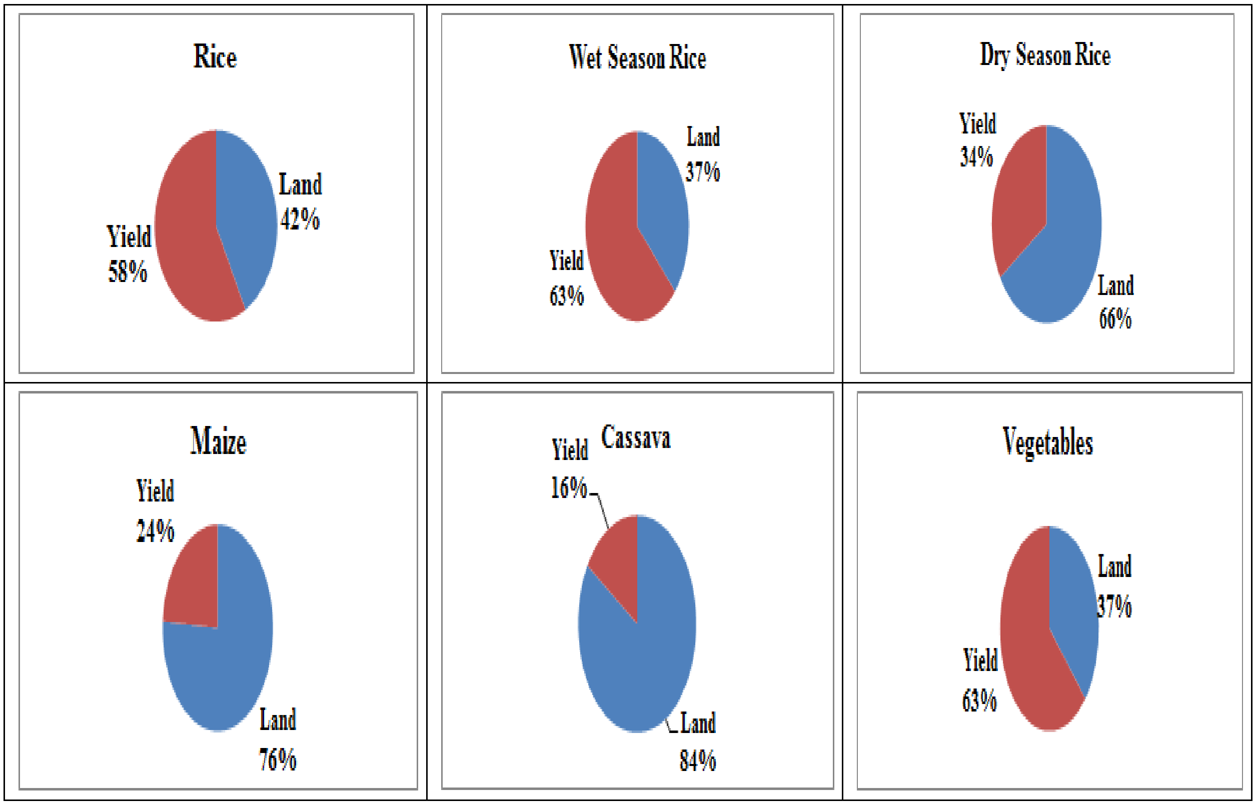
57. **There are also indications that the distribution of farm size is becoming more unequal**. Figure 9.3 indicates that about half of the FGDs experienced an increase in land area in the past 10 years, regardless of the type of land (irrigated and upland). Respondents reported an increase in average farm size, mostly for medium-size and large farms. On the other hand, half of the respondents reported a reduction or at least stagnation in farm size, especially for small farms.

58. **Individual farmer interviews indicated an increase in average farm size over the past five years** (Table 16). In many cases, farmers expanded their cultivated upland crops. Areas under maize and cassava increased about two-fold. FGD participants identified RGC policies in expanding infrastructure such as feeder roads and social land concessions as the main contributing factor to upland expansion (Figure 9.4). Improving access to low-population density regions increased the availability of land for agricultural production. Expansion of rice and vegetable

[26] Even in the short run, total agricultural area (arable and permanent crop) increased from 3.81 million ha in 2010 to 4.50 million ha in 2013, according to MAFF.

cultivated areas as shown in Table 16 was relatively modest, reportedly due to the constraints in availability of good land for vegetable production, technical complexity and labor requirements for vegetable production, and limited irrigation expansion.

Figure 11: Contribution of land and yield to average agricultural production growth, 2003-2012



Source: MAFF 2014b.

59. **Higher agricultural prices and better access to credit provided strong incentives for farmers to expand their cultivated land areas**. Between 2005 and 2013, the farm-gate price of maize increased by 64 percent, from $140/ton to $230/ton; and even more staggeringly, fresh cassava prices skyrocketed 200 percent, from $20/ton to $59/ton between the two years (Table 90).[27] Similar increases were observed for rice, whose prices went up by 90 percent, from $124/ton to $237/ton. These higher prices acted as incentives for farmers to increase their cultivated land. RGC's policies to spread microfinance institutions and improve access to credit also contributed to the expansion of cultivated land areas.

60. **Crop yields increased significantly in the past 10 years as well** (Figure 11). Among the four selected crops, maize had the highest change (58 percent), from 2.8 tons/ha to 4.4 tons/ha; cassava yield increased by 44 percent, from 15.1 tons/ha to 21.7 tons/ha, according to the Production Statistics of MAFF. The same positive changes were observed for wet and dry season rice, from 1.9 tons/ha to 2.9 tons/ha for wet season rice and 3.2 tons/ha to 4.4 tons/ha for dry season rice. In the 2010-2013 FAOSTAT data on yields, Cambodia (with Indonesia) had the highest

[27] According to 2005 survey and 2013 FGDs.

regional yield for cassava, reaching 22 tons/ha (Table 17). On the contrary, it had the lowest average rice paddy yield at 3.0 tons/ha, 80 percent lower than yields in Vietnam and lower than in Thailand (Box 2). Maize yields were comparable to the regional average. Most of FGDs and interviewed experts concurred with the statement that crop yields have increased in the past 10 years.

Table 16: Change in farm size, Cambodia, 2008-2012

	Average Size of Individual Farms (ha)				
By Province	**2008**	**2009**	**2010**	**2011**	**2012**
Kampong Cham	1.28	1.47	2.18	2.61	3.38
Kandal	0.78	0.86	0.98	0.95	0.96
Takeo	0.63	0.67	0.82	0.83	0.85
Kampot	0.68	0.63	0.64	0.63	0.64
Battambang	3.00	3.37	3.65	4.38	4.84
Bantey Meanchey	5.17	4.80	4.17	5.69	7.92
By Crop					
Paddy/ Rice	1.89	1.96	1.95	2.06	2.11
Cassava	3.92	3.75	4.33	5.92	7.72
Maize	2.57	2.80	2.88	3.65	4.84
Vegetables	0.60	0.61	0.65	0.62	0.70
By Farm Size					
Small	0.99	0.73	0.84	0.87	0.88
Medium	1.55	1.83	1.77	2.10	2.38
Large	3.61	3.78	4.14	5.29	7.03
By Technology					
Modern	2.97	2.85	2.81	3.63	4.65
Traditional	1.02	1.21	1.48	1.61	1.85
Total/ Overall	**1.94**	**1.99**	**2.11**	**2.57**	**3.18**

Source: Individual farmers' survey.

Table 17: Average crop yields in selected countries (tons/ha), 2010-2013

Country	Cassava	Maize	Rice Paddy	Population Density*
Cambodia	***22.0***	***4.1***	***3.0***	***256***
Indonesia	21.1	4.7	5.0	444
Philippines	10.2	2.8	3.8	782
Thailand	20.5	4.3	3.0	316
Vietnam	17.7	4.3	5.5	809

Note: *Population density is defined as number of people per km^2 of agricultural land in 2010-2011.
Source: FAOSTAT 2014 data for yields and WDI 2014 data for population density.

61. **While Cambodia lags behind in rice yield, its average yields for other crops are high in a regional comparison**. This is a very positive outcome of the last decade of agricultural transformation given Cambodia's relatively low population density (see the last column in Table 17). Countries with high population density tend to have higher yields due to constraints on land expansion. Cambodian farmers, however, have managed to achieve yields comparable to those of much more populated countries.

Box 2: Rice Yields in Cambodia

How large is the rice "yield gap" in Cambodia? Its average yield looks similar to that in Thailand, so the yield gap may seem small. Yet national averages can be deceiving. A large proportion of Thailand's rice production is of high-value jasmine and glutinous varieties, which inherently have lower yields than conventional varieties. In the Northeast of Thailand (where nearly all jasmine rice is grown, along with glutinous varieties), the average yield of the main crop is 2.3 tons/ha. The more suitable comparator with Cambodia is the wet season crop in Thailand's Central region, where conventional varieties dominate. Average yield there was 3.8 tons/ha over the 2011-2013 period. This would imply a yield gap of about 30 percent.

But what about productivity on Cambodia's best paddy fields? Does that match the situation among peers and competitors? The answer seems to be "no." Even in the best managed irrigation schemes in Cambodia, yield may reach 4 tons/ha, rarely more than that. For comparison, in the better growing areas of Thailand Central Region, farmers get 5.7 tons/ha in dry season (Bordey *et al*., 2014). In Vietnam's Mekong Delta, average yield at a provincial level is between 6-7 tons/ha and some smallholder farmers obtain yields well above this. These high-yielding provinces account for most of Thailand's and Vietnam's rice exports. This situation implies a very large yield gap, even at the top end of Cambodia's production.

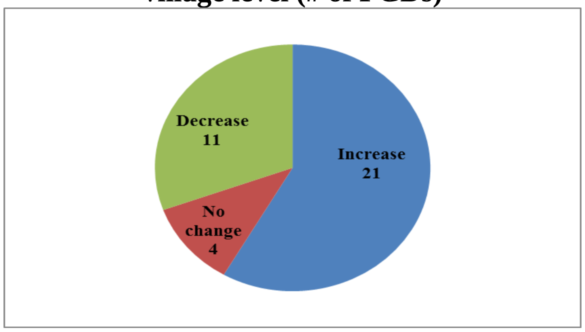
62. **The majority of farmers interviewed in 2013 believed that there is scope for further improvement in crop yields** More than half of the interviewed farmers believed that an increase in yield is likely, especially for rice and vegetables, and somewhat less likely for cassava and maize (Figure 12.1 and Figure 12.2). Their expectations about the change in cultivated land areas in the next five years, however, were more conservative. More than half of interviewed farmers expected no change in the area of cultivated land for vegetables and maize (Figure 12.3). About 10 percent predicted a decrease, and one out of three anticipated an increase. Cassava showed a peculiar pattern: almost equal numbers of farmers expected an increase, no change, or a decrease in cultivated area. The response was determined by location – respondents in the Tonle Sap and Mekong regions were not positive about the possibility of increasing cultivated land. In other regions, the option of land expansion is still open, especially for upland crops. Interviews with different stakeholders revealed that many people were aware of the encroachment of cassava crop cultivation into forest land; this is a relatively easy way to increase agricultural land but is receiving increasing attention from policy makers since it puts more stress on already fragile ecosystems. For rice, the overall expectation was "no change," although more than 20 percent of respondents expected a decrease in cultivated area.

63. **Most farmers, particularly small ones, were concerned about the impact of limited land expansion on their agricultural production**. More than half of the interviewed individual farmers thought that limited land expansion would have a major negative impact on their production, and as expected, small farms worried most, with two-thirds of them identifying the difficulty of expanding agricultural landholding as a major concern (Figure 12.4). Most of these

were rice and vegetable growers. The issue was assessed as not critical by cassava and maize farmers.

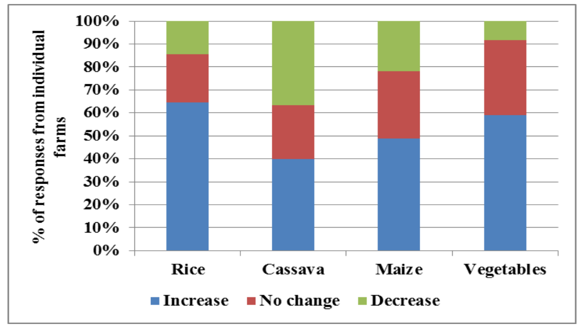
Figure 12: Projections for land expansion and yield changes, Cambodia, 2013

1. Perspectives on changes in crop yield at the village level (# of FGDs)



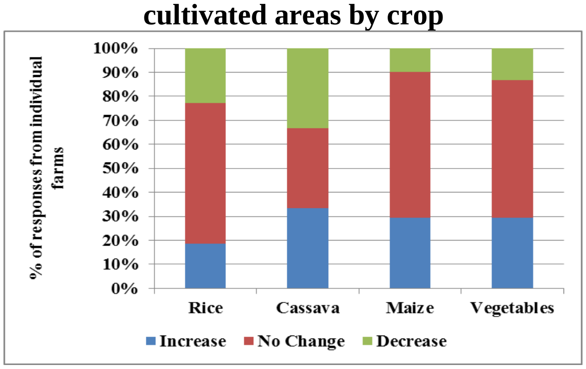
Source: FGDs.

2. Perspectives on changes in yield by crop at the farm level

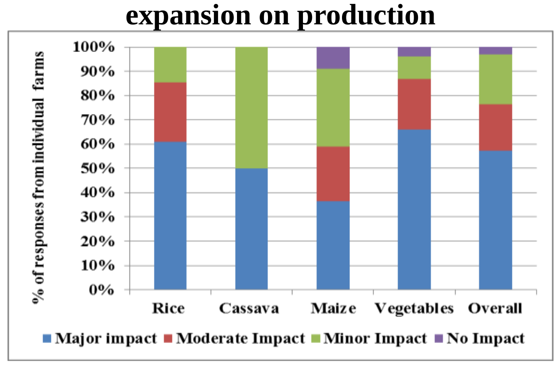


Source: Individual ffarmers' surveys.

3. Perspectives on the possibility of change in cultivated areas by crop



4. Perspectives on the impact of limited land expansion on production



Source: Individual farmers' surveys.

64. **To address the constraints and reduce the negative impact of limited access to land, respondents made several suggestions**:

- Increase public investment in infrastructure, especially irrigation and feeder roads. Investment in irrigation would allow farmers to have more control over the agricultural production cycle, thus intensifying the crop cycle, which would increase cultivated areas. The feeder roads would unlock access to available agricultural land in remote areas, thus increasing the possibility of land expansion. These suggestions were made mostly by farmers in Takeo and Kampot provinces.
- Strengthen technical assistance to farmers, either through the government or private agents. Limited land expansion may be compensated for by intensification on existing agricultural land. Farmers may produce a similar total quantity by intensification, land expansion, or a combination of both. Better extension service would support farmers to attain higher productivity.

- Continue and expand the RGC social land concession policy to small farms. This third suggestion focused on changing the policy to ensure that even smallholder farmers can benefit from it and increase their landholding. Respondents identified the suggestion as possible but it needs policy support to be actionable. This response was quite common from respondents in Kampong Cham, Battambang, and Bantey Meanchey provinces.

3.3. Farmland

Private land transactions

65. **Private land markets were very active over the past 10 years**. Results from the FGDs indicate that farmers bought and sold land for a number of reasons, including family needs and external incentives (Figure 13). Transactions were fueled by the higher agricultural prices received by farmers, better access to credit, and the development of public investment in infrastructure. Higher agricultural prices gave farmers higher incentive to invest in land as this is the main asset for agriculture. With better access to financial services over the years, farmers were able to spread land investments across several years through medium-term loans. Government investment in agricultural infrastructure such as irrigation and rural roads was also identified by farmers as a factor that helped boost agricultural land transactions (Figure 13.1).

66. **In most cases, farmers who sold land faced social and economic distress** (Figure 13.2). Two out of three FGDs reported that farmers who sold land were in default in reimbursing loans from microfinance institutions (MFIs) and banks; about half reported death or serious illness of family members as a reason for selling land. About one-third identified other reasons, such as the need for cash for family obligations (e.g., marriage) and change of activities (e.g., family moving out of agricultural production).

67. **People who bought land were farmers expanding their farm size**. Almost all FGDs reported that other farmers were the main buyers of land, either to expand their own agriculture or with the expectation of leaving more agricultural land to their offspring (Figure 13.3). In some cases, farmers from other villages were the buyers. The RGC policy on land distribution has improved the access to land to some landless and very small land owners. For example, the Land Allocation for Social and Economic Development Project supported by the World Bank targets poor landless individuals and allocates about 0.1 ha for housing and 2-5 ha for agricultural production. Yet many farmers already established in rural areas are not reached by these operations.

68. **The observed agricultural land transactions are likely to result in:** (i) increased average farm size; (ii) lower labor/land ratios; and (iii) an increased gap between small and large farmers:

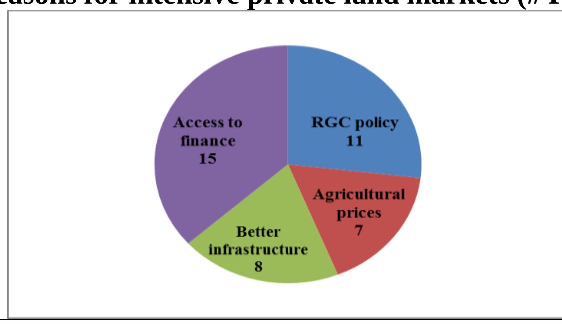
a. In the long term, because of their agricultural land transaction strategies, large farmers would accumulate more land with better land quality. According to the FGDs, such farmers sold small plots and those with poor soil fertility and subsequently bought larger and better quality plots for the sake of building up their farm asset. Sellers of these lands often become landless or subsequently owned farms with fragmented land (which may face more difficult farm management) or poor soil fertility (which will result in lower agricultural profitability).

b. A further consequence is the increase in the extremes: at one end of the spectrum, there are more very small farms struggling to make an agricultural livelihood economically viable, while at the other end, there are more large farms with better quality assets, able to benefit from new technologies for their agricultural production. “Large” includes farms with agricultural landholding exceeding 3-5 ha, but excludes industrial producers with hundreds to thousands of hectares of cultivated land. Even so, this results in a wider gap between small and large landholder households in rural areas.

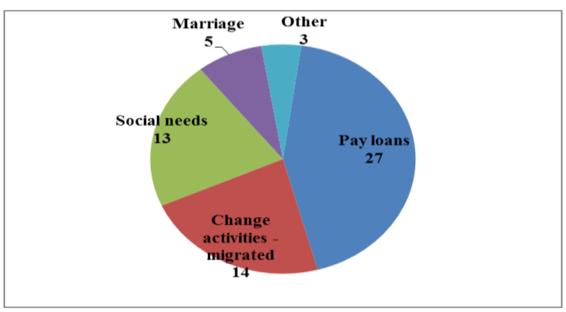
c. An agricultural landscape dominated by large farms would have the capacity to rapidly move to commercial and productive agriculture from the current agrarian structure. Because of their relatively high volume of production, larger farms can be more easily linked to markets, have lower constraints in terms of access to finance, and are able to make profitable the use of agricultural machines.

Figure 13: Private land markets, Cambodia, 2013

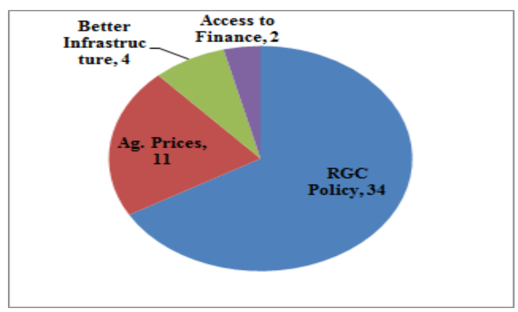
1. Reasons for intensive private land markets (# FGDs)



2. Reasons for selling land (# FGDs)



3. Reasons for buying land (# FGDs)



Source: FGDs.

69. **Landless or marginally landless rural households’ coping strategies include different options**. People who sell their land often become farm laborers, move to off-farm activities in rural and urban Cambodia, or migrate to neighboring countries. The decision is determined by several factors, including their level of education and the overall economic environment in Cambodia, especially the capacity of nonfarm sectors to absorb labor from agriculture. The FGD findings indicate that agricultural transformation (the process by which agriculture engages less people and substitutes labor for capital) is taking place in Cambodia. On average, hired labor income on farm activities increased by 2.7 times from 2005 to 2013, from $1.25/day to $4.56/day, or $109/month for 24 days of work per month. In spite of the past growth, the average farm wage in Cambodia remains low in the regional comparison (Table 18). Off-farm wage, represented by prevailing monthly salaries at garment factories, averaged $159/month based on the FGDs, or 45 percent higher than agricultural labor income. More than 80 percent of FGD respondents reported that

hired labor is increasingly difficult to find, thus the expectation was that rural wages would continue to increase, and farmers must take that into account in their agricultural production operations. Competition from neighboring countries also fuels the exodus of rural laborers. In 2013, the minimum off-farm wage in Thailand was around $10.30/day, very similar to the rate in Malaysia ($9.80/day) and the Philippines (ranging from $6.80/day to $11.10/day depending on location).

Table 18: Wages of labor hired for rice production, selected countries, 2013

Country	Daily wage, US$
China	19.3
Thailand	16.5
Vietnam	8.9
Philippines	7.6
Cambodia	4.5
India	4.2
Myanmar	2.4

Note: Dry season rice production.

Source: Bordey *at al*. 2014; data for Myanmar are from the World Bank.

Land prices and rentals

70. **Irrigation adds value to land**. Between 2005 and 2013, increases in land prices showed significant variation across land types. The price of irrigated land increased by 7 times, up from $1,136/ha to $8,182/ha, while prices of rainfed lowland and upland were up more than 2.5 times, from $888/ha to $3,294/ha for rainfed lowland and $945/ha to $3,294/ha for upland. These figures were obtained from commune council interview respondents (Table 19). The higher price of irrigated land was related to its location, particularly in those irrigated schemes where the government concentrated other investments, such as in roads and energy. Irrigated land also offered the option of growing multiple crops over the year, resulting in higher land productivity.

Table 19: Changes in land prices between 2005 and 2013, Cambodia

	2005 ($/ha)	2013 ($/ha)	Change in Price (%)
Purchase price of 1 ha of land			
Irrigated land	1,136.4	8,182.0	620
Rainfed land	888.7	3,294.0	271
Upland	945.2	3,294.0	248
Rental price for 1 ha of land			
Irrigated land	73.5	225.0	206
Rainfed land	63.8	187.0	193

Source: 2005 survey and 2013 commune council interviews.

71. **Rental prices of land did not follow the same pattern of high increase as the sale prices of land**. Between 2005 and 2013, rental costs for irrigated land increased 200 percent, from an average $73.5/ha to $255/ha. The rental price for rainfed land followed the same pattern. If agricultural production was profitable, then only farmers who faced significant constraints would

rent out their land. The rental prices were below the gross margins calculated in the farm budget analysis. For example, with irrigation, modern farmers got up to $442/ha growing dry season rice, a margin that represented almost twice the rental costs for irrigated land ($225/ha). For rainfed rice, farmers got up to $399/ha, again more than twice the income received if rainfed land was rented out at $187/ha. The difference in rental prices and returns to land may be caused by the difference in land quality. Farmers may only rent out low fertility land or land with difficult access, resulting in increased transportation and transaction costs.

3.4. Agricultural Labor Force

72. **Cambodia continues to have too many people engaged in agricultural activities, but the last decade witnessed a significant reduction in the agricultural labor force**. According to the Social Economic Surveys of NIS, 51 percent of Cambodia's labor force worked in agriculture in 2012, representing 3.9 million workers out of 7.7 million in the total labor force. In 2004, it was 57 percent.

73. **The field evidence confirms that farm labor is being replaced by mechanization services**. In 2005, one hectare of wet season rice production required 73 working days. In 2013, labor use declined to 48 days, or by 34 percent (Table 20). Labor use also declined for maize and dry season rice, but increased for vegetable production, which in principle is hard to mechanize.

Table 20: Use of labor in farm production by crop, Cambodia, 2005 and 2013

	2005 (days/ha)			2013 (days/ha)	Change (%)
	Family	Hired	Total	Total	
Paddy (wet season)	30.30	42.70	73.00	48.29	-34
Paddy (dry season)	24.60	48.70	73.30	27.75	-52
Cassava	13.20	35.20	48.40	48.80	+1
Maize	15.60	26.20	41.80	31.33	-25
Vegetables (mix)	79.80	60.10	139.90	169.85	+21

Source: 2005 and 2013 surveys.

74. **There is the scope for further labor use reduction in Cambodia**. While its farmers used less labor than in the Philippines, India, and Myanmar, in China and Thailand dry season rice production in the main producing areas requires 10-11 man-days/ha, almost 5 times less than in Cambodia (Table 21). In Vietnam, dry season paddy production requires half of Cambodia's labor requirement. The lower use of labor in these countries is driven by their higher wages (Table 18), which in turn accelerate mechanization. Mechanization has also begun in Cambodia, and as the experience of other countries shows, the rate of labor replacement by capital will accelerate with further wage increases.

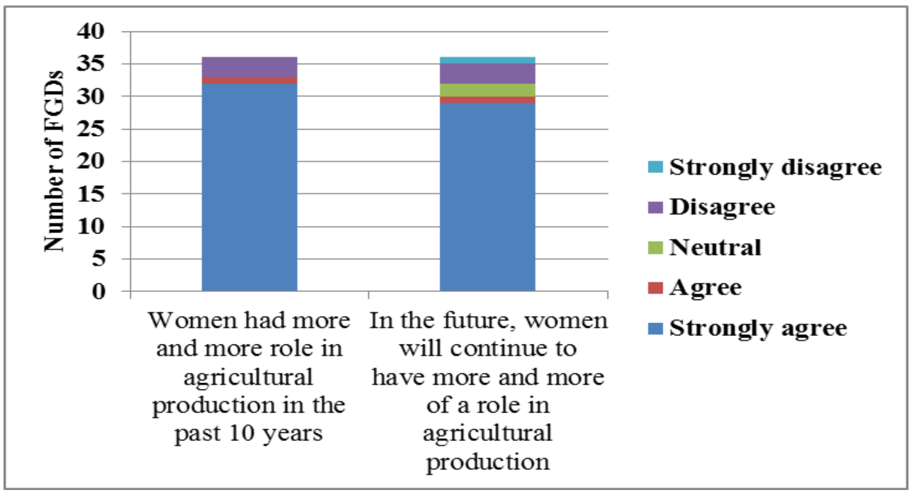
Table 21: Use of labor in dry season paddy production, selected countries, 2013

Country	Man-days/ha
Thailand	10
China	11
Vietnam	23
Cambodia	48
Philippines	69
India	78
Myanmar	110

Source: Bordey *et al*. 2014 and World Bank estimates for Cambodia and Myanmar.

75. **Mechanization and migration affected the structure of rural labor, especially that of women, for both family and available hired labor**. Results from the FGDs indicate that women historically played a critical role in agriculture but this role will be less important in the future (Figure 14). The anticipated change is not significant but conveys households' concern about the increasing difficulty associated with the availability of labor. Two factors are in play: (i) the migration of young women to work in garment factories and young men to work in the construction sector; and (ii) the shift of some agricultural operations from manual to mechanized.

Figure 14: Change in the perception about women's role in agriculture, Cambodia, 2013



Source: FGDs.

76. **Young women are attracted to the relatively high, regular pay from garment factories**. From the FGD results, the average monthly wage at factories was about $162.5/month, 50 percent higher than the calculated monthly salary for hired workers at $4.56/day, and equivalent to $109/month based on 24 days of work. In addition, garment workers have the convenience of regular and continuous monthly wages. Young men are attracted to construction work, often located in urban areas. Data from the 2013 key informant discussions and the 2005 survey suggest a wage increase of 67 percent, from $72/month in 2005 to $120/month in 2013. Though lower than the wage received by most women working at garment factories, this was still about 10 percent above the agricultural wage. The gap between the agricultural and construction wages, however, declined: in 2005, the ratio was about 1 to 3 in favor of construction. Nonetheless, both agricultural and construction work often require daily tasks, implying that employers do not comply with

current labor law, because this kind of wage is not determined under Cambodian labor law. The wage is made by an agreement between the service provider and the employer. Mechanization also contributes to the anticipated decline in the role of women in agriculture. Harvest and post-harvest activities, which previously often involved tasks directed towards women, are currently executed using machinery with male drivers (Box 3).

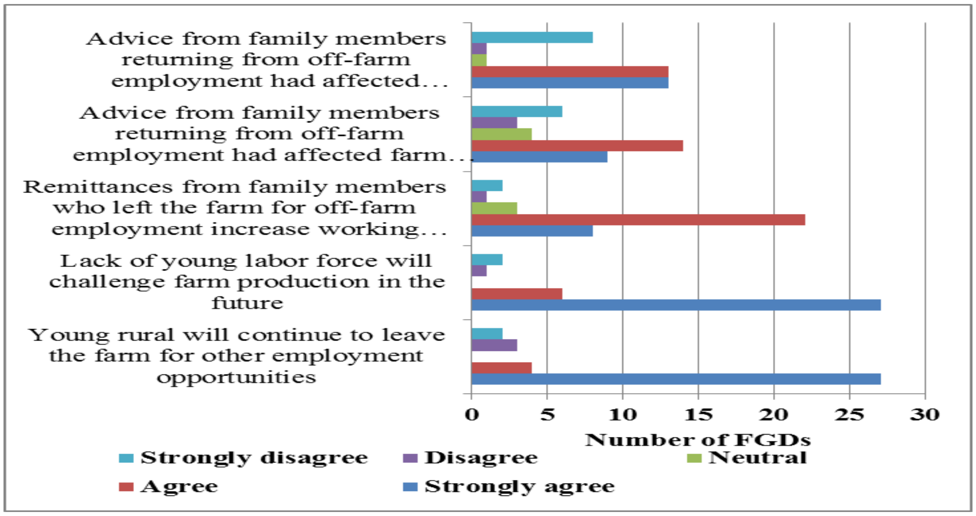
Box 3: Gender Dimensions of Cambodian Agriculture

As Cambodian women are increasingly finding alternative employment in the garment sector and other nonfarm sectors, there is increased demand from women for new services in rural areas such as a savings market for remittances and child care options. For women staying in agriculture, access to extension and other agricultural services remains a large constraint to increased productivity, much larger than for men. Women's needs are often neglected, partially due to the low number of female extension workers and the lack of training and information tailored to women. Mechanization also creates new challenges as female-headed households have less ability to control providers of mechanized services. And hazardous weather events disproportionally impact female-headed households, as their exposure to trainings and programs for disaster risk management remains limited.

Source: World Bank 2015.

77. **Almost all FGD respondents agreed that migration of young rural workers would continue and the subsequent lack of labor force would negatively affect future farm production and farm budgets**. Rural youth leave farms and rural areas for other employment opportunities (Figure 15). However, FGD participants believed that households would benefit from migration through an increase in remittances. Increases in working capital and investment in agriculture and off-farm activities are examples of positive impacts of migration. Nevertheless, respondents did not agree with the statement that young workers leaving the rural households may become a source of good practices and useful information on nutrition and health of children. The same pattern was true for the perceived capability of returning migrants to provide advice on agricultural techniques or commercialization of agricultural products.

Figure 15: Impact of youth migration on agricultural households, Cambodia, 2013



Source: FGDs.

3.5. Use of Agricultural Inputs

78. **Most farmers seemed to be aware of the type of inputs that could boost agricultural productivity**. Improved seeds, urea, insecticides, and herbicides were adopted by more than 50 percent of farmers in several villages (Figure 16.1). Manure, compost, and other fertilizers such as DAP and NPK had lower levels of adoption.

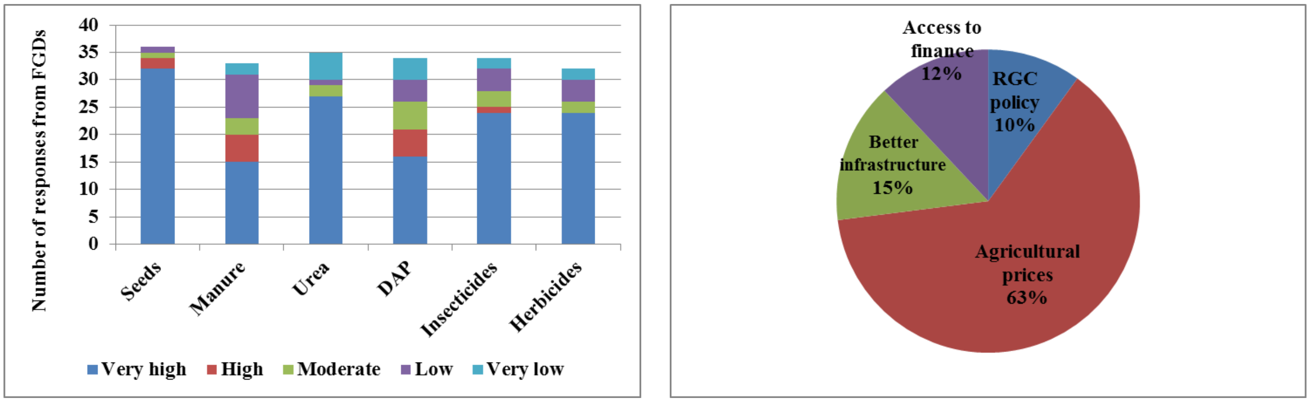
79. **High agricultural prices were the main driving force behind the high adoption of modern inputs**. In order of importance, the reasons driving the high adoption of modern technologies were identified as: the high prices of agricultural products; better infrastructure; and better access to finance (Figure 16.2). The private sector is very active in supplying inputs in all parts of the country. Farmers adopt new technologies based on their profitability expectations, which take into account the perceived production and price risks. Data from the 2005 and 2013 surveys show that cassava prices increased 200 percent, from $19.79/ton to $59.38/ton; maize prices increased 64 percent, from $140/ton to $230/ton; wet season rice prices rose from $124/ton to $237/ton and dry season rice prices from $118/ton to $210/ton; and vegetable prices increased 60-233 percent depending on the type of crop. The expectation of higher prices for the following agricultural year led more farmers to adopt modern technologies targeting higher yields. Additional use of modern inputs was also a result of higher application rates. Initiatives from private firms are discussed in Section 3.7 (extension services), and were undoubtedly a reason for higher use of modern inputs. Better access to finance resolves farms' financial gap during the plantation season. Often, the lean season coincides with the cultivation period, which in the absence of adequate financing would result in lower use of agricultural inputs.

80. **Farmers identified high price of inputs as the main constraint to adoption of modern inputs**. From 2006 to 2013, prices of urea increased by 86 percent (from $0.17/kg to $0.66/kg) and prices of DAP increased by 96 percent ($0.18/kg to $0.74/kg). The most significant increases were observed for improved seeds: around four-fold for rice (from $0.16/kg to $0.66/kg) and around six- to seven-fold for maize (from $0.6/kg to $4.0/kg). For common fertilizers, a valid assumption is that these prices are for the same quality of products (urea, DAP). However for

improved seeds, the very high price increases are likely the result of both a change in commodity prices and a change in seed quality.

Figure 16: Access to inputs, Cambodia, 2013

1. Importance of type of inputs by technology adopters | **2. Reasons for use of agricultural inputs**



Source: FGDs.

81. **Given the simultaneous increase in input and output prices, using higher quantities of modern inputs to get higher yields does not automatically result in higher gross margins per hectare**. Indeed, modern inputs, farm assets, and farmers' skill together constitute a package for higher yield, and the absence of any one of them precludes attainment of the expected results. For example, an adequate rate of chemical fertilizer application would not lead to the expected increase in yield if farmers did not have a minimum level of irrigation control. Similarly, poor weed control would preclude farmers from getting higher yields even with the use of fertilizers. A few cases identified from the farm budgets collected during this survey illustrate the situation where modern farmers with a higher use of inputs had a lower gross margin. For example, a modern wet season rice producer spent $132/ha on fertilizers and reported gross revenue of $499/ha and a gross margin of $132/ha. In contrast, traditional wet season rice farmers spent $39/ha on fertilizers and reported an average gross revenue of $474/ha with a gross margin of $152/ha.

Seeds

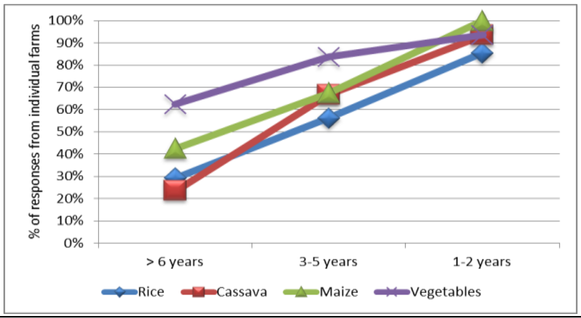
82. **Individual farmers' use of improved seeds increased over the past 10 years**. For the four selected crops, farmers' use of improved seeds increased continuously at a relatively high growth rate (Figure 17.1). Indeed, improved seeds are often one of the most cost-effective technologies to boost productivity. Cambodia can take advantage of the research results in neighboring countries with similar agro-ecological characteristics and the same market preferences. For example, several new rice varieties developed in Vietnam or Thailand can be grown in Cambodia without huge investments in research or seed multiplication.[28] The same applies to other crops such as cassava and maize. However, Cambodia needs more adequate border control and effective quarantine to ensure safe introduction of new varieties of crops and

[28] Although this might be the source of intellectual property rights litigation in the case of use of seeds developed by companies in Thailand or Vietnam.

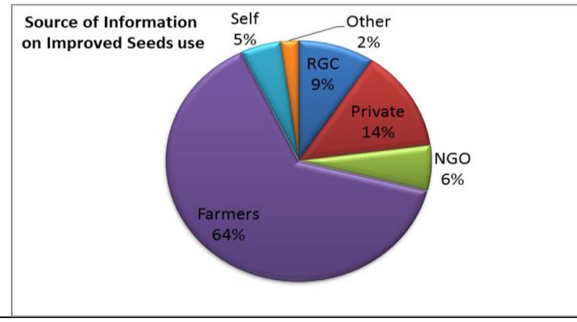
compliance with intellectual property rights and plant variety protection (World Bank 2011 and IFC 2014).

Figure 17: Access to improved seeds, Cambodia, 2013

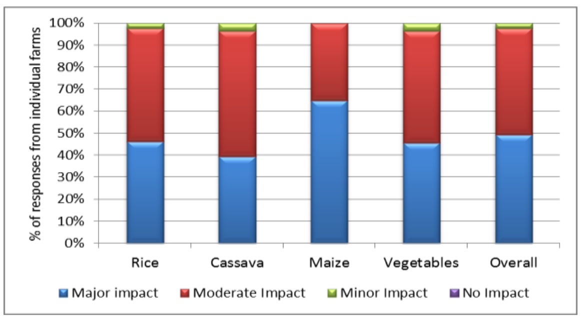
1. Change in the use of improved seeds by crop



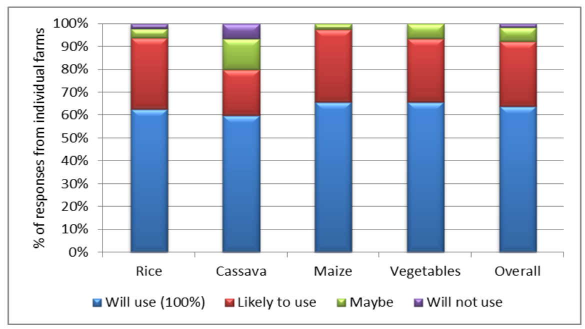
2. Sources of information on improved seeds



3. Perceived impact of improved seeds on agricultural productivity



4. Perspectives on the use of improved seeds by crop



Source: Individual farmers' survey.

83. **Farmer-to-farmer was the most frequently used source of information about adoption of improved seeds**. About two-thirds of interviewed individual farmers reported adoption after discussion with and/or seeing the impact of improved seeds on other farmers' plots (Figure 17.2). Extension agents from different sources (RGC, NGOs, and private suppliers) occupied the second position, with many of them using a farmer-to-farmer approach to increase outreach. Extension services need to provide more support in the future because few farmers were aware of the existence of new crop varieties on their own.

84. **Cambodian farmers seem to have started using higher seed quality**. The increasing use of improved seeds and the amount spent by farmers to buy seeds seem to contradict the conclusions from technicians that farmers still face limited availability of good quality seeds (ADB 2014a; World Bank 2011). For example, in 2013, cassava producers spent \$228/ha on cuttings; maize producers spent \$76/ha on seeds; and on average, dry season rice producers spent \$108/ha on seeds. However, because farmer-to-farmer is the preferred way to adopt seeds, the quality of some seeds is indeed not high because it is often obtained from relatives and other villagers, or used from the previous harvest for planting the following year.

85. **About half of the surveyed farmers believed that the use of improved seeds would increase productivity by more than 20 percent (major impact); the other half believed that the use of improved seeds would increase productivity between 10-20 percent (moderate impact)**. The trends were similar for rice, cassava, and vegetables, with slightly less than half of farmers expecting a major impact and the rest anticipating a moderate impact (Figure 17.3). However for maize, two out of three farmers were quite confident about the productivity impact of using improved seeds. Stakeholders reported that the use of hybrid seeds was common for maize farmers. The supply chain has the advantage of support from large importers, who provide a minimum level of technical advice on the use of hybrid maize seeds.

86. **Farmers were very positive about the continued use of improved seeds over the next five years**. Two out of three interviewed individual farmers claimed they would continue to use them; the remaining claimed they were likely to use improved seeds in the next five years (Figure 17.4). However, a small group of cassava farmers was unsure whether they would use improved seeds. Farmers suggested that the RGC should increase access to improved seeds through strengthening of technical assistance from MAFF and provide quality seeds at a reasonable price.

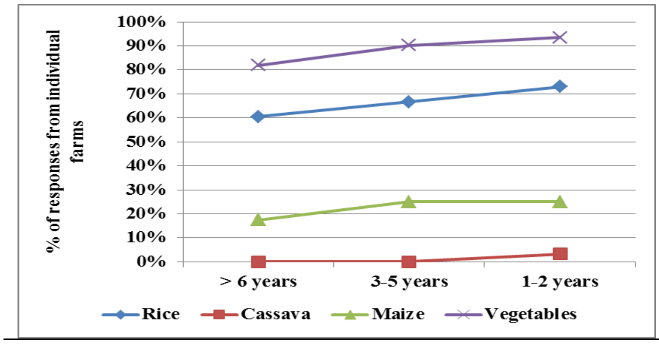
Manure/Compost

87. **Manure and compost use did not change significantly over the past 10 years**. The trends were similar for all four selected crops (Figure 18.1). Often, farmers reserved the use of organic fertilizers for vegetables (almost all farms used manure or compost) and rice production (above half). Non-reconstitution of organic matter on upland cultivation, especially cassava, was a big concern. With land expansion, cassava is cultivated from massive clearings of forest land, which in most cases is still rich in organic matter, reducing the need for manure or compost. Cassava can grow in different types of soil even with little or no additional fertilizer. However, in the medium-to-long term, Cambodia could face productivity issues linked to soil fertility depletion.

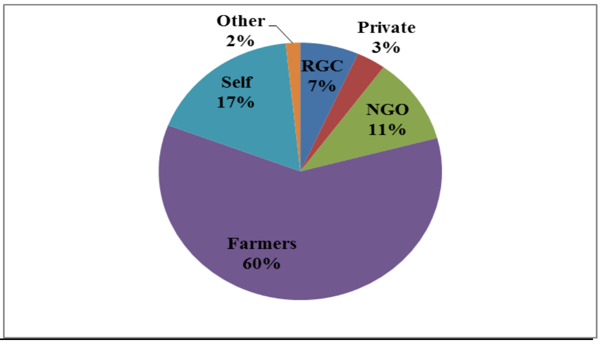
88. **Availability of manure may be a challenge in the future**. Farm budgets collected in 2013 show that farmers bought manure for agricultural production and that expenditures were as high as $300/ha for vegetable producers, representing about 17 percent of their total variable costs. The share went as high as 25 percent for small modern watermelon producers. The drive towards mechanization might further contribute to reducing the stock of cattle used for land preparation and as a source of manure.

Figure 18: Use of manure, Cambodia, 2013

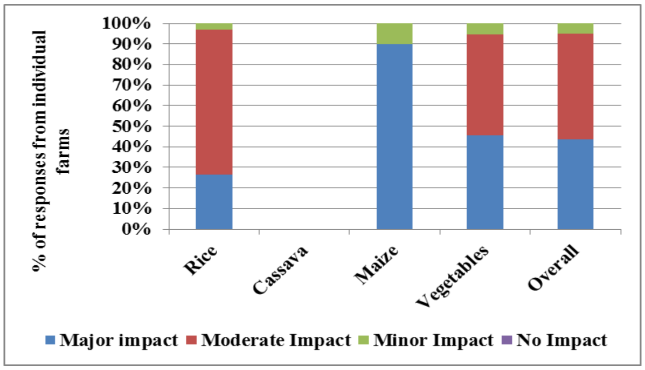
1. Change in the use of manure/compost by crop



2. Sources of information on the use of manure and compost



3. Perceived impact of manure and compost on agricultural productivity



Source: Individual farmers' survey.

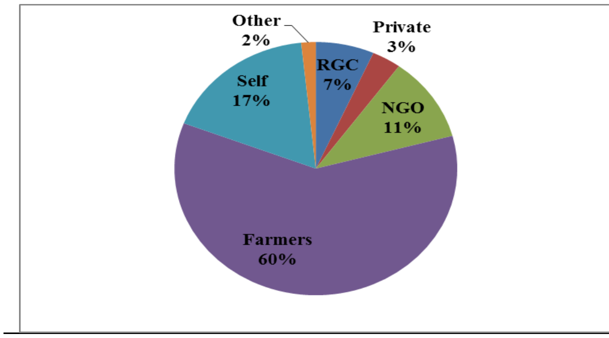
Chemical fertilizers

89. **Most farmers used fertilizer for rice and vegetable production**. The FGDs reported an increase of about 30 percent in the number of users of urea for rice production over the past five years. The change was relatively lower for vegetables and maize, and farmers barely used chemical fertilizers for cassava production (Figure 19.2). The average expenditures from the 2013 farm budget data show that farmers used 153 kg/ha of fertilizers for dry season rice, 66 kg/ha for wet season rice, and 193 kg/ha for vegetables. The results also display that farmers barely used chemical fertilizers on maize (30 kg/ha in 2013) and almost none on cassava (8 kg/ha).

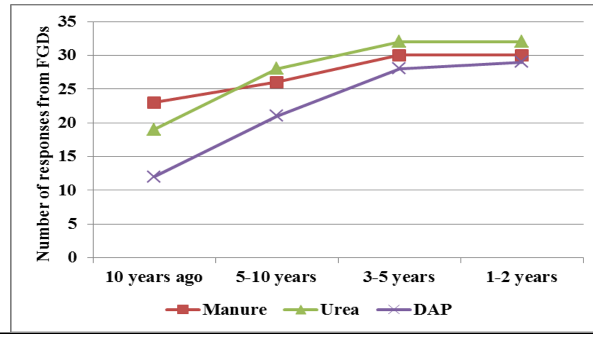
90. **Over time, the use of fertilizers per hectare increased**. For example, for dry season rice production, the rate of use of chemical fertilizers increased 50 percent for medium-size farms (89 kg/ha to 127 kg/ha) and four-fold for large farms (40 kg/ha to 192 kg/ha). Other types of fertilizers such as DAP received increasingly more attention from farmers. The FGD results show a steep increase in the number of villages where farmers used DAP. A breakdown by crop shows that farmers used fertilizers mostly for rice and vegetable production (Figure 19.3 and Figure 19.4).

Figure 19: Use of fertilizers, Cambodia, 2013

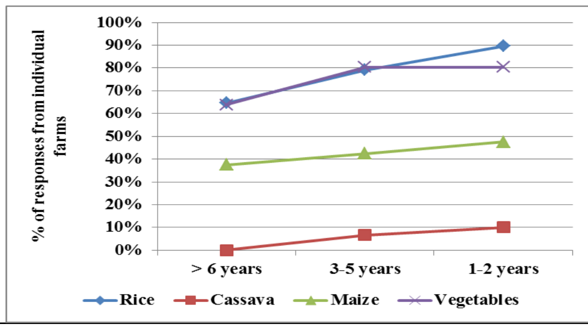
1. Sources of information on the use of chemical fertilizers



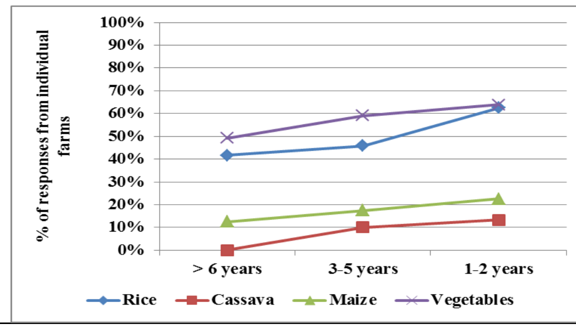
2. Overall trends in fertilizer use



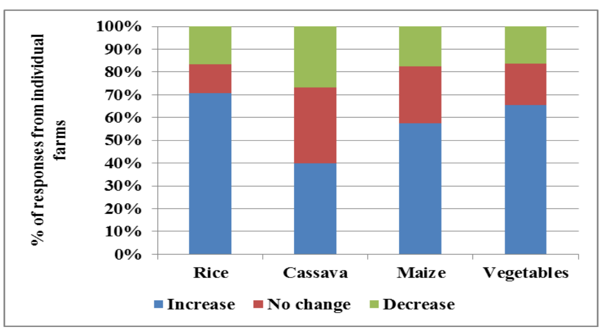
3. Change in the use of urea



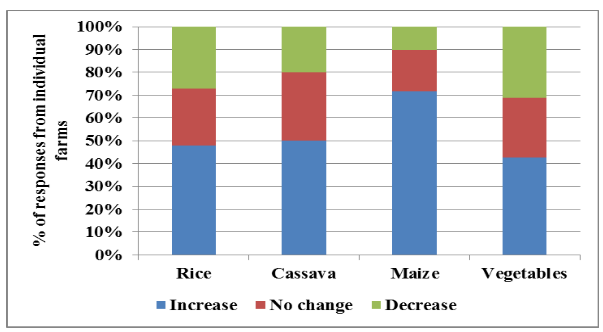
4. Change in the use of DAP



5. Perspectives on the number of users of chemical fertilizers



6. Perspectives on the intensity of use of fertilizers (quantity per hectare)



Source: Individual farmers' survey.

91. **The rates of use of fertilizer for dry season rice, cassava, and maize production increased**. Fertilizer use for wet season rice, however, did not show a similar increase. Table 22 illustrates the changes in the use of chemical fertilizers between the 2005[29] and 2013 surveys.

[29] The 2005 survey was conducted by the Agribusiness Institute of Cambodia (ABiC), which was used for the World Bank's Cambodia Agrarian Structure Study and is used in this report for comparisons with the 2013 survey.

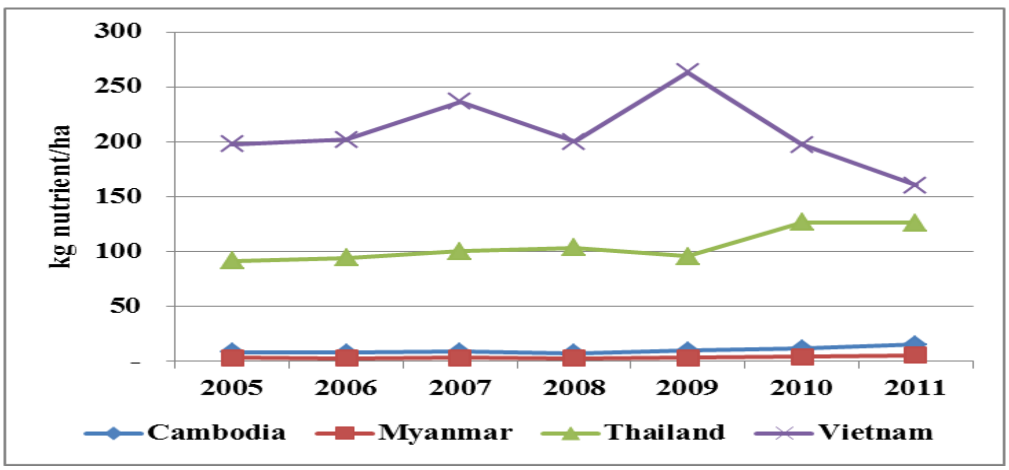
Table 22: Illustrative use of fertilizers, Cambodia, 2005 and 2013

	2005			2013		
	Farm Size			Farm Size		
Crop	**Small**	**Medium**	**Large**	**Small**	**Medium**	**Large**
Wet season rice (kg/ha)	53	94	93	72	65	63
Dry season rice (kg/ha)	133	89	40	133	127	192
Cassava (kg/ha)	-	-	-	12	-	8
Maize (kg/ha)	35	-	-	74	7	9

Source: 2005 and 2013 surveys.

92. **In spite of the increased use, the rate of fertilizer use in Cambodia is still below the regional average**. From FAOSTAT data, average fertilizer nutrient consumption for Cambodia was about 15 kg/ha[30] in 2011, low compared to Vietnam's 160 kg/ha and Thailand's 126 kg/ha (Figure 20). More recent surveys indicate a higher use of chemical fertilizers in Cambodia, but still below the level of regional neighbors.[31]

Figure 20: Trends in chemical fertilizer use (kg nutrient/ha), select countries, 2005-2011



Source: FAOSTAT 2014.

93. **In addition to unfavorable input/output prices and lack of knowledge, the low average level of application may be caused by farmers' adverse selection due to a high risk of obtaining tainted, low-quality fertilizers in the marketplace**. Based on their past purchases, farmers may not be willing to pay the market price for the perceived low-quality fertilizers available in the market. While there are cases of low-quality and sometimes fake fertilizers sold in Cambodia, it does not seem to be a major issue (IFDC 2010). The trend is increasing both in the number of farmers using chemical fertilizers and the amount of fertilizers used per hectare. About three out of four rice and vegetable farmers expected the number of farmers using chemical

30 Calculated as kg of fertilizers per ha of arable land.
31 Field data from a recent (2013) feasibility study conducted by CelAgrid for ADB (TA7833) reported that the average application of chemical fertilizer is 122 kg/ha, 96 kg/ha, and 98 kg/ha, respectively, in rice, vegetable, and corn fields.

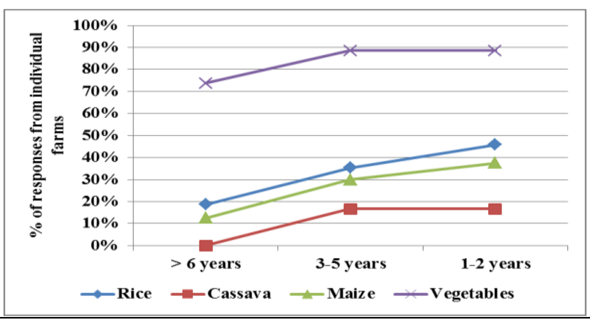
fertilizer to increase in the next five years, and about half anticipated an increase in the dose per hectare (Figure 19.3 and Figure 19.4). Although only less than half of cassava farmers expected to use chemical fertilizers, the amount used per hectare is expected to increase. The most remarkable changes were anticipated for maize: more than half of the respondents anticipated an increase in the number of farmers using fertilizer and more than two out of three anticipated an increase in the quantity used per hectare.

Other chemicals

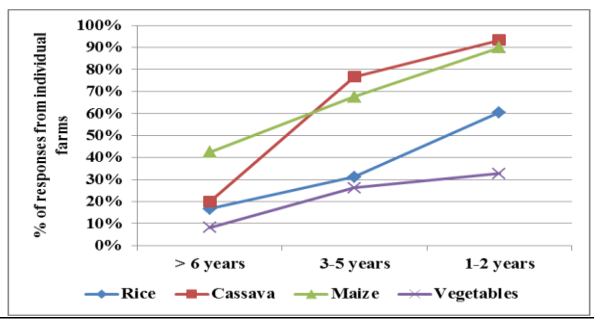
94. **The use of insecticides is increasing in Cambodia**. Vegetable production requires higher use of pesticides; the proportion of users topped at nine out of ten farmers. For maize and rice, the number of users also increased but at a lower magnitude: one-third of respondents used insecticides. For cassava, less than 20 percent of interviewed individual farmers used insecticides (Figure 21.1). Farmers anticipated that the number of insecticide users would increase mostly for vegetable and maize production. In 2013, farmers spent up to $82/ha on insecticides, with vegetables having the highest expenditure. The figures were much lower for dry season rice ($12/ha), and very low for cassava, wet season rice, and maize (less than $4/ha). However, farmers expected the number of pesticide users to continue to increase and remain high for vegetable production. This situation raises concerns of food safety in areas where farmers are not fully aware of the dangers linked to pesticide use and due to improper handling by traders.

Figure 21: Use of pesticides, Cambodia, 2013

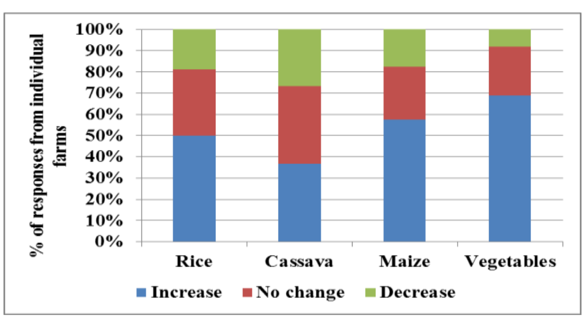
1. Change in the number of insecticide users



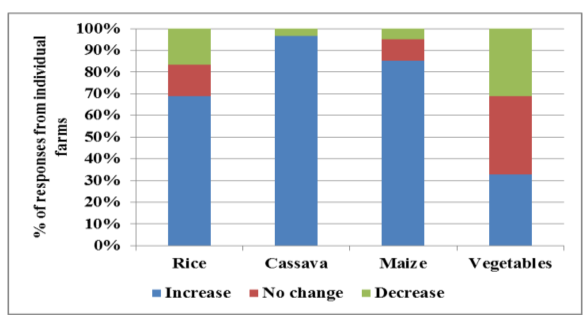
2. Change in the number of herbicide users



3. Perspectives on the number of insecticide users



4. Perspectives on the number of herbicide users



Source: Individual farmers' survey.

95. **The use of herbicides is also increasing, especially for upland crops**. Cassava and maize farmers were the most prominent users of herbicides (Figure 21.2). Weed infestation was a major constraint in large-scale upland production; with the increasing difficulty in finding rural workers and the increase in cultivated land areas, farmers tended to use herbicides. The figure depicts a sharp increase in the use of herbicides in the last five years, a trend expected to continue for the next five years, especially for cassava and maize (Figure 21.3 and Figure 21.4). For irrigated rice, manual rotary weed control equipment allows for good weed control and has the advantage of requiring only a few days of labor per hectare. In the farm budgets collected in 2013, expenditures on herbicides ranged from a low of $4.6/ha for wet season rice production to $33.8/ha for cassava. Expenditures on herbicides for maize ($20/ha) and dry season rice ($12.2/ha) were in between.

3.6. Use of Agricultural Machinery

96. **The past 10 years witnessed a spectacular increase in the use of agricultural machinery in Cambodia**. Changes were observed in land preparation, planting, and harvesting. Data from the Department of Agricultural Mechanization show that the number of combine harvesters increased three-fold from 2006 to 2010, and the number of threshers increased two-fold (Table 23). The 2013 survey shows that increasingly more farmers used tractors (both 4WD tractors and hand power tillers) for land preparation for upland crops (i.e., cassava and maize) and they expected to continue to use this equipment in the next five years (Figure 22.3, Figure 22.4, Figure 22.5, and Figure 22.6). For rice and vegetables, their current use was relatively low (10-20 percent) but farmers indicated that their use would increase. However, the use of agricultural machinery may be constrained by the low purchasing power of smallholders, the high cost of agricultural equipment, and the lack of well-trained operators and mechanics for agricultural machinery.

Table 23: Number of agricultural equipment units, Cambodia, 2006-2010

Equipment	2006	2007	2008	2009	2010
Combines	325	399	430	836	947
Tractors	4,247	4,475	4,611	5,495	6,200
Threshers	7,795	8,036	8,237	13,798	14,390
Power tillers	29,706	34,639	38,912	53,220	66,548
Irrigation pumps	127,610	131,702	136,061	164,974	166,633

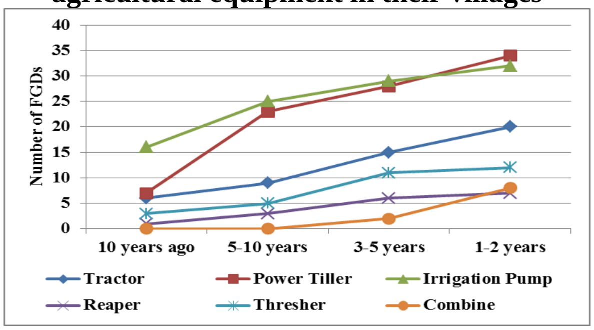
Source: Department of Agricultural Mechanization.

97. **Farmers use different sets of equipment based on their farm size, their agricultural assets and equipment levels, and the availability of services**. Manual tractors will continue to be common in rice and vegetable production despite the uptake of regular tractor use. Manual tractors are an intermediate technology between draught animals and tractors, and are highly effective for puddling, preparatory tillage, and seed bed preparation for rice production. They are also the most efficient form of mechanization for fragmented and small land plots. However, farmers thought that the level of use of power tillers would decrease, except in vegetable production. In terms of costs, 2013 data collected from FGDs show that tractor rental for land preparation cost about $60/ha and two out of three FGDs reported the service as relatively easy to find; animal traction cost a bit more, at $71/ha, and only one out of three FGDs said that service

providers were easily available. For harvest and post-harvest operations, some services were still hard to get. About half of the FGDs reported having difficulty getting combines to their fields. On the contrary, rice reapers and threshers were relatively more available, with only one out of four FGDs stating difficulty in getting them.

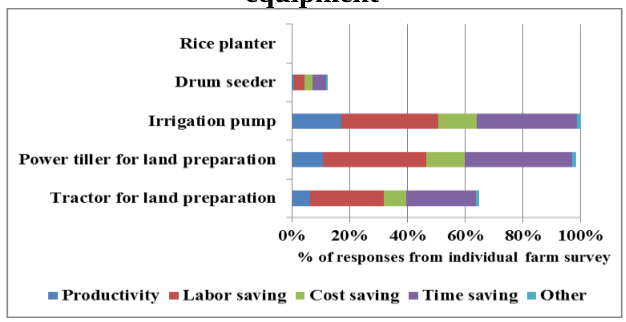
Figure 22: Use of agricultural equipment, Cambodia, 2013

1. Number of FGDs reporting the use of agricultural equipment in their villages



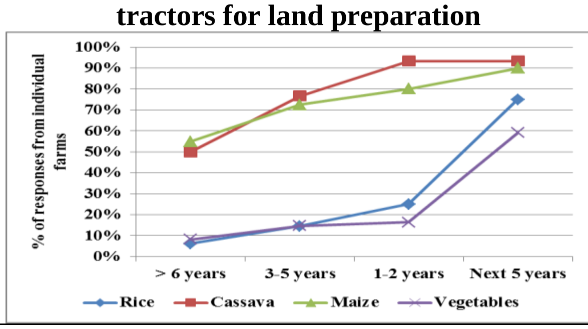
Source: FGDs.

2. Main reasons driving the use of agricultural equipment

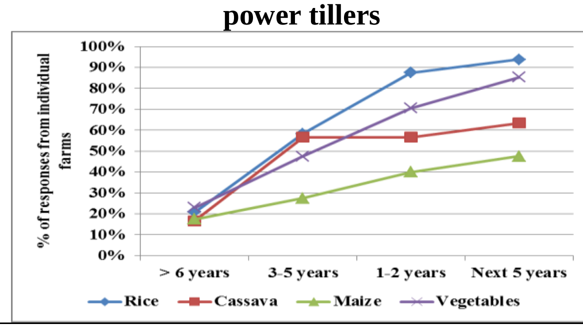


Source: Individual farmers' survey.

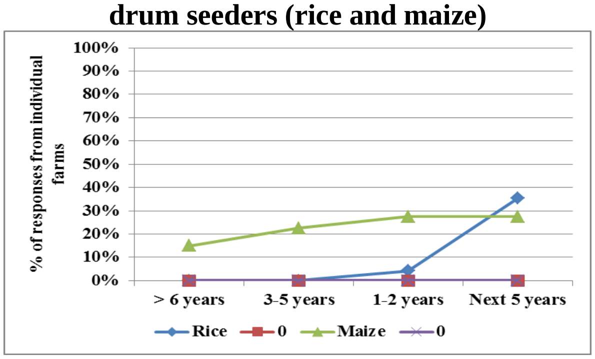
3. Change in the use of and perspectives on tractors for land preparation



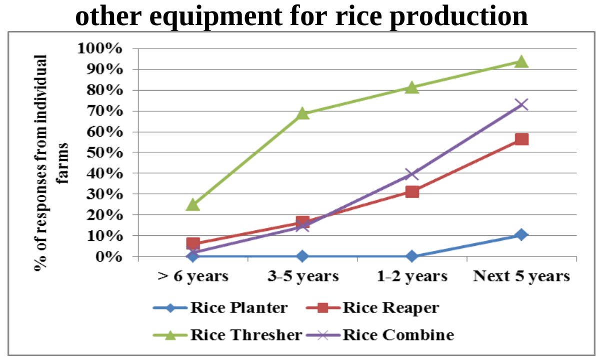
4. Change in the use of and perspectives on power tillers



5. Change in the use of and perspectives on drum seeders (rice and maize)



6. Change in the use of and perspectives on other equipment for rice production



Source: Individual farmers' survey.

98. **Data collected from the FGDs are in line with the increasing trend in the use of agricultural equipment shown by official statistics**. Irrigation pumps and manual tractors were among the earliest equipment adopted by Cambodian farmers. The uptake of manual tractor use started about 10 years ago, and increased until late 2010 (Figure 22.1). Irrigation is the key to rice

production and power tillers are versatile enough to work on muddy plots. The use of tractors, adapted to medium-size to large farms, also started to increase in the last 10 years. The economic land distribution policy and the expansion of agricultural land, resulting in higher average farm size, will contribute to this continued growth. The trends for harvest and post-harvest equipment use show a typical pattern: rice farmers first move from labor-intensive tasks to intermediate mechanization using rice reapers for harvest and threshers for post-harvest; ultimately they move to a highly capital-intensive approach using combine harvesters. The result is a plateau in the number of threshers and rice reapers and an increase in the number of combines (as illustrated in Figure 22 and Table 23).

99. **Combines were often rented by farmers from business entrepreneurs, and the use of combines has taken off**. The high purchase price of the machines makes renting the preferred option for small and medium-size farms. Several FGDs reported having access to such services, with an average payment of $95/ha, 10-15 percent higher compared to the use of reapers and threshers for harvest and post-harvest activities (Table 24). However, some farmers complained about the quality of rented combines and reported that their use brought additional work. With poor-quality harvesters and/or unskilled drivers, the harvested paddy grain is mixed with a lot of broken straw, requiring further cleaning processes. Others criticized the extra costs incurred due to inexperienced drivers, who spend too much time maneuvering at the end of the field while farmers pay for the equipment by the hour.

Table 24: Average costs of and difficulty finding agricultural machinery, Cambodia, 2013

Tasks	$/hectare	% of FGDs Reporting Difficulty Finding Equipment (if rental)
Land preparation by animal	76.5	68
Land preparation by power tiller	59.8	33
Land preparation by tractor	74.3	20
Rice reaping	43.0	27
Rice threshing using mechanical thresher	40.3	8
Combine harvester	95.5	46

Source: FGDs.

3.7. Agricultural Services

Extension services

Availability and access

100. **In the past 10 years, RGC and NGO extension agents provided technical advice in two out of three villages visited during the FGDs**. Commercial firms were also present, but to a lesser extent, in one out of three villages. Technical advice is a source of information on recommended and proven scientific farming techniques. Agricultural extension encompasses several dimensions, including: economic dimensions such as increases in farming income, agricultural productivity, farm financial management, and food preservation, and social dimensions such as improvement in the health of family members, and leadership. Farmers may get technical advice from several sources, comprising government employees, NGOs, and the

private sector. More than 10 years ago, the proportion of villages receiving extension services was less than 10 percent on average for all four crops (Figure 23.1). Services from the RGC and NGOs rapidly increased to cover more than half of these villages and then slowed down in the last five years to around 70 percent (25 FGDs out of 36). At the opposite end of the spectrum, private extension services grew at a slower pace in the early 2000s before rising to a higher and more regular level, currently reaching about half of the interviewed villages.

101. **Specific crops such as rice and vegetables received more attention from RGC and NGO extension agents**. About half of the interviewed farmers reported receiving technical advice on these two crops (Figure 23.2 and Figure 23.3). The RGC agents mostly focused on rice and vegetables and neglected other crops such as maize and cassava, for which extension services were available in only one out of ten villages. NGOs' extension services also targeted mostly rice and vegetables, but they started to add cassava and maize about five years ago. Private commercial advisors were mostly interested in developing vegetable production and had reached about one out of three interviewed villages (Figure 23.4).

Satisfaction, perception of impacts, and perspectives

102. **Farmers considered RGC and NGOs' agricultural extension services more satisfactory than services from private companies**. About nine out of ten FGDs[32] expressed satisfaction with the extension services from RGC and NGOs (Figure 23.5). On the contrary, services from private commercial advisors were perceived by one out of three FGDs as unsatisfactory. The main complaints were about:

a. Difficulty acquiring the inputs required. For example, advice promoting the advantage of a specific new variety of crops was not followed by activities to make the promoted seeds available.

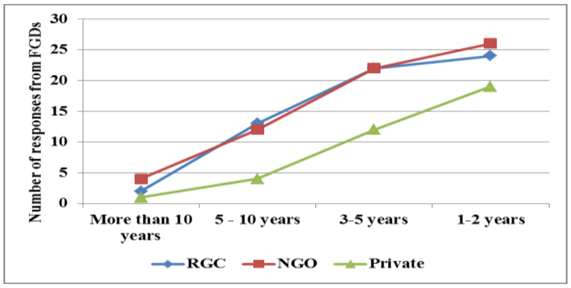
b. The insufficient number of visits conducted by extension agents. More frequent visits would help farmers, as they mentioned gradual improvements in their knowledge and skills from repeated discussions with agricultural extension agents. Farmers wanted extension agents to follow-up and monitor their progress after the initial visit.

c. Confusion regarding commercial activities and dissemination of technical messages. Complaints were on the type of messages, which in some cases are too focused on selling products. Some respondents even reported that they felt obliged to buy the product after meeting with these agents. Some farmers suggested that the government should intervene when the performance of products sold by extension agents is not as effective as advertised.

[32] FGDs with valid responses.

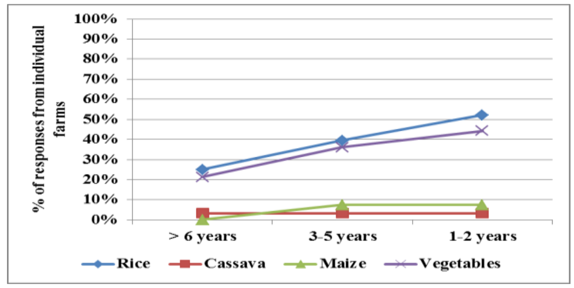
Figure 23: Access to extension services, Cambodia, 2013

1. Number of FGDs reporting access to extension services by type of provider



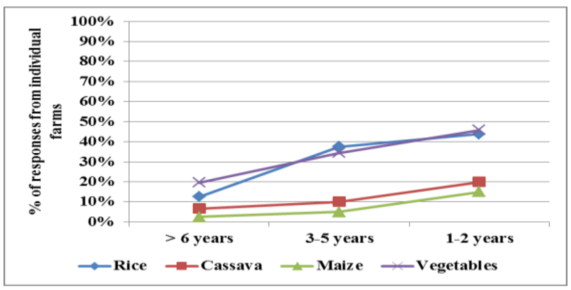
Source: FGDs.

2. Development of extension service from RGC agents



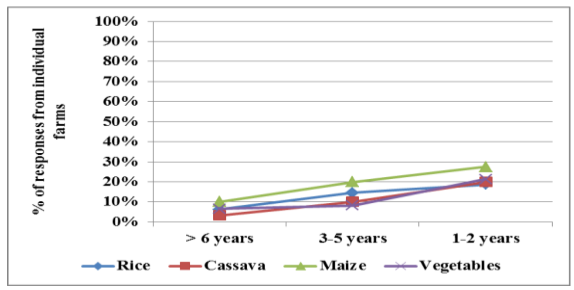
Source: Individual farmers' survey.

3. Development of extension service from NGO agents



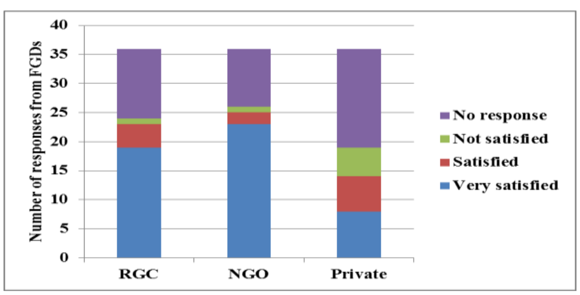
Source: Individual farmers' survey.

4. Development of extension service from the private sector



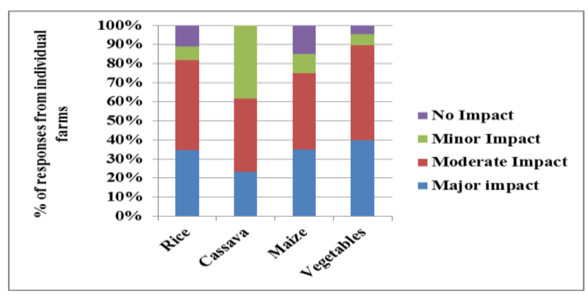
Source: Individual farmers' survey.

5. Satisfaction with the quality of extension service received (# of FGDs)



Source: FGDs.

6. Impact of lack of access to technical advice on agricultural production



Source: Individual farmers' survey.

103. **Farmers reported that extension would be more effective if technical agents had a better understanding of farm characteristics**. Respondents reported that in some cases, innovations proposed by technical agents did not correspond to the existing reality on the farm. For example, agents promoted techniques requiring good water control to farmers who did not have irrigated land; or disseminated technical packages that would not be profitable because of high initial investments. Farmers wanted extension agents to ultimately discuss adoption based on the specific assets, soil quality, and fertility associated with their farms. In an ideal situation, such tailored advice would be provided to farmers, but this approach may face high costs of intervention

and may only be possible for medium-size and large farms, excluding the more numerous small farmers. In other countries, producers' organizations are an effective way to alleviate the unit costs of intervention. They have the advantage of focusing on limited types of crops, if not one crop; and can tackle similar problems encountered by most farmers within the area of interventions. However, the effectiveness of farmers' organizations in Cambodia has been limited so far (see Chapter 3.8).

104. **Relatively few farmers were aware of the impacts of the lack of access to technical advice on their agricultural production**. Several individual farmers did not provide answers to this question. Depending on the type of extension service received, the rates of nonresponse were about two out of five respondents for those dealing with private firms, and about half for farmers working with RGC or NGO extension agents. There was also a difference across crops. For rice, maize, and vegetables, nine out of ten farmers identified the lack of extension services as having a moderate to major impact on their agricultural activities. Cassava growers, on the other hand, did not see the lack of extension services as a major issue in their agricultural production (Figure 23.6). A consequence of such lack of awareness is farmers' low willingness to pay for technical advice. This will be an issue if the RGC decides to privatize agricultural extension.

Credit

Availability and use

105. **Financial services from several sources comprising commercial banks, MFIs, community saving groups, and money lenders were increasingly available to farmers**. In the past 10 years, increased availability of financial services from MFIs was one of the main changes in rural Cambodia, with the proportion of villages having access to credit increasing from 25 percent to above 90 percent (Figure 24.1).

106. **In addition, the types of service providers have diversified with the establishment of commercial banks in small towns and community savings and loans institutions in villages** (World Bank and AusAid 2013). For FGD participants, the availability of commercial banks and community savings and loans services increased 10-fold compared to the situation 10 years ago. However, improved access was not strong enough to satisfy all needs; hence, the continued use of financial services from money lenders.

107. **Farmers' choices of financial service provider varied according to the size of their farm and the type of crop produced**. Maize and cassava growers used financial services from commercial banks and MFIs. More than half of the interviewed farmers growing cassava and maize reported access to MFIs' financial services; and one out of three used financial services from commercial banks (Figure 24.2 and Figure 24.3). Most of these farmers were located in Kampong Cham and Takeo. Commercial banks were not used much in the other four visited provinces. On the other hand, commercial banks were barely used by rice and vegetable growers: the proportion of users remained below 10 percent over the past 10 years. These farms, often small, preferred working with community savings and loans institutions. In sum, respondents were almost unanimous in identifying MFIs as the most available and accessible financial service for farmers. For example, ACLEDA, which currently has commercial bank status, started as a microfinance provider and has been the largest microfinance institution in Cambodia for over a decade.

108. **Community savings and loans institutions are being implemented in more and more villages, but to date, few farmers have had access to their services**. Slightly more than half of

the visited villages reported receiving financial services from community savings and loans institutions, most of them in the past five years (Figure 24.1). However, very few interviewed farmers reported using services from this type of local institution, which was supposed to serve farmers' needs (Figure 24.4). Most users were: rice and vegetable growers; located in Battambang, Takeo, and Kampot provinces; and modern technology users. The Cambodian Community Savings Federation has provided financial and nonfinancial services to low-income families, especially women since early 2000. Cambodian Community Savings Federation is currently working in Battambang and Bantey Meanchey provinces and provides services to more than 3,000 farmers.

109. **Despite the existence of numerous formal financial service providers, farmers still take loans from money lenders, presumably because money lenders do not require collateral and higher risk loans can be obtained**. Individual farmers receiving services from money lenders increased from 10-15 percent about six years ago to 20-50 percent in 2013. Cassava and maize farmers appeared to rely more on money lenders than did other producers (Figure 24.5). These upland crop growers, however, showed higher access to commercial banks and MFIs.

Satisfaction, perception of impacts, and perspectives

110. **About nine out of ten FGDs viewed community savings and loans institutions as providing the most satisfactory quality services**. MFIs came in second place, with two out of three responses "very satisfied" or "satisfied." Commercial banks and money lenders occupied the last place, with less than half of respondents reporting satisfaction.[33] Satisfaction encompasses several aspects, but the most important constraints often cited by farmers were the high interest rate, the excessive delay between time of application and availability of loans, and the required collateral. For community savings and loans institutions, some farmers criticized the constraints linked to the "social organization," such as frequent meetings and the limited amount that can be borrowed by each member (Figure 24.6). For several respondents,[34] lack of access to credit would negatively impact farm production, regardless of the type of crop, size of farms, or region (Figure 24.7).

111. **Only a handful of farmers reported no impact from the unavailability of MFIs and money lenders.** However, there were a large number of nonresponses, varying from half of respondents regarding MFIs to about 80 percent regarding commercial banks. In general, nonrespondent farmers could be categorized as those who did not use financial services, either by choice or because of nonavailability of such services.

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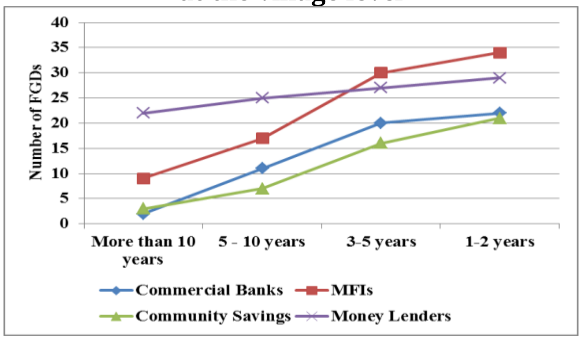
[33] These proportions excluded nonresponses, which in some cases may be large (30 percent nonresponse for extension service from RGC, and 50 percent for extension services from private commercial firms). Responses may be missing because respondents did not receive the services, or respondents did not know the answers even if they had received services.

[34] Information based on individual farmer interviews.

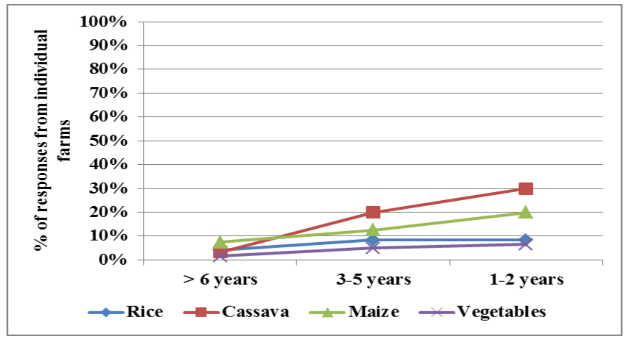
Figure 24: Access to financial services, Cambodia, 2013

1. Change in the availability of financial services at the village level



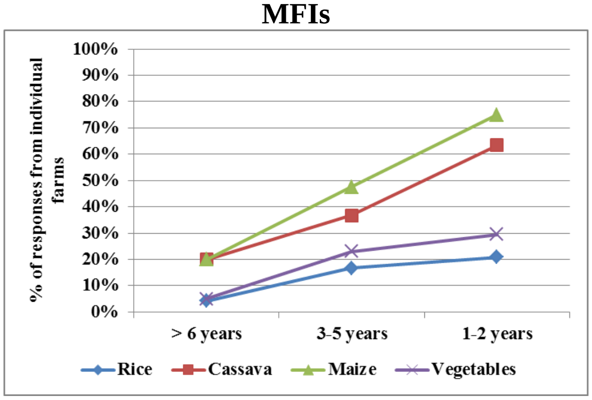
Source: FGDs.

2. % of farmers receiving financial services from commercial banks



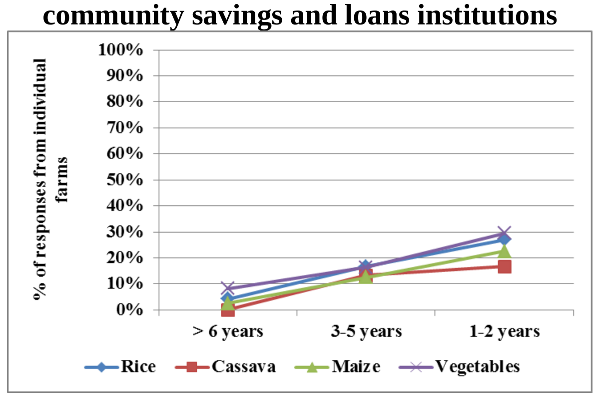
Source: Individual farmers' survey.

3. % of farmers using financial services from MFIs



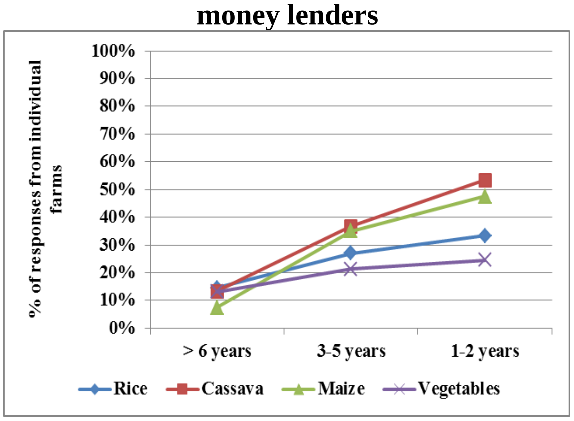
Source: Individual farmers' survey.

4. % of farmers using financial services from community savings and loans institutions



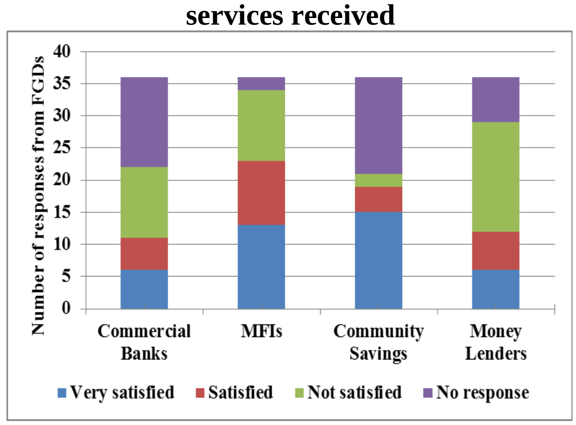
Source: Individual farmers' survey.

5. % of farmers using financial services from money lenders



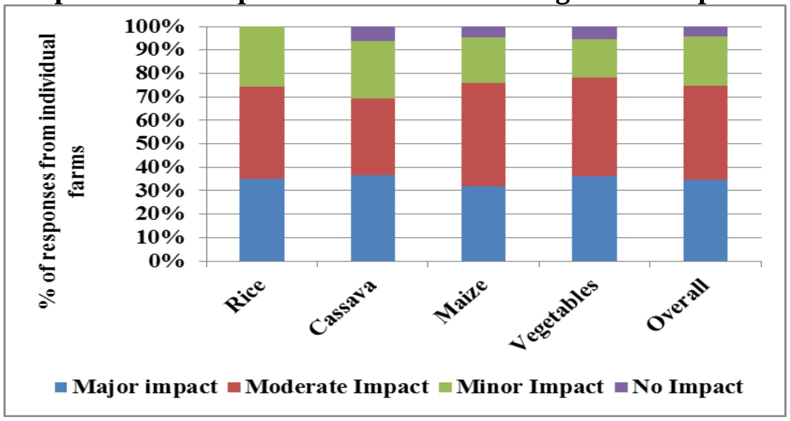
Source: Individual farmer's survey.

6. Satisfaction with the quality of financial services received



Source: FGDs.

7. Perception of the impact of lack of credit on agricultural production



Source: Individual farmers' survey.

Access to other services for agriculture

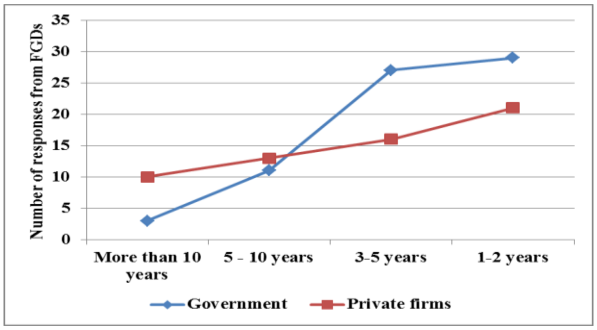
Price information

112. **Over the past 10 years, the RGC made significant efforts to provide regular price information to farmers**. The RGC uses two main ways of information dissemination: mass media, including public radio and TV; and interpersonal communication using extension agents. For the past five years, increasingly more villages have been able to receive information on prices, often from RGC programs (Figure 25.1). These government programs focus on rice and to a lesser extent on upland crops. In addition, dissemination of price information by private businesses became more common in about half of the villages visited during the FGDs. They were more focused on diffusion of information related to vegetables, even though the increase in the number of people getting information slacked off in the past two years.

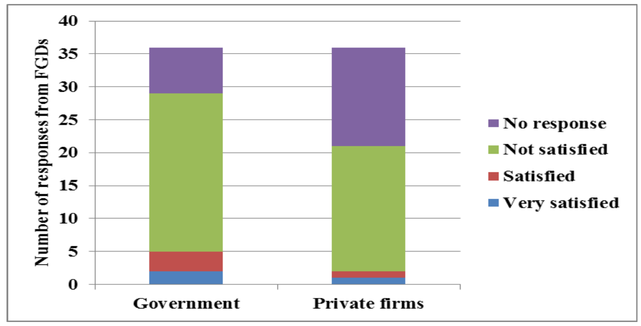
113. **Despite the increased access to information, farmers were not satisfied with the quality of service received**. Only a handful of FGDs reported "very satisfied" and "satisfied" perceptions; the majority reported "not satisfied" (Figure 25.2). The most common reason was discrepancies between the announced prices on TV and the real prices at the market place. Government agents do not conduct their assessment carefully so disseminated prices are often higher than the actual selling prices, resulting in disappointment when farmers face buyers. Ultimately, the businessman/buyer has the last word. Farmers feel cheated and do not know what to do or where to get advice. On the other hand, farmers are frustrated when the announced prices are low, unduly below the production costs for some commodities. The system is then judged not useful since it is the bearer of bad news. Some farmers suggested that the government pass laws to control the price of agricultural products and disseminate information through the system. Indeed, the inadequate quality of prices disseminated through official media was reported by the Cambodian Institute for Cooperation and Peace in 2011: "Cambodian farmers do not get access to updated accurate market price data for their products."

Figure 25: Access to information, Cambodia, 2013

1. Number of FGDs reporting access to information by type of provider

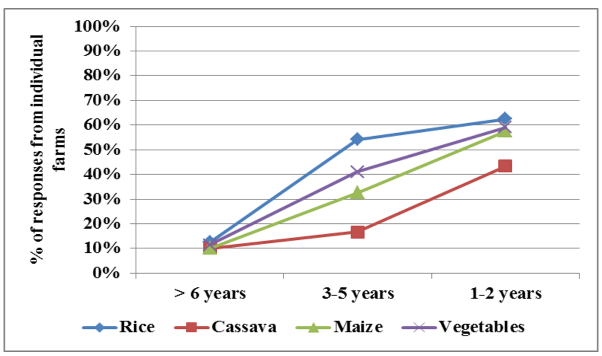


2. Satisfaction with the quality of information received

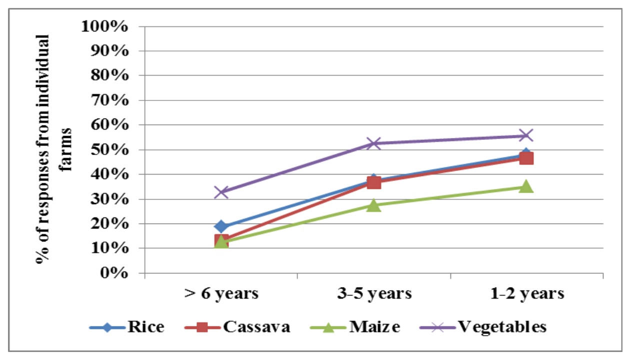


Source: FGDs.

3. % of farmers receiving price information from RGC activities



4. % of farmers receiving price information from other value chain actors



Source: Individual farmers' survey.

114. **Use of mobile technology has started to improve access to information**. In 2013, 95 percent of the interviewed farmers owned a mobile phone. About a quarter reported using their mobile phone to request information, mostly on price and commercialization; most of these were located in Takeo and Kampot provinces. The use of mobile phones to get technical advice on technologies is still at the early stages, with only very few cases in Kampong Cham, Kandal, Battambang, and Bantey Meanchey provinces. These communications were often between private actors (farmers, sellers, suppliers); the percentage of farmers receiving calls or SMSs related to agriculture (price or techniques) from the RGC and NGOs remained below 10 percent.

Business development services and contract farming

115. **Services providing support to farmers with respect to business planning and contract farming are not yet developed in rural Cambodia**. Only a handful of villages reported having these services available to them. For example in the past two years, only three villages in Takeo, Kampot, and Battambang provinces reported having the opportunity to work with business development service providers. The services provided focused on vegetables and upland crops, excluding rice. However, the quality of the support received from business development service providers was disappointing, as reported by several FGDs.

116. **Contract farming in Cambodia is still limited**. Only 6 out of the 36 FGDs provided an answer to the question related to contract farming. Groups that provided an answer were satisfied with the quality of services offered by the contractor. Contract farming is appreciated because it provides farmers with an easy way to sell their products, although some farmers complained about cases where other buyers offered higher prices. Among the individual farmers interviewed in 2013, only a handful of rice and vegetables producers in Takeo were involved in contract schemes.

117. **Farmers with contracts were able to get higher prices and higher gross margins**. The 2005 survey shows that contract farmers had a higher gross margin on rice ($478/ha versus $229/ha) and tobacco ($682/ha versus $132/ha). Even under harsh climate conditions such as drought, contract farmers had higher productivity due to better management practices. The 2013 survey did not specifically look at farmers with contracts. However, data collected on farm budgets show that the few farmers with contracts producing wet season rice had higher yield compared to noncontract farmers (3.5 tons/ha versus 2.84 tons/ha), received higher output prices ($325/ton versus $284/ton); and subsequently had a higher gross margin ($330/ha versus $236/ha). However, they had less cultivated land area, with an average of 0.8 ha versus 1.9 ha for noncontract farmers. Overall, the survey data showed no huge difference between the cost structures of farmers involved in contract farming and those of other farmers. Note that these averages should be treated with caution since they are from very small samples and are not statistically representative (i.e., 3 individual contract farms out of 33 rice farms interviewed in 2013).[35]

3.8. Farmers' Organizations

118. **Most farmers are not yet engaged in farmers' organizations (FOs)**. FGD participants were not able to report the main reasons for using FOs, resulting in low response rates. This could indicate either a lack of awareness or an unsuccessful past experience in participating in an FO. In the selected FGDs, there was no report of creating cooperative FOs. In some cases, being a member of FOs has a direct advantage. For example, most farmers should be willing to be part of a water users association to get the benefits of irrigation and drainage. The low response rate (1 out of 36 FGDs) may be caused by the lack of irrigation infrastructure in the sampled villages. Similarly, a credit group is a valuable tool available to smallholders, alleviating the barrier to access to credit. In this sample, 4 out of 36 FGDs reported having such a group in their village even though there is an overall assessment that access to credit increased for farmers in the past years. On the other hand, higher numbers of FGDs reported having FOs focused on input supplies (6 cases including equipment supply) and production (10 cases) (Figure 26). The move toward mechanization and intensification of agricultural production would entice producers to be more interested in FOs (CDRI 2012). The practice depicted by the current study shows the emergence of private mechanized service providers. Having production groups would reduce the costs and improve the quality of the work for FOs based on machinery and would reduce the transaction costs with higher assurance on the quality for FOs based on inputs supply (seeds, fertilizers).

119. **The governance and capacity of existing FOs need to be improved so that farmers appreciate the benefits of membership**. About half of the FGDs recognized that FOs are very helpful; a quarter reported that they received very little benefit from FOs; and another quarter stated that FOs can do better. Suggestions on improvement from the FGDs included more education and awareness raising for farmers, more technical training to empower farmers to

[35] The 2013 sampling method did not use contract farming as selection criteria.

bargain with other value chain actors, and formalization. Although Cambodia has a variety of FOs (Box 4), most of them are not operational. The RGC is trying to promote the formation of agricultural cooperatives that could lead to sustainable business models. Cambodia's experience with cooperatives so far is still limited and it is too early to fully assess their success.

Figure 26: Reasons for creation of FOs and their perceived benefits, Cambodia, 2013

Source: FGDs.

Box 4: Farmers' Organizations in Cambodia

In Cambodia, five classes of FOs exist, as follows: (i) Farmers' groups, with 5-15 members; (ii) Farmers' associations, with > 15 members; (iii) Farmer Communities, for users of natural resources like forests, fisheries, and Water Users Groups; (iv) Federations, where different groups form an overarching common group; and (v) Cooperatives, called either farmer coops or agricultural coops, established at either the village or commune level

MAFF's current focus is on forming coops because they are supposed to lead to a more sustainable business model than farmers' groups. Cooperatives are subject to a Royal Decree ("Compilation of legal framework for agricultural cooperatives 2012") that includes a model statute for each cooperative to follow in setting its operating rules. There must be a minimum of 30 members to form a coop. Any one member can have a maximum of 20 percent of the coop's shares. Each member has an equal vote, regardless of his/her number of shares. Activities of cooperatives can be many and varied, but must be limited to agricultural activities (e.g., input supply, marketing, production, credit provision, and money savings).

The Royal Decree follows seven international principles of cooperatives, as identified by the International Cooperative Alliance. The Royal Decree is currently in the process of being upgraded to a law (i.e., by passing through the National Assembly).

There is a prescribed five-step process for establishing a coop. The formation of a coop must be voluntary rather than forced upon farmers. Five pilot coops were established in five provinces in 2003. The Royal Decree makes provision for formation of coops, to be registered by MAFF, normally via the relevant Provincial Department of Agriculture (PDA). It is estimated that there are currently 360-370 cooperatives in Cambodia.

The PDA is responsible for taking farmers through the five steps of forming a coop, and the PDA Director signs for registration of a coop once the steps are completed. MAFF provides its Coops Unit with a budget to help farmers obtain the training they require and covers the legal costs of establishing coops. Sometimes project donors contribute toward the costs of establishing coops, but farmer members need to cover their running costs. The PDA cannot interfere with the internal workings of a coop. However, each coop must hold an Annual General Meeting every year and send a report to the PDA.

3.9. Agricultural Infrastructure

Irrigation

120. **In addition to the RGC's investment in irrigation infrastructure, some farmers are making individual investments in irrigation**. Wokker *et al*. (2014) show that the elasticity[36] of water irrigation in Cambodia may vary from 6 percent for the wet season to 12 percent for the dry season, measured in terms of rice production. This relatively low return does not stop Cambodian farmers from paying for and investing in irrigation (Figure 27.1). Sales of irrigation pumps rose 30 percent in the last five years, and the RGC's Rectangular Strategy aimed to increase irrigated land by 120,000 ha from 2008 to 2013. For the 2013 dry season rice production, farmers spent an average $53/ha for irrigation, with the cost peaking at $115/ha for farmers in Takeo province.

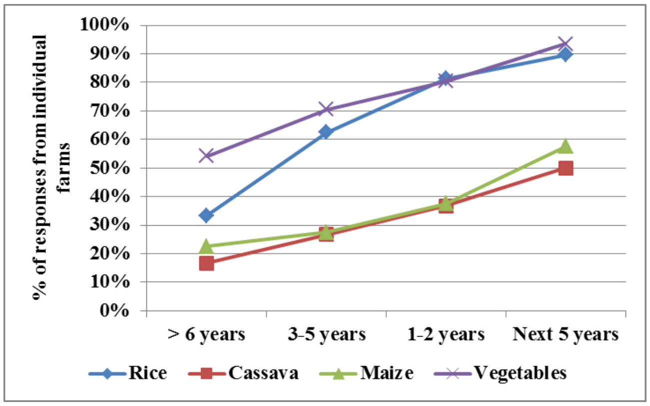
121. **Farmers stressed the importance of irrigation in their assessment of the impacts of flooding and drought on agricultural production**. However, farmers were more concerned about drought than flooding. About half of the FGDs assessed flooding as having a major impact on their activities, while three out of four said the same for drought. Indeed, these natural shocks affect farmers differently depending on whether their landholdings are lowland or upland and on the agricultural season (wet or dry) (Figure 27.2 and Figure 27.3). Fear about the impact of drought led dry season rice producers to invest in small pumps and to allocate 11-20 percent of their total variable costs to irrigation. Indeed, the additional cost of water irrigation from the use of individual water pump equipment resulted in adequate yield and higher gross revenue but negatively affected farms' gross margins. In general, farms using individual irrigation equipment received 50-150 percent lower gross margins than similar size farms with no irrigation costs. For modern farmers, regardless of farm size, irrigation expenditures constituted 18-20 percent of total variable costs (see Table 74 - Table 77 in *Annex 3*).

122. **Aside from irrigation pumps, individual investment in water control is still underdeveloped**. Irrigation pumps were very popular in several villages. Farmers identified pumps as an efficient way to overcome the lack of hard irrigation infrastructure such as a dam, while simultaneously reducing the likelihood of production lost due to drought and in some cases flooding. Pumps are used to drain water from flooded fields. Farmers also used pumps during the dry season, thus increasing the possible number of harvests per year as well as crop productivity. On the other hand, farmers were not using more modern irrigation technologies such as drip irrigation and greenhouses, often used for vegetable production in other countries, except in a few isolated cases.

[36] Defined as the percentage change in production due to a percentage change in irrigated water.

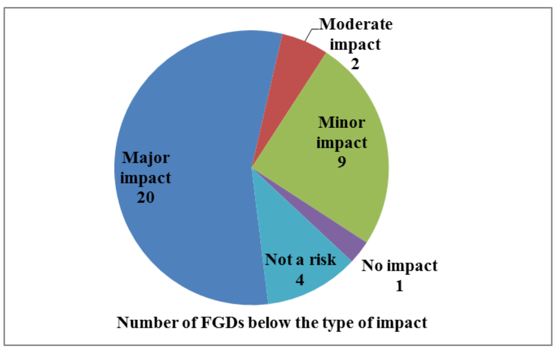
Figure 27: Irrigation, Cambodia, 2013

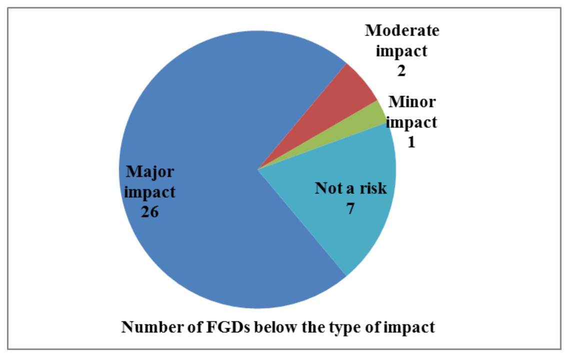
1. Change in the use of and perspectives on pump irrigation



Source: Individual farmers' survey.

2. Perceived impacts of flooding (L) and drought (R) on agricultural productivity





Source: FGDs.

Other agricultural facilities

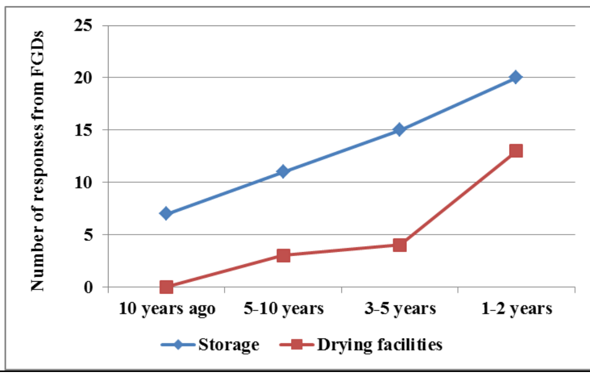
123. **Expansion of cultivated areas and mechanized agricultural production increased the need for drying and storage facilities**. Results from the FGDs show that about one in three villages was concerned with drying and storage facilities (Figure 28.1 and Figure 28.2), a constraint that mostly affected medium-size to large farms. The increased need for storage and drying facilities was directly caused by the mechanization of harvest and post-harvest activities. With mechanization, farmers face a high volume of wet products within a short period of time. To reduce losses and preserve product quality, farmers need to have adequate storage and drying facilities. Drying facilities became a priority for some villages in the past two years. During the FGDs, farmers complained about the low prices offered by middlemen and crop collectors for wet products. Without adequate drying and storage facilities, farmers were obliged to sell at the prevailing prices, often determined by the buyers.

124. **Farmers were also concerned about the lack of social infrastructure, especially sanitation and potable water** (Figure 28.3 and Figure 28.4). In its Rectangular Strategy, the RGC states that "water supply and sanitation" is a critical element of rural development. The government

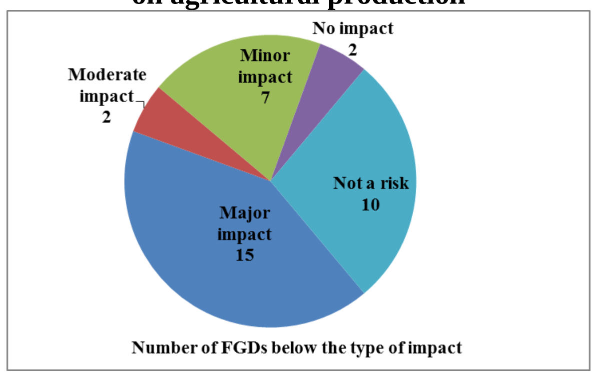
planned to increase access to sanitation from 23 percent of the rural population in 2008 to 33 percent in 2013, and access to drinking water from 40 percent in 2008 to 50 percent in 2015. The overall health of farmers' family members will be improved by greater use of adequate sanitation facilities and better access to drinking water. This will indirectly increase agricultural labor productivity by reducing the number of days of illness, for example. The entire value chain may benefit from this infrastructure due to greater prevention of contamination of fresh fruits and vegetables. Regulations in importing countries sometimes require a minimum level of infrastructure in sanitation and access to drinking water at production and processing units before products are eligible for export.

Figure 28: Agricultural facilities, Cambodia, 2013

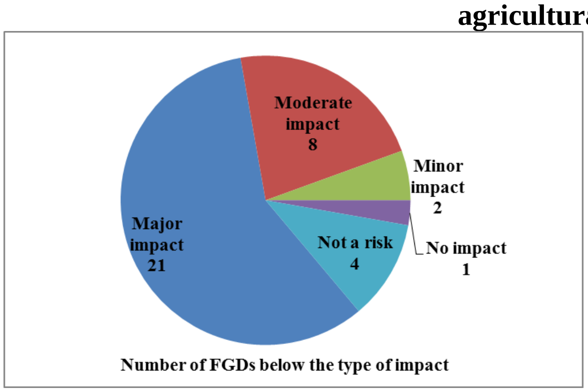
1. Change in the use of agricultural facilities

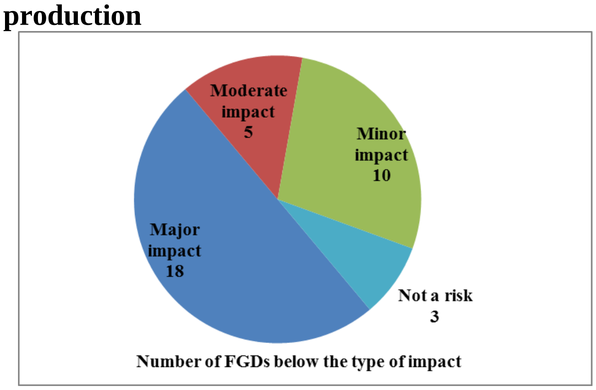


2. Perceived impact of lack of storage facilities on agricultural production



3. Perceived impact of lack of adequate sanitation facilities (L) and water distribution (R) on agricultural production





Source: FGDs.

4. CHANGES IN FARM BUDGETS AND FARM PROFITABILITY

4.1. Introduction

126. **Chapter 3 described the transformational changes taking place in Cambodian agriculture**. Over the last decade, farmers have gotten better access to modern inputs and finance, and they get extension advice from various sources. They use more inputs as a result, and labor is being replaced by mechanized services. Farmers have better access to markets. All these improvements have increased the adoption of yield-increasing technologies. On the other hand, the quality of public programs has not been satisfactory. Farmers want more and better agricultural extension, combined with public and private delivery mechanisms. They want better price and market information. They seek to gain benefits from collective action. And they also want lower production and marketing costs to be achieved through better quality of irrigation and other infrastructure investments. This hints at the issues related to total factor productivity (TFP). Farmers use more inputs to maximize gross revenues but do not necessarily receive adequate public agricultural services to use these inputs as efficiently as possible to maximize incomes.

127. **The 2013 survey collected detailed farm production information to understand the impact of the above changes in the agriculture sector on farm incomes**. This information includes revenues, variable and fixed costs, gross margins, and returns to labor for each farm budget model. Surveyed farmers were selected based on their crops, their level of use of modern technology, and the area of cultivated land allocated to specified crops. Wet season rice, dry season rice, cassava, maize, and vegetables were chosen for study as they best characterize the changes in Cambodia's farming systems since the mid-2000s.

128. **Farms were characterized as small, medium or large.** This categorization varies by the crop (Table 25). For cassava, small is a farm cultivating less than 5 ha, medium is between 5 ha and 10 ha, and large is over 10 ha. For maize and rice, small is below 1 ha, medium is between 1 ha and 3 ha, and large is over 3 ha. Vegetables are quite difficult to categorize because most farms would be considered small. It was decided to categorize farmers with less than 0.3 ha as small, between 0.3 and 0.5 ha as medium, and over 0.5 ha as large. The purpose of the categorization was to assess the likely impact of farm size on farm productivity and profitability.

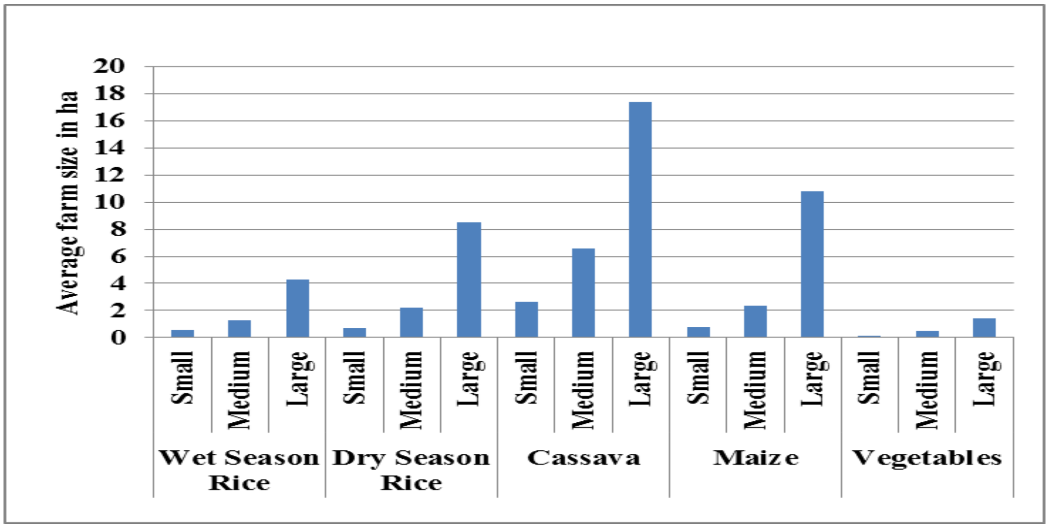
Table 25: Categorization of farm size by cultivated crop areas, Cambodia

Commodity	Farm Size		
	Small	Medium	Large
Wet season rice	Less than 1 ha	Between 1 and 3 ha	More than 3 ha
Dry season rice	Less than 1 ha	Between 1 and 3 ha	More than 3 ha
Cassava	Less than 5 ha	Between 5 and 10 ha	More than 10 ha
Maize	Less than 1 ha	Between 1 and 3 ha	More than 3 ha
Vegetables	Less than 0.3 ha	Between 0.3 and 0.5 ha	More than 0.5 ha

129. **Figure 29 presents the average farm size of the individual farmers interviewed in the 2013 survey**. The average size was: 1.80 ha for wet season rice farmers; 4.15 ha for dry season rice producers; 8.25 ha for cassava farmers; 4.82 ha for maize farmers; and 0.41 ha for vegetable farmers. The average size of large cassava farms, for example, was above 17 ha, while for large

vegetable producers, the average farm size was only 2.37 ha. Average farm size by crop for the current study may differ from the national figures[37] because of the use of purposive sampling for the selection of farms. This survey selected similar numbers of farms (one to two) using the criteria of farm size and level of technology use.

Figure 29: Average land by farm size and crop, Cambodia, 2013



Source: 2013 survey.

130. **In addition to the grouping by size, farmers were grouped into two categories of technology use: traditional and modern**. This grouping was based on initial criteria (such as use of improved seeds, use of fertilizers and chemicals, mechanization, and irrigation) that were then used to carry out a factor analysis to identify similar farmers. An example of factor analysis output is presented in Box 5. For the data collection and analysis, two to three farmers were selected within each category as defined by crop, farm size, and technology use. This sample selection process selected a possible range of farmers who may not be statistically representative.

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[37] Overall, 48 percent of rural households in Cambodia hold less than 1 ha of agricultural land, though the difference between provinces can be significant according to the MAFF crop data assessments of 2003 and 2004.

Box 5: Factor Analysis and *Modern* versus *Traditional* Farmers

The decision to categorize farmers as using traditional or modern technologies is not straightforward. No clear separation exists between users and nonusers of modern technologies in agriculture. Most farmers adopt at least one modern technology, and in practice, farmers are in a continuum of use for each technology. For example, very few farmers do not adopt chemical fertilizers, but for those who do the quantity applied varies from very little to very high.

In this analysis, principal components factor analysis was used to reduce the optimal combination of several independent variables into one score index that ranks farmers along one dimension. The goal is to characterize farmers as modern or traditional based on their level of use of modern inputs, labor, and services. The following factors were retained for the analysis: use of modern inputs (improved seeds, fertilizers, and pesticides), use of agricultural services (land preparation, harvest, post-harvest, irrigation), and use of labor (modern farms have lower use). These variables were used to compute the rank of each farm into one latent variable, the projection of each farm from a multi-dimensional to a one-dimensional space. The analysis was conducted by crop.

131. **The main elements of a farm budget are gross revenue, variable costs, gross margins, and returns to labor, defined as follows**:

a. *"Gross revenue"* is the amount received by farmers assuming that the entire production is sold at the farm gate price determined by farmers. Additional revenues obtained through the sale of byproducts are also taken into account. For example, in the case of paddy, gross revenue includes sales of straw for paddy rice.

b. *"Variable costs"* are the amount spent by households for the production of the crop, excluding the costs of family members' labor or the use of households' agricultural assets for agricultural production. Total variable costs do not take into account the depreciation of households' agricultural equipment. In general, variable costs include: input expenditures (improved seeds, manure, fertilizers, and chemicals – herbicides and insecticides); expenditures on hired labor (land preparation, sowing, plantation, and transplantation, weed control, crop management, labor for irrigation, manual harvest and post-harvest tasks); and costs of services (land preparation, plantation, irrigation, harvest and post-harvest, and transportation).

c. *"Gross margin"* is gross revenue minus variable costs (Box 6). It is the remuneration of farmland, labor, and capital, as well as the profit received by farmers from production activities. Given that very few farmers rent land and own machinery, gross margin in Cambodia can be considered a remuneration to labor and farm management, which allows the calculation of the returns to own labor, the next indicator.

d. *"Returns to labor"* is the gross margin divided by man-hours of own farm household labor spent on the production of specific crops.

Box 6: Gross Margin *versus* Value Added

The concept of farm gross margin is similar to the concept of value added but it is not identical. The difference is in the treatment of hired labor. Value added is defined as gross revenue *less* intermediate inputs, while gross margin is gross revenue *less* intermediate inputs and hired labor. Depending on changes in the cost of hired labor, value added can differ from gross margins, sometimes significantly.

132. **The results of the 2013 survey were compared with the 2005 study,[38] which combined primary data with data from secondary sources, including the 1992/93 and 1997/98 NIS socioeconomic surveys' datasets, market price data collected by Marketing Office/MAFF, and various studies undertaken in Cambodia**. The primary data sources comprise focus discussions with key informants at the district level in representative agro-ecological zones. The list of key informants included local NGOs working in agriculture, forestry, and livestock development, a sample of producers (small, medium, and large) of major commodities, marketing agents, processors, and representatives from government agencies based at the district level.

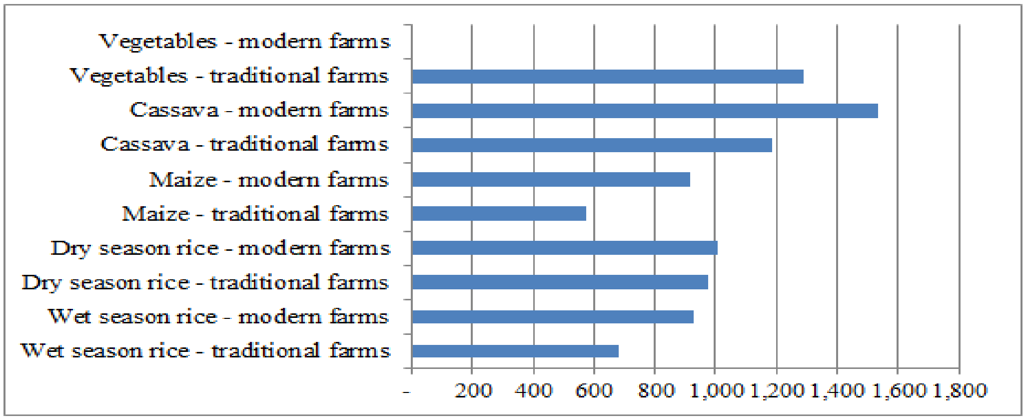
133. **Change over time was assessed by comparing data from the 2005 and 2013 surveys**. These changes are presented in nominal and real terms. The GDP deflator was used to obtain real term results. The cumulative GDP deflator between 2005 and 2013 was 35 percent, according to the International Monetary Fund (IMF). Price data were converted into US$, using the exchange rate of Riels 4,000 to 1 US$.

4.2. Results of the 2013 Survey

134. **Farmers got the highest total revenue per hectare from vegetable production ($2,843/ha)**, followed by cassava ($1,297/ha) and dry season rice ($992/ha). Wet season rice ($756/ha) and maize ($744/ha) were in between. Modern farms tend to generate larger revenues per hectare than traditional farms for all crops; the largest difference is for vegetables and the smallest is for dry season rice (Figure 30). *Annex 3* presents detailed farm budgets for each crop and farm type.

[38] The 2005 survey was conducted as a part of the World Bank's Cambodia Agrarian Structure Study (2008). The 2005 survey collected 2004 wet season and 2005 dry season data (the 2004/05 marketing season), and the 2013 survey collected 2012 wet season and 2013 dry season data (the 2012/13 marketing season).

Figure 30: Gross revenues ($/ha) by crop and farm practice, Cambodia, 2013

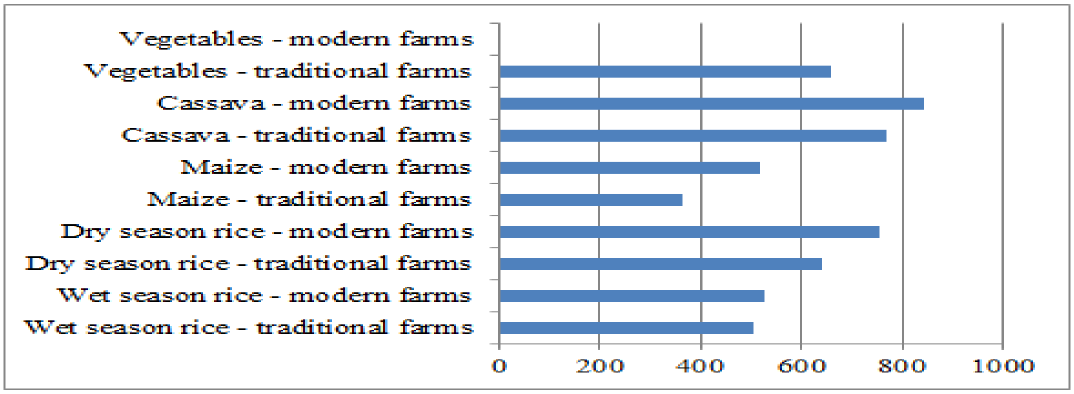


Note: The revenue from vegetables for modern farms does not fit into the scale of this figure, and thus is not shown.
Source: 2013 survey.

135. **In general, farmers using modern technologies had higher yields and often sold their products at higher prices**. The price of paddy for wet season modern producers was $242/ton versus $235/ton for traditional farmers; modern maize farmers received 21 percent more ($235/ton versus $195/ton); and cassava producers got slightly higher prices at $161/ton versus $157/ton. The combination of higher yield and higher prices of outputs resulted in higher gross revenue for modern farmers.

136. **Similar to revenues, <u>total variable costs</u> were highest for vegetable producers**. They averaged $1,481/ha. Total variable cost for maize was $440/ha, wet season rice $510/ha, dry season rice $696/ha, and cassava $791/ha, with differences between traditional and modern farms (Figure 31). Total variable costs are a critical element in determining the choice of crops, the cultivated areas, and the production strategy. If finance is a constraint for upland farmers, then maize would be the best choice because it requires less upfront operational costs compared to cassava. Similarly, growing dry season rice on irrigated land is less financially demanding than growing vegetables, assuming the same cultivated area. High production costs of vegetables explain the slow uptake in vegetable production in Cambodia.

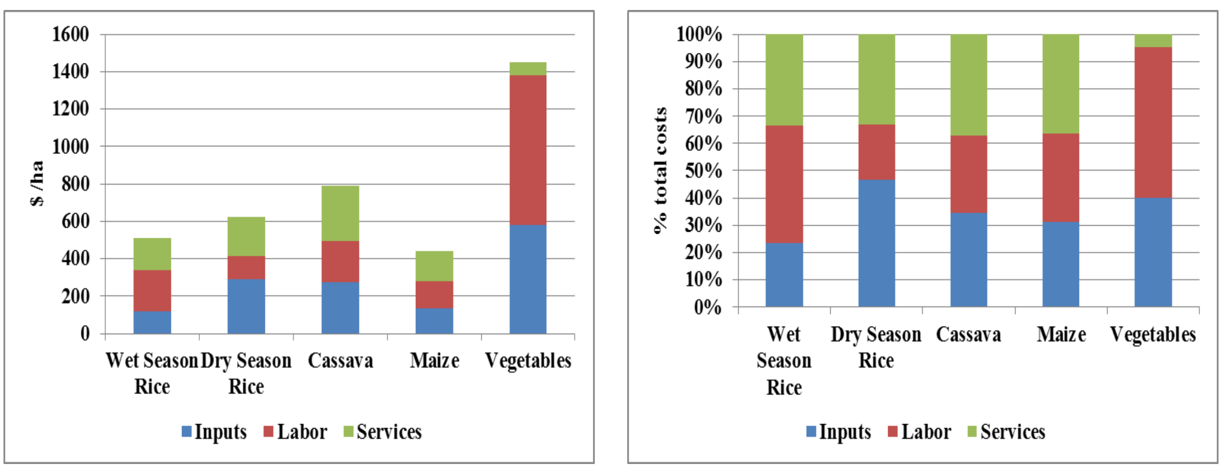
Figure 31: Total variable costs ($/ha) by crop and farm practice, Cambodia, 2013



Note: The costs for vegetables for modern farms do not fit into the scale of this figure, and are thus not shown.
Source: 2013 survey.

137. **Variable costs are influenced by many factors, including farmers' financial position, technology choices, and input prices**. Hired labor accounted for the largest share of total variable costs for wet season rice and vegetable producers (Figure 32). Inputs and mechanized services were important for all crops, except vegetables. On average, expenditures of modern farmers exceeded those of traditional farmers, with the magnitude varying by type of crop: 10 percent for cassava, 40 percent for maize, 20 percent for dry season rice, and more than 200 percent for vegetables (*Annex 3*). These costs were mostly related to purchase of modern inputs and hiring labor.

Figure 32: Breakdown of cost structure by crop, Cambodia, 2013



Source: 2013 survey.

138. **In 2013, farmers producing vegetables got the highest <u>nominal gross margins</u> per hectare**. For one hectare under cultivation, farmers had a gross margin of $1,394 for vegetables, $506 for cassava, $296 for dry season rice, $304 for maize, and $245 for wet season rice (Table 26). Gross margins were much higher for farmers using modern technologies, except for dry

season rice, while the impact of farm size on gross margins was not uniform (see more discussion on economies of scale below).

Table 26: Gross margin ($/ha) by crop, technology use, and farm size, Cambodia, 2013

	Farm Size			
Commodity	**Small**	**Medium**	**Large**	**Total**
	Overall Sample ($/ha)			
Wet season rice	207	270	240	245
Dry season rice	307	283	297	296
Cassava	544	438	512	506
Maize	244	336	330	304
Vegetables	1,575	747	306	1,394
	Users of Modern Technologies ($/ha)			
Wet season rice	522	415	341	400
Dry season rice	276	174	283	255
Cassava	774	788	609	695
Maize	282	504	522	396
Vegetables	2,239	-	-292	2,155
	Users of Traditional Technologies ($/ha)			
Wet season rice	117	236	71	178
Dry season rice	312	349	415	336
Cassava	493	298	416	422
Maize	119	192	253	212
Vegetables	611	747	505	633

Source: 2013 survey.

139. **<u>Returns to labor</u> varied from $4.62/day to $9.58/day, depending on the crop** (Table 27). The returns to labor were well above the prevailing wages paid to hired labor in 2013, averaging $4.5/day. Overall, one day spent working on cassava production yielded $9.43 in return. For wet season rice, the return was $4.62/day, slightly higher than the daily cost of hired labor for medium-size wet season rice farms, but there was a huge difference between modern farmers ($12.67/day) and traditional farmers ($2.86/day). Dry season rice provided the highest returns to labor ($9.58/day), because of the very low share of labor in its cost composition, especially for large farms. Other crops showed a pattern similar to that observed for wet season rice: higher returns to labor when farmers used modern technologies.

Table 27: Returns to labor ($/day) by crop, technology use, and farm size, Cambodia, 2013

	Farm Size			
Commodity	**Small**	**Medium**	**Large**	**Total**
	Overall Sample ($/day)			
Wet season rice	2.99	4.83	8.2	4.62
Dry season rice	6.15	8.27	22.83	9.58
Cassava	10.71	6.82	10.62	9.43
Maize	5.89	9.51	12.12	8.83
Vegetables	7.1	12.88	3.8	7.21
	Users of Modern Technologies ($/day)			
Wet season rice	8.73	9.24	27.98	12.67
Dry season rice	90.61	74.36	55.3	60.04
Cassava	13.75	8.58	12.17	11.2
Maize	6.32	12.09	38.1	10.56
Vegetables	7.54	-	-	7.54
	Users of Traditional Technologies ($/day)			
Wet season rice	1.62	4.05	1.23	2.86
Dry season rice	5.4	6.54	5.43	5.85
Cassava	9.95	5.6	8.94	8.45
Maize	3.83	6.42	7.81	6.75
Vegetables	5.42	12.88	6.31	6.53

Source: 2013 survey.

140. **In most cases, small farms generated similar gross margins per hectare as larger farms**. Only maize production and, to a limited extent, dry season rice production for traditional technology adopters showed higher returns as farm size increased (i.e., economies of scale). In these two cases, large farms had higher gross margins per hectare compared to medium-size and small farms (Table 26). For maize production, large farms using modern technologies had about twice the gross margins of small farms ($522/ha versus $281/ha) and medium farms about three-fourths higher ($504/ha versus $281/ha). Similar trends were observed for farmers practicing traditional techniques, with $253/ha, $191/ha, and $118/ha for large, medium-size, and small farms, respectively.

141. **For vegetable production and modern farmers growing wet season rice, gross margins per hectare were higher for small farms**. Small vegetable farms had the highest gross margin per hectare, with an average of $2,239/ha when adopting modern technologies. Even for farmers using traditional techniques, gross margins calculated from small farms' budgets were 17 percent higher than large farms' gross margins. Lower returns for larger farms may be due to several factors. The theory of indivisibility of assets does not hold for most agricultural tasks. For example, during land preparation farmers have a choice between using draught oxen and ox-plows, power tillers, and small mechanized equipment, and tractors that are available in different sizes and powers. For harvest, farmers' options range from the use of manpower to the use of combines; reapers and threshers lie in between. Farmers may adopt specific strategies depending on

household endowment to maximize either production (for food-insecure households) or profit (for commercial smallholders). Decreasing economies of scale may also be the consequence of small farms' higher efficiency compared to large farms. For farmers with low literacy, management difficulties in addition to increased risks may reduce efficiency as scale expands. For example, a large farm that cultivated 3 ha of watermelon in Battambang ended up with a total gross loss of $876 ($292/ha). Indeed, vegetable production is prone to several critical phases that require timely and adequate management decisions. Poor management of frequent pest attacks, lack of irrigation water during the growing period, or issues of product perishability during harvest and post-harvest periods will reduce the efficiency in vegetable production. Under these constraints, farmers are more vulnerable to production and price risks.

142. **Yet the analysis of the returns to labor shows clearly increasing returns as farm size increases**. Returns to a day of labor for wet season rice production increased from $2.86/day for small farms to $12.67/day for large farms (Table 27). The average return for wet season rice was $4.83/day. Maize production showed very similar trends: medium-size farms exhibited 61 percent higher returns to labor compared to small farms and large farms twice as high, at $12.19/day. Dry season rice production showed the highest impact of farm size on returns to labor with $6.15, $8.27, and $22.83 for small, medium-size, and large farms, respectively. For cassava, the size of farms seemed not to affect returns to labor. Returns to labor for large farms seem to benefit from the reduced labor for management and crop monitoring. It may also benefit from better access to capital, resulting in higher use of labor-saving equipment. Large farms may also have lower costs of transactions and transportation, both for inputs (consolidation of purchase) and commercialization, which would affect assembly costs (consolidation of sales).

143. **The returns to labor for small farms producing rice during the wet season were below the prevailing wage rate**. This has a direct impact on tackling poverty reduction because wet season rice still constitutes 83 percent of total cultivated rice land, comprising most smallholder farmers. This is critical for poverty reduction policy because returns to labor determine farmers' wealth, and rice cultivation occupies more farmers in Cambodia than any other crop.

144. **A higher level of technology use enhances returns to labor**. Farmers using a higher level of technology had much higher returns to labor, regardless of farm size (Table 27). The ratio was about 1 to 2 for maize, 1 to 10 for dry season rice, and 1 to 4 for wet season rice. Vegetable and cassava producers had the least impact of technology use on returns to labor, although modern cassava farmers had a 30-50 percent higher return than traditional farmers.

4.3. Comparison of the 2005 and 2013 Survey Results

145. **In nominal terms, all 2013 gross margins were above the 2005 values, except for maize** (Table 28 and Figure 33). A comparison of the gross margins between the two periods shows that vegetable producers got five times more than the $284/ha received in 2005; the gross margin for cassava increased 2.5 times from $198/ha; and dry season rice doubled from $195/ha. However, maize was reduced by 50 percent, from $574/ha to $304/ha.

Table 28: Comparison of key farm budget indicators, $/ha, Cambodia, 2005 and 2013

Total Revenue	2005 ($/ha)	2013 ($/ha)	Change (%)
Cassava	375	1,297	246
Maize	708	744	5
Wet season rice	345	756	119
Dry season rice	398	992	150
Vegetables	433	2,843	556
Total Variable Costs			
Cassava	178	791	346
Maize	134	440	229
Wet season rice	186	510	174
Dry season rice	202	697	245
Vegetables	149	1,449	893
Gross Margins			
Cassava	198	506	156
Maize	577	304	-47
Wet season rice	159	245	55
Dry season rice	195	296	51
Vegetables	284	1,394	380

Source: 2005 and 2013 surveys.

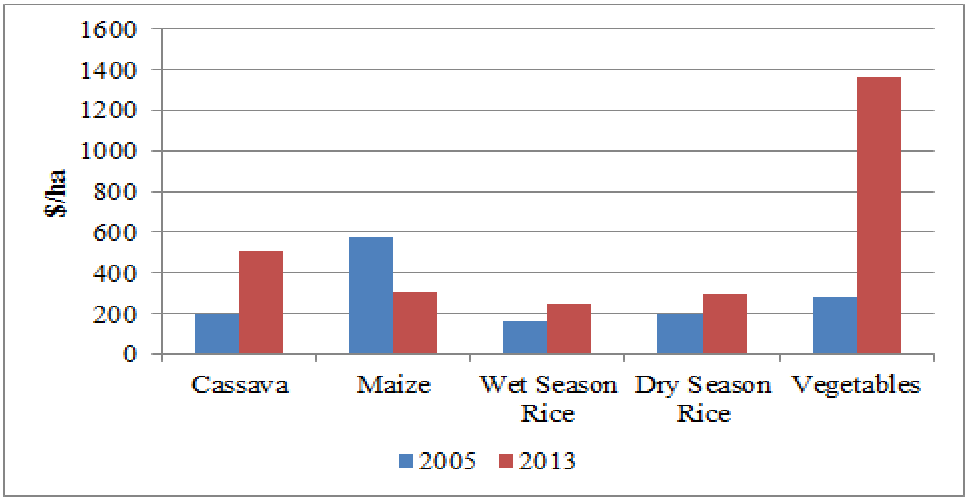
146. **These changes were driven by changes in yields and prices of outputs and inputs**. From 2005 to 2013 (survey data), cassava prices increased by 200 percent, paddy rice prices by 90 percent, maize prices by 64 percent, and vegetable prices from 60 percent (eggplant) to 233 percent (watermelon). During the same period, prices of inputs almost tripled for seeds and labor ($1.2/day to $4.5/day), and doubled for fertilizers (urea from $0.30/kg to $0.56/kg and DAP from $0.35/kg to $0.68/kg).

147. **The structure of costs, especially for the use of labor, also showed radical changes**, with sharp declines of 20 percent (maize) to 70 percent (dry season rice). The lower labor use was a response to rising wages and availability of mechanization services in rural areas. The exception was vegetables, where the labor use increased five-fold, from 38 days/ha to 176 days/ha. Since the 2005 survey included a mix of vegetables while the 2013 survey focused on four main vegetable crops,[39] this huge shift may be due to the change in the types of vegetables produced.

148. **In 2013, farmers used more modern inputs per hectare, especially improved seeds and fertilizers**. In 2005, surveyed farmers applied an average 100 kg/ha of fertilizers (all combined) for dry season rice production. This quantity was 2.5 times higher in 2013, reaching 250 kg/ha. The same pattern was observed for vegetables, with an increase from 110 kg/ha to 295 kg/ha. The rates of application for wet season rice (120 kg/ha) and maize (50 kg/ha) did not change much. However, the rate of application decreased for cassava from an average 30 kg/ha to 10 kg/ha in 2013.

[39] Cucumber, mustard, eggplant, and watermelon.

Figure 33: Comparison of nominal gross margins ($/ha), Cambodia, 2005 and 2013



Source: 2005 and 2013 surveys.

149. **In nominal terms, the sum of gross margins for all selected crops more than doubled, from $469 million in 2005 to $1,067 million in 2013**. The cumulative increase was 103 percent, or 13 percent per year. This increase was driven by both the expansion in land area (37 percent) and the per hectare gross margins (63 percent) (Table 29). The smallest increase in total margin was observed for maize: 90 percent from 2005 to 2013; the largest increase was observed for cassava: 1,180 percent.

Table 29: Comparison of total crop budgets, Cambodia, 2005 and 2013

	2005			2013		
Crop	**Unit Margin ($/ha)**	**Cultivated Land (ha)**	**Total Margin ($ million)**	**Unit Margin ($/ha)**	**Cultivated Land* (ha)**	**Total Margin ($ million)**
Wet season rice	159	2,121,591	337	245	2,484,832	609
Dry season rice	195	321,939	63	296	495,465	147
Cassava	198	30,032	6	506	337,800	171
Maize	577	90,732	52	304	215,442	65
Vegetables	284	35,762	10	1,394	54,155	75
Total	**180**	**2,600,056**	**469**	**298**	**3,587,694**	**1,067**

Note: * Land area is used for the year 2012.

Source: 2005 and 2013 surveys.

150. **In real terms, however, the growth in total gross margins was smaller**. It rose by 68 percent during 2005-2013, or 9 percent a year (Table 30). This increase was due to the 38 percent change in cultivated crop land and 30 percent increase in per hectare gross margin. Unit margins increased for all crops except maize.

Table 30: Changes in crop margins in nominal and real terms, Cambodia, 2005 and 2013

Crop	Change in Unit Margins Between 2005 and 2013 (%)	Change in Cultivated Land Between 2005 and 2013 (%)	Change in Total Margins Between 2005 and 2013 (%)	Change in Unit Margins in Real Terms (%)	Change in Total Margins in Real Terms (%)
Wet season rice	54	17	71	19	36
Dry season rice	52	54	106	17	71
Cassava	156	1,025	1,180	121	1,145
Maize	-47	137	90	-82	55
Vegetables	391	51	442	356	407
Total	**65**	**38**	**103**	**30**	**68**

Note: The cumulative GDP deflator from 2005 to 2013 was 35 percent.

Source: 2005 and 2013 surveys.

151. **There are differences in the sources of growth across crops**. Although cassava's per hectare profitability grew annually by 15 percent, the most growth in total gross margin came from land expansion (Table 31). The problem with that growth is that land expansion in cassava is unsustainable, since it is carried out through exploitation of soils that were previously forest land. Most growth in maize and dry season rice also came from land expansion. But in the case of wet season rice and especially vegetables, the increase in total gross margin was mostly due to the increase in per hectare profitability. On average, the total gross margin for all crops considered increased 8.2 percent per year, due to 4.7 percent land expansion and 3.4 percent in per hectare margins.

Table 31: Annual changes in crop margins in real terms, Cambodia, 2005 and 2013

	Change in cultivated area between 2005 and 2013 (%)	Change in unit gross margin between 2005 and 2013 (%)	Change in total gross margin between 2005 and 2013 (%)
Wet season rice	2.1	2.4	4.5
Dry season rice	6.7	2.1	8.8
Cassava	128.1	15.1	143.2
Maize	17.2	-10.3	6.9
Vegetables	6.4	44.5	50.9
Weighted average	**4.7**	**3.4**	**8.2**

Source: 2005 and 2013 surveys.

152. **The increase in agricultural production and farm profitability has led to an increase in the returns to own farm household labor**. The returns to labor in real terms increased by 84 percent for wet season rice, 254 percent for cassava, and 278 percent for dry season rice

(Table 32).[40] But the returns to labor fell for maize and vegetables. The significant increase in the returns to labor for rice and cassava was a result not only of higher total gross margins but also of the reductions in labor used in production. The reduction in labor used ranged from 19 percent for maize to 69 percent for dry season rice (i.e., the structural transformation in action). Vegetables were the only crop where labor use increased over the observed period. This led to the decline in returns to labor in both nominal and real terms. Labor is being increasingly replaced by mechanized services in Cambodia.

Table 32: Changes in returns to labor in nominal and real terms, Cambodia, 2005 and 2013

Labor ($/ha)	2005	2013	Change in Nominal Terms (%)	Change in Real Terms (%)
Cassava	104.81	227.40	117	54
Maize	46.49	142.85	207	144
Wet season rice	101.81	220.21	116	53
Dry season rice	107.88	126.50	17	-46
Vegetables	45.83	802.10	1,650	1,587
Labor (days/ha)				
Cassava	87.34	49.87	-43	
Maize	38.74	31.33	-19	
Wet season rice	84.84	48.29	-43	
Dry season rice	89.90	27.74	-69	
Vegetables	38.19	175.90	361	
Returns to labor ($/day)				
Cassava	2.26	9.43	317	254
Maize	14.82	8.83	-40	-103
Wet season rice	1.87	4.62	147	84
Dry season rice	2.17	9.58	341	278
Vegetables	7.43	7.21	-3	-66

Note: The cumulative increase in the consumer price index between 2005 and 2013 was 63 percent.

Source: 2005 and 2013 surveys.

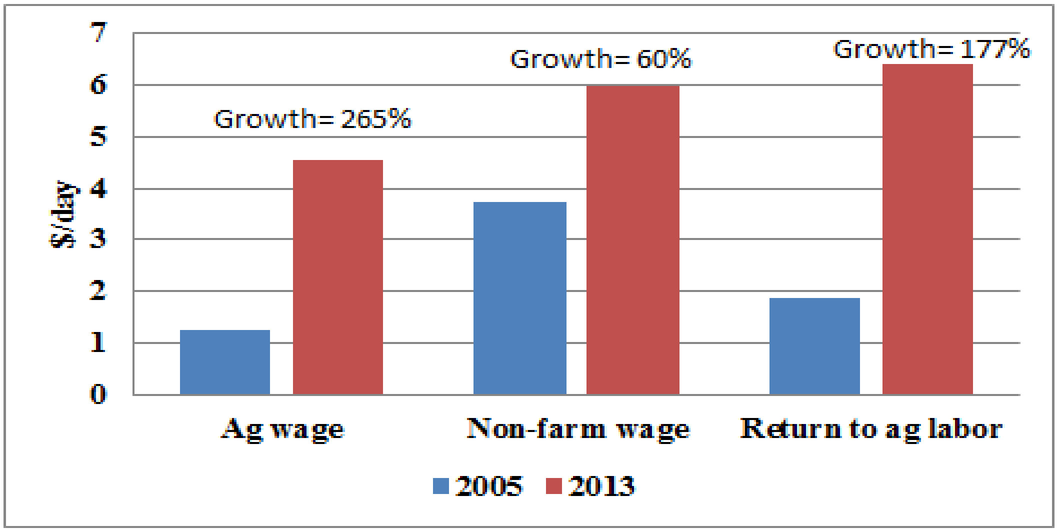
153. **As a result of increasing returns to labor, agricultural wages in general rose, converging with nonfarm wages**. Agricultural wages grew by a factor of almost three between the 2005 and 2013 surveys (**Error! Not a valid bookmark self-reference.**).[41] Over the same

[40] The adjustment factor for converting the returns to labor from nominal to real terms is the consumer price index (inflation), which includes prices of both food and non-food items. This index shows changes in the purchasing power of farmers, and is higher than the GDP deflator used to deflate gross margins. The GDP deflator includes only intermediate inputs used for production.

[41] This agricultural wage increase between 2005 and 2013 surveys is much higher than the 48 percent agricultural wage increase from 2007 to 2009 reported in the 2013 poverty assessment. There are several reasons for this difference. First, the surveys have different household coverage. Second, the poverty assessment does not include the 2005-2007 and 2009-2013 time periods. The increase was especially rapid between 2011 and 2013 when wages grew again after the slowdown during 2009-2011 in the aftermath of the global financial crisis.

period, nonfarm wages increased by only 60 percent. As a result, the gap between farm and nonfarm sector wages declined. Thus agriculture appears to have provided excellent income-earning opportunities in Cambodia over the last decade.

Figure 34: Farm wage, off-farm wage, and returns to agricultural labor ($/day), Cambodia



Source: 2005 and 2013 surveys.

5. COMPETITIVENESS OF CAMBODIAN FARMS

5.1. Introduction

154. **Chapter 4 described the farm income situation in Cambodia**. One of the findings is the rising production costs, especially for maize and rice. In most cases, the rise in production costs is compensated by higher revenues. The question, however, is how the increase in production costs affects farm competitiveness.

155. **Farm competitiveness in Cambodia is analyzed using the Domestic Resource Cost (DRC) approach developed by Tsakok (1990)**. DRC measures a country's efficiency in using domestic resources to produce specific goods. The key question DRC answers is whether a country has a comparative advantage in producing a certain good or if import is a better option so that domestic resources may be used to produce other commodities that result in higher profit. A DRC less than one suggests comparative advantage and efficiency in production: the domestic opportunity costs of producing the selected good are less than the domestic value added generated by the production process. Conversely, a DRC greater than one implies that production is inefficient and that foreign exchange would be better spent importing the product rather than producing it domestically.

156. **The DRC is computed based on the following assumptions**:

a. The foreign exchange premium is set to zero. In Cambodia, the foreign exchange rate is not a source of distortion because of the dollarization of the economy (i.e., US dollars and Riel are freely interchangeable within the country).

b. The capital recovery costs of agricultural equipment are not computed. The rental costs of equipment paid by farmers, including for irrigation using pumps, are split 80:20 percent, where 20 percent represents the cost of fuel, a tradable commodity. For transportation and irrigation, the estimated ratio is 60 percent nontradable and 40 percent tradable. The assumption is that the opportunity cost of equipment can be approximated by the rental fee because of the existence of a competitive market for agricultural equipment rental.

c. Land price is set to zero so that the social profit includes returns to land and to management.

d. A first set of DRCs is computed using average distances of 70-100 km from the production site to the export location for agricultural outputs, and conversely, from the off-load port to input suppliers' stores. This is the average distance between Battambang, Kandal, or Bantey Meanchey to the nearest border. Transportation cost is assumed to be Riel 32,000/ton ($8/ton). One to two provinces per crop were selected to compute the DRCs, taking into account the specificity of farm budgets in each region.

e. The reference international prices used in the analysis are those of Thailand Hom Mali grade A rice, Thailand Bangkok 5 percent broken rice, maize yellow grain, and dried cassava chips.

157. **The computed DRCs illustrate Cambodia's high comparative advantage in agricultural production**. The country has an advantage in producing most agricultural products. All of the DRCs are below one, with some very low, such as those for maize and cassava production, revealing a strong advantage in using domestic resources (Table 33). Least competitive

is wet season paddy production, the costs of which should be monitored closely to avoid losing its comparative advantage in the future.

Table 33: DRCs for selected agricultural crops, Cambodia, 2013

Commodity	DRC
Dry season rice (paddy) Kandal	0.69
Dry season rice fragrant (paddy) Kandal	0.43
Dry season rice (paddy) Bantey Meanchey	0.61
Milled rice (IRRI 5% broken)	0.54
Wet season rice (paddy) Takeo	0.78
Wet season rice (paddy) Bantey Meanchey	0.54
Wet season rice (paddy) Kampot	0.86
Wet season rice fragrant (paddy) Kampot	0.61
Milled rice fragrant Kampot	0.39
Cassava (dried chips) All	0.39
Cassava (dried chips) Battambang	0.35
Maize (grain) All	0.35
Maize (grain) Bantey Meanchey	0.35
Maize (grain) Kampong Cham	0.22

Source: Own estimates based on the 2013 survey data.

5.2. Domestic Resource Cost for Rice

158. **Comparative advantage depends on the variety of cultivated rice but, overall, rice is produced competitively across the country**. Wet season rice production for IRRI varieties in Takeo has a DRC of 0.78 (yield of 2.88 tons/ha), the closest of Cambodia's computed DRCs to inefficient use of domestic resources (i.e., a DRC greater than one). However, farmers producing fragrant rice have a greater comparative advantage, with a DRC of 0.61 in Kampot (yield of 2.5 tons/ha). Despite the lower yield for fragrant rice, the main difference in DRCs is due to the prices of these varieties. The same pattern is observed for dry season rice. IRRI varieties have a DRC of 0.61-0.69 (yield of 4.8 tons/ha), more than 50 percent higher compared to fragrant variety rice with a DRC of 0.43 (yield of 4.0 tons/ha).

159. **How large is the reserve in comparative advantage?** In other words, how sensitive is it to future changes in costs, prices, and types of technology use? For dry season rice, for example, a 50 percent decrease in the cost of agricultural services would result in a 29 percent decrease in the DRC, from 0.60 to 0.43; i.e., Cambodian dry season rice would enjoy a relatively higher comparative advantage. This simulation is based on farmers using water pump irrigation; a different DRC would arise in the presence of public investment in adequate irrigation. An increase in the price of modern inputs (seeds, fertilizers, and other chemicals) would worsen the comparative advantage of dry season rice production (DRC increases from 0.60 to 0.79). In all of

the sensitivity analyses, the simulated DRCs change but remain below the threshold of one, indicating Cambodia's advantage in producing rice (Table 34).

160. **By location, Bantey Meanchey province has a greater comparative advantage in producing dry season rice (DRC=0.61) than Kandal province (DRC=0.69)**. The ratio of tradable components to variable costs in these two provinces differs significantly (26 percent of tradable components for Kandal and 44 percent for Bantey Meanchey). In fact, farmers from Bantey Meanchey allocate more chemical fertilizers and less labor for dry season rice production, resulting in a higher dependence on tradable inputs. Access to and cost of irrigation water, however, may change the DRC for Bantey Meanchey, as farmers spent close to 19 percent of total variable costs on irrigation compared to less than 3 percent for farmers in Kandal.

Table 34: Sensitivity analysis of impacts of changes of production costs on DRC for rice

Dry Season Rice	**Decrease in the Cost of Services**				**Increase in the Cost of Inputs**			
% change in the factors	0%	10%	20%	50%	0%	10%	20%	50%
DRC	0.60	0.56	0.53	0.43	0.60	0.63	0.67	0.79
% change in DRC	0%	-7%	-13%	-29%	0%	5%	10%	30%
Wet Season Rice	**Decrease in the Cost of Services**				**Increase in Yield**			
% change in the factors	0%	10%	20%	50%	0%	10%	20%	50%
Simulated yield (kg/ha)					2,880	3,168	3,456	4,320
DRC	0.98	0.95	0.91	0.80	0.98	0.88	0.79	0.61
% change in DRC	0%	-4%	-8%	-19%	0%	-11%	-19%	-38%

Source: Own estimates based on 2013 survey data.

161. **Wet season rice production's sensitivity analysis was conducted using the price for IRRI high-yielding varieties, a pathway Cambodia may take to improve its rice value chain**. A 10 percent increase in rice yield (from actual 2.88 tons/ha to 3.17 tons/ha) corresponds to an 11 percent decrease in the DRC (DRC=0.88), making the country more competitive in producing high-yielding rice varieties. A 50 percent increase in yield (4.3 tons/ha) results in a 38 percent decrease in the DRC (DRC=0.61). The decrease in the DRC is not linear; for example, doubling average rice yield to 5.76 tons/ha would only result in about a 50 percent decrease in the DRC, and this sensitivity analysis does not take into account the additional cost of inputs required to attain this high level of productivity. Still, even with a 20 percent increase in yield (DRC=0.79), the DRC for high-yielding varieties remains above the DRC for fragrant rice (DRC=0.61), indicating that it is advantageous for Cambodia to focus on fragrant rice. To get to similar DRCs with fragrant rice production, the yield for IRRI varieties would need to increase by about 50 percent, from 2.88 tons/ha to 4.3 tons/ha (Table 34), an increase that would require additional costs.

162. **Takeo (DRC=0.78) shows an advantage over Kampot (DRC=0.86)**. Takeo's DRC is 15 percent lower, as its farmers use slightly more modern inputs than their peers in Kampot, and thus were able to get higher yield (20 percent more at 3.1 tons/ha). Again in this case, the comparative advantage is driven by the difference in yield.

5.3. Domestic Resource Cost for Cassava and Maize

163. **For non-rice crops, Cambodia's highest comparative advantage is in maize production (DRC=0.35), followed by cassava production (DRC=0.39)**. For cassava, nontradable costs represent more than 87 percent of total variable costs, indicating that few policy adjustments related to tradable inputs are available to improve the comparative advantage of this crop (Table 33). However, cassava production still uses relatively high amounts of labor, so changes in labor cost may affect cassava's comparative advantage. A sensitivity analysis showing the effect of change in labor cost is presented in Table 35. Every 10 percent increase in the cost of hired labor would result in an increase of cassava's DRC by 3-4 percent; a 50 percent increase would lead to a loss of about 17 percent in Cambodian cassava production's comparative advantage. Labor cost is likely to increase in the near future if Cambodia continues its path toward agricultural transformation, stimulating more competition between labor available for agricultural versus nonagricultural work.

164. **Battambang province has a better-than-average DRC (0.35 versus 0.39)**. Cassava yield is slightly higher in this province compared to the average (20.4 tons/ha versus 18.4 tons/ha). Cassava production is also less dependent on changes in the prices of tradable inputs (fertilizers, pesticides). A 10 percent increase in the world prices of these inputs will only increase cassava's DRC by 1 percent.

Table 35: Sensitivity analysis of impacts of changes in production costs on cassava and maize DRCs

Cassava	**Decrease in Yield**				**Increase in the Cost of Labor**			
% change in the factors	0%	10%	20%	50%	0%	10%	20%	50%
Simulated yield (kg/ha)	18,650	16,785	14,920	9,325				
DRC	0.39	0.43	0.49	0.81	0.39	0.40	0.41	0.45
% change in DRC	0%	12%	27%	111%	0%	3%	7%	17%
Maize	**Increase in the Cost of Inputs**				**Increase in Yield**			
% change in the factors	0%	10%	20%	50%	-50%	-20%	20%	50%
Simulated yield (kg/ha)					1,970	3,152	4,728	5,910
DRC	0.35	0.36	0.37	0.40	0.89	0.46	0.28	0.22
% change in DRC	0%	2%	5%	14%	154%	31%	-20%	-38%

Source: Own estimates based on 2013 survey data.

165. **Cambodian farmers use relatively high amounts of modern inputs for maize production**. About 40 percent of the production costs for maize are tradable commodities, implying that the comparative advantage of Cambodia for this crop closely depends on the world market behavior. Overall, doubling the price of modern inputs (seeds, fertilizers, and chemicals) would result in a 14 percent increase in maize's DRC (0.40); i.e., Cambodia still has a strong comparative advantage in producing maize.

166. **To keep maize's comparative advantage, the focus needs to be on maintaining its relatively higher yield (3.9 tons/ha), which is currently not far from the average yields in neighboring countries**. A 20 percent decrease in average yield would result in a loss of 31 percent of maize's comparative advantage (DRC=0.46); and a 50 percent decrease (to 1,970 kg/ha) would

cause the country to lose most of its comparative advantage (DRC=0.88). On the other hand, any increase in yield is expected to improve its advantage in producing maize (DRC= 0.22 with a 50 percent increase in yield, to 5.9 tons/ha).

167. **Bantey Meanchey province has the least comparative advantage in maize production (DRC=0.35), while Kampong Cham province has the highest comparative advantage (DRC=0.22)**. The ratio 1:1.6 of the comparative advantage is partially related to the observed yields in these provinces: 3.9 tons/ha versus 5.3 tons/ha for Bantey Meanchey and Kampong Cham, respectively.

5.4. Summary

168. **All commodities analyzed indicate Cambodia's comparative advantage in agricultural production**. The comparative advantage is the strongest for fragrant rice, maize, and cassava. However, wet season rice production has an almost neutral advantage. Fragrant rice has a much higher comparative advantage than high-yielding IRRI varieties, and dry season rice has a comparative advantage relative to wet season rice.

169. **The advantage of agricultural production is strongly affected by price variation in the world market**. A 20 percent decrease in rice prices or a 20 percent increase in tradable input prices would make wet season rice production uncompetitive (Table 36). Other crops have more room to accommodate rising costs and falling prices, however, indicating a strong foundation for continued strong agricultural growth in Cambodia for many years to come.

Table 36: Sensitivity analysis of impacts of changes in tradable input and output prices on DRCs of all crops (except vegetables)

Scenario		Dry Season Rice	Wet Season Rice	Cassava	Maize
Current status	**DRC**	0.60	0.98	0.39	0.35
10% increase in world price of commodities	**DRC**	0.53	0.87	0.35	0.31
	Change	-11%	-11%	-9%	-10%
20% decrease in world price of commodities	**DRC**	0.83	1.32	0.49	0.46
	Change	39%	35%	27%	33%
20% increase in world price of tradable inputs	**DRC**	0.66	1.01	0.39	0.36
	Change	10%	3%	1%	4%

Source: Own estimates based on 2013 survey data.

6. DRIVERS OF PAST GROWTH

170. **Cambodia's agricultural growth of the past decade can be interpreted as the outcome of a number of factors**. These positive factors or drivers can be divided into policy, connectivity and investments, and incentives (Table 37). This list is not exclusive but it includes most important drivers.

Table 37: Drivers of agricultural growth during 2002-2012

Policy	Connectivity and Investment	Incentives (Food Prices and Wages)
• Market-oriented agricultural and trade policies conducive for private sector investments • Trade integration with the global economy and in particular with ASEAN countries	• Improved connectivity to markets, technology, and finance • Private sector investments, including FDI	• Higher food prices originating from world market structural changes • Expansion of domestic market due to the economic growth • Increase in labor cost originating from migration of labor out of agriculture

Source: Own assessment.

171. **The most powerful factor behind the past agricultural growth was private sector performance in Cambodia**. It was the energy, resources, and entrepreneurship of farmers, traders, and other businesses that made the growth possible. Cambodia's agricultural and trade policy has been generally market oriented and conducive to private sector development. Although the costs of doing business in Cambodia are still high (World Bank 2014e), they would have been much higher had the RGC introduced farm output or input subsidies or restricted exports at the time of the food price spikes in 2007-2009. The market-oriented policy allowed farmers and entrepreneurs to make undistorted decisions about production and trade and to respond to incentives. It allowed the higher global rice prices that prevailed in the past decade to pass through to local markets. It helped trigger a strong farm supply response to higher demand for agricultural commodities such as rubber, cashews, and beef originating from neighboring countries, and facilitated farmers' diversification towards upland crops such as cassava and maize in response to higher prices.

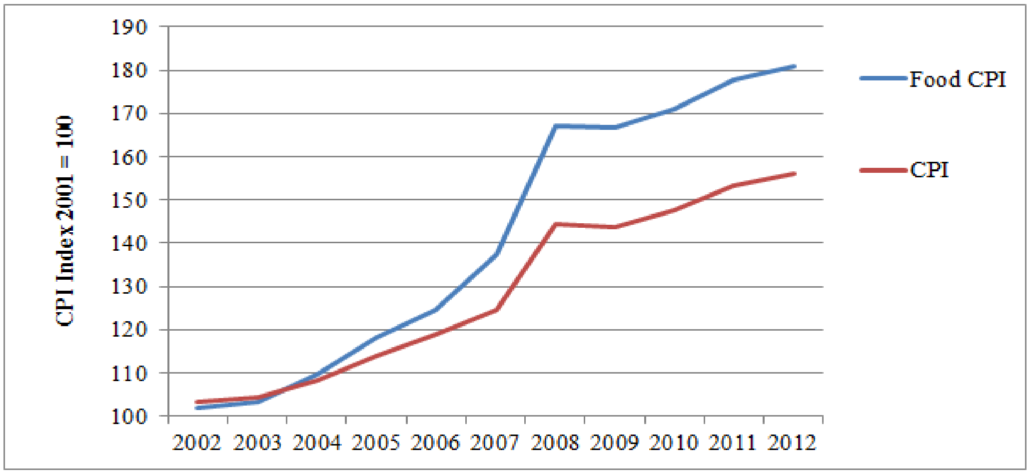
172. **In the last decade, global agricultural markets experienced structural changes**. Due to a combination of factors that resulted in global demand for food exceeding global supply, global food prices significantly increased after 2007-2008. The World Bank Food Price Index in real terms increased by 43 percent between 2003-2006 and 2009-2013 (Table 38). The world market prices of cereals, coffee, and rubber increased the most. The price increase in global markets has passed through to Cambodia. As a result, in recent years the food CPI consistently exceeded non-food CPI in spite of the rising agricultural production (Figure 35), pointing to the external factors of food inflation in Cambodia.

Table 38: Global agricultural prices, selected commodities, $/ton (in real 2010 prices)

	2003-2006	2009-2013	Change (%)
Maize, Yellow, US Gulf	128	230	80
Rice, 5% Thai	298	513	72
Wheat, Hard Wheat, US Gulf	190	266	40
Rubber, Asia, TSR 20	1,720	3,170	84
Coffee, Robusta, New York	1,220	1,940	59
Beef, Australia/New Zealand	2,810	3,500	25
World Bank Food Price Index	71.22	102.17	43

Source: World Bank Pink Sheets.

Figure 35: CPI and food price index in Cambodia, 2002-2012



Source: NIS 2014.

173. **Located in the heart of the Greater Mekong subregion, Cambodia benefits from connectivity and trade with its regional partners**. Most surplus paddy, cashew nuts, sesame seeds, cassava, and cattle find a market in neighboring Vietnam and Thailand. However, most of this trade is informal and consists of unprocessed products. An estimated 9 million tons of cassava, 3 million tons of paddy, 1 million tons of sugarcane, and perhaps another million tons of agricultural, livestock, and fishery products move across borders, representing about 1 ton of agricultural export per capita. At the same, time considerable volumes of pigs, vegetables, and oil are imported.

174. **The formal exports of rice mainly go to the EU**. Cambodia primarily exports quality rice to European countries, benefiting from access to the EBA, which provides price benefits to Cambodia relative to competitors India, Vietnam, and Thailand. Vietnam and Thailand, two major rice exporters, are highly diversified globally in terms of their destination markets. In the group, only Vietnam lags behind in terms of quality rice exported. India and Thailand are renowned for their fragrant rice (Basmati and Jasmine) and Cambodia also now produces and exports high-quality fragrant rice. However, Vietnam recently started producing and exporting quality fragrant rice and its share of fragrant rice in total rice exports is expected to increase rapidly in the years to come.

175. **Among these four countries, Cambodia has the most clearly formulated rice policy**. The RGC has set clear targets for exports and is promoting development of transportation (by upgrading the Sihanoukville port) and power infrastructure. At the same, time it is promoting investment in rice milling and in a number of programs to support better seeds and irrigation. As a result, formal rice exports increased from 1,500 tons in 2008 to 378,000 tons in 2013 (recall Table 9).

176. **Due to private investments, Cambodia's rice milling capacity increased remarkably in recent years**. Cambodia's modern rice milling (i.e., the larger mills) capacity increased sevenfold, from 96 tph in 2009 to over 700 tph in late 2013. The polishing capacity of mills also jumped, from 72 tph in 2009 to 564 tph in 2013, with an average milling rate of 64 percent. All of the investment in large mills came from the private sector, at least 35 percent of which was from joint ventures with foreign investors. In theory, the existing milling capacity could process almost the entire paddy surplus in Cambodia. However, the high cost of fuel and electricity renders Cambodia's average milling cost about 30 percent higher than that of Thailand and Vietnam. Moreover, rice mills lack the working capital to purchase and store paddy.

177. **Cambodia's rapid economic growth since the mid-1990s has led to significant changes in the country's labor market especially in terms of increased employment, shift in employment structure, and improved outcomes for workers**. Agriculture employed about 81.4 percent of the labor force in 1995, but this share had shrunk to 51 percent by 2012 (recall Table 11). Employment in the industry sector increased from 3 percent of the total employed workforce in 1995 to 19 percent in 2012, while employment in the services sector doubled from 16 percent to 32 percent. Labor market outcomes improved more or less in parallel with the growing trend towards labor migration. In 2008 there were 2.5 million recorded internal migrant workers, 89,545 migrants registered as working abroad officially and an estimated 180,000 working abroad unofficially.

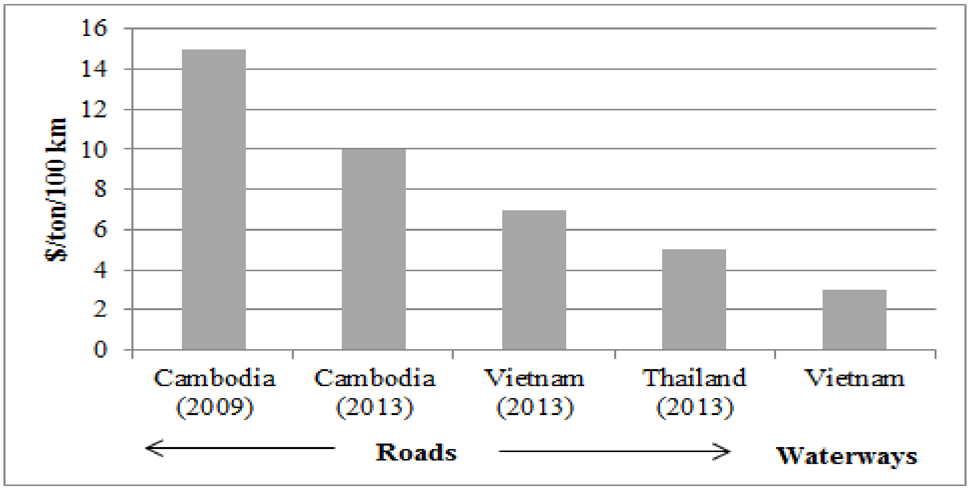
178. **The options for labor in Cambodia, particularly youth labor, are to migrate from agriculture to nonfarm activities, to migrate from rural areas to urban areas (for example, to garment factories for young women and construction work for young men), or even to migrate out of the country**. These options result in increased choices for job seekers in rural areas in addition to agricultural work. As a result, agricultural wages have increased by a factor of four over the past 10 years (**As a result of increasing returns to labor, agricultural wages in general rose, converging with nonfarm wages**. Agricultural wages grew by a factor of almost three between the 2005 and 2013 surveys (**Error! Not a valid bookmark self-reference.**). Over the same period, nonfarm wages increased by only 60 percent. As a result, the gap between farm and nonfarm sector wages declined. Thus agriculture appears to have provided excellent income-earning opportunities in Cambodia over the last decade.

179. Figure 34). This has pushed farmers towards increased adoption of mechanization.

180. **Outside of the agriculture sector, connectivity has improved in terms of both communication and roads**. With a population of 14.6 million, Cambodia had 19 million mobile phone subscribers in 2012. Currently transportation costs for rice and other agricultural commodities are around $10-13/100 km/ton (Figure 36). Compared to an estimated $15/100 km/ton in 2009 (ADI 2009), transportation costs decreased due to road improvements, more trucks available, and more competition amongst local transport companies. Yet transport costs in Cambodia are still higher than in neighboring countries such as Vietnam, where it is about

$7/100 km/ton and Thailand where it is around $5/100 km/ton. Costs are also higher on rural roads due to the underinvestment. The ADB survey of 18 communes in Battambang, Kampong Thom, and Takeo provinces in 2013 found only one to have an asphalt road (ADB 2014a). It should be noted that both Vietnam and Thailand rely significantly on river transport for moving rice and other crops, which is significantly cheaper. Using its waterways, Vietnamese transport costs are only $3/ton compared to $15-17/ton to move the same distance by truck in Cambodia.[42]

Figure 36: Transportation costs in Cambodia and neighboring countries, $/100 km/ton



Source: Own estimates and ARPEC.

181. **While past agricultural growth in Cambodia resulted in an impressive increase in production and exportable surplus of a number of commodities, it had limitations**. To promote future growth, limitations that need to be addressed include: (i) the reliance on crop land expansion; (ii) the increase in the number of very small farms; (iii) the slow job creation outside agriculture; (iv) relatively low productivity growth; and (v) weak development of agroprocessing and other agribusinesses.

182. **First, the large share of the past growth was achieved through the expansion of cultivated land**. This expansion was stimulated by the sharp increase in agricultural prices and the improved market opportunities. Between 2008 and 2011, cultivated rice area grew 4.5 percent annually. After agricultural prices leveled and even began declining, land expansion slowed down. In 2012, cultivated paddy area grew only 0.4 percent and in 2013 even declined 0.4 percent (World Bank 2014b). Without increasing farm profitability through higher productivity, it will be very hard to increase agricultural profits in the future.

183. **Even at higher farm profitability, repeating the past land expansion in the future is not feasible given the RGC's plans to revert deforestation**. The target is to have 60 percent of land area forested, from the current 57 percent (World Bank 2014e).Thus growth of cultivated land in the future is likely to be just a fraction of what it was in the past. This is good news, because past land expansion seemed to have contributed to land degradation. Degradation has been especially high in the upland areas used for cassava production, for which little fertilizer has been applied to maintain soil nutrients. Land degradation can be defined as the persistent reduction or

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[42] The Phnom Penh Post "Waterways May Reduce Export Costs," March 12, 2013, quoting the Alliance of Rice Producers and Exporters of Cambodia (ARPEC).

loss of land ecosystem services. Using global information on the changes in the normalized difference vegetation index between 1982 and 2006, which serves as a proxy for land degradation, Cambodia was found to be among the countries with the largest share of land degradation hotspots. About 55 percent of its crop land and 42 percent of its total land are estimated to have degraded in terms of net productivity and vegetation cover (Le *et al*. 2014). About 60 percent of Cambodians are estimated to reside in land degradation hotspots, and human-induced activities are the source of most degradation.

184. **Second, the past growth was accompanied by an increase in the average farm size and an increasingly unequal agricultural land distribution**. Large farms are becoming larger and small farms are becoming smaller.[43] This change in distribution of farmland occurred independently of economic land concessions. The increasing disparity is accompanied by land consolidation and more commercial farming. Even though no general economies of scale in land use are found in Cambodia, economies of scale in returns to labor have increased as a result of mechanization, and larger farms seem to be integrated more easily into modern food value chains.

185. **Thus, the main concern is that the returns to labor for these small farms will remain low**. For example, the returns to labor in small farms producing rice during the wet season are estimated to be below the prevailing wage rate. The returns to a day of labor for wet season rice production increase from $2.86/day for small farms to $12.67/day for large farms. Dry season rice production has the highest impact of farm size on returns to labor, at $6.15, $8.27, and $22.83 for small, medium-sized, and large farms, respectively. This has a direct impact on the ability to attack poverty, because wet season rice still constitutes 83 percent of total cultivated rice land, comprising most smallholder farmers. Very small farms are less willing and able to mechanize production processes, falling behind larger farms in income generation.

186. **Another concern is that while farm size increases, landlessness may increase**. If landlessness is the result of rural households moving out of agriculture into other profitable employment opportunities, then landlessness is not a major issue. Yet when landlessness is associated with poverty and vulnerability, future growth strategies need to address the impact of increasing landlessness on poor and vulnerable households through a combination of measures including safety nets, insurance, and capacity building.

187. **Third, one of the most worrying aspects of the past growth of agriculture in Cambodia is that, despite growing yields and production, per hectare profitability of farming has increased slowly**. The average gross margin per hectare in real terms increased by only 3.4 percent between 2005 and 2013, due to the increase in yields and the gradual shift of production to more diverse mix of crops more profitable than wet season paddy. Yet there is more room to increase yields, especially of paddy, which would need to come from more efficient use of resources rather than just higher use of intermediate inputs, labor, and machinery. For farming to be attractive, the increase in revenue needs to exceed the increase in costs. In the situation with limited potential for farmland expansion, this puts emphasis on productivity, profitability, and competitiveness to underpin future growth.

188. **Achieving higher agricultural productivity depends on many factors, with investments in the delivery of core public goods and good quality of public programs among the key factors**. But most productivity-enhancing public programs such as agricultural extension,

[43] It should be noted that even though farm size can increase over the next decade or so, the vast majority of Cambodian farms will remain less than 5 ha in size.

agricultural research, vocational training, and input quality control are underfunded in Cambodia. Farmers rely mainly on extension advice from the private sector and NGOs, which are often limited to specific commercial products. Some inputs are fake and their quality control by public agencies is not adequate or present at all, reducing farmers' willingness to purchase more inputs. Other programs such as irrigation receive sufficient funds but are mostly used to construct primary structures making Cambodia's irrigation coverage the lowest in Asia (recall Table 5). The effectiveness of these investments and impacts on farm incomes appears to be very low.

189. **Fourth, during the past 10 years, the cost of labor has increased tremendously, creating a number of adjustments in production, including accelerated mechanization, reduction of labor use, and adoption of labor-saving technologies**. This is consistent with the key patterns of agricultural transformation from a traditional to a modern agriculture sector. However, if continued, the increasing cost of labor will also imply that agriculture will not be able to absorb the increasing labor force and therefore new sources of labor demand have to be identified not only in urban areas and outside of the country (the two traditional "solutions" for surplus labor in agriculture), but in the rural nonfarm sector as well. Outside the garment and footwear industry and construction sectors, nonfarm job creation has been slow.

190. **Finally, the past growth of agriculture was mostly related to the production sector; very little value added was generated by agriculture and in fact an enormous surplus of commodities was exported in raw form**. The RGC has made a concerted effort to change this situation in the case of rice, but the objective of one million tons export by 2015 is not likely to be achieved. Contract farming and productive partnerships between farmers and agroenterprises are very limited; sustainable farmer organizations are few despite the promotion of agricultural cooperatives. Yet the development of agribusiness and, more generally, of an agri-based rural, nonfarm economy must be an indispensable element of any future growth strategy.

7. DRIVERS OF FUTURE GROWTH

191. **Some drivers underpinning future agricultural growth in Cambodia will be similar to those of the past**. For example, GDP growth will increase domestic demand for more diverse food and encourage further outmigration of labor from agriculture. According to the World Bank (2013a), Cambodia's GDP will continue to expand rapidly up to 2030, though at a slower pace (slightly over 7 percent) than over 2000-2010 (8.2 percent). GDP is expected to increase in real terms from its present value of $13 billion to $23 billion by 2020, and to nearly quadruple to $50 billion by 2030 (Table 39). With population growth expected to decline from 1.4 percent to 1.1 percent over this projection period, real GDP per capita would increase from $957 in 2012 to $2,733 by 2030.

Table 39: Selected economic projections, Cambodia, 2012-2030

Indicator	Future Growth rate (%)	2012 (Baseline)	2015 (Short-term Projections)	2020 (Medium-term Projections)	2030 (Long-term Projections)
Real GDP, $ billion	7.2	14.2	17.5	24.7	49.5
Population, million	1.1	14.8	15.3	16.2	18.0
Real GDP/capita, $	6.1	957	1,140	1,526	2,733
Urban population, million	5.1	3.3	3.8	4.8	8.0
% of urban population	4.0	22	25	30	45

Source: Own estimate based on World Bank 2013a.

192. **Rising global and regional demand for food will continue to provide markets for increased Cambodian exports** (Table 40), which will be facilitated by the continuation of market-oriented agricultural and trade policies. Public investments will help continue to reduce the costs of doing business and attract private investments to create jobs.

193. **Yet there will be important differences**. **First, it is expected that future economic growth in Cambodia will be accompanied by accelerated urbanization**. Total population will rise from 14.8 million in 2012 to 18.0 million by 2030; assuming an urban population growth rate of 5.1 percent (consistent with the past decade's growth), the urban population will more than double from 3.3 million to 8 million over the projection period. This implies Cambodia's rapid urbanization rate increase from 22 percent to 45 percent (Table 39).

194. **Rapid urban population growth has a number of implications for Cambodia's agri-food system**. An increasingly urban population will need to be fed by a relatively smaller rural population. While in 2012, Cambodia needed one agricultural worker on average to feed 2.8 persons, in 2030, each agricultural worker will need to feed 4.5 persons. For the urban population, the food consumed will be richer in protein and micronutrients and will require more stringent quality standard; consumers will want food that is more convenient to prepare and consume. Increasing urbanization also implies more pressure on agricultural land in peri-urban areas, often the most fertile land. Food distribution systems appropriate for urban areas need improved marketing and distribution infrastructure. An increasing amount of food will be distributed via modern outlets and supermarkets, will be more processed, and will be sold in a variety of packaged forms. This will put pressure on very small farms, which often find it difficult to integrate into

modern value chains. Agroindustry will also need to develop to provide enhanced features such as storability, convenience, improved packaging, and more diversified products.

Table 40: Caloric food demand projections, world and selected regions/countries

Region/Country	2009	2030	Annual growth rate
	Actual	Projections	%
World	2,831	3,050	0.4
East Asia	2,694	3,190	0.9
East Asia (less China)	2,663	2,965	0.5
China	3,036	3,739	1.0
Cambodia	**2,382**	**2,667**	**0.5**
Japan	2,723	2,613	-0.2
Lao PDR	2,377	2,662	0.5
Malaysia	2,902	3,249	0.5
Mongolia	2,434	2,725	0.5
Myanmar	2,493	2,792	0.5
Philippines	2,580	2,889	0.5
South Korea	3,200	3,583	0.5
Thailand	2,862	3,205	0.5
Vietnam	2,690	3,012	0.5

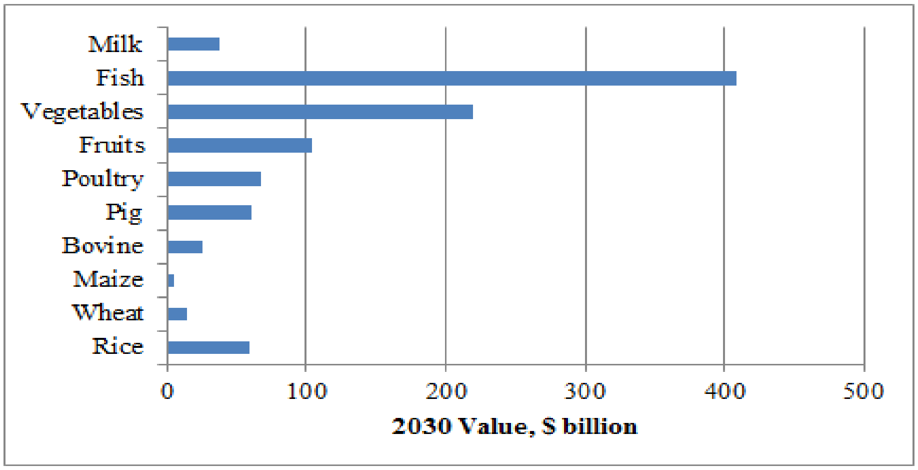
Note: Caloric food demand refers to the amount of food expressed in kilocalories (kcal) per day, available for each individual during the reference period.

Source: Jamora 2014 using FAOSTAT.

195. **Due to increasing income and urbanization, diets will be more diversified, and richer in protein and micronutrients**. Not only in Cambodia but also in East Asia and the world as a whole, more animal and fish products and more processed foods will be consumed (Figure 37). More people will be aware of health issues related to nutrition and food safety (cholesterol, diabetes, allergies, chemical residues, antibiotics in animal feeding, etc.). Rice consumption per capita in Cambodia will likely remain high but lower than its current level, implying an increasing availability of rice for export. Rice quality will have to increase not only for export markets but for domestic and urban markets as well.

196. **Rising ASEAN and global demand for food will offer market outlets for Cambodian exporters, but penetrating foreign markets will be more challenging**. The further increase in cross-border trade will require Cambodia to have an adequate capacity and network of agreements in place with major trading partners (especially China) for food safety and quality standards, phytosanitary and quarantine, double tax agreements, transit, and harmonized trade and commerce legislation (e.g., anti-dumping, labeling, trademark protection). Cambodia’s agri-food industries must become competitive with those of neighboring countries. Adequate physical and institutional infrastructure is needed to achieve such competitiveness, including more stable and cheaper access to energy, improved transportation network and logistics systems, highly effective information and communication systems, and financial institutions to support trade and investment.

Figure 37: Value of the projected food demand in East Asia, $ billion, 2030



Source: Jamora 2014 using data from IMPACT/IFPRI model and OECD.

197. **Exporting much more rice, especially of low quality, will be difficult**. Total per capita consumption of rice is projected to decline by 2030 due to global income growth and substitution effects (Table 41). Future global consumption rates are heavily affected by future rice consumption in China and India, but consumers are projected to demand more higher-quality rice (Slayton and Muniroth 2012b). Structural changes in diets will continue to reduce the relative importance of rice in favor of meat, fruits, vegetables, fish, and milk (Alexandratos and Bruinsma 2012; Sharma 2014).

Table 41: Global rice demand projections (kg per capita) per year

Sources/assumptions	2020	2025	2030
FAPRI 2005	65	62	61
FAO 2003	63	62	61
Abdullah *et al*. 2008			
Scenario 1: China -0.33%/India -0.93%	59	58	57
Scenario 2: China -1.77%/India -1.44%	54	51	48
Scenario 3: China -3.55%/India -3.03%	49	46	43

Source: Jamora 2014.

198. **Future agricultural TOT is projected to be less favorable than in the last decade**. As shown in Table 38, global food prices increased significantly in the past decade. In the future, however, prices of most agricultural products are projected to decline (Table 42). Prices of grains are projected to decline 12 percent in real terms between 2010 and 2025, with rice prices in 2025 projected to decline by 20 percent compared to 2015. On the other hand, energy prices are expected to keep increasing, though fertilizer prices are expected to fall in the future. Overall agricultural TOT, defined as the ratio of prices of agricultural outputs to prices of inputs for agricultural production proxied by the simple average of fertilizers and energy, is projected to decline. Rising costs of energy will drive up costs of irrigation and mechanization, while declining agricultural prices will put pressure on profits and competitiveness. In this context, profitable farming systems will depend on access to modern knowledge and technologies and the efficient use of more

expensive inputs, along with resilience to weather variations and climate shocks. In other words, high attention will need to be paid to TFP.

Table 42: Global agricultural terms of trade, index projections (in real 2010$)[44]

	2010	2015	2020	2025
Agricultural prices	100	97.4	90.1	83.1
inc. Food	100	102.2	93.1	84.3
Fats and oils	100	106.4	96.1	86.2
Grains	100	104.3	96.0	87.9
Other food	100	94.9	86.5	78.4
inc. Beverages	100	87.5	77.2	67.9
inc. Raw materials	100	78.7	75.2	71.6
Fertilizer prices	100	89.4	81.2	73.3
Energy prices	100	120.0	113.5	108.9
Agricultural TOT	**1.00**	**0.930**	**0.926**	**0.912**

Source: World Bank Commodity Price Forecast, July 2014.

199. **Future agricultural growth will depend less on land expansion**. Reaching the RGC target of 60 percent of land under forest requires afforestation programs, strict compliance with land and forest protection laws and regulations, attention to sustainable management of natural resources, and improvements in the land tenure system. The sustainability of environmental resources such as land and forests has been neglected in the past decade of growth in Cambodia. Further depleting natural resources for sustained growth is not a good option. Failing to take into account the environment, even at the early stages of growth, can be a big mistake, and one that is extremely expensive to fix in the future (World Bank 2013a). Cambodia is endowed with rich environmental resources that have benefited its economy and people greatly, and it is important to ensure that this remains the case in the future.

200. **The agricultural labor force will continue to decline, while agricultural wages increase**. As in other countries, Cambodia's rural youth are increasingly choosing employment in sectors other than agriculture. Labor shortage provides incentives for increased mechanization. Outmigration might also accelerate the process of increasing farm size. As the agriculture sector transforms to a more commercial and competitive industry, it will attract more investment and support more semi-skilled and higher-paid employment. Yet without strengthening land tenure security and reducing the cost of capital, adoption of farm mechanization in Cambodia will be slow, putting upward pressure on farm production costs. Modern farm machinery and new farming technologies, such as precision farming, are increasingly available to Cambodian farmers, but they can be more efficiently used on larger farms. The existing land tenure insecurity precludes this from evolving at a natural pace, as it creates distortions in the land tenancy market that constrain small absentee land owners from renting their land to capable and entrepreneurial farmers.

[44] Agricultural price index is the sum of food, beverages and raw materials. Fats and oils include coconut oil, copra, groundnuts, palm oil, palm kernel oil, soybeans, soybean meals, and soybean oil. Grains include barley, maize, rice, sorghum and wheat. Other food includes bananas, oranges, sugar, meats, and fish. Beverages include cocoa, coffee, and tea. Raw materials include cotton, rubber and tobacco. Fertilizers include DAP, urea, TSP, potassium, and phosphate rock. Energy includes coal, crude oil, and natural gas.

However, land speculation, which could be caused by low land taxes stemming from outdated land valuation prices, is another potential motivation for increasing farm size.

201. **More budget resources will be available to spend on agricultural programs in Cambodia but more resources will also be required for other purposes to sustain growth and boost shared prosperity**. Competition for public funds will motivate ministries to use funds more efficiently; those doing so will receive and spend more on their programs. Fiscal discipline will require clearly definition of what to finance (public goods) and what not to (private goods) from the budget. Except irrigation, many critical agricultural programs (such as research, extension, food safety, input quality control, etc.) are underfunded. Improvements in the quality of agricultural programs and the ability to attribute their impacts on agriculture sector outcomes through impact evaluations will determine the funding that MAFF and Ministry of Water Resources and Meteorology (MOWRAM) receive from the national budget and donors to support further agricultural development.

202. **Finally, more attention needs to be paid to implementation**. Most of the messages above are not new to Cambodia and are rightly identified in the RGC's new five-year Rectangular Strategy III. The key challenge for Cambodia is implementation, which will require increased inter-ministerial coordination, leadership, and most importantly, monitoring of specific targets linked to those reforms. Successful implementation of the reforms could help Cambodia reach a GDP growth path of 8 percent and sustain its successful agricultural transformation. The driving forces discussed in this chapter and their impacts on future agricultural growth are summarized in Box 7.

Box 7: Driving Forces Underpinning Future Agricultural Transformation in Cambodia

1. **Economic growth in Cambodia**
    a. Stimulate more demand for food
    b. Pull labor out of agriculture
    c. Increase labor costs
    d. Lower cost of capital and increase farm demand for mechanization
    e. Create a larger fiscal space for public investments in agriculture
2. **Urbanization in Cambodia**
    a. Put pressure on land available to agriculture, converting land to urban purposes
    b. Lead to declining per capita rice consumption
    c. Create higher demand for more diversified (change of diet) and processed foods
    d. Require more attention to food safety and quality
    e. Create challenges to integrate small farms into value chains
    f. Increase demand for farm labor force
3. **Rising ASEAN and global demand for food**
    a. Lead to declining per capita rice consumption of low-quality rice
    b. Create more demand for higher-value, better processed and marketed rice
    c. Raise demand for higher-value, processed foodstuff
    d. Require high attention to safety and quality to comply with the rules of buyers and avoid non-tariff barriers
4. **Declining global agricultural TOT**
    a. Without increasing TFP, lower farm prices will reduce farm profits and incomes
    b. Call for more and better spending on core agricultural public goods
5. **Deceleration of agricultural land expansion in Cambodia**
    a. Increase pressure for sustainable management of natural resources (land, water, forests)
    b. Bring more attention and urgency to reduced land degradation
    c. Call for building institutions and clear rules for natural resource management
    d. Bring urgency to raise agricultural productivity to sustain farm incomes
6. **Fiscal discipline**
    a. Despite a larger fiscal space due to continued economic growth, more budget resources will be required for various purposes. Public in general would also require better transparency and accountability on the use of funds. This would lead to stronger fiscal discipline.
    b. Define the role of government and key public investments to support agricultural transformation under fiscal constraints

8. A LONG-TERM VISION FOR CAMBODIAN AGRICULTURE

203. **The RGC's long-term vision, including a 2030 vision for the country, is focused on rapid development that is resilient, inclusive, and sustainable**. Continuing its strong economic performance will be a central pillar to achieve the country's aspirations. With the appropriate policies, Cambodia's economy can more than triple in size by 2030. Beyond economic growth, the aspirations for Cambodia's progress towards 2030 are threefold: (i) for progress to be resilient to shocks such as economic crises and natural disasters; (ii) for progress to be inclusive, ensuring continued poverty reduction, shared prosperity with an expanding middle class, and social cohesion; and (iii) for progress to be environmentally sustainable, securing future benefits from the country's rich land, forest, and water resources for future generations. Overall, the RGC's long-term vision mentioned in the strategic documents consists of seizing opportunities to make Cambodia a more prosperous, inclusive and successful nation (World Bank 2013a).

204. **Agricultural transformation is the key to realizing a 2030 Vision**. The agriculture sector was instrumental in stimulating growth, reducing poverty and boosting shared prosperity in the past and it remains a powerful source of pro-poor growth in the future, given its large share in the economy, labor force, and exports. The sector also has an important role in achieving environmental sustainability and resilience objectives as it is the largest user of land, water, and other natural resources and is the most vulnerable to climate change. The Agricultural Sector Strategic Development Plan 2014-2018 prepared by MAFF aims to continue the past growth in agricultural value added at 5 percent in the future. Achieving the 5 percent growth is possible but challenging as can be judged from the recent growth slowdown. In 2013, the growth in agricultural value added was only 1.6 percent and it is expected to be even smaller in 2014.

205. **Four lessons from agricultural transformation around the world are relevant to the formulation of Cambodia's vision**:

a. At early stages of development, agricultural growth is the main engine of poverty reduction because most of the poor are in rural areas.
b. TFP growth is a main source of long-term agricultural growth. TFP requires not only land, labor, and capital accumulation, but also technology, innovation, efficiency, human resource capacity, and governance. TFP growth contributed 40-70 percent of agricultural output growth in Asia over the last 50 years (Fuglie 2010).
c. Increasing urbanization presents challenges foe which traditional farming systems are not well prepared. Helping small farmers integrate into modern value chains is a feasible response for governments to these urbanization challenges.
d. As an economy moves closer to middle-income status, development of the rural nonfarm sector (including agri-food manufacturing, services, marketing, and logistics) becomes increasingly important in closing the gap between rural and urban incomes.

206. **Cambodian agriculture will need to use these lessons to continue its successful transformation**. As the country moves to middle-income status, it will continue to experience agricultural transformation, whereby the economic structure of its society will change from one based on agriculture to one based on agribusiness, industry, and services. During this process, agriculture's importance in the economy, as measured by its share of labor and GDP, will decline (Box 8). At the same time, agriculture will become more productive: returns to agricultural labor and land will increase and agricultural GDP will grow in the absolute terms.

Box 8: Indicators of Agricultural Transformation

Agriculture becomes less "important" in the economy

- Declining share of agriculture in labor
- Declining share of agriculture in GDP

Agriculture becomes more productive

- Increasing agricultural labor income
- Increasing agricultural GDP per unit of labor and land

207. **By 2030, Cambodia's agriculture needs to become "less important" but "more productive."** The challenge is to continue the past agricultural growth of 5 percent per year via higher resource use efficiency rather than cultivated land expansion. With 5 percent annual agricultural growth by 2030, the share of agriculture in GDP is projected to decline to 23 percent in current prices and 17 percent in real prices (Table 43). The labor share in agriculture will decline to 32 percent compared to 51 percent in 2012. Cambodia may reach the status of a "transitioning economy" based on the framework presented in Table 12. More productive agriculture (land and labor productivity) would not only increase farm incomes in absolute terms, but would also significantly reduce the income gap in current prices between agriculture and non-agriculture to 1.6 by 2030, starting from a high ratio of 2.1 in 2012.

Table 43: Indicators of agricultural transformation at 5 percent agricultural growth

Indicator	Unit	Past Growth Rate (%)	Future Growth Rate (%)	2012 (Baseline)	2015 (Short term)	2020 (Medium term)	2030 (Long term)
Agriculture as a share in GDP (in current prices)	%	1.3	-2.1	34%	32%	28%	23%
Agriculture as a share in GDP (in real prices)	%	-1.9	-2.1	26%	24%	22%	17%
Labor share in agriculture	%	-1.5	-2.6	51%	47%	41%	32%
Agricultural GDP/agricultural labor force	$/capita	4.5	6.5	1,210	1,460	2,000	3,700
Agricultural GDP/cultivated land area	$/ha	0.3	3.9	1,325	1,485	1,800	2,640
Ratio of nonfarm GDP/nonfarm labor and agricultural GDP/farm labor	Ratio	-1.2	-1.6	2.1	1.9	1.8	1.6

Notes: Based on assumptions indicated in *Annex 4*.

Source: Own estimates.

208. **A 5 percent agricultural GDP growth is not assured, however**. Future growth may well be only 3 percent, especially if needed policy actions and investments are not made ("doing nothing"). The costs of doing nothing would be very high for Cambodians. For illustration purposes only, it is estimated that the 3 percent growth in agricultural value added would reduce overall GDP,[45] make agriculture less productive sector, keep more people in the sector,[46] and, most importantly, increase the income gap between farm and nonfarm workers (Table 44). The cumulative reduction in agricultural value added by 2030 can reach 29 percent, and the income gap between agriculture and non-agriculture can stay the same, at 2.1, compared to 1.6 at the 5 percent growth in agricultural GDP. Thus, achieving the 5 percent agricultural growth is important.

Table 44: Changes of indicators of agricultural transformation at 3 percent compared with 5 percent growth

Selected indicators	Future Growth Rate		2020 (Medium Term) (%)	2030 (Long-Term) (%)
	5%	3%		
GDP growth	7.2	6.0	-8.6	-18.3
Agricultural GDP growth	5.0	3.0	-14.3	-29.3
Agriculture as a share of GDP	-2.2	-3.0	-6.4	-13.7
Agriculture as a share of total labor force	-2.7	-2.3	3.3	7.7
Agricultural GDP/ agricultural labor	6.4	4.0	-16.7	-33.7
Ratio of nonfarm GDP/nonfarm labor and agricultural GDP/farm labor	-1.54	-0.02	15.0	32.7

Source: Own estimates.

209. **A long-term vision for Cambodian agriculture would need to aim to continue higher growth but with more emphasis on intensification and farm income convergence and lower costs to the environment**. The proposed vision statement can be the following: "*A sustainable and competitive agriculture sector that fosters productivity growth and contributes to increased farm and nonfarm incomes*."

210. **This vision statement is largely in line with the policy goal of the Agricultural Strategy Development Plan for 2014-2018**, which is "*enhanced agricultural productivity, diversification and commercialization, thereby contributing to reduced poverty and accelerated economic growth while, at the same time, ensuring environmental protection and sustainable natural resource management*." The additional point emphasized by the proposed vision statement is the increase

[45] In 2013, the share of agricultural GDP in total GDP was 24 percent. Thus, in the short run a 2 percent reduction in agricultural GDP would lead to a 0.48 percent reduction in overall GDP. The longer-run effect is likely to be much higher given the strong links between agriculture and trade, transportation, and food processing sectors in Cambodia. For the hypothetical calculations of the implications of the 3 percent growth in agricultural GDP, the long-term GDP growth is reduced from 7.2 percent to 6.0 percent.

[46] The impact of lower agricultural growth on agricultural labor is not known. It is, however, likely that lower growth in the long-term agricultural GDP would keep more people in the sector than 5 percent growth. At 3 percent agricultural growth, the agricultural labor force is assumed to decline by 1 percent annually, compared to 1.4 percent at 5 percent agricultural growth.

in farm incomes and their convergence with nonfarm incomes, which would indicate successful structural transformation.

211. **The key elements of the proposed Vision are sustainability, competitiveness, productivity, and income growth**:

a. **Sustainability**: Sustainable agriculture includes many dimensions, including environmental sustainability. Progress in achieving environmental sustainability will be judged by the success in securing future benefits from the country's rich land, forest, and water resources for future generations. It implies reversing the expansion of cultivated land at the expense of forest and other environmentally sensitive land, increasing soil organic matter, reversing land degradation through good agricultural practices and climate-smart agriculture, and increasing agricultural water productivity.

b. **Competitiveness**: Having farms able to produce at competitive prices will not be enough to maintain high agricultural growth rates and increase farm incomes. Even future farm competitiveness is at risk if policy actions do not address pertinent constraints, including poor infrastructure, weak governance, weak quality and safety control, low technology, limited capacity and human resources, and difficulty in accessing credit and doing business. These constraints harm not only farms but also agribusinesses. Competitiveness implies a production and distribution system oriented towards the market and meeting consumers' demand effectively by providing higher value. Competitive products are not necessarily cheaper, but meet the preferences and budgets of consumers, using efficient value chains. Competitiveness is based on comparative advantage, productivity, and profitability, but goes one step further: rather than focusing only on cheaper costs, it looks at higher value added, quality, and safety.

c. **Productivity growth**: Consistent with the insights of agricultural transformation, a more dynamic agriculture is accompanied by higher productivity growth. The agricultural land expansion that took place in previous decades is not a viable option in the future. Productivity growth needs to become a central element of agricultural development in the country. Growth of agricultural-based activities will have rural nonfarm effects and imply nonfarm employment. Higher economic growth in the agriculture sector will in turn contribute to higher GDP. Combined with a reduced population growth rate and reduced growth of agricultural labor, higher GDP per capita in agriculture will reduce poverty and improve living standards in rural areas.

d. **Income growth**: A desirable agricultural transformation implies growing incomes for farmers and improved integration with the rest of the economy, primarily through strong linkages with the agribusiness sector, reflected in growing returns to agricultural labor. As a result of labor migration from agriculture to other sectors, overall productivity growth, and a more diversified (profitable) mix of agricultural products, the gap between agricultural and non-agricultural incomes will decline. The growth of agricultural income will increasingly depend on the development of agroprocessing, storage, trade, food service, production services, and agri-tourism. The income growth of the smallest farms may lag behind that of larger farms, calling for special attention to this group of farmers.

212. **The key elements of the proposed vision require indicators and targets for agricultural transformation**. Targets indicate what is intended and possible to achieve as a result of the agricultural strategy's implementation. The proposed indicators and targets are presented in

Table 45. They are based on the underlying data summarized in *Annex 4*. Targets are listed for the short term (3 years), medium term (8 years), and long term (18 years). Each target is accompanied by indicators that allow progress (or lack thereof) toward the target to be measured.

Table 45: Proposed indicators and targets for a Long-Term Vision for Cambodian Agriculture

Vision's Elements	Indicator	Unit	Annual Growth Rate		2012	2015	2020	2030	Comments
			Past (2004-2012)	Future	Baseline	Short Term	Medium Term	Long Term	
Sustainability	Forest cover	% of land	-1.1%	0.4%	56%	57%	58%	60%	The 2012 baseline and the 2030 target are from NDSP. Past growth rate is from MAFF.
	Degraded land	million ha	NA	-3.8%	7.8	6.9	5.7	3.9	Baseline data based on Sovuthy Pheav, Director, Department of Ag Land Resources Management. Targets to be achieved through soil conservation, reforestation, and soil nutrient management programs.
	Soil organic matter	%	NA	8.0%	1.0%	1.3%	1.9%	4.0%	Baseline data from Rice Production in Cambodia edited by Harry J. Nesbitt SRI. Targets to be achieved by no tillage, intercropping, organic fertilizer, and other methods.
	Water productivity	liters / kg rice	NA	-1.2%	2,500	2,409	2,264	2,000	Baseline based on Wokker *et al.* 2014. Targets to be achieved by more efficient use of irrigation.
Competitiveness	Agricultural Exports	$ million	19%	14%	400	587	1,113	4,000	Past growth is based on stat.wto.org.
	Agribusiness GDP	% of Ag. GDP	6.4	9.7%	27.4%	31.3%	38.9%	60.3%	For agribusiness to grow from 30% to 60% of agricultural GDP, growth of agribusiness GDP has to be 9.7 % (if agricultural GDP grows at 5%).
	Capital-ag land ratio	$/ha	NA	3.9%	1,000	1,122	1,361	2,000	Baseline based on FAOSTAT.
Productivity	Ag land productivity	Ag. GDP /cultivate	0.3%	3.9%	1,325	1,485	1,800	2,640	Baseline based on data from WDI. Target derived from assumption on

Vision's Elements	Indicator	Unit	Annual Growth Rate		2012	2015	2020	2030	Comments
			Past (2004-2012)	Future	Baseline	Short Term	Medium Term	Long Term	
		d area, $/ha							ag GDP growth of 5% and a moderate increase in cultivated land of 1% per year.
	Agricultural labor productivity	Ag. GDP/ ag labor force, $/person	4.5%	6.5%	1,210	1,460	2,000	3,755	Baseline based on data from WDI and NIS. Target derived from assumption on ag GDP growth of 5% and decrease in ag labor by 1.4%.
Income	Returns to agricultural labor	$/day	12.0%	6.3%	6.0	7.2	9.8	18.0	Baseline based on data from the 2013 survey. Target derived from the conservative assumption of future growth to be only a half of the past growth.
	Gap between nonfarm per capita income and farm per capita income	Ratio	-1.2%	-1.6%	2.1	1.9	1.8	1.5	Derived from the assumptions on ag GDP growth, ag labor growth, non-ag GDP growth, and non-ag labor growth.

9. Options for Supporting a Long-Term Vision for Agriculture

9.1. Introduction

213. **Realizing the Long-Tem Vision for Cambodian Agriculture requires a conducive policy environment and high-quality public programs**. These policies and programs must take into account the factors underpinning future agricultural development described in Chapter 7. A number of priority areas exist, as well as trade-offs. Analysis of the farm budget and profitability database for Cambodian agriculture offers a useful platform to compare policies and programs in terms of their impact on farm gross margins, net present value (NPV), returns to agricultural labor and extra demand for labor, demand for fertilizers, and impacts on competitiveness.

214. **Four sets of policy scenarios are developed to support Cambodia's agricultural transformation over the next twenty years and movement toward a Vision 2030**:

a. **Environmental sustainability**: Ensuring sustainable land expansion through land use planning; reverting agricultural land to forest, aiming to reach the country's target of 60 percent forest cover by 2030; and maintaining soil fertility through optimal use of available land and use of fertilizer and organic matter.
b. **Productivity growth**: Increasing adoption of improved technologies through extension services and use of more and better quality inputs; and investing in effective irrigation by ensuring strong linkages with extension programs and enforcement of operations and maintenance guidelines.
c. **Competitiveness**: Analyzing the effect of price changes of inputs and outputs and making adjustments to maintain competitiveness of Cambodian agriculture.
d. **Income growth**: Increasing farm households' income through land consolidation (i.e., higher total available income per capita because of larger assets), higher productivity, and better informed choice of higher-value crops and technologies.

9.2. Scenarios for Environmental Sustainability

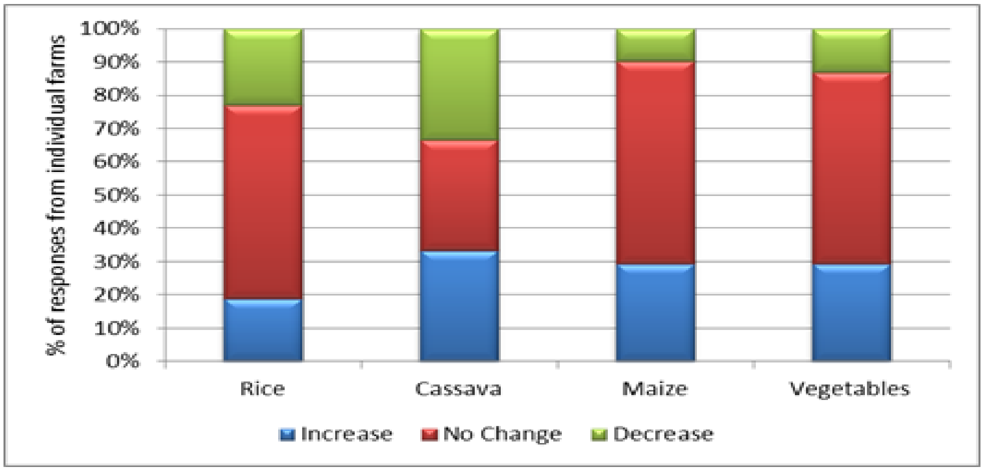
215. **Land expansion has been a major factor of agricultural growth in Cambodia**. Over 2002-2012, cultivated land for crops covered by the survey (rice, maize, cassava, and vegetables) increased by 50 percent. The growth in upland crops was even more dramatic: cultivated land increased by a factor of 2 for maize and 13 for cassava. Even for rice, where the increase in land was more modest than the average, the contribution of cultivated land to rice production growth was over 40 percent.

216. **For upland crops, especially cassava, FGDs and expert interviews revealed that cultivated land expansion comes at the expense of forest land**. Moreover, as soil nutrients are mined and not replenished, land expansion results in soil fertility degradation. In other areas of the country, cultivated land expansion puts pressure on water resources and may encroach on pasture land. This consideration, in line with any biodiversity conservation program that Cambodia may have, would argue against continuing a development strategy based on land expansion.

217. **The majority of farmers interviewed during the 2013 survey believed that their total cultivated land area will not change**. Farmers were relatively conservative regarding their expectation of cultivated land areas in the next five years. More than half of interviewed farmers

expected no change in the area of land cultivated with vegetables and maize (Figure 38). About 10 percent predicted a decrease, and one out of three anticipated an increase. Cassava showed a peculiar pattern, with almost equal numbers of farmers expecting an increase, no change or a decrease in cultivated areas.

Figure 38: Perspectives on the possibility of change in cultivated areas by crop, Cambodia



Source: 2013 survey.

218. **The response was determined by location**. Respondents in the Tonle Sap and Mekong regions were not positive regarding the possibility of increasing cultivated land. In other regions, the option of land expansion is still open, especially for upland crops. During interviews with different stakeholders, many people were aware of the encroachment of cassava crop cultivation into forest land. This is a relatively easy way to expand agricultural land, but its practice is receiving increasingly more attention from policy makers since it puts more stress on already fragile ecosystems. For rice, the trend was "no change," although more than 20 percent of respondents were pessimistic, expecting a decrease in area cultivated.

219. **As land expansion cannot play the same role in production growth in the future, alternative growth strategies such as yield increase, crop and technology choices, and competitive market advantage will have to play a more important role**. The analysis of environmental sustainability is divided into two types: (i) "weak environmental sustainability," whereby the increase in cultivated area for agricultural production continues but at a slower pace, and (ii) "strong environmental sustainability," whereby cultivated land area stays the same or decreases over time.

Weak environmental sustainability

220. **Three scenarios (L1, L2, and L3) are developed**. They consider a slower cultivated land expansion growth rate compared to past trends and calculate the resulting total production, gross margins, and demand for inputs. Except land, all other factors are held constant at their 2013 observed values. To make the simulation results comparable, the overall increase in cultivated land for the selected crops is set at about 450,000 ha by 2030. This leads to a total cultivated land area of 4.01 million ha in 2030, an increase of 11-12 percent depending on the scenario, compared to 3.58 million ha for the selected crops in 2012.

221. **The scenarios' assumptions are summarized in Table 46**. Scenario L1 considers maintaining upland crops and vegetables' areas constant at their 2013 levels and the land area under rice growing at 25 percent of its past growth rate. This scenario focuses on rice production, reinforcing its role in the economy at the expense of diversification. Scenario L2 assumes a land expansion of about one-tenth of its past growth rate for all crops. This scenario treats all crops equally. Scenario L3 sets upland crops and vegetables' cultivated land expansion at slightly less than 14 percent of their past growth and keeps cultivated rice land at its current level. The policy then emphasizes diversification toward expansion of upland crops, which may present an environmental challenge.

Table 46: Assumptions about land expansion for Environmental Sustainability scenarios L1-L3

	Baseline	L1	L2	L3
Cassava	0.0%	0.0%	10.0%	14.0%
Maize	0.0%	0.0%	10.0%	14.0%
Wet season rice	0.0%	25.0%	10.0%	0.0%
Dry season rice	0.0%	25.0%	10.0%	0.0%
Vegetables	0.0%	0.0%	10.0%	14.0%

Source: Own estimates.

222. **In scenario L1, rice production increases by 17 percent from the baseline of 9.6 million tons to 11.2 million tons**. This is the result of land expansion for rice by one-fourth of its past growth rate. Gross margins for rice increase by 15.8 percent, from $756 million to $876 million (Table 95A[47]). The overall gross margin for the combined five crops increases by 11.2 percent, from $1.02 to $1.19 billion (Table 47).

223. **In scenario L2, the assumption is that land expansion for all crops continues at 10 percent of past growth rates**. Rice production increases by 6.4 percent from the baseline 9.6 million tons to 10.17 million tons (Table 96A). Assuming cassava maintain its level of productivity, a strong assumption due to the low use of organic and chemical fertilizer for this crop, cassava production increases by 74 percent, from 6.3 million tons to 10.96 million tons; maize production increases from 849,000 tons to 1 million tons (17.8 percent increase). Rice is still the most important crop in terms of gross margins even through its share falls by 7 percent, from its 71 percent baseline. The overall gross margins for the five crops increase by 18.2 percent (Table 47), reaching $1.26 billion by 2030.

224. **In scenario L3, which focuses on upland crops and vegetables production, rice production remains similar to the baseline at 9.6 million tons**. Cassava production is more than twice the baseline, rising from 6.3 million tons to 13.6 million tons; and maize production increases by 25.8 percent, from 0.85 million tons to 1.07 million tons (Table 97A). The share of upland crops and vegetables in overall gross margins increases from 29 percent to 42 percent, reaching $542 million. The share of gross margins from rice drops by 13 percentage points, from 71 percent to 58 percent. Overall gross margins increase by 21.6 percent (Table 47), reaching $1.30 billion, the highest among the three weak environmental sustainability scenarios.

[47] Table numbers with "A" are presented in *Annex 4*.

Table 47: Simulation results for Weak Environmental Sustainability scenarios L1-L3

	Simulation	Change in Gross Margin, $ million (%)	NPV ($ million)	Returns to Ag. Labor ($/day)	Change in Demand for Ag. Labor million days (%)	Change in Demand for Fertilizers, tons/year (%)	Likely Effect on Competitiveness (DRC)
	Baseline	**1,023**	**10,220**	**6.41**	**166.5**	**464,861**	
L1	Rice areas increase by 25% of past land expansion	11.2%	10,644	6.42	11.2%	17.1%	Neutral
L2	Equal increase of all cultivated land by 10%	18.2	10,882	6.70	13.1%	8.2%	Neutral
L3	Increase of upland areas by 14%	21.6	10,958	6.86	13.7%	2.6%	Neutral

Source: Own estimates.

225. **These simulations suggest that the policy toward crop diversification (scenario L3) results in the highest gross margin and NPVs**. Moreover, diversification toward upland crops favors more regionally-balanced development. However at the same time, there is a serious danger of soil degradation and forest land loss because of its focus on upland crops, particularly for cassava plantation (more than 400,000 ha of new upland brought into agricultural production). The scenario focusing only on rice (scenario L1), at the current level of per-hectare gross margins, results in the worst economic outcome.

226. **For each of the three scenarios, demand for labor is roughly comparable, 11-14 percent higher than the baseline**. On average, 20 million days of additional demand for labor are generated, which is related to the increase in cultivated land area. By 2030, the total demand for labor in scenario L1 is expected to reach 185 million days; the demand in scenario L2 is higher at 188 million days; and the demand in scenario L3 is 189 million days due to the labor requirement for cassava production (Table 101A). The average returns to labor do not change much and remain close to $6.5 per day (Table 103A).

227. **The policy focusing on rice requires the highest amount of chemical fertilizers**. It results in a 17 percent increase, from 465,000 tons to 544,000 tons; i.e., an additional demand of 80,000 tons (Table 102A). Scenario L3 leads to the lowest increase in demand for chemical fertilizers (2.6 percent at 476,000 tons) while scenario L2 results in an additional demand of about 40,000 tons for chemical fertilizer reaching 477,000 tons. These demands were estimated assuming the status-quo application and adoption rates of chemical fertilizers as in 2013.

Strong environmental sustainability

228. **Under the strong environmental sustainability group, three scenarios were developed**. Two scenarios (L4 and L6) maintain the same agricultural land area until 2030 and one scenario (L5) reduces the agricultural land available.

229. **Scenario L4 keeps the current land use for agriculture but assumes a decrease in cassava yield**. Assuming that current farm practices are maintained, characterized by low-to-no use of organic and low use of inorganic fertilizers for cassava, a drop in yield is likely. It is estimated that cassava yield can be as low as 12.6 tons/ha when cultivated on low fertility soil. It is assumed under this scenario that such a low yield will be attained by 2030, corresponding to an annual decrease in cassava yield of 2.4 percent from 2013 to 2030.

230. **The RGC's objective is for 60 percent of land to be forested by 2030, up from its current 56 percent**. To meet that goal, scenario L5 takes back land from agriculture through reforestation. This policy target results in about 710,000 ha of non-forest land converted into forest, increasing forest areas to 10.83 million ha from the current 10.12 million ha. Scenario L5 assumes that 25 percent of the required increase comes from cultivated agricultural land in upland areas and the remainder from barren, non-cultivated land. This corresponds to an annual increase of 40,000 ha of forest cover, with about 10,000 ha converted from agriculture.

231. **Scenario L6 assumes status quo in the area of agricultural land but simulates the impact of nutrient restitution by putting upland fields into fallow one out of every three years**. This practice is expected to restore organic matter and maintain soil fertility at an acceptable level, allowing for the possibility of increased yields. The required yield level is estimated to maintain the current agriculture sector performance with reduced land under cultivation.

232. **Soil depletion on upland crops (simulated on cassava production) reduces the annual cassava gross margin by 31 percent** (Table 98A). This decline is the direct effect of lower yield, from 18.65 tons/ha in 2012 to 12.80 tons/ha in 2030, corresponding to a production of 4.3 million tons in 2030 compared to the current 6.3 million tons. Overall gross margin for the five crops drops by 5 percent, resulting in an NPV loss of $213 million by 2030 (Table 48).

233. **Reducing agricultural land to contribute to the country's target of 60 percent forest cover in 2030 (scenario L5) also reduces the gross margin**. The overall gross margin and NPV decline by 7.5 percent and 4.7 percent in 2030, respectively (Table 48). This decline is the direct effect of lower cultivated land areas for cassava and maize (Table 99A). Because the hypothesis is reduced upland cultivated areas, the share of cassava and maize in total gross margin decreases from 22 percent to 17 percent; the gross margins from rice and vegetables do not change because of the initial assumption. The results show that reducing upland areas harms the agriculture sector in the absence of options to increase agricultural productivity and profitability.

234. **In scenario L6, the cultivated upland area is decreased by allocating one-third of the current area to fallow to restore soil fertility**. With this assumption, the results show the possibility of maintaining the 2013 level of productivity level until 2030 even with the decrease in cultivated land area. Under scenario L6, overall gross margin remains stable at $1.02 billion despite the lower areas under cassava and maize. The total annual cultivated land declines by 5.2 percent but this amount of land (about 187,000 ha in 2030) becomes fallow and is not reforested (Table 100A). The annual cultivated area under cassava drops by one-third, from 337,800 ha to 223,515 ha, and area under maize drops by the same proportion, from the current 215,442 ha to 142,553 ha. A better production system putting into fallow one-third of the available upland area results in improved soil fertility, optimal pest management and likely higher productivity.

235. **However, scenario L6 makes a strong assumption about yield growth**. To overcome the impact of lower cultivated areas, farmers need to efficiently manage crop production and adopt agricultural techniques that will result in increased yield. The unchanged gross margin obtained

with this scenario requires an increase in cassava yield of 50 percent, from its current 18.65 tons/ha to 25.91 tons/ha, and a similar increase for maize yield from 3.94 tons/ha to 5.90 tons/ha (Table 100A).

Table 48: Simulation results for Strong Environmental Sustainability scenarios L4-L6

	Simulation	**Change in Gross Margin, $ million (%)**	**NPV ($ million)**	**Returns to Ag. Labor ($/day)**	**Change in Demand for Ag. Labor million days (%)**	**Change in Demand for Fertilizers, tons/year (%)**	**Likely Effect on Competitiveness (DRC)**
	Baseline	**1,023**	**10,220**	**6.41**	**166.5**	**464,861**	
L4	Loss of soil fertility	-5.0%	10,007	6.09	0.0%	0.0%	Worsened/ DRC increased
L5	Decrease of upland crop area by 2.4% a year	-7.5%	9,901	6.23	-4.7%	-1.2%	Neutral
L6	Fallow 1/3 of upland crop area	-0.2%	10,211	6.72	-4.7%	-1.2%	Improved/ DRC decreased

Source: Own estimates.

9.3. Scenarios for Productivity Growth

236. **Considerable technological change has occurred in crop production in the past ten years**. A lot of this technological change has the typical features of the green revolution (improved seeds, use of inorganic fertilizers and other chemicals, and irrigation), but there is also an increasing reliance on mechanization, driven by higher labor costs and scarcity of available rural labor.

237. **Cambodian farmers are aware of the importance of improved and higher-quality seeds**. They think that seeds have a high impact on productivity. Farmer-to-farmer communication is the main source for adoption of new and improved seeds: according to farmers, it was even more important than information obtained from technical agents of the extension system. Farmers are positive about the continuous improvement in seeds. This is not necessarily because of the effort of related institutions such as the research and extension organizations in Cambodia, the public extension system, NGOs or private companies. A key role in improved seed dissemination and adoption is played by contact with farmers and traders in neighboring countries. In practice, many of the improved seeds in Cambodia originated from research and development systems of Vietnam and Thailand. While access to this research and development effort is a positive externality for Cambodia, the seed trade remains largely uncontrolled and issues of intellectual property rights are not addressed.

238. **Chemical inputs are increasingly used**. But Cambodian farmers use much less chemical inputs than neighboring countries. This lag in adoption of chemical inputs might have some positive effects in terms of reducing environmental impact and chemical residues on food.

However, the lower use of chemicals in Cambodia appears to be less the result of a conscious choice inspired by environmental or food safety concerns than the outcome of a poorly functioning input distribution system characterized by high input prices and often inputs of dubious quality. In some cases, most notably cassava and to a lower extent maize, the very low use of fertilizer (whether chemical or organic) has serious negative impacts on soil fertility and sustainability.

239. **The increasing use of inputs, however, does not appear to have significantly increased farm profits.** In other words, improved technology use has not been accompanied by efficiency improvements or increased TFP. Over the past decade, the overall profitability of agriculture (measured by gross margins per ha in real terms) has not increased for the majority of farmers. The profitability of those engaged in rice might have been stagnant or declining in spite of the noted changes in output prices and use of modern technology. For cassava, the increase in output prices was higher than the increase in the unit cost of production. The problem is that the land expansion in cassava is itself unsustainable, since it is carried out through exploitation of soils that were previously forest land.

240. **Labor competition is increasing and labor costs are mounting**. Wages for basic agricultural tasks have increased by a factor of three over the past decade, implying changes in production techniques and production cost structure. Farmers are using more services (e.g., mechanization), more modern inputs, and less labor. This movement favors larger farmers who have access to capital and penalizes small farmers for whom labor is a main asset. Migration of youth and women to nonfarm rural sector and urban sector employment continues unabated. The subsequent lack of labor in rural areas puts pressure on rural wages, which has a negative impact on the cost of production; at the same time, it accelerates mechanization.

241. **According to the surveys' findings, rural wages increased tremendously over the past decade, from $1.25/day in 2005 to $4.56/day in 2013**. The estimated monthly salary for rural labor is about 70-80 percent of the industrial wage, depending on the season. The most dramatic changes in the production system regard labor use in cassava and dry season rice production, where mechanization has contributed to labor substitution in operations such as land preparation, weed control, harvesting, and threshing. The increasing use of labor in vegetables production might be associated with the need to provide better care, the use of more intensive practices such as several cycles over the year, and the trend toward more labor-intensive vegetables such as broccoli, lettuce, and cucumber.

242. **As a result, labor use is decreasing, except in vegetables production (Figure 39), while returns to labor are increasing for all crops, with the exception of maize (Figure 40)**. Perhaps in the case of maize, early adopters of hybrids were rewarded with higher margins. Figure 39 also shows the higher variability of the returns to labor in 2005, ranging from $1.87/day (wet season rice) to $14.82/day (maize). The gap across crops become less acute in 2013 (between $5.08/day and $10.65/day), indicating improved allocation of available labor in rural areas.

243. **It is important to note that the share of service in the cost of production is indicative of a new type of farming emerging in Cambodia, namely one better integrated with the nonfarm service sector**. The idea of a self-sufficient farmer is changing. Even though a farmer might be able to produce more than what s/he consumes (at least for some specific commodities), s/he is highly dependent on labor and services provided outside of her/his household. The trend is for the Cambodian farmer to become a farm manager, namely somebody who in the effort to maximize profitability out of land will use inputs, services, and knowledge more than her/his own

labor. The implicit concern in all these major changes in the cost and use of labor in agriculture is that neither agriculture nor other sectors of the economy will be able to absorb the increasing labor force.

244. **To simulate the effect of factors that could improve TFP, four scenarios are developed**. The first scenario (P1) simulates *technical change* (moving the farm technology frontier up). The second scenario (P2) is about *technical efficiency* (reducing the productivity gap by shifting farms from traditional to modern practices). The third scenario (P3) combines technical change and technical efficiency. The fourth scenario (P4) simulates the effects of irrigation on TFP.

Figure 39: Labor use in production (days/ha), Cambodia

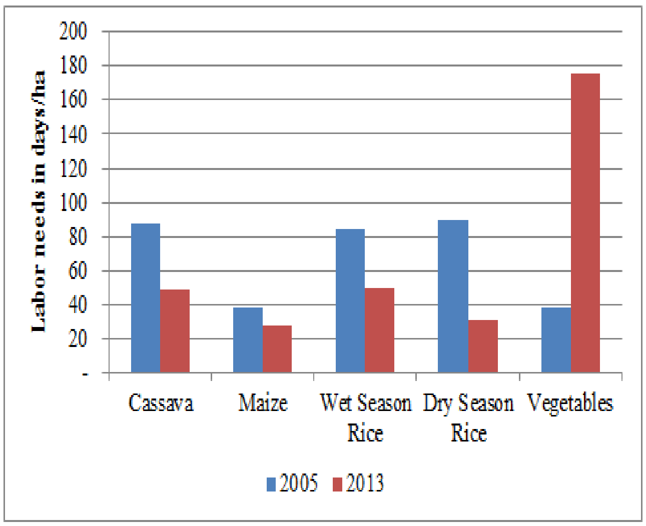
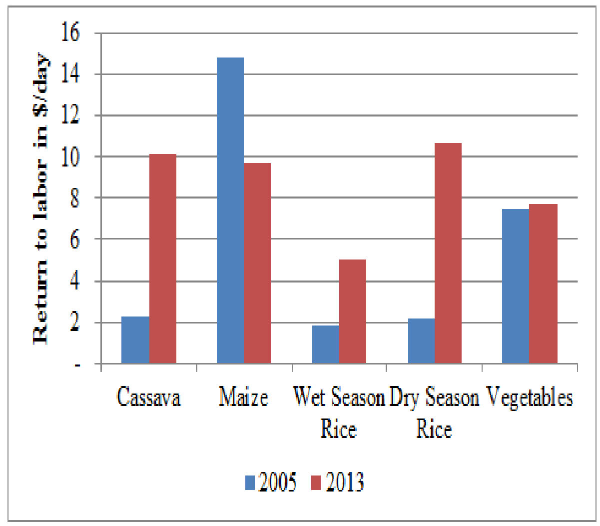


Figure 40: Return to labor ($/day), Cambodia



Source: 2005 and 2013 surveys.

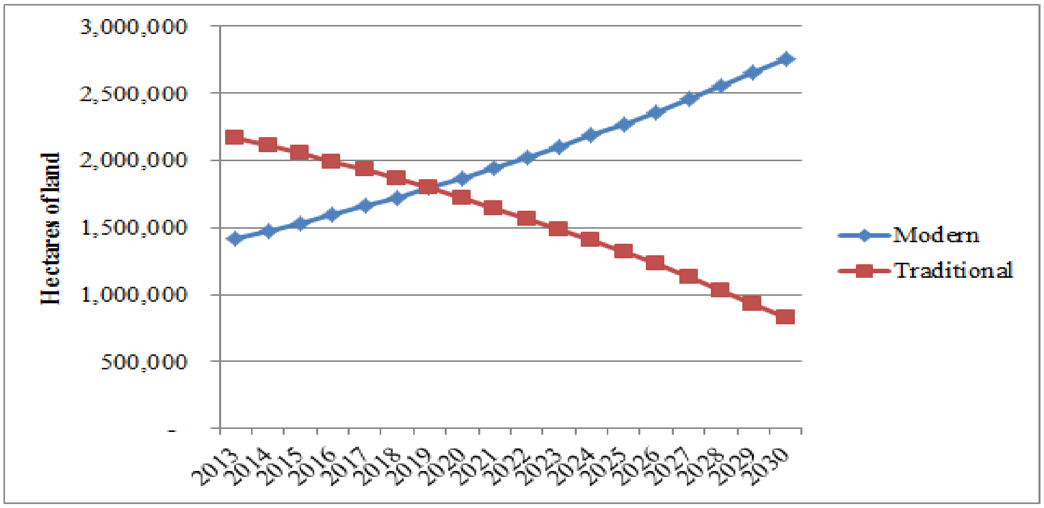
Increased adoption of modern farm technologies

245. **Scenarios P1 through P3 assume that increasingly more farmers will become modern technology adopters, resulting in fewer farmers using traditional practices**. In these simulations, the level of chemical fertilizer application, the use of improved seeds, and labor allocation in the farm budgets are used as measure for modern technology adoption and contribute both to the higher adoption of new technologies (technical change) and to a larger share of farms using existing improved technologies (technical efficiency), thereby increasing an overall TFP. The basis for the simulation is an annual 4 percent shift from traditional to modern farming until 2030.

246. **As the initial distribution of farms by technology use is not known with precision, the information collected during the FGDs was used to make assumptions**. Modern technology adopters appear to account for 35-40 percent of total farms in Cambodia. Details of modern input use and the distribution of farms by level of technology use are presented in Table 104A and Table 105A. The projected trend in the number of modern and traditional farms is presented in Figure 41 and shows that by 2030 at least 75 percent of farmers will be categorized as users of modern technologies. This requires at least a 4 percent shift per year from traditional to modern farming in

terms of cultivated land. The simulation shows that by 2019, the total area cultivated by modern farmers exceeds that cultivated with traditional techniques; by 2030, there is a clear dominance of farmers using modern technologies in Cambodia.

Figure 41: Shift in land used by traditional and modern farmers, Cambodia



Source: 2013 survey.

247. **Modern farmers differ from traditional ones in the following manner**. For rice and cassava, modern farmers use about twice the amount of chemical fertilizers that traditional farmers do (Table 104A). Maize production presents the largest gap (2.6 kg/ha versus 104 kg/ha), and vegetable production a ratio of about 1 to 3.5 (traditional versus modern). The table shows different levels of adoption of improved seeds between modern farmers and those using traditional varieties: the difference is largest for rice and vegetables, with modern farmers using a higher amount of improved seeds per hectare. Table 105 details the level of labor use per hectare across farms using traditional and modern technologies, the wage rate assumed as in 2013. It is assumed that every year, 4 percent of farmers practicing traditional technology shift to modern technology. The breakdown of modern farmers by crop is as follows: 35 percent for cassava, 40 percent for maize and rice, and 40 percent for vegetable production. With the retained growth rate of 4 percent, the overall proportion of farms adopting modern technologies reaches 75 percent in 2030, an increase of 35 percentage points from the current average of 40 percent.

248. **Farmers using modern technologies are more productive and profitable**. In the baseline, modern cassava producers generate 65 percent more in gross margins compared to traditional farmers; for maize, the gap is higher, at 87 percent. For dry season rice production, the gross margins between modern and traditional farmers are quite close, at $387/ha versus $336/ha. For wet season rice and vegetables, the differences are huge: 124 percent for rice and 240 percent for vegetables. In scenarios P1-P3, it is assumed that modern farmers do not incur additional irrigation costs.

249. **Scenario P1 consists of keeping the farm distribution by technology use at 2013 status**. However, due to access to better input quality and extension services, modern farmers have higher efficiency, which translates into productivity growth twice as high as that of traditional farmers by 2030 (Table 49).

250. **Scenario P2 simulates the effects of an annual shift of 4 percent of land cultivated with traditional techniques to land cultivated with modern techniques**. However, there is no additional efficiency gain; i.e., the productivity gap between traditional and modern farmers remains the same as the level recorded during the 2013 baseline.

251. **Scenario P3 combines the effect of an annual 4 percent shift on land cultivated with improved efficiency of modern technology users by using a productivity gap twice the baseline**. This means that modern farmers should be able to get higher gains from the use of any inputs through better crop production systems, improved knowledge and skills, and better information on the quality of inputs.

Table 49: Assumptions about Productivity Growth scenarios P1-P3

	Baseline	P1	P2	P3
% decrease in no. of traditional farms	0.0%	0.0%	4.0%	4.0%
% increase in no. of modern farms	0.0%	0.0%	4.0%	4.0%
Increase in yield to ensure effectiveness of modern farms				
Cassava	0.0%	1.1%	0.0%	1.1%
Maize	0.0%	1.1%	0.0%	1.1%
Wet season rice	0.0%	1.0%	0.0%	1.0%
Dry season rice	0.0%	0.4%	0.0%	0.4%
Vegetables	0.0%	2.3%	0.0%	2.3%

Source: Own estimates.

252. **The results simulated with scenario P1 show positive outcomes for the agriculture sector**. The gross margins for modern farmers increase by 19.9 percent from $636 million to $764 million in 2030 (Table 107A). This corresponds to an additional NPV of $450 million, 7.3 percent higher compared to the baseline. The total gross margin for the five crops and total NPV increase by 11.1 percent and 4.1 percent, respectively (Table 50). The share of modern farms in total gross margin in 2030 reaches 60 percent.

253. **Scenario P2 simulates an annual shift of 4 percent of traditional to modern farming, but without improved productivity**. This growth rate leads to three-fourths of farmers adopting modern technologies by 2030. The additional NPV generated by the shift corresponds to $887 million by 2030, 8.6 percent higher than the 2012 NPV (Table 108A). The gross margins for the five crops increase by 25.8 percent (Table 50), including for modern farms by 94.8 percent. This is the direct effect of more traditional farmers adopting modern technologies. Since the assumption is to keep the total cultivated land unchanged, the projected gains in gross margin and NPV exceed losses from potential agricultural land conversion into forest land simulated in the previous section. Moreover, the gain in gross margins for modern farms outweighs the loss in gross margin for traditional farms.

254. **Scenario P3 presents more efficient farm production in combination with an annual 4 percent shift in the use of traditional versus modern technologies**. The overall gross margins and NPV for the five crops increase by 47.4 percent and 14.9 percent, respectively (Table 50 and Table 109A), with 88 percent of the increased NPV provided by modern farms, which cultivate 77 percent of the total area.

Table 50: Simulation results for Productivity Growth scenarios P1-P3

	Simulation	Change in Gross Margin, $ million (%)	NPV ($ million)	Returns to Ag. Labor ($/day)	Change in Demand for Ag. Labor million days (%)	Change in Demand for Fertilizers, tons/year (%)	Likely Effect on Competitiveness (DRC)
	Baseline	**1,023**	**10,220**	**6.41**	**166.5**	**464,861**	
P1	More efficient modern farms	11.1%	10,640	7.14	-19.9%	26.6%	Improved/ DRC decreased
P2	Shift from traditional to modern farms	25.8%	11,107	10.10	0.0%	0.0%	Improved/ DRC decreased
P3	Combined effects of shift and efficiency	47.4%	11,749	11.84	-19.9%	26.6%	Improved/ DRC decreased

Source: Own estimates.

255. **The results of three scenarios show that the best economic outcome is achieved by a simultaneous increase in the number of farmers adopting modern technologies and more efficient use of production factors**. Scenario P3, combining both the technology shift and higher efficiency, leads to the highest gross margins, the largest NPV, and the highest returns to agricultural labor, which is the proxy for farm incomes (Table 50 and Table 110A). The returns to labor are projected to increase to $11.84/day, 86 percent above the 2012 baseline. This high return, however, remains below the long-term Vision's target as stated in Table 45 ($9/day in 2020 and $18/day in 2030), requiring high attention to additional sources of income growth (e.g., irrigation and diversification).

256. **Modern farmers are associated with higher gross margins and higher costs because of the use of more modern inputs**. The demand for chemical fertilizers peaks at 598,600 tons in 2030; i.e., an additional 125,000 tons or 26.6 percent higher compared to the baseline (Table 113A). The average application rate for cassava increases by 32 percent, from 14 kg/ha to 19 kg/ha. Chemical fertilizer use on maize increases by 89 percent, from 43 kg/ha to 82 kg/ha. Rice growers apply 158 kg/ha for wet season rice and 317 kg/ha for dry season rice, up by 25 percent and 23 percent, respectively, compared with the baseline. The increase chemical fertilizer use for vegetables is 52 percent, from 303 kg/ha to 460 kg/ha.

257. **But modern farms will use less labor, freeing it for other nonfarm uses**. With P2 and P3 scenarios, the demand for labor decreases by 19.9 percent in 2030, corresponding to 33 million fewer days (Table 112A) compared to the 2012 baseline. This overall decrease from 166 million to 133 million days, keeping area cultivated the same, comes mainly from reduced demand for rice production. Yet rice producers remain main users of labor, even though their share goes down from 80 percent in 2013 to 72 percent in 2030. Labor demand for other crops increases (7 percent for cassava, 4 percent for maize, and 28 percent for vegetables) but these higher needs are offset by the decreased demand from rice production. Post-harvest activities related to higher productivity generate higher demand for labor for cassava and maize production while for vegetables the increase in labor demand is linked to the overall vegetable production system.

Improved irrigation

258. **A critical element for increased productivity is the availability and quality of irrigation water**. Irrigation increases the likelihood of success when using modern inputs such as improved seeds and fertilizers. It also allows increasing crop intensity through multiple crop cycles per year and provides a system of water control and disaster risk reduction. In this simulation, the assumption is that irrigated land is cultivated twice a year and produces a higher yield (the dry season rice yield observed in the 2013 survey). Foregone revenues and costs are those related to the wet season rice production system, based on data from the 2013 survey. It is assumed that the land used to grow wet season rice receives irrigation and thus reaches the performance of dry season rice productivity. And lastly, all costs are held the same, with the exception of irrigation costs for dry season rice.

259. **Scenario P4 focuses on the investment in irrigation**. The assumption is that every year about 2 percent of nonirrigated land receives water irrigation infrastructure. If so, land productivity and profitability become similar to dry season rice production. If the rice field is irrigated, the expected yield is 4.34 tons/ha versus 2.78 tons/ha for rainfed rice. From the 2013 farm budgets, the unit price for paddy is $228/ton during the dry season and $262/ton during the wet season. Lastly, the gross margin for dry season rice is $370/ha (excluding irrigation costs) and $245/ha for wet season rice.

260. **The NPV from investment in irrigation amounts to $11.98 billion, about 17 percent above the 2012 baseline**. This increase comes from about 450,000 hectares of new land with irrigation, with the possibility of two crops per year. Table 51 presents the simulation results from irrigation investment.

Table 51: Simulation results for Productivity Growth scenario P4

	Simulation	Change in Gross Margin, $ million (%)	NPV ($ million)	Returns to Ag. Labor ($/day)	Change in Demand for Ag. Labor million days (%)	Change in Demand for Fertilizers, tons/year (%)	Likely Effect on Competitiveness (DRC)
	Baseline	**1,023**	**10,220**	**6.41**	**166.5**	**464,861**	
P4	Expansion of irrigation coverage	32.4%	11,984	8.52	3.1%	66.7%	Improved/ DRC decreased

Source: Own estimates.

261. **Irrigation requires a large amount of upfront investment**. Table 111A presents some costs observed in South and Eastern Asia that range from $1,400/ha to $4,000/ha. With these levels of prices, the total amount required for scenario P4 range between $636 million and $1.8 billion. The average cost for this scenario is assumed at $2,500/ha, which implies a need for $1.13 billion over the next 10 years to provide irrigation schemes for more than 450,000 ha. With a cost of irrigation of $4,000/ha, the computed internal rate of return (IRR) until 2030 is as low as 7 percent; at $2,500/ha, the IRR is 17 percent. However, if Cambodia manages to get reasonable irrigation investment costs of $1,400, comparable to costs in South Asia, then irrigation is a good candidate for agricultural development, with an IRR reaching 34 percent.

9.4. Scenarios for Improved Competitiveness

262. **Over the past decade, the overall cost of production for important crops such as rice and maize increased more than the overall revenues from production, implying a decline in profitability per unit of land for farmers engaged in those activities**. The concern is then whether the cost of production will continue to increase for key agricultural commodities and/or if profitability (as measured by gross margins per hectare) will decrease. Better linkages between farmers and enterprises and other value chain actors might be a solution to improving farm profitability. Improved linkages could result in higher output prices and lower prices of inputs due to lower transaction and transportation costs from better supply chain management and sales and marketing organization.

263. **The DRC analysis showed that agricultural production in Cambodia has a high comparative advantage, with most DRCs less than 1**. However, the DRC ratio is closely linked with the level of prices and thus any changes in prices will affect the advantage of the country producing the goods. Price changes for both outputs and inputs are simulated in scenarios C1-C6.

264. **The scenarios' assumptions are summarized in Table 52**. Scenarios C1 and C2 hypothesize an increase in output prices by quarter of their past growth rate, and simulate the effect of changes on input prices (scenario C1: identical to the percentage change in output prices; scenario C2: double the change in output prices). In both scenarios C3 and C4, output prices remain stable, but in scenario 3 the wage rate increases by half of its past growth rate, while in scenario C4 the cost of services increases by a quarter of its growth rate. Scenario C5 assesses the impact of lower output prices (15 percent less than current prices in 2030 in nominal terms); in scenario C6, the opposite occurs, such that output prices have a growth rate of 15 percent.

Table 52: Assumptions about Competitiveness scenarios C1-C6

Increase/decrease in	Baseline	C1	C2	C3	C4	C5	C6
Price of outputs	0.0%	25.0%	25.0%	0.0%	0.0%	-15.0%	15%
Price of seeds	0.0%	25.0%	50.0%	0.0%	0.0%	0.0%	0.0%
Price of fertilizers	0.0%	25.0%	50.0%	0.0%	0.0%	0.0%	0.0%
Price of other inputs	0.0%	25.0%	50.0%	0.0%	0.0%	0.0%	0.0%
Wage rate	0.0%	25.0%	50.0%	50.0%	0.0%	0.0%	0.0%
Service costs	0.0%	25.0%	50.0%	0.0%	25.0%	0.0%	0.0%

Source: Own estimates.

265. **Scenario C1 assumes equal increases in output and input prices**. From 2005 to 2013, the annual increases in output prices were spectacular in nominal terms: 17 percent for cassava, 13 percent for vegetables, 7-9 percent for rice, and 4 percent for maize. For a more conservative assumption, the simulation uses one-quarter of the past trends for the calculation. All production costs are also assumed to increase at a quarter of their past growth rate.

266. **Scenario C2 focuses on the effect of input prices increasing at twice the rate of output prices**. The simulation assumes a growth rate increase of one-quarter of the past rate for outputs, and double the rate for the cost of inputs. Indeed, a comparison of the 2005 and 2013 farm budgets shows a decrease in the gross margin in real terms, partly due to the rapid increase of input costs relative to output prices. This scenario tests the strength of the gross margins with respect to different price trends.

267. **Scenario C3 simulates the effect of status quo output prices and a 50 percent increase in the wage rate**. The analysis simulates the impact of increased wages on key profitability indicators. Cultivated land and labor requirements are expected to remain at the 2013 level to isolate the effect of an increased wage rate. For the simulation, the target of $18/day of returns to labor is used to estimate the annual wage rate growth. An additional assumption is that labor use is inelastic to the wage rate (i.e., it does not change as the wage rate increases).

268. **Scenario C4 is similar to C3 but simulates a moderate increase in the cost of services compared to its past growth rate**. The cost of services, mainly mechanization, increases by 25 percent, with prices of other inputs assumed constant.

269. **Scenario C5 looks at the effect of a reduction of output prices of 15 percent of the past growth rate by 2030**. Scenario C6 assesses the impact of an increase in output prices of the same magnitude of 15 percent. Other factors' costs remain constant.

270. **The economic results of the scenarios are summarized in Table 53**. A balanced increase of prices of outputs and inputs (scenario C1) results in an NPV gain of $766 million (7.5 percent increase). Price of outputs may increase due to an increase in world market prices or lower marketing costs along with a stronger domestic agroprocessing industry offering higher prices. The nominal yearly gross margin increases by 16.5 percent, from $1.02 billion in 2013 to $1.24 billion in 2030 (Table 116A). The overall growth, however, hides huge discrepancies across crops. Cassava, wet season rice, and vegetables benefit most from these balanced price increases. The NPVs for dry season rice and maize are 9 percent and 27 percent below the 2012 baseline, respectively.

271. **Scenario C2 assumes that the prices of inputs (seeds, fertilizers, and other inputs), labor, and services increase at half the rate of their past trends and that output prices increase at one-fourth their past rate**. This scenario's effects harm the profitability of agriculture in Cambodia. The overall NPV is $6.5 billion less than that of the scenario without price changes ($3.76 billion versus $10.2 billion). The NPVs for all crops are lower, with proportional changes ranging from an 18 percent loss for vegetables to a 94 percent loss for maize.

272. **If output prices remain stable but the daily wage rate grows at half of its past trend until 2030, Cambodia's agricultural sector will collapse**. The NPV for scenario C3 is only $3.76 billion by 2030, corresponding to a loss of $7.3 billion, the highest among the five competitiveness scenarios (Table 53). This $7.3 billion shortfall is the result of the wage rate increasing at an annual rate of 8.8 percent (half of the past growth rate), from $4.56/day in 2013 to $19.1/day in 2030, comparable to a long-term Vision's target in Table 45. The largest drop in NPV is for wet season rice (82 percent reduction) due to the relatively low gross margin per hectare ($245/ha) combined with relatively higher labor use (48 days/ha); the smallest reduction is for maize (a 22 percent reduction).

Table 53: Simulation results for the Competitiveness scenarios C1-C6

	Simulation	Change in Gross Margin, $ million (%)	NPV ($ million)	Returns to Ag. Labor ($/day)	Change in Demand for Ag. Labor million days (%)	Change in Demand for Fertilizers, tons/year (%)	Likely Effect on Competitiveness (DRC)
	Baseline	**1,023**	**10,220**	**6.41**	**166.5**	**464,861**	
C1	Equal increase in output and input prices (25%)	16.5%	10,986	7.09	0.0%	0.0%	Improved/ DRC decreased
C2	Input prices increase twice that of output prices	-247.7%	3,761	-10.92	0.0%	0.0%	Worsened/ DRC increased
C3	Wages increase by 50%	-226.2%	3,655	-7.84	0.0%	0.0%	Worsened/ DRC increased
C4	Cost of services increases by 25%	-25.2%	9,290	4.85	0.0%	0.0%	Worsened/ DRC increased
C5	Output prices decrease by 15%	-66.5%	7,499	2.36	0.0%	0.0%	Worsened/ DRC increased
C6	Output prices increase by 15%	182.8%	16,739	19.48	0.0%	0.0%	Improved/ DRC decreased

Source: Own estimates.

273. **In scenario C4, a moderate increase in the cost of services (a quarter of the past growth rate, at 1.9 percent per year) affects the overall gross margin less than the wage rate increase does**. The NPV is only by $930 million less (9 percent lower) compared to the baseline scenario. The nominal gross margins in 2030 decline by 25.2 percent (Table 53). Vegetables production remains stable with an NPV of $717 million; other crops' NPV losses range from 7 percent (maize) to 13 percent (dry season rice). The scenario of a moderate increase in the cost of services is more plausible because more competition across small enterprises providing agricultural services may happen in the near future, and would keep the increase in the cost of services at a lower growth rate.

274. **Scenario C5 considers the impact of reduced output prices on overall agricultural productivity**. By 2030, the gross margins from the five crops decline by $3.5 billion and the annual gross margins are 66 percent lower compared to the baseline, decreasing from $1.02 billion to $357 million.

275. **An increase in output prices as illustrated in scenario C6 results in higher gross margins and makes agricultural production profitable for farmers in Cambodia**. The NPV increases by 64 percent, from $10.2 billion to $16.7 billion. The gains are between 64-80 percent, with the exception of vegetables (26 percent). The nominal gross margin in 2030 is 182 percent higher than the margin in 2012 ($3.02 billion versus 1.02 billion).

276. **Ranking the impact of the five scenarios on gross margins with unchanged or reduced output prices, moderate increases in the cost of services result in the least negative impact**. This is either compared to the changes due to a higher wage rate (half the past growth rate) or to unequal increases in the cost of inputs versus output prices with a ratio 2 to 1. The changes in gross margins and the level of the demand for labor both affect returns to labor. If the wage rate increases by 8.8 percent a year, which corresponds to a wage rate of $19.1/day in 2030 (scenario C3), and output prices remain the same as in 2013, returns to labor are negative by 2024 (Table 117A). By 2018, agricultural activities under that scenario do not provide incentives to farm given an average return of $4.28/day, below the prevailing 2013 wage rate of $4.56/day. The simulations show very similar results for scenarios C2 and C4 in terms of returns to labor. In these three scenarios, agriculture is not competitive since the simulated returns to labor tend to go below the prevailing wages and even plummet below zero. Farmers would not be willing to stay in agricultural production, and would instead seek other opportunities to earn income. Any increase in the costs of inputs, keeping the price of output constant, is a significant threat for the agriculture sector because in a competitive economy, farmers would choose to leave farming and become wage earners.

277. **Scenarios C1 and C6 result in highest returns to labor**. In scenario C1, returns to labor increase but only by 7.14 percent, from $6.41/day to $7.09/day. On the other hand, returns to labor increase quite substantially in scenario C6. The average returns to labor reach the expected $19.5/day in 2030. In scenario C6, returns to labor for cassava, maize and dry season rice, ranging between $30/day and $33/day, are highly attractive (Table 117A). Because the wage rate is assumed to not affect the demand for labor, the labor needs remain at 166.5 million days per year. The demand for fertilizer also remains stable, at 474,000 tons because of the zero price-elasticity assumption (Table 118A).

9.5. Scenarios for Income Growth

278. **The convergence of farm and nonfarm incomes is the ultimate objective of agricultural transformation**. In the past decade, the high growth in agricultural incomes led to a significant reduction in the gap between farm and nonfarm incomes. The ratio of non-agricultural GDP per nonfarm worker to agricultural GDP per farm worker fell from 3.2 in 2002 to 2.1 in 2012. The wages of agricultural workers grew much faster than the wages of unskilled workers employed in the construction and garment industries (recall **As a result of increasing returns to labor, agricultural wages in general rose, converging with nonfarm wages**. Agricultural wages grew by a factor of almost three between the 2005 and 2013 surveys (**Error! Not a valid bookmark self-reference.**). Over the same period, nonfarm wages increased by only 60 percent. As a result, the gap between farm and nonfarm sector wages declined. Thus agriculture appears to have provided excellent income-earning opportunities in Cambodia over the last decade.

279. Figure 34), causing the farm wage gap to fall from 0.35 in 2005 to 0.75 in 2013.

280. **Growth in future farm incomes depends on many factors, but it is imperative for agriculture to grow faster than the rest of the economy on a per capita basis to continue the farm income convergence**. The productivity growth analyzed in Chapter 9.3 is a powerful driver of future growth. A declining agricultural labor force will also help increase per capita income. Additional sources of income growth, simulated in this chapter, are: (i) a change in the variety of cultivated crops (for example, to fragrant rice); (ii) the addition of processing to increase the value added of crop production (for example, cassava); and (iii) a change in land distribution by farm size, which affects farmers' per-capita income.

281. **Hardest to support is the income convergence of the smallest farms**. During the past decade, small farms became smaller while large farmers grew larger. Farms with less than 1 ha producing annual crops, except vegetables, have smaller incomes on average. They are less likely to adopt modern technologies and integrate into modern value chains. Special attention is needed for this group of farm households, as they will continue to account for the largest share of farm households in Cambodia.

Fragrant rice production

282. **The DRC analysis showed that producing fragrant rice instead of the IRRI rice would give Cambodia a higher comparative advantage relative to neighboring countries**. One consequence of switching to fragrant rice production is the reduction in production volumes (fragrant rice has a lower yield than IRRI rice), but this is compensated by the higher price for fragrant paddy.

283. **Two scenarios assess the impact of farmers switching varieties of rice from high-yielding IRRI to fragrant**. Scenario I1 assumes a 4.2 percent annual shift from IRRI to fragrant rice, combined with a 75 percent price difference in the output (difference based on the 2013 survey). Scenario I2 looks at a further annual shift (9.9 percent), keeping the same price difference between fragrant rice and high-yielding IRRI rice varieties (Table 54). The growth rate of areas cultivated with fragrant rice is based on a hypothetical 10 percent and 25 percent of all rice area in Cambodia adopting fragrant rice by 2030. To reach these targets, the annual growth rates must be 4.2 percent and 9.9 percent, respectively, with initial land area producing fragrant rice estimated at 5 percent.

Table 54: Assumptions about rice variety changes under Income Growth scenarios I1-I2

Scenario	Baseline	I1	I2
Land area under fragrant rice, annual change	0.0%	4.2%	9.9%
Land area for other crops, annual change	0.0%	-4.2%	-9.9%

Source: Own estimate.

284. **Unser scenario I1, the areas cultivated with fragrant rice doubles by 2030**. Gross margins for rice show an annual 6.2 percent increase, from $762 million in 2013 to $808 million in 2030 (Table 121A). These gains are the effect of a higher price for fragrant rice that compensates for the lower yields. It is assumed that the wet season rice yield gap is 16 percent (2.89 tons/ha for other varieties versus 2.5 tons/ha for fragrant rice), and the dry season rice gap is 37 percent (4.80 tons/ha versus 3.50 tons/ha for fragrant rice). Labor and fertilizer demand are held constant. The NPV gains 2.1 percent, from $7.29 billion to $7.44 billion (Table 55). The returns to agricultural labor from producing rice increase by 6.2 percent.

Table 55: Simulation results for Income Growth scenarios I1-I2

	Simulation	Change in Gross Margin, $ million (%)	NPV ($ million)	Returns to Ag. Labor ($/day)	Change in Demand for Ag. Labor million days (%)	Change in Demand for Fertilizers, tons/year (%)	Likely Effect on Competitiveness (DRC)
	Baseline	**762.04**	**7,293**	**5.68**	**134.08**	**430,134**	
I1	Fragrant rice area increases to 10% of total rice area	6.2%	7,443	6.03	0.0%	0.0%	Improved/ DRC decreased
I2	Fragrant rice area increases to 25% of total rice area	24.2%	7,744	7.06	0.0%	0.0%	Improved/ DRC decreased

Source: Own estimate.

285. **If the 2030 target is expanded to 25 percent of total rice land cultivated with fragrant rice, the gains on gross margins rise by 24.2 percent (scenario I2)**. This corresponds to an increase of the NPV to $481 million over the next 17 years. Returns to labor increase by 24 percent, reaching $7.06/day in 2030 (Table 55).

Processing cassava into dry chips

286. **The second group of scenarios assesses the effects of domestic value addition on farm incomes**. Data on cassava from the 2013 survey are used to compare the gains from selling fresh cassava to those from selling dry chips processed from cassava. The loss in product weight is about 50 percent after drying but the gain in price could reach 50 percent or higher (Table 126). The assumed annual growth rates are a hypothetical 10 percent (scenario I3) and 25 percent (scenario I4) of total cassava area used for production of cassava for processing and selling as dried chips by 2030. Scenario I3 looks at the likely changes due to an annual 4.2 percent increase in the area processing cassava before sales (Table 56), corresponding to the hypothetical 10 percent of total area with processing by 2030. Scenario I2 assesses the changes resulting from a further shift from fresh to processed, with annual growth rate of 9.9 percent, aiming to have 25 percent of land selling processed cassava by 2030.

Table 56: Assumption about cassava processing under Income Growth scenarios I3-I4

Scenarios	Baseline	I3	I4
Land area for cassava processing, annual change	0.0%	4.2%	9.9%
Other cassava land area, annual change	0.0%	-4.2%	-9.9%

Source: Own estimate.

287. **Processing cassava into dry chips incurs additional costs, but the cost increase is offset by the gains from better output prices**. Under scenario I3, the 2030 gross margin shows a slight increase of 2.2 percent, from $155.5 million to $158.9 million (Table 125). The changes are quite small because of the relatively lower starting point (5 percent of production processed). Scenario

I4 further simulates the shift to be around 9.9 percent a year, aiming at 25 percent production processed in 2030. With that hypothesis, cassava gross margins increase by 8.6 percent, from $155.5 million in 2013 to $168.9 million in 2030. As a consequence, the returns to labor increase by 8 percent, from $10.61/day to $11.49/day in nominal terms (Table 127A). As per the initial assumption, the demand for fertilizers is not affected by processing but the demand for labor is slightly altered because of the additional manual tasks required for cassava drying. For scenario I4, total demand for labor increases from 14.66 million to 15.01 million days per year by 2030.

Farm size distribution

288. **Agricultural land markets are already very active in Cambodia, and are likely to become more so in the future as the result of improved property rights and agricultural transformation**. The latter might imply a number of situations whereby small and marginal farmers sell their land to larger farmers, commercial farmers consolidate their landholdings in contiguous plots, and new lands are opened up as a result of improved connectivity. The transformation of land size distribution is likely to be in the direction of larger farm size.

289. **The 2013 survey indicates that farm size distribution is becoming more unequal**. Large farms are becoming larger; small farms are becoming smaller; and the number of landless or marginally landless rural households is increasing. Sophal (2008) reported that about 21 percent of rural households are involuntarily landless, while a further 45 percent are land-poor owning no more than 1 ha per household. This process is fueled by an active land market that farmers use to either sell or buy land. Generally, young married couples are most affected.

290. **In the current analysis, "large" is a relative term**. For rice and maize production, large refers to farms with cultivated rice land of more than 3 ha. For cassava, the benchmark is 5 ha; and for vegetables, large farms have more than 1 ha of land. Therefore, even though the trend is towards larger farms, the agricultural farmland distribution over the next decade will continue to be dominated by farmers who have farms less than 5 ha.

291. **The farm budget analysis in Chapter 4 showed that in general there are no economies of scale in Cambodian crop agriculture**. The situation is very complex and varies from crop to crop and with different farm sizes and technologies. For some crops and some types of crop cultivation (e.g., vegetables production and modern wet season rice) there were indications of decreasing economies to scale; for maize, there was an indication of increasing economies of scale; and for cassava and dry season rice, there was no indication of economies of scale (either increasing or decreasing).

292. **Given these findings, the current trend towards increasing inequality in farm size distribution might have either positive or negative implications in terms of overall profitability of the sector**. The outcome is an empirical one that is not preordained a priori. Small farmers may be negatively affected by the trends toward agricultural transformation, becoming landless or near-landless. The initial distribution of farm size is not known with precision, so information collected during FGDS is used to estimate the proportion of farm by size. Though very rough, these data allow simulating the impact of the move toward larger farm sizes. On average, small farms account for 47-75 percent of total farms; medium-size farms for about 21-41 percent; and large farms for less than 10 percent, with the exception of maize (12 percent). Details of the farm size distribution used in the analysis are presented in Table 128A.

293. **Two scenarios simulate the effect of a change in land distribution by farm size on gross margins and returns to labor**. If the land holding per household increases, overall income per capita shall also increase. The initial data about unit margin by crop and by farm size allow derivation of the distribution of overall margins (reported in Table 128A). To compare the simulated effect of farm size distribution on key indicators, overall cultivated land is held constant at its 2013 level of 3.58 million ha for the five crops.

294. **Scenario I5 assumes an annual decrease of 1 percent of land under small farms, holding the total cultivated land and average landholding by farm constant**. This scenario assumes that half of the land area from small farms goes to medium-size and half goes to large farms (Table 57). It implies a decreasing number of small farms and inversely, an increasing number of medium-size and large farms, and an overall lower number of agricultural farms but with higher average farm size.

295. **Scenario I6 assumes the same farm distribution as in scenario I5, but more efficient large and medium-size farms such that their gross margins are higher than in the 2012 baseline**. For the simulation, the increase in efficiency is set at an annual 5 percent. This efficiency may, for instance, come from better farm management.

Table 57: Assumptions about Income Growth under scenarios I5-I6

Scenarios	Baseline	I5	I6
% decrease in small farms	0.0%	1.0%	1.0%
% increase in medium farms	0.0%	0.5%	0.5%
% increase in large farms	0.0%	0.5%	0.5%
Effectiveness of large farms	0.0%	0.0%	5.0%

Source: Own estimate.

296. **Using the parameters for scenario I5 over the 2030 horizon, total land cultivated by small farms decreases by 15.7 percent, from 2.10 million ha to 1.78 million ha**. Land for medium-size farms increases by 14.6 percent, from 1.14 million ha to 1.31 million ha; and large farms cultivate 52 percent more land, from 319,000 ha to 486,000 ha. The resulting farm distributions are the same for both scenarios.

297. **Changes in farm size distribution do not lead to any increase in the profitability per capita and per hectare farm production**. Focusing only on land distribution, scenario I5 results in a tiny increase of 0.1 percent of the NPV, from $9,799 to $9,811 million (Table 132A). However, there are changes within each crop related to the area cultivated by farm size. For example, increases in gross margins for medium-size farms range from 9 percent for maize to 28 percent for vegetables under scenario I5. For large farms, the increases are more significant, from 30.8 percent (maize) to 147 percent (vegetables). These increases are proportional to per hectare gross margins and offset the decreases in gross margins for small farms (an average 16 percent reduction). Because the data on farm budgets do not show clear economies of scales, the impact on the overall gross margins is very marginal. Under scenario I5, simulating only shifts from small to medium-size and large farms, the gross margins from small farms still dominate the industry, capturing 49 percent of the overall gross margins, albeit down from the 58 percent 2013 baseline.

298. **A more detailed analysis of the results of the changes in farm size distribution is presented in Table 130A**. It shows that small farms cannot rely solely on agricultural revenue for

their livelihood. By 2030, the average total landholding for small farms is around 1 ha, which provides $0.14 gross margin per capita per day, assuming an average household size of 4.5. This per capita gross margin is 16 percent lower than the 2013 baseline. Even for medium-size farms, the daily agricultural gross margins are around $0.48, making these households vulnerable, yet they get 16 percent higher gross margin per capita gains. Only large farms with an average landholding of 15 ha benefit from agricultural production, with a daily per capita gross margin of $2.31, 51 percent higher than the 2013 baseline. This simulation demonstrates the challenge of small farms relying only on agriculture for their livelihoods.

299. **To ensure that the agriculture sector economy benefits from increasing farm size, larger farms have to become more efficient, the main hypothesis in scenario I6**. Higher efficiency may be a result of better farm management, lower prices of inputs through consolidation of purchases, or higher prices of outputs through better coordination with traders. To keep costs constant, there is no assumption on increased use of inputs, and the farm size distribution remains similar to scenario I5. With a 5 percent increase in gross margin for large and medium-size farms, gross margins for medium-size farm increase by 162 percent, from a total $342 million to $899 million (Table 130A), and gross margins for large farms by 250 percent, from $88 million to $308 million (Table 131A). On the other hand, the share of gross margins for small farms drops to 29 percent. Medium-size farms provide 53 percent and large farms 18 percent of the overall gross margins.

300. **Demand for labor and fertilizers are barely affected by the changes in farm size distribution**. Labor demand slightly decreases by 4 percent because large and medium-size farms use less labor for their agricultural activities. Similarly, demand for inorganic fertilizers stay practically, decreasing slightly from 438,000 tons to 429,000 tons per year. Overall, there is however a gain in efficiency because with lower labor and fertilizers demand, and the same amount of land, scenario I6 results in slightly higher gross margins.

9.5 Summary of Simulations' Results

301. **Table 58 presents the summary of the main results of all scenarios**. A rise in agricultural productivity has the largest positive effect on farm incomes, especially if the shift from traditional to modern technologies is accompanied by higher efficiency of modern input use. Farmers producing fragrant rice, processing cassava into dry chips, and undertaking other value addition activities can further increase their incomes. Lowering production costs through better use of existing resources (e.g., productivity increase) and minimizing drops in farm output prices through lower logistics costs are the keys to maintaining farm competitiveness. The continuation of land expansion also provides additional income but sustainability considerations limit large expansions in the future. This constraint makes agricultural productivity, commercialization, and diversification even more critical for ensuring future agricultural growth that reduces poverty and boosts shared prosperity in Cambodia.

Table 58: Summary of the simulations' results

	Simulations	Effect on Gross Margin (%)	NPV ($ million)	Effect on Returns to Labor ($/day)	Effect on Demand for Labor (mill. days)	Effect on Demand for Fertilizers (tons/year)	Likely Effect on DRC (Competitiveness)
	Sustainability						
	Baseline	**1,023**	**10,220**	**6.41**	**166.51**	**464,861**	
L1	Rice area increased by 25%	11.2%	10,646	6.42	11.1%	17.1%	Neutral
L2	Equal increase of cultivated land by 10%	18.2%	10,882	6.70	13.1%	8.2%	Neutral
L3	Upland area expansion by 14%	21.6%	10,958	6.86	13.7%	2.6%	Neutral
L4	Loss of soil fertility	-5.0%	10,007	6.09	0.0%	0.0%	Higher: Disadvantage
L5	Decrease of upland areas by 2.4% a year	-7.5%	9,901	6.23	-4.7%	-1.2%	Neutral
L6	Put into fallow one third of upland areas	-0.2%	10,211	6.72	-4.7%	-1.2%	Lower: Increased advantage
	Productivity						
	Baseline	**1,023**	**10,220**	**6.41**	**166.51**	**464,861**	
P1	More efficient modern farms	11.1%	10,640	7.14	-19.9%	26.6%	Lower: Increased advantage
P2	Shift from traditional to modern farms	25.8%	11,107	10.10	0.0%	0.0%	Unknown: depends on costs
P3	Combination of P1 and P2 scenarios	47.4%	11,749	11.84	-19.9%	26.6%	Lower: Increased advantage
P4	Irrigation	32.4%	11,984	8.52	3.1%	66.7%	Lower: Increased advantage
	Competitiveness						
	Baseline	**1,023**	**10,220**	**6.41**	**166.51**	**464,861**	
C1	Equal increase of all prices by 25%	16.5%	10,986	7.09	0.0%	0.0%	Lower: Increased advantage
C2	Input prices increase twice output prices	-247.7%	3,761	-10.92	0.0%	0.0%	Higher: Disadvantage
C3	50% increase of wages	-226.2%	3,665	-7.84	0.0%	0.0%	Higher: Disadvantage
C4	25% increase of costs of machine services	-25.2%	9,290	4.85	0.0%	0.0%	Higher: Disadvantage
C5	15% decrease of output prices	-66.5%	7,449	2.36	0.0%	0.0%	Higher: Disadvantage
C6	15% increase of output prices	182.8%	16,379	19.48	0.0%	0.0%	Lower: Increased advantage
	Income Growth						
	Baseline		**7,293**	**5.68**	**134.08**	**430,130**	
I1	Fragrant rice 10% of rice area in 2030	6.2%	7,443	6.03	0.0%	0.0%	Lower: Increased advantage
I2	Fragrant rice 25% of rice area in 2030	24.2%	7,744	7.06	0.0%	0.0%	Lower: Increased advantage
	Baseline		**1,488**	**10.54**	**14.66**	**4,577**	
I3	Cassava chips 10% of total in 2030	2.2%	1,499	10.78	0.6%	0.0%	Lower: Increased advantage
I4	Cassava chips 25% of total in 2030	8.6%	1,523	11.45	2.4%	0.0%	Lower: Increased advantage
	Baseline		**9,799**	**6.20**	**166.00**	**464,861**	
I5	Small farms shift land to medium and large	0.3%	9,811	6.40	-4.0%	0.0%	Unknown: depends on costs
I6	Farm distr. shift + large farms more efficient	6.8%	11,793	10.70	-4.0%	-2.1%	Lower: Increased advantage

10. POLICY AGENDA TO SUPPORT A LONG-TERM VISION FOR CAMBODIAN AGRICULTURE

302. **Agriculture can and should continue to make a large contribution to economic growth and poverty reduction in Cambodia**. Realization of a Long-Term Vision for Cambodian Agriculture can build on the transformative changes of the past decade and the strength of Cambodian farmers to respond quickly should market opportunities arise. However, it should be noted that despite the significant reduction in poverty in the past, vulnerability of the poor to shocks is still high, and any slowdown in agricultural and non-agricultural growth could push many people back into poverty. Further reforms are required to support future growth and to get closer to the final outcome of structural transformation where agriculture as an economic activity has no distinguishing characteristics from other sectors (in terms of the productivity of labor and capital, or the location of poverty). The main challenge is to move from extensive agricultural growth to intensive one. The past agricultural growth in Cambodia was largely achieved by farmland expansion and higher use of inputs in light of rising agricultural prices. With the land frontier closing and inputs getting more expensive relative to outputs, future growth depends on other driving forces and policy actions.

303. **The medium-term policy agenda to support realization of a Long-Term Vision for Cambodian Agriculture needs to include "old" policies that helped drive past growth and "new" policies that were previously either ineffectively implemented or less relevant**. Based on the analysis carried out in the previous chapters, the priority areas include: (i) maintaining a private sector friendly agricultural policy environment; (ii) strengthening the environmental sustainability of agricultural production; (iii) increasing the quality of and budgets for agricultural public programs, without undermining the fiscal sustainability; and (iv) helping develop the agribusiness and agroprocessing industry. These priority areas are important in the next five-year horizon period, and each broad priority area includes three to four critical actions presented below.

10.1. Maintaining a Private Sector Friendly Agricultural Policy Environment

304. **Cambodia's market-oriented agricultural and trade policy helped achieve the high past rates of agricultural growth**. The private sector has benefited from minimal, if any, interventions in farm output and input pricing, from the strong commitment to open trade, including across the border, and from the reduction of export costs and time for export processing. This has created conditions for the private sector to invest and generate profits. These open trade and market-oriented agricultural policies remain critical to future growth, and need to be protected by all means. Some proposals being discussed in the country may undermine the past achievements, however, such as:

a. Redirecting paddy and other raw commodities from exports to domestic processing or storage through the use of export restrictions would be a mistake. Restricting paddy exports in the face of high processing and storage costs in Cambodia would result in lower farm prices and thereby lower farm incomes. Farmers need to remain free in their production and trade choices.

b. Promotion of agricultural diversification requires better rural infrastructure, investments in agricultural innovation systems (agricultural research, extension, education, training), and programs related to integrated pest management, food safety, wholesale markets, and input market development. On the other hand, supply-driven promotion of diversification including through land zoning by allocating farmland to specific crops such as vegetables or subsidies to specific crops would not lead to sustainable, market-driven diversification.

c. Slower agricultural growth and worsening agricultural TOT may lead to the calls to introduce direct farm support measures. This happens in countries where farm incomes do not converge quickly enough with nonfarm incomes (China and Thailand, for example), and this may well happen in Cambodia. Introducing direct farm protection measures can slow down agricultural growth and hamper structural transformation as is the case in other countries with high farm protection (see Chapter 2.4). Cambodia can use agriculture for poverty reduction for many years to come, if it avoids the farm subsidy trap seen in other countries.

305. **In regard to the new policies, attention needs to be paid to improving efficiency in farm input industries, especially seeds.** The removal of burdensome regulations and the state monopoly in the seed sector would provide further incentives for intensification, commercialization, and diversification, all needed to maintain high agricultural growth in the future. Access to high-quality seeds is essential to achieve the growth targets as discussed in Chapter 9. Without quality seeds, farmers' investments in fertilizers and machinery bring lower rates of return. It is estimated that the current supply of improved rice seed varieties meets only 22 percent of farmers' demand (IFC 2014). The main reason for this undersupply of rice seeds is the monopoly of the Cambodia Agricultural Research and Development Institute (CARDI) in production of the foundation seeds required for further multiplication to certified seeds. CARDI also produces and sells certified seeds, competing with seed companies, which is unusual for a research institution. The trial and release of imported varieties are not clearly defined and import of seeds for trials, production, and commercialization has proved to be difficult and expensive. Overall, the legislative and institutional environment for development of the seed sector is absent.

306. **The seed industry requires urgent reform**. The reform agenda is challenging but the costs of doing nothing are very high. Table 59 summarizes the key issues and recommendations for the seed sector reform developed by the International Finance Corporation, the World Bank Group (IFC 2014).

307. **Regulatory improvements are also required for other inputs such as fertilizers to reduce costs to farmers**. Regulatory burden is mainly related to simplification of importation procedures. If they are simplified and streamlined, farmers will be able to access cheaper fertilizers. Potential measures to improve regulations include the approval of import licenses on the basis of product suitability only and allowing all importers to import any quantity of registered fertilizers, without the need to receive license/approvals for each new import lot.

Table 59: Key issues and options to reform the seed sector in Cambodia

Issues	Options/Recommendations
Lack of a framework for long-term development of the seed sector, which reduces confidence of investors	• Finalize and approve the National Seed Policy • Begin work on a separate Prakas to implement Chapter 2 of the 2008 Seed Law which relates to Plant Breeders Rights
Lack of clear procedures on variety testing/registration and seed quality control	• Approve the Prakas to implement the seed management part of the 2008 Seed Law and prepare two manuals for technical procedures • Define and simplify the procedures for variety testing and registration, taking into account different needs of different crop groups, esp. rice, maize, and vegetables
Lack of transparency in seed sector regulations	• Prepare and update regularly the National List of varieties that recognizes new varieties within the country so they can be subject to proper regulations • Publish the scale of fees for all government services, maximum periods for processing requests, and clear mandatory requirements
Inadequate supply of seeds	• For rice varieties bred in Cambodia, increase the supply of foundation seed and explore alternative schemes to complement government resources • For varieties bred elsewhere, a company registered in Cambodia could be designated by the breeder as the maintainer and be responsible for foundation seed production, provided they can demonstrate the necessary competence • Facilitate imports of seed by streamlining and setting transparent and clear procedures, especially seed intended for trial purposes • Coordinate and strengthen the many small local seed producers by improving the quality of their product and facilitating market access, for example by linking them to rice mills
Poor systems to ensure quality of seeds	• Establish a single office to handle all official matters relating to seeds and varieties; this is consistent with the proposal now under consideration by the General Directorate of Agriculture of MAF to establish a 'Seed Secretariat' • Establish the key elements of official quality control including a certification scheme and a Seed Testing Laboratory, based within the National Agricultural Laboratory of General Directorate of Agriculture

Source: IFC 2014.

10.2. Strengthening the Environmental Sustainability

308. **Sustainability would need to be more strongly embedded in agricultural policy**. Past agricultural growth in upland areas was largely driven by rapid land expansion. Especially for

cassava, the FGDs and expert interviews revealed that some cultivated land expansion comes at the cost of forest land. Moreover, as soil nutrients are mined and not replenished due to low use of fertilizers for cassava production, this land expansion resulted in some land degradation. In other areas of the country, cultivated land expansion puts pressure on water resources and might also encroach on pasture land. This consideration, in line with any biodiversity conservation program that Cambodia may have, would argue against continuing a development strategy based on land expansion. And to reach the 60 percent target for forest land, such an expansion is not a feasible option in Cambodia.

309. **The main policy implication is then the formulation of land use planning and its enforcement at the local level to prevent loss of forest land**. This needs to be accompanied by other measures such as a program to raise awareness about loss of soil fertility and incentives to use good practices in soil nutrient management. Extension workers can work with farmers and the cassava processing industry to ensure sustainable supplies of raw material. The program could lead to the emergence of a domestic cassava processing industry rather than the current situation whereby Cambodian farmers sell raw material primarily to Thai cassava plants, and by doing so, they mine Cambodian soil nutrients.

310. **In addition to protecting forest land, strengthening land tenure security would make agricultural growth in Cambodia more sustainable**. Farm intensification and diversification require investments; more will be invested when land is secure. Yet 30 percent of farmers in Cambodia still operate on land without legal titles, according to ADB (2014a). This reduces investments in agriculture and creates risks of land degradation.

311. **Promotion of sustainable land management practices is also needed**. The slower expansion in farmland considered in Chapters 8 and 9 would reduce some farmers' income but is necessary to avoid further soil degradation and loss of valuable forest resources. Short-term income losses of farmers can be compensated by longer-term benefits from higher soil fertility and more efficient management of available resources. Promotion of putting land on fallow to regenerate soil fertility (recall scenario L6 from Chapter 9), the use of crop mixes such as alternating pulses with maize to enhance nitrogen rates, and other sustainable land management practices can further enhance environmental sustainability (FAO 2014). The international experience shows that the most effective way to promote such practices is to combine the enforcement of natural resource protection with agricultural extension and other public programs that increase land users' awareness of the longer-term costs and benefits and promote adoption of modern technologies.

312. **With more farmers using chemicals for vegetable and other crop production, the government is recommended to strengthen public health regulations related to their safe use and promote alternative programs that ensure safe, effective and environmentally sound pest management**. These alternative programs include integrated pest management, where pest population is controlled through biological controls, cultural practices and the development and use of crop varieties that are resistant or tolerant to the pest.

10.3. Improving the Agricultural "Public Goods" Investments

313. **The quality of future agricultural growth will depend on the RGC's success in spending more and better on agriculture with the ultimate objective of helping farmers raise their incomes**. The higher spending on agriculture, therefore, would need to be considered within

the feasibility of total government budget so not to undermine fiscal sustainability (Box 9). The rising land and labor constraints call for closing yield gaps (intensification), more effective use of modern technologies (commercialization), better use of labor-saving technologies (mechanization), and faster response to the evolving market opportunities (diversification). The analysis in the previous chapters shows that these processes have already begun and that farms using modern technologies are more capable of overcoming these constraints than traditional farms. Converting more traditional farms into commercial ones offers a very powerful source of agricultural productivity growth in the upcoming decade in Cambodia. This in turn requires more and better public spending on productive infrastructure and human capital.

Box 9: Importance of Fiscal Sustainability for Pro-Poor Agricultural Growth

Sustainable macroeconomic environment is a necessary pre-condition for translating public expenditures into pro-poor agricultural growth. Public expenditure policy is a form of direct economic intervention. Like other interventions, public spending on agriculture should be part of a market-friendly approach to economic policy, and supportive of development and adjustment goals. Excessive agricultural public spending can lead to high or rising budget deficits that can result in different types of macroeconomic imbalances (e.g., higher inflation and misaligned exchange rate), causing lower economic growth and weaker demand for farm products. By investigating the underlying factors in agricultural growth Gardner (2005) found macroeconomic stability and real income growth in the non-agriculture economy among the most important factor explaining agricultural growth in 85 developing countries during 1960-2001. That's why public spending on agriculture should remain consistent with the aggregate fiscal discipline.

314. **It is important to have a view of productivity growth broader than a narrow emphasis on yield growth**. Yield growth could be accomplished without an increase in profitability; in fact, this is exactly what seems to have happened over the past decade for most crops in Cambodia. Farmers use more inputs but fail to translate this into much higher profits. The emphasis on profitability forces researchers, extension agents, farmers, and the private sector to look at the combination of inputs and outputs, prices, and technologies that make a certain production activity more profitable over time. If profitability could be increased, given the same natural resources and same amount of labor, then a real gain in productivity is achieved.

315. **Future public programs for agriculture need to take into account the impacts of climate change**. Cambodia is significantly exposed to weather shocks, mainly shorter rainy seasons and longer and drier dry seasons (World Bank and AusAid 2011; Thomas *et al*. 2013). High dependence on rainfall for agriculture makes Cambodia, and particularly the poorest farmers in Cambodia, vulnerable. Farmers already report the negatives impacts of more frequent drought spells, and to lesser degree, floods (see Chapter 3.9, Figure 27). Climate change leads to more variable growing seasons and water deficits, which require investments in water storage, development of new crop varieties and farming techniques that are more resilient to unpredictable growing seasons, and better weather forecasting. In other words, a move to the climate-smart

agriculture is required.[48] As programs related to water management, agricultural research, and advisory services offer a triple win (by simultaneously helping Cambodian farmers raise productivity, mitigate the impacts of climate change, and support adaptation to climate change), they would need to be prioritized.

316. **All these have implications for the selection and design of agricultural programs (e.g., agricultural public expenditures)**. Agricultural public spending does not seem to have played much of a role in past agricultural growth. Public investments in connectivity (i.e., roads, ports, and ICT), and private investments in rice mills, played the larger role as discussed in Chapter 6. One reason for the low impact in the past is the *underfunding of agricultural programs*. During 2007-2009, the total budget of three agriculture-related ministries, e.g., MAFF (agricultural innovation systems), MOWRAM (irrigation), and Ministry of Rural Development (rural roads), was only 1.4 percent of GDP (World Bank and AusAid 2011). In 2014, the agricultural budget has hardly changed in relation to GDP, except for higher spending on irrigation. Another reason is the *low quality of agricultural programs*. Going forward, both the level and quality of funding need to be addressed.

317. **Investments in *irrigation* are critical to support future agricultural growth**. But spending more on irrigation alone does not guarantee successful outcomes in Cambodia. Past irrigation investments have so far failed to improve farmers' access to water in the dry season, due to the excessive focus on primary irrigation structures, small operation and maintenance (O&M) budgets, disempowered farmer water user communities (FWUCs), and the lack of river basin management institutions. These problems were described in the World Bank and AusAid report in 2011, and according to the ADB (2014b), they still prevail in 2014. In spite of the relatively large irrigation investments, the actual irrigated area in the country is only about 350,000 ha, or 8 percent of arable land, the lowest irrigation coverage in Asia (Table 5).

318. **During 2014-2018, MOWRAM is projected to invest $250-300 million annually** (Figure 42). This will be a significant increase compared to past years: in 2009, MOWRAM's budget was about $60 million. Only 12 percent of the project future budget is national funding, with the remainder provided by development partners (Figure 43). China provides about half, Korea about a quarter, and the remainder from a number of other partners. This sizable investment means that substantial areas of new and rehabilitated irrigation areas will come on line in the coming years, highlighting the need to address these problems:

a. **To increase the effectiveness of irrigation investments, public funds need to be extended to secondary canals and associated infrastructure**. Rehabilitation of tertiary canals using public funds is also justified, provided that it includes arrangements for O&M costs to be recovered from end users. In a 2011 survey carried out for the World Bank and AusAid, 85 percent of farmers reported the lack of water, mainly due to the lack of distribution canals. In the 2013 survey conducted for this report, most farms using irrigation reported using pumps rather than gravity irrigation. Farmers spend 11-20 percent of total variable costs on pump irrigation for dry season rice. Future irrigation investments, therefore, need to focus on improving farmers'

[48] Climate-smart agriculture seeks to increase productivity in an environmentally and socially sustainable way, strengthen farmers' resilience to climate change, and reduce agriculture's contribution to climate change by reducing greenhouse gas emissions and increasing carbon storage in farmland.

access to gravity irrigation to reduce farm production costs and maintain their competitiveness rather than investing in new dams and primary irrigation structures.

b. **FWUCs need to be empowered**. They still play a very nominal role as they are not authorized to collect irrigation service fees and have little say in system management decisions. The FWCU subdecree that would assign appropriate responsibilities and rights for irrigation infrastructure to respective FWUCs and allow them to collect irrigation service fees remains unapproved. The CDTA/ADB provides technical assistance to MOWRAM to find flexible solutions for fee collection, and the subdecree needs to be approved soon to underpin the sustainability of large future irrigation investments (ADB 2014b).

c. **Capacity for O&M of irrigation schemes needs to be strengthened**. In addition to a lack of financial resources[49], fundamental problems exist with organizational systems, planning processes, assessment of O&M needs and priority, and capacity of staff. A 2014 study on the economics of O&M in irrigation schemes demonstrated that the lack of O&M results not only in suboptimal return on investment but also negative returns (CDTA 2014). Until recently, MOWRAM allocated almost nothing for O&M, and the Provincial Departments of Water Resources and Meteorology have limited capacity to maintain their assets, too.

Figure 42: MOWRAM's projected investments, $ million, 2014-2018

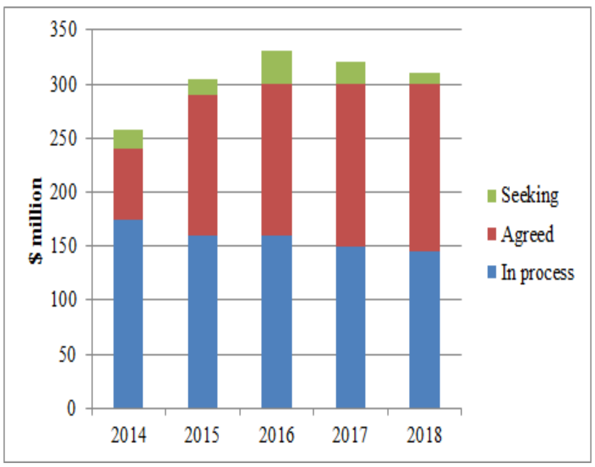
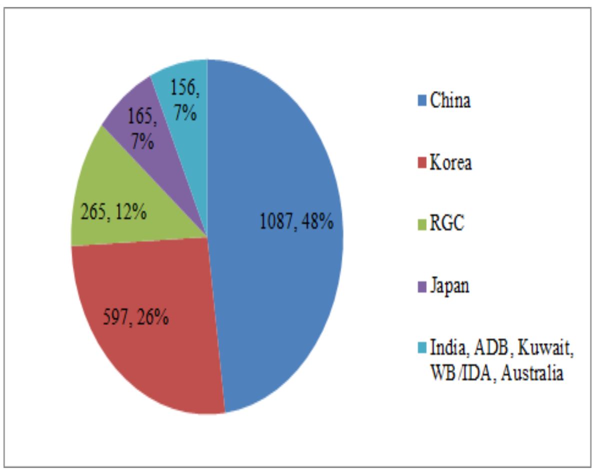


Figure 43: Structure of MOWRAM's projected investments by source



Source: ADB 2014b.

319. **Investments in irrigation need to be accompanied by improved water use efficiency**. This will allow achievement of one of the sustainability targets from Table 45. However, water efficiency may be low and irrigation investments may not be profitable if yields are not boosted or the production costs are high. Using the data from the 2013 survey it is estimated that at a unit

[49] In 2009, only $1 million, or 14 percent of total recurrent budget of MOWRAM, was allocated to O&M versus the international best practice of allocating 33 percent of total investments on O&M (equivalent to $17 million in Cambodia).

cost of investment of $2,500/ha, an increase of 1.5 percent per year of dry season rice yield would lead to a 4.2 percentage point increase in the irrigation IRR.

320. **Agricultural innovation systems that include agricultural research, extension, education, and training have an important role to play to raise yields and more importantly productivity**. *Research* needs to produce new technologies and knowledge relevant to farmers. *Extension* is tasked with bringing these technologies and knowledge to farmers and helping them with adoption and improvement of their management skills. *Education* creates knowledge, while *training* helps youth and adults improve their vocational skills. Working together for these four elements is the key to bringing innovation to agriculture and accelerating long-term agricultural productivity.

321. **Cambodian *agricultural research* has underperformed in the past decade**. The main reasons include overall underfinancing, limited operational budgets, and project-based financing. Problems to resolve to increase public agricultural research's contribution to future agricultural growth include:

a. **Too little is spent on agricultural research in Cambodia**. In 2009, agricultural public research spending was only 0.1 percent of agricultural GDP, or $0.10 per $100 of agricultural GDP (Table 60). This is a very small amount compared to the countries with competitive agriculture sectors. Thailand, for example, spends 0.5 percent of agricultural GDP on public agricultural research (Nippon 2013). Other agricultural exporters spend even more, with more successful ones spending 1-2 percent of agricultural GDP.

b. **Especially little is allocated to operational expenses**. Researchers are constrained in going to the field to talk to farmers and extension officers. The demand responsiveness of agricultural research programs is therefore very low. This also results in the weak link to agricultural extension services.

c. **Allocation of the majority of the agricultural research budget is largely short-term project-based**. There are few large long-term research programs, which makes it difficult to ensure synergies between various small research projects as researchers are not able to work together under the same program to attain overarching strategic research objectives which would lead to knowledge accumulation and innovation. It also limits the ability to hire better quality research staff. Funds are provided mainly by donors.

d. **Project-based research funding should be complemented by core funding**. The international experience shows that project-based funding approaches, often based on contestable funding mechanisms, while showing good results in some large research systems with strong research capacity, could have severe limitations as they tend to undermine long-term strategic planning. The longer-term nature of agricultural research (i.e., development of new crop varieties or a system to manage animal disease) raises the question of the ability of project-based research funding system to respond to the needs of agriculture as opposed to allocating resources through longer-term core funding commitments relative to the priority needs of the agriculture sector.

Table 60: Agricultural research intensity (public research spending in $ per $100 in agricultural GDP)

Location	2000	2008
Developed countries	2.40	3.07
Developing countries	0.53	0.54
Asia	0.41	0.42
Cambodia	n/a	0.10

Source: IFPRI 2012 and World Bank and AusAid 2011 for Cambodian data.

322. ***Public agricultural extension* is very important in countries with many small farms, such as Cambodia**. Agricultural extension encompasses several dimensions: the economic dimension focuses on increasing farm income, agricultural productivity, farm financial management, and food preservation and nutrition; the social dimension includes improvement in the health of family members, and leadership. Despite the recent increase in coverage (recall Figure 23.1), many farmers do not receive extension services of high quality. They value more highly services received from the public sector and NGOs than those from private companies (recall Figure 23.5).

323. **Numerous problems weaken public agricultural extension in Cambodia**. These include low funding, lack of trained manpower, poor communication skills of extension workers, unavailability of appropriate technologies for smallholder farmers, little attention to market linkages, and poor collaboration between research and extension. These problems are well recognized in the country, which led to the preparation of the Agricultural Extension Policy, to be completed early 2015. A number of strategic policy decisions are needed to operationalize this policy. Among many, these include sustainable financing, farmers' outreach, service delivery models, and the evolving role of public extension:

a. **Similar to agricultural research, public agricultural extension is underfinanced**. In 2009, the budget for agricultural extension was $6.7 million, 0.2 percent of agricultural GDP. Most funds come from donors. While continued funds from donors can be expected, more resources should also come from the RGC given the high importance of agricultural extension to future agricultural growth. Commercialization of some services may bring additional revenue, but it is probably unrealistic to expect large income flows in the near term. The 2013 survey showed farmers' low willingness to pay for extension services.

b. **Many farmers are not reached out by extension services**. At present, there are 1,103 public agricultural extension officers. An estimated additional 696 commune extension workers, 8,794 village extension workers, and 14,607 village animal health workers work through donor-funded projects, NGOs, and the private sector (MAFF 2014a). Considering public officers only, one officer has to reach out to 1,700 farm households and cover 4,100 ha of agricultural land to serve all farm households.[50] This is a very low outreach rate. But with all extension workers included, except animal health workers, the outreach rate falls to 177 farm households and 425 ha, a reasonably good ratio. To maintain this outreach rate and even increase it, will MAFF seek to increase

[50] According to the 2013 Agricultural Census, the total number of farm households in Cambodia is 1,875,712. Total agricultural area consisting of arable land and land under permanent crops is 4.5 million ha.

the number of public officers to replace the private agents? Or will it try to utilize the existing network of extension agents pursuing public private partnerships? The latter may be a preferred option from the perspectives of demand responsiveness and fiscal sustainability.

c. **How to deliver extension services?** Many different extension service providers operate in Cambodia, and the pluralism is well recognized in the upcoming Agricultural Extension Policy. The key question is how to further promote it in a coordinated manner. The international experience suggests that matching grants to the private sector on a competitive basis or vouchers given to farmers to procure services of private extension providers are effective ways to deliver services to farmers. Recipients of such grants must be able to demonstrate improved service delivery based on expressed demand and the specific local needs of farmers for training and technology transfer. The public sector would play an important role in setting up the funding mechanisms, criteria to access funds, monitoring, and quality controls. ICT needs to be used to monitor delivery of services by the private sector and increase extension outreach at low costs.

d. **The focus of extension services would need to shift**. It is necessary for extension to move away from supply-driven advice to support of technology adoption, market orientation, competitiveness, and sustainability. Extension services have a large role to play in achieving the targets presented in Chapter 8 and the successful outcomes presented in Chapter 9. It can do more to link farmers, especially smaller-scale ones, into value chains, through promotion of input purchase and marketing farm groups, contract farming, and productive partnerships. The trend in Cambodia is for small farms to become smaller, and these farms often face the biggest challenges integrating into food value chains. Extension can also do more to promote export of agricultural products. In collaboration with other departments, it can help increase buyers' trust in the quality and safety of Cambodian products through better surveillance of pests, monitoring the use of agricultural inputs in production areas, and promoting good agricultural practices. Along with food safety actions at other segments of the value chains, these public programs are the key to promoting agricultural exports, including to China, the largest market in the world.

324. **Investing in human development though *education and vocational training* would also help raise agricultural productivity**. Farming is a knowledge-intensive industry with changing requirements, not least because of climate change. The recent movement towards more mechanized agriculture, for example, requires many workers with skills to operate tractors and other farm machines. This in turn would require more spending on vocational training for youth and continuous education programs for adult farmers. Yet public investment in vocational training and agricultural education remains very low. This needs to change to allow farmers to translate the use of machinery into higher profits, not just higher production volumes as has happened so far.

325. **The public sector has other roles to play and services to deliver to raise agricultural productivity**. The full list of such services cannot be made in this report. But the critical point for public programs is to identify and address the underlying roots of the problems, without crowding out the private sector. Examples for *fertilizers* and *agricultural finance* follow.

326. **It is a fact that losses in yields from climate change can be compensated by increases availability of nitrogen in the soil**. The research on the impact of climate change on Cambodian agriculture conducted by Thomas *et al*. (2013) shows that applying more fertilizers can help maintain crop yields (Table 61).

Table 61: Yield response for supplementing nitrogen to soil, Cambodia

	Nitrogen Used for High-Fertilizer Scenario (kg N/ha)	% Change in Yield for Each Additional 10 kg N/ha	
		2000	2050
Rainfed wet season rice	90	7.2	5.5
Irrigated dry season rice	90	6.7	5.5
Rainfed maize	90	4.3	3.4
Irrigated maize	90	4.8	3.7
Rainfed taro	90	3.7	3.1
Irrigated taro	90	5.4	4.5

Source: Thomas *et al*. 2013.

327. **In recent years fertilizers use in Cambodia has increased**. The FGDs in the 2013 survey showed a 30 percent increase in the number of urea users for rice production. According to ADB (2014a), 86 percent of rice farmers in Battambang, Kampong Thom, and Takeo use inorganic fertilizers. In contrast, fertilizer use for cassava and maize production remains limited. As a result, average fertilizer nutrient consumption remains low, at 15 kg/ha in 2011, according to FAOSTAT. Fertilizers are increasingly available on local markets, but their low consumption is explained by high prices, low quality, and poor knowledge of soil-specific requirements. The public sector has an important role to play in correcting these market failures:

a. **Fertilizer prices in Cambodia can be reduced**. For example, import licenses can be approved on the basis of product suitability only, and all importers be allowed to import any quantity of registered fertilizer products.

b. **No reliable soil maps in Cambodia exist to allow the development of soil- specific fertilizer recommendations**. Extension workers give blunt recommendations. As a result, many farmers apply too much, too little, or even the wrong fertilizer to trigger a profitable supply response. Production of such soil maps and fertilizer recommendations are core functions of public research and extension.

c. **The existence of fake fertilizers reduces their use by farmers**. While the true extent of fraudulence is probably lower than perceived, this perception is strong enough to affect fertilizer adoption. MAFF estimated that in 2008 about 30 percent of fertilizers were fraudulent or of low quality. The rapid assessment in 2010 found a much smaller share of fraudulent fertilizers (IFDC 2010). To reduce this negative perception, it is essential that the Department of Agricultural Legislation in Cambodia and the field inspectors have access to reliable and fast fertilizer analytical services as visual inspections cannot detect product adulteration or below-guarantee analysis. In the field, inspectors can use a simple pill cutter to cut DAP and APS granules in half to check their consistency. It was recommended to MAFF to ask for independent quality assurance certificates of analysis from accredited organizations for all imported fertilizers, particularly those with multi-nutrient content, either NP or NPK.

d. **Applying nitrogen fertilizers is not the only way to get more nitrogen into the soil for plant use**. Another approach is to improve soil fertility management by using animal manure, cover crops, crop rotation, and crop or agroforestry residue. This is another important role for agricultural research and extension to play in helping farmers gain knowledge about these technologies and adopt them.

328. **Cambodia does not need subsidy programs to promote fertilizer use**. There are many examples of huge failures of such programs in Asia, ranging from Indonesia and India to Sri Lanka, and around the world. The example from Sri Lanka is presented in Box 10. Fertilizers are available on the market in Cambodia in all locations, even for the smallest farmers. The public role is to increase their sustainable use through extension, quality and safety controls, and investments in infrastructure, not through subsidies.

329. **Another government role is to improve farmers' access to affordable and suitable agrifinance products**. As described in Chapter 3.7, financial services from several sources comprising commercial banks, MFIs, community saving groups, and money lenders are increasingly available to farmers in Cambodia. Access to finance can be further improved.

330. **Subsidizing interest rates or providing concessional credits to agriculture are not recommended, due to their low sustainability and high economic distortions, including crowding out rural MFIs**. There are innovative ways to improve access to finance in a sustainable manner at low cost. Cambodia's financial sector needs institutions, markets, and products tailored to farmers and agribusinesses' needs. One example of such products is agricultural loans tailored to farming practices, seasonality, and cash flow projections.

Box 10: Fertilizer Subsidy in Sri Lanka

Sri Lanka has subsidized fertilizer costs for many years, spending a large part of its agricultural budget on these subsidies. Its total agricultural budget share is large, accounting for 12 percent of agricultural GDP over 2008-2012. Yet these high subsidies have failed to induce strong growth. Since 2000, average growth in agricultural GDP has been 3.2 percent. A recent study analyzing the effectiveness of the fertilizer subsidy found that although fertilizer use positively and significantly explains paddy productivity in Sri Lanka, the marginal returns to fertilizer progressively declines with higher application rates (Gautam and Kar 2014). A majority of farms in irrigated areas, while behaving rationally in terms of profitability, tend to use fertilizer way above the level recommended by the Department of Agriculture. The lack of proper education in efficient fertilizer practices (like balanced use of nutrients) and existing inefficient practices result in lower private and social economic returns from fertilizer use.

The study also found that despite the higher intensity of fertilizer use in Sri Lanka than in most South Asian countries, yields are modest and have not grown significantly since 2000. Improvements in the composition of public spending for agriculture could have greater impact on the sector's productivity by targeting fertilizer subsidy benefits and investing in other production inputs. Investments on agricultural public goods such as research and extension services would also result in more efficient fertilizer use.

331. **Amret, with the support of the World Bank/AgriFin project, helped develop and introduce such a loan product in Cambodia**. Agricultural loans are provided for both agricultural activities (agricultural loans) and agriculture combined with other businesses (hybrid loans). In contrast to Amret's existing credit products, agricultural loans' repayment terms are flexible. They are aligned with individual clients' seasonality of income and cash flow projections. The interest rates for agricultural loans are on par with Amret's existing individual loan products and there are no penalties for early repayment.

332. **Agricultural loans are reportedly popular with farmers**. They also turned out to be more profitable for Amret compared to traditional loans in rural areas, which do not take into account farm business characteristics. An agricultural credit officer reaches break-even costs in month five with these loans (compared with month eight for traditional loans), and on average all costs of agricultural loans' set up and provision are covered in eight months. As a result, the share of agricultural loans in Amret's total loan portfolio increased from 0.6 percent in December 2013 to 2.8 percent in June 2014.

333. **The RGC can increase awareness about such products and promote their wider adoption by other banks and MFIs**. This would be a much more cost-efficient and sustainable way to improve access to agricultural finance in Cambodia.

10.4. Helping Develop the Agroprocessing and Agribusiness Industry

334. **The growth of the agribusiness and agroprocessing industry is critical to future agricultural growth, job creation, farm income convergence, and structural transformation in Cambodia**. Yet the country seriously lags behind in this respect, as presented in Chapter 2.2, in spite of the growing raw material base. The main trigger for a stronger industry is an improvement in the business environment, addressing the following main constraints (World Bank 2014e):

a. The high cost of electricity (Cambodia has the second highest price per kilowatt in the Southeast Asia after Singapore).
b. Informal payments and burdensome regulations. Cambodia's ranking in the overall ease of doing business in the Doing Business 2014 report has fallen over the past ten years; it is now 137 out of 189 economies. It also ranks 162/189 for contract enforcement because of an unreliable conflict resolution system.
c. Weak capacity and inefficiencies in transport systems resulting in high transport costs, long transport durations, and unreliable delivery.
d. The undeveloped financial system, high informality, and predominantly fixed asset collateral-based lending limit private sector lending from banks and increase financing costs.

335. **There are no substitutes for reforms and investments to improve a business climate that would facilitate private sector investments**. However, particular policy actions that would have the strongest impact on agribusiness development in Cambodia in the upcoming decade include improvements related to: (i) food safety and sanitary and phytosanitary (SPS) measures; (ii) rice trade logistics; and (iii) access to finance.

336. **Difficulty complying with *food safety* and *SPS measures* of importing countries is among the major constraints for agribusinesses in Cambodia**. While there are positive changes

in rice industry in this respect,[51] the majority of rice mills and other firms do not have good facilities and personnel to meet demanding market segment requirements and to supply high-end markets. The country does not have a good diagnostic capability for food safety/SPS testing, and the SPS implementation capacity in terms of human skills, technical capacity and operational funding is weak (van der Meer and Samrith 2014). Transaction costs for the private sector are high and awareness of the high impact of transaction costs on trade among SPS agencies is very low. The situation in Cambodia contrasts with the situation in Thailand, for example, where food safety standards are not a major constraint for agri-food exports (Box 11 and van der Meer 2014).

Box 11: Food Safety Investments in Thailand

Thailand was among the first group of emerging countries to invest in food safety infrastructure and has developed the capability to export safe food since the mid-1990s. For example, when Thai exports of shrimp and chicken faced stricter SPS measures in the EU in 1996 and the early 2000s, the Thai private sector quickly responded (Nidhiprabha and Chamchan 2005). It introduced bio-safety farms that use fewer chemicals and lobbied the government to invest in food-safety infrastructure and to legislate new food safety laws. Some large exporters have established brand names for hygienic products of high food safety standards. Consequently these actions make Thai exporters more competitive vis-a-vis their competitors in the region, though many small-scale exporters still have problems complying with the strict standards, and foods sold in domestic markets are not as safe as exported foods.

337. **Even for rice, Cambodia needs new markets outside the EU**.[52] To fine them the RGC would need to: (i) assist rice mills with complying with food safety standards of different countries; (ii) foster technical upgrades; (iii) promote rice specifications and a strong brand identity for Cambodian rice; and (iv) facilitate trade with more information, building for example on the IFC's Rice Sector Support Project.[53] China is a particularly important market as the largest importer of rice in the last few years, but it is very strict with respect to food safety requirements for imports. The RGC can do many things to help its exporters sell more rice and other products to China (Box 12).

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[51] The Cambodian private sector has made significant progress in this area, including with the support from the IFC Rice Sector Support Project, which helped seven rice mills certify for the Hazard Analysis and Critical Control Points during 2014. More mills are in pipeline for such a food safety certification. This certification is critical in terms of accessing export markets such as the EU and the United States.

[52] The major export market for Cambodian rice is the EU under the EBA. Cambodia enjoys the zero import tariff, which gives it a $240/ton cost advantage compared to other exporters. An EU safeguard may be triggered when imports under EBA exceed by 25 percent the volume imported the previous year. In 2014, Cambodia was close to this 25 percent ceiling, calling for identification of new outlets for expanded exports.

[53] The IFC project was launched in 2012 to support the development of the Cambodian rice industry, aiming to increase farmers' access to improved inbred rice seed and increase their yields, increase milling efficiency and product quality, develop and implement a strategy to increase Cambodian rice exports, and reduce the price differential between Thai and Cambodian rice.

Box 12: Requirements for an Increase in Cambodian Rice Exports to China

A 2014 rice marketing study (Agland Investment Services 2014) identified key constraints for Cambodia to access the growing Chinese rice import market. A selection of the recommended actions includes:

- Focus on improved packaging and labelling on consumer packs.
- Establish contacts at the government-to-government level with Chinese trade authorities who control the level of imports and quotas; understand the quota system[54] and ensure that exporters comply with it.
- Support the role of China Certification and Inspection Co. Ltd in Cambodia for inspections.
- Improve storage and logistics to lower marketing costs. Cool storage may improve quality especially for the preferred new crop rice.
- Establish the "White Gold" emblem as a quality design factor of genuine Cambodian rice.
- Ensure compliance with buyer requirements.

338. **Improving *rice export logistics* is another priority area to develop agribusiness**. Currently, Cambodian rice export's competitiveness is significantly affected by high logistics costs and unreliable timelines. Average logistics costs from rice mills to the Sihanoukville port in Cambodia are twice as high as similar costs in Vietnam and Thailand (Table 62). It also costs more in Cambodia to move paddy from farm gate to rice mills. Moreover, Cambodia's logistics performance indicators on timelines have worsened since 2007, unlike in neighboring countries, damaging Cambodia's image as a reliable partner for buyers (World Bank 2014d). This reduces the profitability not only of farmers but also of rice mills and traders, thereby hindering investment in the agroprocessing and post-harvest handling.

339. **An important reason for the high logistics costs in Cambodia is cumbersome and expensive export procedures**. Cambodia's export procedures have improved recently both in terms of processing time and associated costs, but still largely fall behind its neighbors. The SOWS-REF was set up in the compound of the Council for Development of Cambodia. While all services related to rice export have yet to be included in the SOWS-REF,[55] rice exporters note that the time and cost to obtain all necessary approvals have reduced remarkably. On average in 2013, export procedures cost $14/ton and took four days to process; i.e., the costs declined by 30 percent compared to 2012 and the processing time fell by one-half (Table 63). Yet these procedures are reported to be highly bureaucratic and loaded with informal costs. Despite the reduced export procedure cost per ton, it is still high compared to Thailand ($0.10/ton), Vietnam ($0.05/ton), and even Myanmar ($8.50/ton) (World Bank 2014f). Further reduction is therefore needed.

[54] The tariff rate quota for import of rice to China is divided into 2.26 million tons each for long grain rice and medium grain rice. While the tariff rate quota for long grade rice was largely exhausted in each of 2012 and 2013, very little - if any - of the medium grain rice quota was utilized. This may provide an opening up for Cambodia (see Slayton and Muniroth 2012b).

[55] The Certificate of Origin and Phyto-Sanitary Certificate are in the SOWS-REF but not the Quality Certificate (CamControl) and Custom Certificate.

Table 62: Prices and logistics costs of rice in Cambodia, Vietnam, and Thailand

	Farm-gate price	Costs from farm to rice mill	Rice mill price	Costs from rice mill to port	FOB price
Cambodia	247	163	410	50	460
Vietnam	253	122	375	23	398
Thailand	339	126	465	25	490

Note: Prices of white rice per ton in 2013.

Source: World Bank 2014d.

340. **In addition to export procedures, container-based exports increase costs**. In Cambodia, most aromatic and non-aromatic rice is shipped in containers. But in the rest of the world, most rice is transported as break bulk cargo. Break bulk is cheaper and easier to handle, but it has hardly been tried in Cambodia. The Sihanoukville and Phnom Penh Port drafts limit break bulk to ocean destinations only, not Asian destinations. Possibilities exist to export rice in bulk for intra-Asian trade from Sihanoukville Port if key constraints are tackled (World Bank 2014d), including: (i) lack of a suitable hygienic rice warehouse; (ii) lack of professional stevedoring; (iii) a combination of high port and National Shipping Agency and Brokerage charges; and (iv) the missing link between railway station and port quay. Improving logistics requires actions across several ministries, agencies, and the private sector.

Table 63: Time and cost in rice export procedures, Cambodia, 2012-2013

Services	**Processing Costs**		**Processing Time**	
	2012	**2013**	**2012**	**2013**
SPS Certificate	$150/case	$35/case	2 days	1 day
Fumigation Certificate	$20/container	$35/container	1 day	1 day
Certificate of Origin	$250/case	$141/case	1 day	1 day
Custom Certificate	$25/container	$6.50/container	2 days	½ day
CamControl Certificate	$25/container	$52.50/ container	2 days	½ day
GMO Certificate	$150/sample	$80/sample	3-4 days	2-3 days
Average total*	**$20/ton**	**$14/ton**	**8 days**	**4 days**

Note: *The average services fee per ton is lower for the larger export size.

Source: World Bank team's estimates based on information from key rice exporters and SOWS-REF.

341. **Improving *access to finance* is necessary to support development of a strong agroprocessing industry in Cambodia**. There are opportunities to introduce a warehouse receipt system (WRS), starting with rice. Currently, there is too little working capital in the rice milling sector (similar constraints have been reported in other agricultural processing sectors, such as cassava). Most mills use their land, buildings, and equipment (i.e., long-term fixed assets) to secure loans that they use for short-term working capital needs. These loans tend to fall far short of their actual working capital needs, and furthermore, using long-term assets for working capital needs reduces millers' ability to upgrade their storage and production capacity (and thus to invest in the needed expansion of rice export capacity).

342. **In Cambodia, paddy or rice are not yet used as collateral for working capital loans**. Yet many of the conditions for such loans are present (Rutten 2014). Rice is a seasonal crop that has to be stored over a prolonged period so that it can be processed throughout the year – thus,

during many months large physical stocks exist in the country. The rice produced in Cambodia is far from uniform, but rice millers and traders categorize it into three varieties (fragrant, mixed and white), with the actual paddy and rice traded being priced at a discount or premium to a reference price for that variety – so for bankers who wish to finance against rice inventory, there is a reference price against which to determine its value. Rice production is fairly concentrated. Four of the country's 24 provinces produce almost half of the total, permitting financiers to get access, at least in principle, to large paddy stocks without having to cover too large a geographical region. The potential market is attractive in size as one million tons of rice may require as much as $300 million in working capital finance, and rice for the domestic market also needs to be financed.

343. **Rice mills are potential clients for banks**. Rice mills maintain large inventories and have an incentive to continue doing so, not just to ensure that they have enough raw materials to keep their mills operating the longest time possible, but also to meet client demands for specific kinds of white rice. Expanding financing for mills would lead to improved financing for the whole rice sector: rice millers act as financiers both upstream (pre-financing traders and at times, even providing inputs on credit to farmers) and downstream (selling on credit to wholesalers and exporters, permitting the latter to sell on deferred payment terms to international buyers).

344. **Even in the short run, the potential benefits of providing more working capital finance to the rice sector are large enough to promise profits to those who take the initiative to build its necessary institutional infrastructure**. While many of the required activities are most logically undertaken by the private sector, support from the RGC, including in conceptualizing strategies and coordinating efforts, will help in realizing the possibilities outlined before. The RGC has an important role to play in creating a conducive environment for a WRS (Rutten 2014). The first important step is to remove discrepancies in the Secured Transaction Law and the Civil Code on the access to movable assets in case of default. Other steps include improving the collateral registry, strengthening lenders' capacity and awareness, and providing insurance guarantees for a WRS. Pro-active support can be given to pilots before scaling up nation-wide. Avoiding credit subsidization and supply-driven investments in warehouse construction is also an important step for the RGC. Support for a WRS will create a financing system that can measure up to the government's aspirations for its rice sector, and will lay the foundation for more sustainable, balanced growth.

11. CONCLUSIONS AND POLICY RECOMMENDATIONS

345. **This report seeks to understand the successes, challenges and opportunities of Cambodia's agricultural transformation over the past decade to derive lessons and insights on how to maintain future agricultural growth, and particularly on the government's role in facilitating it**. In 2013-2014, the agricultural growth slowed down to 1 percent from its average of 5.3 percent over 2004-2012. Is the country in transition to a slower agricultural growth? Cambodia can ill afford it because agricultural growth will be critical to continued poverty reduction in the country, given its large size in the economy. Market and private investment friendly policies and targeted public sector investments in irrigation, extension, and other "public good" agricultural services, as feasible within the government's total budget, can help secure continued robust agricultural growth.

Key Findings

346. **In the last decade, the agricultural sector in Cambodia has gone through significant structural transformation**. Although still playing a large role, the agriculture sector became relatively less "important" in the economy in terms of its share in GDP and labor force, but more "productive" in terms of land and labor productivity. This transformation was driven by high and pro-poor agricultural growth.

347. **The agricultural growth in Cambodia was high**. During 2004-2012, the annual growth in agricultural gross production was 8.7 percent. The agricultural value added grew by 5.3 during this period. This exceptional growth, among the highest in the world, was driven by crop production, mainly paddy rice (annual growth of 9 percent) but also spectacular growth in other crops, particularly maize (20 percent), cassava (51 percent), sugarcane (22 percent), and vegetables (10 percent). The growth in livestock and fisheries was modest at around?

348. **The agricultural growth was also pro-poor**. Cambodia's poverty headcount declined from 50 percent in 2007 to 21 percent in 2011, with the number of poor declined from 7 to 3 million. Most poverty reduction took place in rural areas. More than 60 percent of the poverty reduction was attributed to the agriculture sector: higher rice prices stimulated the larger rice production that increased farm wages. Yet, in 2011, 91 percent of the poor still lived in rural areas. Thus, further poverty reduction will continue to depend on the success of agriculture for many years to come, due to its large role in labor force, value added, and exports.

349. **Due to the high agricultural growth, agricultural wages have been converging with nonagricultural wages**. Agricultural wages grew by 2.6 times between the surveys conducted in 2005 and 2013, while the nonfarm wages increased by 60 percent. As a result, the ratio between per worker nonagricultural to agricultural valued added in current prices fell to 2.1 in 2012 from 3.2 in 2004. Returns to farm labor have been increasing.

350. **The crop diversification has started**. Although crop production is still mainly focused on paddy, the crop mix has been changing driven by higher profitability of non-rice crops. In 2013, average farm gross margins (and returns to labor) were $506/ha ($9.4/day) for cassava, $303/ha ($8.8/day) for maize, and $1,393/ha ($7.2/day) for vegetable production, compared to $245/ha ($4.6/day) for wet season rice and $296/ha ($9.6/day) for dry season rice. Dry season rice competes with non-rice crops in terms of returns to labor but its expansion is constrained by limited irrigation. The share of total area planted under paddy declined from 86 percent in 2002 to 74

percent in 2011, while the share of planted area for maize and cassava production increased significantly, by 1.7 and 8 times, respectively.

351. **Even the paddy sector has started to diversify**. Triggered by the demand from modernized rice mills, more farmers grow more profitable aromatic paddy, estimated at 10 percent of rice cultivated area and 30 percent of total production. Thought aromatic yields tent to be lower? Further expansion of farmland under aromatic paddy is possible with improvements in quality seed supply, agricultural extension, and irrigation.

352. **Yields increased for most crops**. With the annual growth in cultivated land areas at 4.7 percent and agricultural gross production at 8.7 percent, the average growth of yields was 4 percent during 2004-2012. This growth in yields was triggered by a wide adoption of improved technologies, expanded (yet still limited) irrigation, more use of modern inputs, and better access to mechanized services, pointing to the advances in commercialization. Farmers also have better access to markets.

353. **Cambodian farm products remain price competitive at farm gate**. A domestic resource cost analysis of competitiveness shows that despite rising labor costs and prices of farm inputs, the value added generated by farmers exceeds the costs of domestic factors of production (land, labor, and capital). This high competitiveness explains the large increase in agricultural exports in the recent decade. However, the competitiveness of ordinary rice produced during the wet season has worsened in recent years due to the increase in labor costs and weak knowledge/skills of most farmers in using modern inputs. Many small farmers start losing a competitive edge.

354. **The past agricultural growth was driven by several factors**. Among the major was open trade and, in general, market-oriented agricultural policy. Cambodia was one of the few developing countries that did not overact to the 2008 global food price spike but actually saw higher food prices as an opportunity to induce agricultural growth. Other net-exporting countries such as India, Lao PDR, and Vietnam used export restrictions to limit transmission of the global food price spike into their markets. Higher agricultural prices in Cambodia made farmland expansion profitable. In addition, the agriculture sector benefited from: (i) improved access to overseas markets through the Everything but Arms Agreement with the European Union and open cross-border trade with neighbors; (ii) better availability and wider use of mechanization services triggered by the higher cost of rural labor; (iii) better farm access to finance; and (iv) private investments in rice mills.

355. **But there have also been challenges**. The large share of the past agricultural growth was driven by farmland expansion. The average contribution (weighted by crop areas) of land expansion to the change in farm gross margins in real terms between 2005 and 2013 was about 60 percent. Farmland expanded annually by 4.7 percent, with very large increases (128 percent) for cassava. This farmland expansion has contributed to the accelerated deforestation, especially in the upland areas.

356. **The average increase in per hectare gross margin was good, at 3.4 percent per year**. But it varied between 2.1 percent for dry season rice to 44.5 percent for vegetables. The per hectare maize's margin even declined. In many cases, farmers expanding their land areas received higher incomes, but farmers with land areas unchanged or reduced were not able to substantially increase their incomes. The period of relatively high food prices was largely used to expand land areas rather than build a strong foundation to productivity increases.

357. **While poverty was reduced significantly, the number of vulnerable people has increased**. Most people who escaped poverty did so by a small margin. The loss of only 1,200 Riels per day (the cost of 2 small water bottles) would cause Cambodia's poverty rate to double to 40 percent. This high rate of vulnerability is the sign of still modest productivity increases in the agricultural sector.

358. **Vulnerability is largest among smallest farms**. Small farmers with the land area less than a hectare, who still account for 48 percent of all farmers, reported to find it difficult to expand and get integrated into the emerging modern food supply chains. The larger farms are becoming larger and smaller farms are becoming smaller in Cambodia. This change in distribution of farmland occurs independently of economic land concessions. The average size of the interviewed farms with less 1 ha declined from 0.99 ha in 2008 to 0.88 ha in 2012, while the average size of medium farms (between 1 and 3 ha) increased from 1.55 ha to 2.38 ha and the larger farms (above 3 ha) from 3.61 ha to 7.03 ha. Productivity of small, traditional farms also hardly improved, as agricultural extension and other public services have not reached them at a large scale. It appears that the income increase for this group of farmers in the past decade largely came from higher production values, driven by high agricultural prices, and the sale of their labor to larger farms at higher wages.

359. **Except for rice, the agroprocessing industry has played a limited role in agricultural growth**. Almost all crops were exported to neighboring countries unprocessed. This indicates serious weakness in the value chain, particularly in the post-harvest system of supply chain management (collection of raw material, storage, finance, logistics, transportation, and information).

360. **Addressing weaknesses of the past growth is a good strategy for maintaining a future agricultural growth at 5 percent**. With the global food prices declining and land frontier closing down, the Cambodian agriculture has been losing its two major growth drivers. On top of that, agricultural labor continues to decline and become more expensive adding to production costs. Global agricultural prices are projected to continue their decline in the next decade, and selling low-quality ordinary rice on domestic and foreign markets will be less and less profitable. Relying on higher domestic demand driven by the increase in GDP and higher import demand alone, without more efficient use of resources, will not be enough to maintain the past growth.

361. **The recent slowdown in agricultural growth in Cambodia is worrisome**. As global food prices gradually declined, Thailand returned to the rice market after several years of quasi isolation due to its distortive rice pledging scheme and the re-entry of Myanmar into global rice market, the rice (especially dry season) production in Cambodia has stalled. And with it, total crop value added declined, from 4.9 percent in 2012 to 0.6 percent in 2013. The growth in agricultural value added slowed down to 1.6 percent in 2013 after the 5.3 percent average growth between 2004 and 2012.

362. **Returning to a 5 percent growth is important**. Agriculture maintains a large share in GDP, trade, and labor force, which means that it stays the key to further reduce poverty and vulnerability in the upcoming decade. If Cambodia's structural transformation continues, with agricultural growth averaging 5 percent, by 2030 Cambodian agriculture will be less significant in the economy but more productive. Its share in GDP (and total labor force) is projected to go down to 17 percent (31 percent) in 2030, from 26 percent (51 percent) in 2012, while land productivity would increase from $1,300 to $2,700 and labor productivity rise from $1,200 to $3,700.

363. **By contrast, the cost of slow agricultural growth would be huge**. If average agricultural growth is only 3 percent between 2012 and 2030, the end agricultural value added would be 29 percent lower by 2030 compared with the 5 percent growth scenario, slicing overall GDP by 18 percent, keeping more people in agriculture, reducing agricultural labor productivity by 34 percent and stopping any income convergence between farmers and nonfarmers. A lower agricultural growth will also lead to a slower reduction in poverty.

Policy Recommendations

364. **A long-term vision for Cambodian agriculture includes elements of sustainability, productivity, competitiveness, and income growth, beyond a focus on production**. Simulation of different scenarios for future agricultural development reveals that a rise in farm productivity would have the largest positive effect on farm incomes, especially if the shift from traditional to modern technologies is accompanied by higher efficiency of modern input use and irrigation. Farmers producing fragrant rice, processing cassava into dry chips, and undertaking other value addition activities can further increase their incomes, illustrating the importance of the agroprocessing industry. Lowering production costs through better use of existing resources (e.g., productivity increase) and minimizing drops in farm output prices through lower logistics costs are the keys to maintaining farm competitiveness. Continued land expansion also provides additional income but sustainability considerations will limit large expansions in the future. This constraint makes agricultural productivity, commercialization, and diversification even more critical for ensuring future agricultural growth that reduces poverty and boosts shared prosperity in Cambodia.

365. **Continued rapid agricultural growth and further structural transformation in the agriculture sector are possible in Cambodia**. Four sets of policies together will help support such continued agricultural growth during the next five years (short-to medium run). The first is maintaining a private sector friendly agricultural policy environment, with added attention to lower the regulatory burden in farm input sectors. The second is strengthening the environmental sustainability of agricultural production. The third is improving the quality of agricultural public programs and as feasible within total government budget, increasing allocations to more effective programs. And the fourth is helping develop the agribusiness and agroprocessing industry. Table 64 presents the key policy recommendations of the report by implementing agency.

Maintaining a Private Sector Friendly Agricultural Policy Environment

366. **Cambodia's market-oriented agricultural and open trade policy helped achieve the high past rates of agricultural growth**. The private sector has benefited from minimal, if any, interventions in farm output and input pricing, from the strong commitment to open trade, including across the border, and from the reduction of export costs and time for export processing. This has created conditions for farmers and other players to invest and generate profits. These open trade and market-oriented agricultural policies remain critical to future growth and need to be protected by all means.

367. **In addition to maintaining a non-distortive agricultural policy, reforms in the seed sector can make an important contribution to agricultural growth**. Insufficient supply of seeds and their poor quality in Cambodia have been among main reasons for the relatively slow productivity improvements, putting significant constraint on future agricultural growth mainly because investments in fertilizers and machinery pay off only when combined with the use of improved seeds. Many policy distortions exist in the seed sector, ranging from the state monopoly

on the supply of foundation seeds to the lack of clear and conducive regulations for trials, releases, production, and import of seeds. The regulatory and legislative bottlenecks in the seed sector need to be addressed in the upcoming years.

368. **Regulations for inputs such as fertilizers can also be improved to reduce costs to farmers**. Cambodia has in place the burdensome requirements to importers of fertilizers to register products and apply for import license for each imported lot. The procedures can be simplified through approval of import licenses on the basis of product suitability only, and once received all importers can be allowed to import any quantity of these registered inputs.

Strengthening the Environmental Sustainability

369. **Embedding environmental sustainability in agricultural policy will become increasingly important**. This implies more sustainable expansion of cultivated land though better land use planning, strengthened land tenure security, and maintenance of soil fertility through better use of available land and promotion of sustainable land management practices. International experience shows that the most effective way to promote such practices is to combine the enforcement of natural resource protection with agricultural extension and other public programs that increase land users' awareness of the longer-term costs and benefits and promote adoption of modern technologies.

370. **With more farmers using agricultural chemicals for vegetable and other crop production, the government may wish to strengthen public health regulations related to their safe use and promote alternative programs that ensure safe, effective and environmentally sound pest management**. These alternative programs include integrated pest management, where the pest population is controlled through biological controls, cultural practices and the development and use of crop varieties that are pest resistant or tolerant.

Improving the Agricultural "Public Goods" Investments

371. **Future growth will likely come from productivity improvements, commercialization, and diversification, all of which strongly depend on effective "public goods" investments in agriculture**. The relatively small size of most farms in Cambodia and their large numbers require more resources for service provisions than in countries with large farms and few farmers. Public programs proven worldwide to contribute to long-term agricultural growth include those for irrigation, research, extension, education, vocational training, food safety, and provision of market information. While these programs are also critical to Cambodia's future growth and continued structural transformation, they have little to show in terms of their contribution to past agricultural growth. The main reason is their low efficiency and effectiveness. Many programs have poor design and weak implementation record. Most expenditure goes to capital and wages, with little spent on operation and maintenance. Relatively low funding levels are another reason for the weak record of some of these programs in Cambodia.

372. **Agricultural programs, especially extension, can become more gender sensitive**. Female-headed households and women in male-headed households have different needs than men due to the different roles they play in agricultural production, and given women's time constraints and limited mobility which affects their access to training. Hiring and training of more female extension workers, the use of varied information and communication technologies to improve extension outreach, and promotion of more active participation of women in farmer extension

groups, as well as nutrition and disaster risk management trainings are all measures that would empower women and bring economic benefits.

373. **Irrigation investments deserve special attention**. Without reliable access to affordable water in a tropical country such as Cambodia, it is hard to expect intensification and commercialization. Farmers' access to water in the dry season, when it is mostly needed, has improved only marginally. Irrigation coverage in Cambodia is among the lowest in Asia, in spite of the fact that most resources allocated to irrigation investments have been spent on primary infrastructure. While irrigation coverage needs to be further expanded, this expansion needs to go hand-in-hand with the extension of secondary canals, rehabilitation and upgrade of the existing systems, investments in participatory management of irrigation and drainage infrastructure and better coordination of irrigation/flood management with the delivery of other agricultural public services.

374. **Higher attention is also merited to the integration of small farms into modern food value chains**. Public extension services are especially important for these farms because they are unlikely to receive sufficient extension services from the private sector, while without improved farm management skills and information they will stay poor and vulnerable, disconnected from economic transformation processes. Small farms, including households participating in social land concessions, can be supported through public services to facilitate stronger links with the agroprocessing and agribusiness industry through productive partnerships (e.g., contract farming and farmer organizations), training in business and other skills, and provision of market information.

Helping Develop the Agribusiness and Agroprocessing Industry

375. **Future agricultural growth in Cambodia depends on the extent of development of agribusiness and agroprocessing industry**. A more developed industry would absorb the increased supply of raw materials, bring more stability to farm prices, create value added, and create nonfarm jobs in rural areas. Alternatively, with no changes to the current situation, urban Cambodians will increasingly eat imported processed foods while the country continues to export raw commodities.

376. **Although development of the agribusiness and agroprocessing industry is to be considered part of the improvement in the overall business environment in Cambodia, several areas with a strong impact on agribusiness development will involve government action**. They include investments in: (i) increased access to and reduced costs of electricity, to increase profit margins in the processing industry and stimulate private investments; (ii) better food safety and sanitary and phytosanitary capacity, to help Cambodian firms meet importers' requirements and capture foreign markets and help them compete with the increasing food imports triggered by Cambodians' rising incomes and demand for more diversified diets; (iii) export logistics, to reduce transaction costs; and (iv) improved access to finance, including through WRS, to create new investment opportunities for the processing and trade industry.

377. **Future agricultural growth at its past speed and further structural transformation are possible in Cambodia**. A slower growth cannot become a new normal. More attention to sustainability, the quality of public services, an enabling policy environment, and implementation would turn these possibilities into reality. It is worth well trying.

Table 64: Summary of the report's key policy recommendations by implementing agency

Policy recommendations	Implementing agencies
Maintaining a private sector friendly agricultural policy environment	
Continue the open trade policy and non-distortive agricultural policy	Ministry of Commerce (MOC), Ministry of Economy and Finance (MEF), Ministry of Agriculture, Forestry and Fisheries (MAFF)
Open up seed sector for private investments through deregulation and institutional strengthening, and reduce the costs of importation of fertilizers	MAFF, Cambodia Agricultural Research and Development Institute (CARDI)
Strengthening the environmental sustainability	
Improve land use planning and better enforce land laws/regulations	MAFF, Ministry of Land Management, Urban Planning and Construction (MLMUC)
Strengthen land tenure security	MLMUC
Promote sustainable land management practices	MAFF (CARDI and Extension)
Promote the safe use of agricultural chemicals	MAFF
Improving the agricultural "public goods" investments	
As feasible within total government budget, increase the budget for core agricultural public goods, especially irrigation, applied research, extension, soil nutrient management, input quality control, food safety, vocational training, and rural roads	MAFF, SNEC, MEF, Ministry of Labor and Vocational Training
In irrigation, pay more attention to upgrades and rehabilitation of existing systems and participatory management of irrigation infrastructure	MOWRAM, MAFF
Improve the quality of agricultural public programs	MAFF, MOWRAM
Facilitate integration of small farms into food value chains	MAFF, MOC
Helping develop the agribusiness and agroprocessing industry	
Improve access to and reduce electricity costs	Ministry of Mines and Energy
Invest in food safety public infrastructure	CARD, Ministry of Health
Improve rice trade logistics, including cost reduction	Ministry of Public Works and Transport, MOC
Remove barriers for introduction of warehouse receipts	MEF, National Bank of Cambodia

12. References

Abdullah, A., H. Kobayashi, I. Matsumura and S. Ito. 2008. "World Rice Demand Towards 2050: Impact of Decreasing Demand of Per Capita Rice Consumption for China and India." Japan and East Asian Regionalism.

ADB. 2014a. "Improving Rice Production and Commercialization in Cambodia: Findings from the Farm Investment Climate Assessment." Asian Development Bank, Manila.

ADB. 2014b. "Water Resource Management Sector Development Program, Ninth Quarterly Progress Report (February 1-April 31, 2014)." Asian Development Bank, Phnom Penh.

ADI. 2009. "Rice Sector Profile." Agriculture Development International, Phnom Penh.

Agland Investment Services. 2014. "Cambodia International Rice Marketing Study for Six Countries: China, Cote Divoire, France, Germany, Singapore and USA." Report sponsored by IFC and Agence Francaise Development, Phnom Penh.

Alexandratos, N., and J. Bruinsma. 2012. "World Agriculture: Towards 2030/2050." UN Food and Agriculture Organization, ESA Working Paper, Rome.

Bordey, F., P. Moya, J. Betran, C. Launio, A. Litonjua, R. Manalili, A. Mataia, J. Besenio, F. Macalinta, R. Malasa, E. Marciano, M. Milanes, S. Paran, G. Redondo, R. Relado, M. San Valentin, I. Tanzo, E. Tulay, S. Valencia, C. Viray, and C. Yusongco. 2014. "Benchmarking The Cost and Profitability of Paddy Production in Selected Asian Rice Bowls." Philippine Rice Research Institute, International Rice Research Institute, Benguet State University, and Philippine Council for Agriculture and Fisheries.

CDRI. 2012. "Impact Assessment of Farmer Organization on Food Security for Rural Poor." Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

CDTA. 2014. "Economics of O&M of Irrigation Systems in Cambodia." Capacity Development Technical Assistance Project, Phnom Penh.

FAO. 2003. "World Agriculture: Towards 2015/2030." Food and Agriculture Organization of the United Nations, ESA Working Paper, Rome.

FAO. 2014. "A Regional Rice Strategy for Sustainable Food Security in Asia and the Pacific." RAP Publication 2014/05, Food and Agriculture Organization of the United Nations, Regional Office for Asia and Pacific, Bangkok.

FAOSTAT. 2014. FAO Statistics: http://faostat.fao.org/default.aspx (accessed November 20, 2014).

Fuglie, K. 2010. "Total Factor Productivity in the Global Agricultural Economy: Evidence from FAO Data." USDA, Washington, DC.

Gardner, B. 2005. "Causes of Rural Economic Development." College of Agriculture and Natural Resources, University of Maryland, College Park, MD, USA.

Gautam, M., and A. Kar. 2014. "Public Expenditure Priorities for Competitiveness. Farm Level Evidence on the Effectiveness of Subsidies in Sri Lanka." World Bank, mimeo.

IFC. 2014. "Preliminary Assessment of the Rice Seed Sector in Cambodia: Policy Recommendations to Overcome Regulatory Constraints." Investment Climate Business Line, Phnom Penh, Cambodia.

IFDC. 2010. "Rapid Apparaisal of Fertilizer Quality in Cambodia." International Fertilizer Development Center. Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

IFPRI. 2012. ASTI Global Assessment of Agricultural R&D Spending: Developing Countries Accelerate Investments. Washington, DC. http://ifpri.org/sites/default/files/publications/astiglobalassessment.pdf.

Isvilanonda, S., A. Ahmed, and M. Hossain. 2000. "Recent Changes in Thailand's Rural Economy: Evidence from Six Villages." *Econ. Polit. Weekly* 35: 4650-4656.

Ivanich, M., and W. Martin. 2014. "Short and Long-Run Impacts of Food Price Changes on Poverty." Policy Research Working Paper 7011, World Bank, Washington, DC.

Jamora, N. 2014. "Food Demand Trends and Prospects in East Asia." Report prepared for the World Bank, Washington, DC.

Le, Q., E. Nkonya, and A. Mirzabaev. 2014. "Biomass Productivity-Based Mapping of Global Land Degradation Hotspots." ZEF-Discussion Paper on Development Policy No. 193, Bonn.

MAFF. 2014a. "Agricultural Extension Policy in Cambodia. Second Draft." Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, October 30, 2014.

MAFF. 2014b. "Agricutural Statistics." Ministry of Agriculture, Forestry and Fisheries, Phnom Penh.

Nidhiprabha, B., and C. Chamchan. 2005. "SPS and Thailand's Exports of Processed Food. Food Safety Regulation Concerns: The Developing Country Perspective." Edited by Rajesh Mehtha and J. George. Delhi: Macmillan India.

Nippon. 2013. "Sustaining Competitiveness of the Thai Agriculture." Report prepared for the World Bank, Bangkok.

NIS. 2014. Cambodian Statistics. The National Institue of Statistics. http://www.nis.gov.kh/index.php/en (accessed November 20, 2014).

Rutten, L. 2014. "Review of Potential Constraints for Warehouse Receipts Financing in Cambodia with a Focus on Rice." Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

Sharma, R. 2014. "Outlook for Rice Demand, Supply and Trade." In Dawe, D., S. Jaffe and N. Santos (eds.) *Rice in the Shadow of Skyscrapers: Policy Choices in a Dynamic East and Southeast Asian Settings*. Food and Agricultural Organization, International Rice Research Institute, and World Bank.

Slayton, T., and S. Muniroth. 2009. "A Road Map for Cambodian Rice Exports." Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

Slayton, T., and S. Muniroth. 2012a. "A More Detailed Roadmap for Cambodian Rice Exports." Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

Slayton, T., and S. Muniroth. 2012b. "Turning Rice into 'White Gold." Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

Sophal, C. 2008. "Impact of High Food Prices in Cambodia." CDRI Policy Brief No. 2, Phnom Pehn.

Thomas, T., T. Ponlok, R. Bansok, T. De Lopez, C. Chiang, N. Phirun, and C. Chhun. 2013. "Cambodian Agriculture: Adaptation to Climate Change Impact." IFPRI Discussion Paper 1285, Washington, DC.

Timmer, P. and S. Akkus. 2008. "The Structural Transformation as a Pathway out of Poverty: Analytics, Empirics, and Politics." Centre for Global Development Working Paper 150, www.cgdev.org.

Tsakok, I. 1990. *Agricultural Price Policy: Practitioner's Guide to Partial-Equilibrium Analysis*. Cornell University Press: New York.

van der Meer, K. 2014. "Implemeting SPS Measures to Facilitate Safe Trade. Principles and Practice in Cambodia, Lao PDR, Philippines, and Thailand." Study conducted for the Standards and Trade Development Facility.

van der Meer, K., and S. Samrith. 2014. "Implemeting SPS Measures to Facilitate Safe Trade in Cambodia." Country study conducted for the Standards and Trade Development Facility.

Wokker, C., P. Santos, and R. Bansok. 2014. "Irrigation Water Productivity in Cambodian Rice Systems." Agricultural Economics 45: 1-10.

World Bank. 2007. "Philippines: Agriculture Public Expenditure Review." Technical Working Paper, World Bank, Manila and Washington, DC.

World Bank. 2008. "Cambodia Agrarian Structure Study." World Bank, Washington, DC.

World Bank. 2011. "Cambodia Seed Sector Overview." Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

World Bank. 2013a. "Cambodia Vision 2030: Input Papers." World Bank, Phnom Penh.

World Bank. 2013b. "Where Have All the Poor Gone? Cambodia Poverty Assessment 2013." World Bank, Washington, DC.

World Bank. 2014a. "The Agricultural Transformation Matrix." Presentation, Agriculture Global Practice, World Bank, Washington, DC.

World Bank. 2014b. "Cambodia Rice Sector Monitoring Note 2013." Technical Assistance Report ACS8955, World Bank, Washington, DC.

World Bank. 2014c. “Cambodia: National Accounts Data.” World Bank, Phnom Penh.

World Bank. 2014d. “Improving Rice Trade Logistics to Help Reach 1 Million Tons Export Target.” Presentation on the Trade Seminar organized by the Ministry of Commerce on September 2, 2014, Phnom Penh.

World Bank. 2014e. “Input Notes for Rectangular Strategy III and National Strategic Development Plan 2014-2018 based on the World Bank Investment Climate Assessment 2014.” World Bank, Phnom Penh.

World Bank. 2014f. “Myanmar: Capitalizing on Rice Export Opportunities.” Economic and Sector Work Report No. 85804, World Bank, Washington, DC.

World Bank. 2014g. “What Does Recent Evidence Tell Us About Poverty in Lao PDR?” Lao PDR Poverty Brief, December 2014, World Bank, Washington, DC.

World Bank. 2015. “Cambodia Gender in Agriculture Assessment.” Draft Technical Assistance Note, Phnom Penh.

World Bank and AusAid. 2011. “Agriculture, Irrigation, and Rural Roads Sectors: Integrated Fiduciary Assessment and Public Expenditure Review for Cambodia.” Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

World Bank and AusAid. 2013. “Study on Access to Financial Services for Small and Medium Enterprises in Cambodia.” Technical Working Paper No. 82585-KH. Prepared by Agrifood Consulting International, Kensington, Maryland. Report commissioned by the World Bank and AusAID under the Cambodia Food Crisis Capacity Support Partnership Trust Fund funded by AusAID, Phnom Penh.

WDI. 2014. World Development Indicators. World Bank: http://databank.worldbank.org/data (accessed November 20, 2014).

ANNEX 1: ANALYTICAL WORK FROM THE WORLD BANK AND AUSAID PARTNERSHIP

1. The World Bank and Australian Aid signed an agreement in 2009 to produce a series of analytical reports to underpin the efforts of the government and donors to improve food security and promote smallholder-driven agricultural growth in Cambodia. Eight reports were produced on topics ranging from input markets and rice sector development to access to finance, all of which feed into this large report on agricultural transformation, which is also supported through the partnership.

2. These reports are the following:

- *Rapid Appraisal of Fertilizer Quality in Cambodia* prepared in 2010 by the International Fertilizer Development Center.
- *Seed Sector Overview* prepared in 2011 by a team led by M. Chamroeun, the World Bank.
- *Impact Assessment of Farmer Organizations on Food Security for Rural Poor* prepared in 2012 by CDRI.
- *Roadmap for Cambodian Rice Exports* prepared in 2009 and updated in 2012 by T. Slayton and S. Muniroth.
- *Turning Rice into "White Gold"* prepared in 2012 by T. Slayton and S. Muniroth.
- *The Agriculture, Irrigation, and Rural Roads Sectors: Public Expenditure Review,* prepared in 2011 by a team led by P. Eliste, the World Bank.
- *Study on Access to Financial Services for Small and Medium Agribusiness Enterprises in Cambodia* prepared in 2013 by a team led by P. Eliste, the World Bank.
- *Review of Potential and Constraints for Warehouse Receipts Financing in Cambodia with a Focus on Rice Sector*, prepared in 2014 by L. Rutten.

ANNEX 2: METHODOLOGY FOR THE 2013 FARM SURVEY

1. This survey investigated the main changes in Cambodia's agriculture sector over the past 10 years, the key drivers of those changes, and stakeholders' medium- and long-term perspectives about the future of the agriculture sector. Based on the information from agricultural experts in Cambodia, supported by data gathered from farmers, the findings from this assessment will provide insights to help shape the RGC's agriculture sector strategies.

2. The survey team used qualitative methods to collect data for this assignment, including key informant interviews and FGDs, complemented by quantitative data collection on farm budgets. The project team collected data at the national, provincial, district, commune, village, and individual farm level. Individual interviews are typically the preferred approach, but FGDs were determined to be more effective for talking with farmers. The survey team also used structured survey tools to gather data from individual farmers for the financial analysis of farm enterprises.

Selection of Products

3. The commodities selected for this analysis were chosen because they best characterized the changes in Cambodia's farming system since the mid-2000s. The team first selected four products that had significant changes in production growth over the past 10 years. In addition, each of these products had specific defining characteristics: (i) rice is the most important crop in terms of GDP contribution, employment, food security, and exports; (ii) maize is characterized by its rapid adoption of improved seeds and integration with the feed industry; (iii) cassava growth is exceptional but its development is subject to intense discussion related to sustainability and biodiversity conservation; and (iv) vegetables are related to nutrition and food safety, and are a good candidate for import substitution.

4. The survey team discussed the selection of these crops during a stakeholder meeting held in Phnom Penh on September 18, 2013. Table 65 summarizes the characteristics of the four selected commodities.

Table 65: Product selection for the 2013 field survey

Product	Justification	Related Policies	Region and Province
Wet season rice	* Staple food * Large domestic and international demand * RGC focus * High economic impact * Contribution to food security * 2013 production: 7.14 million tons	* Land * Export promotion * Food security	TONLE SAP: * Battambang * Bantey Meanchey COASTAL: * Kampot MEKONG: * Takeo * Kampong Cham * Kandal

Dry season rice	* Staple food * Large domestic and international demand * RGC focus * High economic impact * Contribution to food security * 2013 production: 2.15 million tons	* Land * Irrigation * Food security * Export promotion	TONLE SAP: * Battambang MEKONG: * Takeo * Kampong Cham
Cassava	* Subsidiary crop with relatively reliable demand (starch, animal feed, ethanol) thus ensuring relatively stable incomes for upland farms * Drastic increase of production from 2004 to 2013 * Valorization of upland * 2013 production: 7.61 million tons	* Land * Environmental sustainability * Export promotion * Agribusiness Promotion	TONLE SAP: * Battambang * Bantey Meanchey MEKONG: * Kampong Cham
Maize	* Production increased 20 percent a year from 2003 to 2012 * Existence of demand (animal feed) thus ensuring relatively stable incomes for upland farms * Farmers tend to adopt new technologies (e.g., hybrid seeds) * 2013 production: 0.95 million tons	* Seed production * Agribusiness promotion	TONLE SAP: * Battambang * Bantey Meanchey MEKONG: * Kampong Cham * Kandal
Vegetables	* Production increased 10 percent a year from 2003 to 2012 * Import substitution * Contributes to improve nutrition * Improved food safety * From ADB 2009: vegetable production provides highest gross margin per ha * 2013 production: 0.41 million tons	* Food safety * Pesticide management * Seed production	MEKONG: * Takeo * Kandal * Kampong Cham COASTAL: * Kampot TONLE SAP: * Battambang * Bantey Meanchey

Selection of Sites

5. The team selected the provinces, districts, and communes for the field work based on their contribution to the production of the selected products. The team used data from MAFF and information from various experts in Phnom Penh. In addition, provinces, districts, and communes visited in the 2005 survey were included in the sample if they fit the purpose of the current research questions. In some cases, villages or communes had altered their farming systems, shifting to commodities not part of the survey list; in these cases, a new, more appropriate site selection for the four commodities was decided through discussion with the District of Agriculture Office Chief.

6. At the commune level, the team requested the commune council to provide a list of villages where many farmers produced the selected commodities. The team chose one village from the list proposed by commune leaders.

Table 66: Selected locations for 2013 field work

Zone (3)	Province (6)	District (12)	Crop (4)	Commune (12)	Visited in 2005
Mekong	Kampong Cham	Memot	Maize/Cassava	Dar - Memot	Yes
		SreySnathor	Rice/Maize	Prey Poh - PrekDamboke	Yes
	Kandal	Sa Ang	Vegetable/Maize	PrekAmbel	No
		KandalStoeng	Rice/Vegetable	Siem Reap	No
	Takeo	Batti	Rice/Vegetable	Champei	No
		Tram Kok	Rice/Vegetable	Tram Kak	No
Coastal	Kampot	Chhouk	Rice/Vegetable	Meanchey - TrapeangPhleang	Yes
		Kampong Bay	Rice/Vegetable	TraeyKoh - Andong Khmer	Yes
Tonle Sap	Battambang	Ek Phnom	Rice/Vegetable	PrekKhpop-PrekNorin	Yes
		Banan	Cassava/Maize	Kanty 2 - Chheuteal	Yes
	Bantey Meanchey	Malai	Maize/Cassava	OuSampou	No
		MongkolBorei	Rice/Cassava	RohatTouk	No

7. In summary, the selection sequence was: (i) selection of provinces; (ii) selection of two districts within each province; (iii) selection of one commune within each district; and (iv) selection of one village within each commune.

8. The six sampled provinces accounted for 46 percent of the national production of rice in 2013[56]; 83 percent of maize production, 57 percent of cassava production, and 60 percent of vegetable production.

[56] Broken down by 44 percent of wet season rice production and 53 percent of dry season rice production.

Selection of Respondents

A. Provinces, districts, and communes

9. At the national, provincial, district, and commune level, the project team conducted key informant interviews with experts in the field of agriculture, rural development, and land management. The list included senior officers at the Ministry of Economy and Finance; the Supreme National Economic Council; the Ministry of Agriculture, Forestry, and Fisheries; the Ministry of Land Management, Urban Planning, and Construction; and responsible staff members of development projects and NGOs working in Cambodia. During the fieldwork, the team interviewed provincial department and district office representatives of the two ministries (MAFF and MLMUPC), as well as the responsible person for agricultural development at the commune level.

10. The survey team used two different sampling methods for key informant interviews: (i) purposive sampling based on the information from initial meetings with MEF, SNEC, and MAFF and the initial identification of respondents by the project team; and (ii) snowball sampling, which consists of interviewing key informants identified by the respondents themselves.

11. The interview guide[57] for key informants had two sections, aimed at eliciting information on: (i) changes that happened in the past 10 years in the agriculture sector, their driving forces, and stakeholders' perspectives for the next five years; and (ii) prices, farmers' use of inputs including land, and agricultural production.

12. For the first section, interviewers ensured that all possible changes and their causes were discussed during the interview. Topics included:

a. Land use and land availability;
b. Awareness and use of improved varieties and use of good (certified) seed;
c. Awareness and use of other modern inputs such as fertilizer and pesticides;
d. Access to agricultural services such as finance, extension, and information on prices;
e. Extent of mechanization and types of farm machinery used;
f. Use of family and hired labor and dynamics of hired labor costs across geographic locations, and the overall availability of labor;
g. Role of women in agriculture; and
h. Importance (or not) of farmers' organizations.

13. In addition, interviewers asked questions about the key constraints to improved productivity and farmers' perspectives about the agriculture sector over the next five years.

B. Villages

14. At the village level, the team used FGDs to get information from farmers. For each village, one FGD was conducted separately for each selected crop for the sake of homogeneity of respondents. The FGD questionnaire had two sections: the first captured the same information collected from key informants but at the village and farm level, and the impact of changes on farm

[57] The detailed field tools are listed in the Inception Report.

activities; the second section included more detailed questions on prices, yields, and use of inputs for agricultural production.

15. The team again used a purposive approach to sample FGD participants. Focus groups consisted of 10 to 12 farmers, and ideally included different farmers growing the selected crop in three categories of cultivated areas (by size) and two levels of use of modern technologies. The team asked village leaders to identify farmers who met the criteria for farm size (small, medium, and large cultivated areas) and level of use of modern technologies (use of improved seeds, fertilizers and pesticides, agricultural machineries, and irrigation).

16. To assess the level of modern technology use, the project team initially characterized farmers as traditional or modern based on the following: for each category of technology (improved seeds, fertilizers and pesticides, machineries, and irrigation), the farm was rated 2 in case of use and 1 for no use. The maximum attainable score was thus 8 for a farm using improved seeds, modern inputs (fertilizers or pesticides), agricultural machineries (e.g., harvester or power tiller for land preparation), and irrigation. At the other end of the spectrum, a completely traditional farmer was given a score of 4. Farmers' scores thus ranged from 4 to 8. Farmers scoring less than 6 were qualified as traditional and those scoring 6 or more were categorized as modern. During the analysis, the project team used a statistical method (factor analysis) to distinguish between farmers adopting more modern technologies and farmers using more traditional practices for agricultural production.

17. In summary, a FGD included at least one farmer satisfying the criteria for each cell of the following matrix:

Table 67: Matrix of size x technology

		Cultivated Area (farm size)		
		Small	**Medium**	**Large**
Level of use of modern technologies	**Low**	Cell 1	Cell 2	Cell 3
	High	Cell 4	Cell 5	Cell 6

C. Farms

18. At the farm level, the survey team collected data on farm budgets for the selected crops, qualitative information on changes observed by farmers in the past 10 years on their farms, and their perspectives for the next five years.

19. Data on farm budgets for the financial analysis of farm enterprises were collected from individual farmers. In every village, the survey team visited one to two households within each of the six cells in Table 67 (matrix of 3 sizes and 2 levels of technology use). However, not all cells existed in every village; for example, there were not always farmers growing vegetables on large areas (> 0.5 ha). Although information for each cell per village was not always available, the project team ensured that within each agro-ecological zone, each cell contained at least one sampled farmer.

20. The farm budget model was then defined by the four following parameters:

$$\text{Model} = M(c, s, l; z)$$

where c is the commodity, s is farm size, l is the level of modernization, and z is the agro-ecological zone. In total, the project produced: (i) 29 budget models of crop production based on five crops (including wet season and dry season rice), three categories of farm size (small, medium, and large), and two levels of technology adoption (low and high), with one category missing (medium-size modern vegetable producers); and (ii) 23 models based on location. The project highlighted any sub-regional differences existing within each agro-ecological zone.

21. The individual farm survey contained three sections:

- Section 1: Farm budget
- Section 2: Information related to the past 10 years on:
  - Production trends
  - Trade trends
  - Changes in the use of inputs, machineries, and access to agricultural services
  - Changes in the use of labor and the impact of migration
  - Changes in marketing
  - Dynamics of landholdings over the past decade
  - Source of change in landholdings
- Section 3: Data on farms' and farmers' characteristics

D. Summary of the type and number of respondents

22. Table 68 presents a list of respondents for the survey.

Process for Setting Up the Tools for Data Collection

23. The assignment required the use of five different data collection tools:

a. Interview guide for provincial and district staff of MAFF

b. Interview guide for provincial and district staff of MLMUPC

c. Interview guide for key person responsible for agriculture in commune

d. FGD guide for groups of farmers

e. Questionnaire for individual farmer survey, including farm budget sheet

24. The survey team pretested the FGD guide and the individual farmer questionnaire with farmers in Takeo province. The objectives were to check for consistency and flow, to identify other relevant responses to each question in the guide, and to determine the timing of the interview and FGD.

25. The questionnaire was translated into Khmer before the field staff training. The training lasted for five days, including a second pretest of the revised questionnaires in the field, and another session to update the tools based on feedback from the field.

26. After the stakeholder consultations held on September 18, 2013, additional questions were added on gender, changes in the role of women in agriculture, the impact of migration on agricultural labor, and households' consumption. Questions about who led the changes were also added.

Table 68: List of respondents to 2013 survey

Categories of Respondents	Objectives	Location
Executive Senior Staff at MEF, MAFF, SNEC members	Information on the project Guidance	Phnom Penh
World Bank	Guidance Administrative Expectations	Phnom Penh
Technical staff at CDRI, FAO, CAVAC, HARVEST/USAID, IDE, LASED	Statistical information Documents Experience Lessons learned Suggestions	Phnom Penh
Provincial Department and District Office of MLMPC	Guidance Policy information Data validation	In each of the 6 selected provinces and 12 districts
Provincial Department and District Office of MAFF	Guidance Statistical information Find out other actors to talk to	In each of the selected 6 provinces and 12 districts
Commune Authority (Council)	Guidance Data validation Suggestions on names of villages	In each of the 12 selected communes
Group of Farmers (FGD)	Information Data validation Suggestions on names of farmers by size, technology use	In each of the 12 selected villages
Individual farmers representing the cell (crop x farm size x level of technology use)	Information Data validation Farm budget model	1 to 2 in each of the 12 selected villages (if possible), for each selected crop, farm size, and level of technology use

Quality Control

27. The survey team consolidated the information received from key informants and FGDs every day. Each completed interview was signed by the interviewer, and controlled and signed by the supervisor. For each questionnaire, the team:

a. Checked the consistency of the gathered information;

b. Checked its completeness; and

c. Checked the reliability and accuracy of answers.

28. In addition, the supervisor of each field team communicated to the field survey manager on a daily basis the work progress, any encountered issues, and major findings worth sharing with the other teams.

Data Analysis

29. The team used qualitative data gathered from key informants to explain why and how Cambodia has attained such a remarkable improvement in agricultural production in the past 10

years, and to identify opportunities and threats for the future of the agriculture sector. The ultimate goal was to recommend policies to ensure that the agriculture sector remains central to Cambodia's overall economic development.

30. For each key question (such as land use and land availability; use of inputs and machinery; issues of labor; access to agricultural services; constraints to agricultural production; and perspectives about the sector), the project team produced tables summarizing the findings by agro-ecological zone and by farm size.

31. The team used farm-level data to compute financial indicators of farmers' costs and profitability, including gross margins, net profit per hectare, and total production, as well as gross profit per day of family labor and net profit per day of total labor. The team also estimated the financial rates of return: gross margin over variable cost and net profit over total variable cost.

32. For the analysis of returns to labor, the project team compared the indicators of returns to labor from various farm enterprise models to prevailing nonfarm returns to unskilled labor in key economic sectors (manufacturing, construction, and services).

33. The team also conducted a trend analysis explaining trends in cost structures, profitability, and cash flows, and use of labor and machinery between the 2005 and 2013 farm enterprise models. Information from key informant interviews and the qualitative data were used to compare the factor dynamics between 2005 and 2013 in farming systems and to identify the causes of these changes.

34. The team benchmarked the cost of production and input uses against available farm enterprise data from other ASEAN countries and financial and returns to labor indicators from the above farm enterprise models. The team assessed the comparative advantage of Cambodia's agricultural products relative to other countries in the region, using available data on comparative advantage indicators from recent analytical work and economic literature. To that end, the project team computed:

a. Comparative advantage indicators using financial farm enterprise models as a starting point; economic prices (shadow prices) for internationally traded outputs and inputs; and other economic prices (such as for labor) that are adjusted for public transfers (subsidies and taxes);

b. Indicators of social profitability, to measure the comparative advantage of various farm enterprise variations; and

c. The DRC indicator to assess Cambodia's comparative advantage in producing agricultural commodities relative to its neighbors.

ANNEX 3: DETAILED FARM BUDGETS BY CROP

1 Farm Budget for Wet Season Rice

1. From 2005 to 2013, the nominal gross margin on wet season rice production increased by 55 percent, from $158/ha to $245/ha. In real terms this increase was close to zero. Within the same period, gross revenue increased by 1.2 times and total variable costs by 1.7 times. In real terms, using the GDP deflator from 2005 to 2013 as an adjustment factor,[58] the increase was much smaller.

2. The changes in gross revenues were mostly driven by prices. From 2005 to 2013, wet season paddy rice prices increased 98 percent in Cambodia, rising to $247 per ton from $125 per ton. For reference, FAOSTAT reported a similar trend in Thailand, with an increase of 144 percent over the same period, 50 percent higher than in Cambodia, but the Thai prices might have been altered by the policy of subsidizing rice farmers. On average, this variation in prices should lead to a doubling of the nominal values of production, thus significantly affecting nominal gross margins, assuming no or only slight changes in productivity.

3. Wet season rice producers used increasingly more modern inputs. A comparison of the cost structure between 2005 and 2013 shows that farmers used more fertilizers for wet season rice production. In 2013, traditional farmers spent on average $49/ha (75kg/ha) to purchase chemical fertilizers, up from almost no expenditures in 2005. For modern users, the amount spent increased two-fold, from $30-$40/ha (100-133 kg/ha) to over $80/ha (125kg/ha). However, between 2005 and 2013, the price of urea and DAP also increased almost two-fold, from $0.35/kg to $0.68/kg, an increase that may partially explain the increase in chemical fertilizer expenditures. Wet season rice producers also used more pesticides and herbicides as farm size increased. This expenditure amounted to $4/ha for small, $6/ha for medium, and $12/ha for large farms. Expenditures on herbicides, an alternative to manual weed control, constituted the main part of the costs of chemicals (other than fertilizers).

4. The relative share of costs allocated to hired labor decreased as farm size increased. For small farms, the relative share of labor in the partial farm budget represented more than half of total variable costs. The percentage decreased slightly below 50 percent for medium-size farms and dropped further to a quarter for large farms. Indeed, results from the FGDs and the interviews with MAFF and Ministry of Land in the regions and districts show that it is increasingly difficult to find agricultural workers in rural areas. In addition, the daily cost of hired labor increased four-fold, from $1.0-1.2/day to $4.5/day between 2006 and 2013, according to the survey data. These factors forced medium-size and large farms to find better alternatives and more cost-efficient approaches to substitute for the use of hired labor.

5. On the other hand, the cost structure shows the relative importance of expenditures on services for large farms. In 2013, 45 percent of the total production costs for large wet season rice producers were allocated to services. This proportion was 27 percent for medium-size farms and 22 percent for small farms. On a per hectare basis, large farms spent 35 percent and 25 percent more on services than small and medium-size farms, respectively. Most of these costs were related to harvest and post-harvest operations, as large farms sought services from businesses renting combines. According to the FGD results, farmers in Cambodia expected an increasing shift of

[58] The cumulative change of the GDP deflator between 2005 and 2013 was 35 percent.

harvest and post-harvest operations from manual labor to the use of mechanized agricultural equipment.

6. Each province has its own specific cost composition for producing wet season rice depending on the cost of labor, technology, and connectivity to urban and industrial zones. Farmers in Takeo (65 percent) and Kampot (50 percent) allocated a larger percentage of their total variable costs to labor. In contrast, farmers in Battambang had the lowest share of labor costs (6 percent). Expenditures on services ranged between 17 percent (Kampot) and 47 percent (Battambang), and close to 40 percent in Kandal, Kampong Cham, and Bantey Meanchey. In most provinces, rice farmers spent an average of 16-22 percent of their costs on the purchase of fertilizers, with the exception of Kampong Cham, where the share was about 6 percent ($29/ha). These differences in cost composition illustrate the diversity of the techniques used by farmers to produce wet season rice. For example, direct seedlings are more commonly used in Battambang and Bantey Meanchey. They are also an indication of the cost and availability of agricultural inputs within each province. Farmers located farther away from urban centers and/or borders with neighboring countries might opt for a more labor-oriented approach, favoring the use of family and hired labor. Farmers closer to urban centers and economic industrial zones might adopt a more capital-oriented approach – e.g., greater use of herbicides, and use of combines for harvest and post-harvest operations.

7. The choice of technology is a critical component of profitability in wet season rice production: the gross margins of modern farmers were more than twice those of traditional farmers ($399/ha versus $178/ha). Modern technology users were characterized by higher expenditures on fertilizers ($99/ha) and lower expenditures on labor ($130/ha) compared to traditional farmers, who allocated about $5/ha for fertilizers and $259/ha for labor. These differences should allow modern farmers to reach higher yields, and indeed, modern farmers had a 25 percent higher yield compared to farmers using traditional practices.

8. According to MAFF statistics, average yields for wet season rice have slightly increased since 2006, to 2.9 tons/ha in 2012. In 2013, data collected by the project team for the purposively selected farmers showed an average yield of 2.6 tons/ha, varying from 2.4 tons/ha for farms using traditional technologies to 3.0 tons/ha for farms using modern technology. Although the current study did not intend to measure average yield, it is reassuring to find these data in the range of official figures.

2 Farm Budget for Dry Season Rice

9. The data show that on average, farmers earned higher gross margins per hectare in nominal terms in 2013 than in 2005, regardless of farm size. The magnitudes of the change were higher as farm size increased. In 2005, gross margins for small dry season rice producers ranged from $200/ha to $391/ha; in 2013, they ranged from $276/ha to $311/ha. For medium-size farms, the changes were higher, with an average $283/ha, almost 1.5 times the 2005 gross margin for this size category. Large farms showed the largest increase, with the 2013 gross margin on average three times the recorded 2005 gross margin due to higher use of inputs, which resulted in higher productivity.

10. On average from 2005 to 2013, dry season rice yields also increased, from an average 3.0 tons/ha to 4.8 tons/ha for the surveyed farms. Over the same period, statistics from MAFF show the yield increase of 500 kg, reaching 4.4 tons/ha in 2012 from 3.9 tons/ha in 2005. Data collected by the project team show the average 2013 farm gate price higher by 75 percent in nominal terms

compared to the 2005 situation; the price rose from $118.5/ton in 2005 to $206/ton in 2013. This increase was moderate compared to the paddy price changes in Thailand, which increased 144 percent from $172/ton in 2006, but was comparable to the farm gate prices in the Vietnam Mekong region at $240/ton. This difference in prices makes profitable the informal export of paddy from Cambodia to Vietnam and Thailand.

11. Dry season rice producers' revenue increased less than their costs; the total increase in their margins, however, was still positive. Data collected by the project team in 2005 and 2013 show a 150 percent increase in gross returns, attributable to the combination of higher price and higher yield. However, the much higher increase in total variable costs (218 percent) resulted in an increase of only 79 percent in the gross margin (in nominal terms). This difference varied across type of farm, level of technology use, and location.

12. Use of modern technology is no guarantee of higher gross margins. In a few cases, dry season rice producers using modern technologies received lower gross margins compared to farmers using traditional practices. Besides the use of modern technologies, other factors such as soil quality, labor skills, and quality of seeds are important. In some cases, the expected returns to intensive use of chemicals, improved seeds, and irrigation are offset by gaps in these other factors. If all conditions were the same, modern technology would clearly be better than traditional methods. But all conditions are not the same, particularly when isolated observations are compared, as in this study. This finding seems to be counterintuitive and goes against the conventional wisdom about the advantage of modern technologies. Indeed, the distinction between modern and traditional is very qualitative, based on the level of use of factors such as irrigation, improved seeds, fertilizers, chemicals, and mechanization. Modern farms are expected to spend more on these inputs; e.g., modern small farms spent $228/ha on fertilizers versus $117/ha for traditional small farms; medium-size farms showed similar patterns ($168/ha versus $102/ha) and so did modern large farms ($203/ha versus $100/ha). The same disproportions were observed for herbicides and seed expenditures; this latter may reflect the use of high-quality improved seeds. Modern farms are also characterized by lower expenditures on hired labor regardless of their size: $113/ha for small traditional versus $32/ha for small modern farms; $98/ha for traditional medium-size versus $29/ha for medium-size modern farms; and $96/ha for large traditional versus $42/ha for large modern farms. The costs of harvest were very similar for both types of farms. The most striking difference was in expenditures on irrigation. Overall, the field interviews found that gross margins for modern farms ($255/ha) were lower than those of traditional farms ($336/ha). In summary, increasing yield is not enough if it comes at the cost of margins or sustainability.

13. Dry season rice producers adapt their production strategies to maximize their profit according to their assets: labor cost shares decrease and services cost shares increase with farm size. The analysis shows that regardless of farm size, gross margins remained similar, ranging from $283/ha for large farms to $306/ha for small farms. As with modern versus traditional farms, the structure of costs for different sizes of farms was quite different, especially in the use of labor-alternative technologies. For example, large farms used increasingly less manual labor (e.g., on weed control), using chemicals as substitute, and reapers and threshers or combines for harvest and postharvest. This resulted in lower costs for labor as farm size increased. In dry season rice farm budgets, expenditures on labor amounted to $53/ha, $140/ha, and $204/ha for large, medium, and small farms, respectively. On the other hand, larger farms reported higher expenditures for herbicides ($21/ha for large versus $9/ha for small farms).

14. The gross returns to dry rice production were similar for all provinces; however, the production costs showed huge disparities. Takeo, the province with the highest dry season rice production (460,000 tons in 2012, 21 percent of total production – Source: MAFF), also had the highest gross margin, $384/ha. The farm budget in Takeo was characterized by the absence of irrigation costs, which may denote the existence of good public irrigation infrastructure. The cost of labor in Takeo was the highest of all four provinces in this analysis, at $192/ha. The dry season rice farm budget in Battambang had a gross margin of $334/ha, slightly less than that in Takeo, but Battambang is "penalized" by high expenditures on irrigation ($132/ha). It also had high expenditures on chemical fertilizers ($186/ha). The combination of these investments brought about a higher yield, above 5.1 tons/ha, thus generating the highest gross return, at $1,047/ha. If farmers in Battambang did not pay as much for irrigation, their gross margin would be closer to farmers in Takeo. The total dry season rice production in Battambang was around 100,000 tons in 2013 (MAFF). Kandal was in third place with a gross margin of $288/ha. The province produced about 270,000 tons of dry season paddy (12 percent of total production) in 2012. It has the disadvantage of lower gross returns, a direct consequence of lower yield (4.3 tons/ha versus 4.9 tons/ha for Takeo for surveyed farmers). Bantey Meanchey's gross margin was the lowest of the four provinces, at $175/ha. Its farmers' expenditures on seeds were almost double those of Takeo's farmers; they also had the highest expenditures on fertilizers ($207/ha) and the highest cost of irrigation ($150/ha). Their yield was similar to yields in Takeo and Battambang, but because of the relatively lower prices of products (gross return of $970/ha) and the high costs previously mentioned, their gross margin fell to $175/ha.

3 Farm Budget for Cassava

15. Overall, for all farm sizes and regardless of the level of technology use, the gross margins per hectare for cassava significantly increased in nominal terms between 2005 and 2013, varying from 86 percent for medium-size farms using traditional practices to 300 percent for small farms adopting modern technologies. In real terms, the increase in per hectare gross margins was more modest, varying from 51 percent to 265 percent for the two categories of cassava farmers previously mentioned. These changes were mostly driven by prices. From 2005 to 2013, fresh cassava prices increased 200 percent in Cambodia, rising to $59.4/ton from $19.8/ton. For reference, FAOSTAT reported a similar trend in Thailand, with an increase of 166 percent over the same period. The RGC policy on feeder roads rehabilitation in the past 10 years might have contributed to higher changes in farm gate prices.

16. Use of modern technologies is positively correlated to an increase in gross margin per hectare. Overall, cassava farmers using more modern technologies had a 65 percent higher gross margin per hectare compared to farmers using traditional practices. The difference was lower for large farms compared to medium-size and small farms. In the 2013 survey, modern technology adopters recorded a gross margin of $695/ha, about 64 percent higher than that of their traditional counterparts, at $422/ha. This difference is partly explained by the difference in yields: 21.9 tons/ha versus 17.2 tons/ha for modern and traditional technology users, respectively. For cassava, use of modern technologies seems to be limited to the adoption of high-productivity varieties, which may account for a productivity increase of 24 percent, and better crop management practices. Chemical and organic fertilizers are barely used by farmers, and represent only about 1 percent of total variable costs (slightly less than $2) for the surveyed cassava producers. The 2013 survey did not shows significant differences between the recorded average farm gate prices for the

two groups of producers. Traditional farmers sold fresh cassava at $71/ton, very similar to the $73/ton received by modern farmers.

17. According to MAFF statistics, average yield for cassava fluctuated between 2006 and 2012, with a reported yield of 22.5 tons/ha in 2012. Data collected by the project team show a lower average yield of 18.9 tons/ha, varying from 14 tons/ha for medium-size farms using traditional technologies to 27 tons/ha for farms using modern technology. Although the current study did not intend to measure average yield, it is reassuring to find the survey data in the range of official figures. Further analysis by category of farm size shows a slight inverse relationship between productivity and farm size: larger farms tended to have lower productivity per hectare compared to small farms. The difference was mostly between the small and other farm sizes, with a gap of close to 10 percent.

18. The most commonly observed changes in the cost structure were an increase in the relative cost of cassava cuttings and a decrease in the relative cost of services. The share of cutting costs out of total variable costs increased from 2-3 percent to 20-30 percent for farmers using traditional methods between the two periods. In 2013, the gap in the relative costs of cassava cuttings decreased between the levels of technology use. Overall, traditional farmers spent about 17 percent less than modern farmers on cassava cuttings. Indeed, use of improved varieties is one of the most cost-efficient technologies to improve productivity. Farmers expanding cassava plantation, in some cases to lower fertility land, would get higher productivity if they adopted more modern varieties of cassava. Modern farmers were also characterized by lower costs of services ($253/ha versus $314/ha), higher costs of labor ($257/ha versus $207/ha), and higher use of fertilizers and chemicals although in lower magnitude.

19. Low use of fertilizers, including organic fertilizers is a concern for the sustainability of cassava production. The cassava farm budgets showed that for any category of farm size, the amount spent on fertilizers remained very low, on average less than 1 percent of total variable costs. Out of the 26 observations, no farmers reported using manure or compost, one out of 5 used urea, and only one used DAP. The rates of use were around 50 kg/ha for urea (for users only) and 25 kg/ha for DAP (one case).

20. The analysis did not find significant differences across provinces. The magnitudes of revenue and total variable costs remained very similar across surveyed farm budgets in three of the six provinces surveyed. The ratios of gross margins to revenue per hectare were quite similar, ranging from 35-42 percent. In addition, the structures of total variable costs were not dissimilar.

21. About half of the interviewed cassava farmers dried their products before commercialization. Farmers who opted to sell chips received higher gross margins ($505/ha versus $452/ha). Their total variable costs were also higher by 4 percent, including a 12 percent increase on labor expenditures, but these costs were offset by a 19 percent higher final product price. The 12 percent gain on gross margin was mostly due to the difference in average yield (18.3 tons/ha versus 16.9 tons/ha) and the 10 percent value added to price from processing.

Table 69: Comparison of key indicators across type of commercial cassava (chips vs. fresh)

Processing	Total Revenue ($/ha)	Total Variable Costs ($/ha)	Labor Costs ($/ha)	Gross Margin ($/ha)	Yield (tons/ha)	Unit Price (Riel/ton)
No	1,224	772	197	452	16.9	72.3
Yes	1,306	801	220	505	18.3	79.3
% Change	7%	4%	12%	12%	8%	10%

4 Farm Budget for Maize

22. The trend between 2005 and 2013 for maize indicates a reduction in the gross margin per hectare received by farmers in real terms. In general, the gross margin per hectare is affected by the prices of outputs and inputs and crop yields. Over this period, recorded prices for maize grain increased from an average $140/ton to $230/ton (i.e., 64 percent, according to data recorded by the project team). For reference, between 2006 and 2011, farm gate prices for maize in Thailand increased 110 percent, from $119/ton to $250/ton (FAOSTAT). If the costs of production follow the same increase as the price of products, then the change in yields will determine the direction of the nominal change in gross margins. Maize yield over the period increased 25 percent according to MAFF statistics. On the other hand, input prices increased at a higher rate; e.g., the price of nitrogen fertilizers in 2012 was about three times higher than in 2006 (FAOSTAT). Based on these facts, it can be assumed that there was a decrease in real terms in the level of gross margins received by maize farmers. Information collected in 2005 and the results of the survey conducted by the project team in 2013 support this assumption. In 2005, maize farms received an average gross margin of $574/ha with a yield of 6.0 tons; this margin is 90 percent more than the same measure calculated from a similar farm budget in 2013 ($304/tons). The trend is even more negative in real terms.

23. Maize production is responsive to the use of modern inputs such as fertilizers, chemicals, and improved seeds. Farmers using modern inputs to produce maize are more likely to have a higher gross margin, and the gain increases as farm size decreases. In 2013, the overall gross margin for modern farmers was $396/ha and $211/ha for traditional farmers. There were large disparities across farm size: small farms using modern technologies had twice the margin of farmers practicing traditional technologies ($282/ton versus $118/ton). The same advantages of modern farmers were observed, albeit at lower magnitude, for large farms ($522/ton versus $253/ton). The budgets provided by maize producers showed that users of modern technologies spent about $83/ha on improved seeds versus $71/ha for traditional farmers; their expenditures on fertilizers and chemical amounted to 20 percent of total variable costs versus 5 percent for users of traditional practices. Modern farmers had 15 percent higher yields across all size categories.

24. According to MAFF statistics, the average yield for maize fluctuated between 2006 and 2012, with a reported yield of 4.4 tons/ha in 2012. For the last four years, average yield moved up and down around 4 tons/ha. Data collected by the project team show lower average yield (3.94 tons/ha), varying from 0.8 tons/ha to 10 tons/ha, with a median of 3.5 tons/ha. Although the current study did not intend to measure average yield, it is reassuring to find these data in the range of official figures.

25. Analysis of the cost structures showed that the cost of improved seeds was the most important budget line item, regardless of farm size and level of technology adoption. This cost represented between 16 percent (for small modern farms) and 24 percent (large modern farms) of total variable costs. The enthusiasm for using improved maize seeds, particularly hybrid seeds, was often highlighted by respondents during the expert interviews and FGDs. However, this does not automatically mean that yield will be higher. Many farmers complained of the existence of fraudulent seed suppliers. The second most significant expenditures were for land preparation. Depending on the type of farm, this cost ranged between 16 percent (small traditional) to 34 percent (medium-size traditional) of total variable costs. Note that this partial budget did not take into account the cost of family labor or that of work by farmers for their own agricultural production. Modern farmers were also characterized by a high percentage of cost allocated to fertilizers and chemicals, ranging from 9 percent for medium-size farms to 21 percent for small and large farms. These values contrast with the lower percentages for traditional farmers, which ranged from 4-5 percent of total variable costs.

26. The analysis found significant differences across provinces in the gross margin, total variable costs, total revenue, and cost structure. The magnitudes of revenue and total variable costs were quite different. Farmers in Bantey Meanchey and Kandal had higher revenues ($839/ha and $1,133/ha, respectively), while revenues in Kampot and Battambang were quite low (around $370/ha to $402/ha). Kandal exhibited the highest total variable costs at $634/ha, comprising $85/ha for improved seeds, $105/ha for fertilizers and chemicals, and $177/ha for land preparation. This province also had the highest gross margin, at $500/ha.

5 Farm Budget for Vegetables

27. Data from 2005 and 2013 show that the nominal gross margins per hectare for small farms growing vegetables decreased by about one-fifth. Medium-size farms exhibited an increase of more than 50 percent and large farms doubled their gross margins compared to 2005. Gross margins for small farmers in 2005 ranged from $415/ha (cucumber production in Battambang) to $1,775/ha (watermelon production in Kampot); for medium-size farms, the highest gross margin ($1,100/ha) was observed in Pursat for cucumber production and the lowest ($77/ha) in Sihanouk region for watermelon production. In 2013, a similar spread of gross margins per hectare was observed, especially for small farms, with values ranging from $164/ha for watermelon production in Bantey Meanchey to $3,450/ha for eggplant production in Kampot. For medium-size farms, the range was quite narrow: from $635/ha for mustard production in Kampong Cham to $1,302/ha for watermelon production in Battambang. Data for large farms were scarce and thus very difficult to interpret. The only case reported in 2005 was a large cucumber producer in Pursat with gross margin of $134/ha. In 2013, one large farm was observed producing watermelon and cucumber in Battambang. From these pieces of information, nominal gross margins for small vegetable producing farms appeared to decrease; the changes were more favorable for medium-size and large producers. In real terms, the trend was negative for small farms, stagnant for medium-size farms, and positive for large farms. One complication is that these data related to numerous types of vegetables from different provinces, making comparisons difficult. For example, in 2013, the project team analyzed several farm budgets for cucumber, mustard, watermelon, and eggplant producers in Battambang, Kampot, Kampong Cham, Bantey Meanchey, and Kandal provinces. In 2005, the data were collected in Pursat, Battambang, and Sihanouk provinces for cucumber and watermelon production.

28. Prices of vegetables in nominal terms increased one- to three-fold between 2005 and 2013, depending on the type of vegetable. The price of watermelon tripled from 2005 to 2013, reaching $277/ton versus $84/ton in 2005; cucumber prices more than doubled, from $86/ton to $187/ton. The price of eggplant did not change much compared to other vegetables, rising to $200/ton from $125/ton. In real terms, the increases were more modest: double for watermelon and about one-third for cucumber, while eggplant prices remained the same. Comparable figures from Thailand increased within these ranges but exhibited different patterns, with watermelon prices the least increased. Thai cucumber prices had very similar increases to Cambodian farm gate prices. On the other hand, statistics from MAFF show a steady increase in average yield and production of vegetables in the past four years. Based on these two data sets, farmers' total revenue increased on average but the change in gross margin ultimately depends on the increase in production costs.

29. From 2006 to 2013, average total revenue increased three-fold, from $836/ha to $2,842/ha. This is the result of a combination of increases in yields and prices. However, during the same time, total variable costs increased eight- to nine-fold, from $161/ha to $1,481/ha. The increase in costs was attributable to an increase in input prices, the higher rate of use of modern inputs, and the higher amount of hired labor. For example in 2005, vegetable farmers spent about $23/ha for seeds, the same for fertilizers, and $4/ha for chemicals. In 2013, the figures were $141/ha for seeds, $341/ha for fertilizers (half of it manure), and $130 for pesticides (two-thirds for insecticides). In addition to an increase in the price, the four-fold increase in expenditures on seeds could be due to the use of higher-quality varieties to better respond to market demand. Expenditures on labor skyrocketed to $802/ha, an increase of about 16 times compared to the $50/ha in 2005. Again, this is the combination of an increase in the cost of labor (1 to 4 based on the 2013 data) and the shift to more labor-intensive activities, requiring greater use of hired labor. For the future, this could become a constraint to further development of vegetable production.

30. In 2013, the cost structures show the dominance of labor costs (54 percent), followed by the cost of inputs (41 percent). The share of services is very low, especially for small and medium-size farms. Despite the constraints linked to hiring rural laborers, vegetable farmers still relied heavily on manual labor, which represented about two-thirds of total variable costs. The ratios were lowest in Kampot, Takeo, and Kampong Cham provinces but still remained around 50 percent of total variable costs. Indeed, these variations were directly related to the type of vegetables grown in these provinces. Cucumber production required the highest amount of labor (72 percent of total variable costs), followed by eggplant production (64 percent), and mustard (50 percent). The lowest share was for watermelon production (42 percent), which also had the lowest average total production costs of $592/ha. In general, the share of labor decreased and share of services increased as farm size increased.

31. As expected, vegetable farmers adopting modern technologies used a high amount of inputs including manure, chemical fertilizers, pesticides, and seeds. Input expenditures for modern farmers represented five times the expenditures of traditional farmers, but there was variability across the type of vegetables and farm size. For example, small modern cucumber producers spent $728/ha versus $155/ha for traditional farmers; the figures were $920/ha versus $378/ha for mustard; and $636/ha versus $250/ha for eggplant producers. The variations were more difficult to assess for medium-size and large farms since very few of them were characterized as modern in the 2013 survey. In general, modern farmers allocated about 45 percent of their costs to inputs versus 30 percent for traditional vegetable producers.

32. Vegetable production is also characterized by intensive use of organic fertilizers. The use of manure or compost represented on average 9 percent of the total variable costs for vegetables. The share was highest in Takeo (17 percent) and lowest in Battambang and Bantey Meanchey (3-4 percent). Modern and small farms were also the most intensive users of organic fertilizers, with expenditures reaching $150/ha.

33. Intensification does not always mean higher gross margins for vegetable production, as already reported for the case of dry season rice production. Besides modern inputs, other factors such as irrigation system, commercialization, type of vegetable crop and varieties, and crop management may enter into consideration. For cucumber production, small farms allocating $728/ha for inputs reported a gross margin $650/ha, 3.7 times higher than the gross margin of small traditional farmers. However, for mustard and eggplant production, modern small farms received a lower gross margin compared to their traditional peers: $760/ha versus $983/ha for mustard and $689/ha versus $1,107/ha for eggplant, despite the two- to three-fold greater expenditure on modern inputs.

34. Access to and use of services remained insignificant for vegetable production. Only large and medium-size farms required substantial expenditures on services as part of their cost structures. In most cases, there were no reported expenditures. Either farmers supplied these services using family assets, which are very plausible because of the relatively small cultivated areas, or the services were not available to or known by farmers. For the future, the farm budget for vegetables should include a substantial amount for irrigation, a critical element for reaching high and sustained productivity. During the interviews and FGDs, very few respondents were aware of the possibility of using drip irrigation or greenhouses to improve vegetable production and quality or to lower dependency on uncontrolled factors such as rainfall.

Table 70: Wet season rice farm budget by technology and farm size

	Level of Technology Use and Farm Size					
	Modern Small	**Traditional Small**	**Modern Medium**	**Traditional Medium**	**Modern Large**	**Traditional Large**
Average cultivated area (ha)	0.60	0.54	1.33	1.27	3.80	5.00
Yield (tons/ha)	3.38	2.48	3.25	2.81	3.33	2.77
Inputs ($/ha)						
Seeds	42.50	19.81	30.42	17.13	49.69	19.84
Manure	22.50	41.59	8.17	23.70	13.08	1.67
Chemical fertilizers	173.27	43.28	81.88	60.82	79.08	36.13
Herbicides	-	0.47	6.27	1.31	7.03	12.33
Insecticides	2.68	0.67	4.17	0.43	1.21	0.83
Subtotal inputs	240.95	105.82	130.90	103.38	150.09	70.80
Labor ($/ha)						
Land preparation	-	-	-	-	-	-
Plantation, transplantation	156.25	124.72	148.75	90.04	26.75	117.92
Weed control	23.04	30.61	6.92	26.50	14.05	2.50
Crop management	63.57	119.27	29.17	100.85	6.04	114.00
Harvest	-	11.36	-	10.26	-	-
Post-harvest	5.08	12.86	1.67	14.54	3.77	5.00
Subtotal labor	247.93	298.82	186.50	242.19	50.61	239.42
Services ($/ha)						
Land preparation	85.00	98.65	118.33	92.00	144.80	158.33
Plantation, transplantation	-	-	-	4.04	-	-
Harvest	25.00	-	100.00	7.50	81.25	-
Post-harvest	37.14	32.53	48.96	31.74	19.85	56.25
Subtotal services	147.14	131.18	267.29	135.27	245.90	214.58
Total variable costs ($/ha)	636.02	535.82	584.69	480.85	446.60	524.80
Total revenue ($/ha)	1,157.86	652.68	1,000.00	717.05	787.80	595.83
Gross margin ($/ha)	521.84	116.86	415.31	236.20	341.20	71.04
Returns to labor ($/day)	8.73	1.62	9.24	4.05	27.98	1.23

Table 71: Wet season rice farm budget by farm size

	Size			
	Small	**Medium**	**Large**	**Total**
Average cultivated area (ha)	0.56	1.28	4.25	1.80
Yield (tons/ha)	2.68	2.89	3.12	2.89
Inputs ($/ha)				
Seeds	24.85	19.62	38.50	25.62
Manure	37.35	20.79	8.80	22.40
Chemical fertilizers	72.17	64.77	62.98	66.35
Herbicides	0.36	2.24	9.02	3.37
Insecticides	1.12	1.13	1.06	1.11
Subtotal inputs	135.85	108.54	120.36	118.85
Labor ($/ha)				
Land preparation	-	-	-	-
Plantation, transplantation	131.73	101.05	60.94	99.69
Weed control	28.93	22.83	9.72	21.31
Crop management	106.89	87.41	46.53	82.81
Harvest	8.83	8.33	-	6.45
Post-harvest	11.13	12.12	4.23	9.94
Subtotal labor	287.51	231.75	121.41	220.21
Services ($/ha)				
Land preparation	95.62	96.94	149.88	109.41
Plantation, transplantation	-	3.28	-	1.59
Harvest	5.56	24.84	50.78	25.87
Post-harvest	33.56	34.97	33.50	34.23
Subtotal services	134.73	160.03	234.16	171.10
Total variable costs ($/ha)	558.09	500.32	475.93	510.16
Total revenue ($/ha)	764.94	770.10	715.82	755.53
Gross margin ($/ha)	206.85	269.79	239.89	245.37
Returns to labor ($/day)	2.99	4.83	8.20	4.62

Table 72: Wet season rice farm budget by technology use

	Level of Technology Use		
	Modern	**Traditional**	**Total**
Average cultivated area (ha)	2.42	1.53	1.80
Yield (tons/ha)	3.32	2.70	2.89
Inputs ($/ha)			
Seeds	42.47	18.30	25.62
Manure	13.49	26.27	22.40
Chemical fertilizers	98.76	52.26	66.35
Herbicides	5.40	2.49	3.37
Insecticides	2.39	0.56	1.11
Subtotal inputs	162.50	99.87	118.85
Labor ($/ha)			
Land preparation	-	-	-
Plantation, transplantation	89.25	104.23	99.69
Weed control	13.71	24.62	21.31
Crop management	24.49	108.17	82.81
Harvest	-	9.25	6.45
Post-harvest	3.40	12.78	9.94
Subtotal labor	130.84	259.06	220.21
Services ($/ha)			
Land preparation	124.90	102.68	109.41
Plantation, transplantation	-	2.28	1.59
Harvest	75.63	4.24	25.87
Post-harvest	32.04	35.18	34.23
Subtotal services	232.57	144.37	171.10
Total variable costs ($/ha)	525.91	503.31	510.16
Total revenue ($/ha)	925.47	681.65	755.53
Gross margin ($/ha)	399.56	178.34	245.37
Returns to labor ($/day)	12.67	2.86	4.62

Table 73: Wet season rice farm budget by province

	Province					
	Kampong Cham	**Kandal**	**Takeo**	**Kampot**	**Battambang**	**Bantey Meanchey**
Average cultivated area (ha)	4.17	2.00	1.12	0.88	5	3
Yield (tons/ha)	3.12	3.23	3.08	2.54	3.30	2.65
Inputs ($/ha)						
Seeds	16.25	35.83	28.27	12.53	74.75	30.32
Manure	1.67	7.06	33.62	26.99	23.13	-
Chemical fertilizers	13.47	73.96	91.84	55.21	64.56	60.18
Herbicides	13.58	6.94	1.00	0.16	8.91	6.39
Insecticides	0.77	1.33	2.56	-	0.42	0.46
Subtotal inputs	45.73	125.12	157.29	94.90	171.76	97.35
Labor ($/ha)						
Land preparation	-	-	-	-	-	-
Plantation, transplantation	129.17	115.42	118.40	111.27	5.00	6.58
Weed control	-	13.53	27.29	31.10	3.13	4.72
Crop management	114.17	30.28	80.47	108.45	4.69	70.67
Harvest	-	-	-	17.68	-	6.13
Post-harvest	-	-	11.91	11.14	9.42	18.54
Subtotal labor	243.33	159.22	238.07	279.64	22.23	106.64
Services ($/ha)						
Land preparation	150.00	174.17	98.98	94.25	127.25	86.00
Plantation, transplantation	-	-	-	4.77	-	-
Harvest	-	100.00	23.86	8.86	45.50	34.25
Post-harvest	72.50	44.79	45.48	21.67	-	13.02
Subtotal services	222.50	318.96	168.32	129.55	172.75	133.27
Total variable costs ($/ha)	511.57	603.30	563.68	504.09	366.74	337.26
Total revenue ($/ha)	662.50	991.67	895.75	654.66	734.25	482.40
Gross margin ($/ha)	150.93	388.37	332.07	150.57	367.51	145.14
Returns to labor ($/day)	2.57	10.12	5.79	2.23	68.61	5.65

Table 74: Dry season rice farm budget by technology and farm size

	Level of Technology Use and Farm Size					
	Modern Small	**Traditional Small**	**Modern Medium**	**Traditional Medium**	**Modern Large**	**Traditional Large**
Average cultivated area (ha)	1.00	0.67	2.67	2.04	9.13	3.50
Yield (tons/ha)	5.00	4.64	4.50	4.46	5.19	5.14
Inputs ($/ha)						
Seeds	115.00	107.20	134.29	82.43	119.91	61.71
Manure	-	16.67	-	-	-	-
Chemical fertilizers	228.75	117.38	168.13	102.96	203.59	100.71
Herbicides	20.00	4.91	19.00	2.33	21.18	5.71
Insecticides	7.50	11.14	7.44	13.61	10.99	19.64
Subtotal inputs	371.25	257.30	328.85	201.33	355.66	187.79
Labor ($/ha)						
Land preparation	-	62.50	-	36.50	-	92.50
Plantation, transplantation	12.50	16.55	9.58	14.15	20.97	14.29
Weed control	-	29.84	-	19.00	-	30.00
Crop management	-	27.07	-	24.20	-	38.57
Irrigation	-	-	-	-	-	-
Harvest	-	7.32	-	6.16	-	12.86
Post-harvest	-	93.33	-	119.00	-	125.00
Subtotal labor	12.50	236.61	9.58	219.01	20.97	313.21
Services ($/ha)						
Land preparation	132.50	29.17	129.17	55.00	114.84	-
Plantation, transplantation	-	-	-	-	-	-
Harvest	100.00	98.33	105.83	96.50	105.16	112.50
Post-harvest	20.00	33.19	19.42	35.29	20.56	-
Subtotal services	252.50	160.69	254.42	186.79	240.56	112.50
Cost of irrigation services	150.00	16.67	150.00	-	136.56	-
Total variable costs ($/ha)	786.25	671.27	742.85	607.14	753.76	613.50
Total revenue ($/ha)	1,062.50	983.19	916.67	956.42	1,036.56	1,028.57
Gross margin ($/ha)	276.25	311.92	173.81	349.28	282.81	415.07
Returns to labor ($/day)	90.61	5.40	74.36	6.54	55.30	5.43

Table 75: Dry season rice farm budget by farm size

	Size			
	Small	**Medium**	**Large**	**Total**
Average cultivated area (ha)	0.71	2.28	8.50	4.15
Yield (tons/ha)	4.70	4.48	5.18	4.80
Inputs ($/ha)				
Seeds	108.31	101.88	113.44	108.09
Manure	14.29	-	-	4.17
Chemical fertilizers	133.29	127.40	192.16	153.40
Herbicides	7.07	8.58	19.46	12.22
Insecticides	10.62	11.29	11.95	11.34
Subtotal inputs	273.58	249.15	337.01	289.22
Labor ($/ha)				
Land preparation	53.57	22.81	10.28	27.08
Plantation, transplantation	15.97	12.44	20.22	16.39
Weed control	25.58	11.88	3.33	12.67
Crop management	23.21	15.13	4.29	13.42
Irrigation	-	-	-	-
Harvest	6.27	3.85	1.43	3.65
Post-harvest	80.00	74.38	13.89	53.33
Subtotal labor	204.60	140.48	53.44	126.54
Services ($/ha)				
Land preparation	43.93	82.81	102.08	78.70
Plantation, transplantation	-	-	-	-
Harvest	98.57	100.00	105.97	101.82
Post-harvest	31.31	29.34	18.28	25.77
Subtotal services	173.81	212.15	226.33	206.29
Cost of irrigation services	35.71	56.25	121.39	74.69
Total variable costs ($/ha)	687.70	658.03	738.17	696.74
Total revenue ($/ha)	994.52	941.51	1,035.68	992.28
Gross margin ($/ha)	306.83	283.48	297.50	295.55
Returns to labor ($/day)	6.15	8.27	22.83	9.58

Table 76: Dry season rice farm budget by technology use

	Level of Technology Use		
	Modern	**Traditional**	**Total**
Average cultivated area (ha)	6.83	1.48	4.15
Yield (tons/ha)	5.00	4.61	4.80
Inputs ($/ha)			
Seeds	123.09	93.09	108.09
Manure	-	8.33	4.17
Chemical fertilizers	196.82	109.98	153.40
Herbicides	20.54	3.90	12.22
Insecticides	9.81	12.88	11.34
Subtotal inputs	350.26	228.19	289.22
Labor ($/ha)			
Land preparation	-	54.17	27.08
Plantation, transplantation	17.41	15.36	16.39
Weed control	-	25.34	12.67
Crop management	-	26.83	13.42
Irrigation	-	-	-
Harvest	-	7.30	3.65
Post-harvest	-	106.67	53.33
Subtotal labor	17.41	235.66	126.54
Services ($/ha)			
Land preparation	119.90	37.50	78.70
Plantation, transplantation	-	-	-
Harvest	104.90	98.75	101.82
Post-harvest	20.23	31.30	25.77
Subtotal services	245.02	167.55	206.29
Cost of irrigation services	141.04	8.33	74.69
Total variable costs ($/ha)	753.74	639.73	696.74
Total revenue ($/ha)	1,008.75	975.82	992.28
Gross margin ($/ha)	255.01	336.08	295.55
Returns to labor ($/day)	60.04	5.85	9.58

Table 77: Dry season rice farm budget by province

	Province				
	Bantey Meanchey	**Battambang**	**Kandal**	**Takeo**	**Total**
Average cultivated area (ha)	7.83	5.83	1.25	1.70	4.154
Yield (tons/ha)	4.92	5.08	4.31	4.91	4.81
Inputs ($/ha)					
Seeds	144.02	102.17	111.47	74.71	108.09
Manure	-	-	16.67	-	4.17
Chemical fertilizers	207.68	185.96	96.53	123.43	153.40
Herbicides	16.71	24.37	-	7.81	12.22
Insecticides	8.98	10.64	10.23	15.53	11.34
Subtotal inputs	377.39	323.13	234.90	221.47	289.22
Labor ($/ha)					
Land preparation	-	-	14.58	93.75	27.08
Plantation, transplantation	9.54	25.29	18.46	12.26	16.39
Weed control	-	-	17.22	33.45	12.67
Crop management	-	-	15.93	37.74	13.42
Irrigation	-	-	-	-	-
Harvest	-	-	-	14.59	3.65
Post-harvest	-	-	97.92	115.42	53.33
Subtotal labor	9.54	25.29	164.11	307.21	126.54
Services ($/ha)					
Land preparation	130.83	108.96	75.00	-	78.70
Plantation, transplantation	-	-	-	-	-
Harvest	106.04	103.75	110.42	87.08	101.82
Post-harvest	20.48	19.98	42.19	20.42	25.77
Subtotal services	257.35	232.69	227.60	107.50	206.29
Cost of irrigation services	150.00	132.08	16.67	-	74.69
Total variable costs ($/ha)	794.28	713.19	643.28	636.18	696.74
Total revenue ($/ha)	970.21	1,047.29	931.60	1,020.04	992.28
Gross margin ($/ha)	175.93	334.10	288.31	383.86	295.55
Returns to labor ($/day)	75.65	54.15	7.20	5.12	9.58

Table 78: Cassava farm budget by technology and farm size

	Level of Technology Use and Farm Size					
	Modern Small	**Traditional Small**	**Modern Medium**	**Traditional Medium**	**Modern Large**	**Traditional Large**
Average cultivated area (ha)	3.25	2.50	6.25	6.70	19.50	15.38
Yield (tons/ha)	21.11	19.32	27.85	14.16	19.32	16.27
Inputs ($/ha)						
Seeds	200.63	244.51	317.50	153.17	250.31	235.00
Manure	-	-	-	-	-	-
Chemical fertilizers	18.75	10.49	-	-	16.34	-
Herbicides	75.35	20.27	60.10	17.94	62.61	21.56
Insecticides	-	5.93	-	3.53	-	2.81
Subtotal inputs	294.72	281.20	377.60	174.63	329.26	259.37
Labor ($/ha)						
Land preparation	-	-	-	-	-	-
Plantation, transplantation	12.50	42.99	43.75	35.08	45.49	36.47
Weed control	45.00	37.96	11.79	38.28	45.57	30.39
Crop management	69.44	62.93	5.96	62.68	91.53	83.72
Harvest	-	19.44	146.63	4.25	-	-
Post-harvest	106.50	42.47	172.88	80.36	25.00	42.19
Subtotal labor	233.44	205.79	381.03	220.66	207.59	192.77
Services ($/ha)						
Land preparation	87.50	110.53	118.75	166.16	75.94	136.63
Plantation, transplantation	21.25	10.00	-	10.00	10.63	9.38
Harvest	31.25	51.50	-	41.52	22.34	12.81
Post-harvest	77.78	181.14	-	52.45	229.08	122.25
Subtotal services	217.78	353.17	118.75	270.13	337.99	281.06
Total variable costs ($/ha)	745.94	840.17	877.37	665.42	874.83	733.20
Total revenue ($/ha)	1,519.44	1,333.33	1,665.06	963.15	1,483.81	1,148.67
Gross margin ($/ha)	773.50	493.17	787.69	297.73	608.97	415.48
Returns to labor ($/day)	13.75	9.95	8.58	5.60	12.17	8.94

Table 79: Cassava farm budget by farm size

	Size			
	Small	**Medium**	**Large**	**Total**
Average cultivated area (ha)	2.64	6.57	17.44	8.25
Yield (tons/ha)	19.65	18.07	17.79	18.65
Inputs ($/ha)				
Seeds	236.53	200.12	242.66	228.61
Manure	-	-	-	-
Chemical fertilizers	11.99	-	8.17	7.59
Herbicides	30.29	29.99	42.09	33.84
Insecticides	4.85	2.52	1.41	3.16
Subtotal inputs	283.66	232.62	294.32	273.20
Labor ($/ha)				
Land preparation	-	-	-	-
Plantation, transplantation	37.45	37.56	40.98	38.56
Weed control	39.24	30.72	37.98	36.56
Crop management	64.11	46.48	87.63	66.60
Harvest	15.91	44.93	-	18.83
Post-harvest	54.11	106.80	33.59	61.98
Subtotal labor	210.82	266.48	200.18	222.53
Services ($/ha)				
Land preparation	106.35	152.61	106.28	118.78
Plantation, transplantation	12.05	7.14	10.00	10.10
Harvest	47.82	29.66	17.58	33.62
Post-harvest	162.35	37.46	175.66	132.82
Subtotal services	328.56	226.88	309.52	295.32
Total variable costs ($/ha)	823.03	725.98	804.01	791.05
Total revenue ($/ha)	1,367.17	1,163.69	1,316.24	1,296.72
Gross margin ($/ha)	544.14	437.72	512.23	505.67
Returns to labor ($/day)	10.71	6.82	10.62	9.43

Table 80: Cassava farm budget by technology use

	Level of Technology Use		
	Modern	**Traditional**	**Total**
Average cultivated area (ha)	12.13	6.53	8.25
Yield (tons/ha)	21.90	17.21	18.65
Inputs ($/ha)			
Seeds	254.69	217.03	228.61
Manure	-	-	-
Chemical fertilizers	12.86	5.24	7.59
Herbicides	65.17	19.91	33.84
Insecticides	-	4.57	3.16
Subtotal inputs	332.71	246.75	273.20
Labor ($/ha)			
Land preparation	-	-	-
Plantation, transplantation	36.81	39.34	38.56
Weed control	36.98	36.37	36.56
Crop management	64.62	67.48	66.60
Harvest	36.66	10.90	18.83
Post-harvest	82.35	52.93	61.98
Subtotal labor	257.41	207.03	222.53
Services ($/ha)			
Land preparation	89.53	131.78	118.78
Plantation, transplantation	10.63	9.86	10.10
Harvest	18.98	40.13	33.62
Post-harvest	133.98	132.30	132.82
Subtotal services	253.12	314.08	295.32
Total variable costs ($/ha)	843.25	767.85	791.05
Total revenue ($/ha)	1,538.03	1,189.47	1,296.72
Gross margin ($/ha)	694.79	421.61	505.67
Returns to labor ($/day)	11.20	8.45	9.43

Table 81: Cassava farm budget by province

	Province			
	Bantey Meanchey	**Battambang**	**Kampong Cham**	**Total**
Average cultivated area (ha)	10.67	8.42	6.19	8.25
Yield (tons/ha)	20.30	20.44	17.75	18.65
Inputs ($/ha)				
Seeds	225.45	228.85	230.63	228.61
Manure	-	-	-	-
Chemical fertilizers	-	14.11	3.48	7.59
Herbicides	23.57	33.30	42.34	33.84
Insecticides	2.44	5.10	0.79	3.16
Subtotal inputs	251.46	281.37	277.24	273.20
Labor ($/ha)				
Land preparation	-	-	-	-
Plantation, transplantation	43.13	27.30	52.02	38.56
Weed control	19.72	17.22	78.18	36.56
Crop management	56.67	48.02	101.92	66.60
Harvest	3.54	39.02	-	18.83
Post-harvest	64.15	102.22	-	61.98
Subtotal labor	187.21	233.79	232.13	222.53
Services ($/ha)				
Land preparation	144.48	143.98	61.72	118.78
Plantation, transplantation	-	17.71	6.25	10.10
Harvest	44.45	40.73	14.84	33.62
Post-harvest	163.33	60.04	219.11	132.82
Subtotal services	352.26	262.46	301.92	295.32
Total variable costs ($/ha)	790.93	777.63	811.28	791.05
Total revenue ($/ha)	1,219.56	1,352.28	1,271.24	1,296.72
Gross margin ($/ha)	428.64	574.65	459.96	505.67
Returns to labor ($/day)	9.50	10.20	8.22	9.43

Table 82: Maize farm budget by technology and farm size

	Level of Technology Use and Farm Size					
	Modern Small	**Traditional Small**	**Modern Medium**	**Traditional Medium**	**Modern Large**	**Traditional Large**
Average cultivated area (ha)	0.67	1.00	2.10	2.54	9.75	11.40
Yield (tons/ha)	3.98	2.91	4.15	3.38	5.70	3.77
Inputs ($/ha)						
Seeds	79.17	50.58	88.28	68.20	87.75	76.41
Manure	12.17	-	12.25	0.03	9.66	-
Chemical fertilizers	93.40	10.00	16.76	-	32.94	-
Herbicides	29.88	10.78	16.78	16.37	26.41	14.93
Insecticides	5.12	-	8.06	0.38	8.44	2.16
Subtotal inputs	219.75	71.36	142.13	84.98	165.19	93.49
Labor ($/ha)						
Land preparation	-	-	-	-	-	-
Plantation, transplantation	40.43	34.12	29.90	26.73	13.35	19.98
Weed control	26.35	22.09	16.75	12.92	11.56	15.71
Crop management	71.40	66.24	56.77	65.08	28.21	69.01
Harvest	41.91	6.25	68.82	19.21	3.75	29.81
Post-harvest	4.86	-	0.83	-	-	-
Subtotal labor	184.96	128.70	173.07	123.93	56.88	134.51
Services ($/ha)						
Land preparation	150.90	65.83	112.08	132.05	60.03	94.56
Plantation, transplantation	4.00	-	8.94	6.43	12.82	14.66
Harvest	4.00	-	-	9.46	37.50	-
Post-harvest	52.69	24.23	13.03	35.42	38.61	26.51
Subtotal services	211.59	90.06	134.06	183.36	148.96	135.73
Total variable costs ($/ha)	616.30	290.11	449.26	392.27	371.03	363.73
Total revenue ($/ha)	897.77	408.74	953.31	584.07	893.13	616.83
Gross margin ($/ha)	281.47	118.62	504.06	191.80	522.10	253.10
Returns to labor ($/day)	6.32	3.83	12.09	6.42	38.10	7.81

Table 83: Maize farm budget by farm size

	Size			
	Small	**Medium**	**Large**	**Total**
Average cultivated area (ha)	0.75	2.34	10.93	4.83
Yield (tons/ha)	3.73	3.73	4.32	3.94
Inputs ($/ha)				
Seeds	72.57	77.47	79.65	76.64
Manure	9.36	5.67	2.76	5.85
Chemical fertilizers	74.16	7.74	9.41	29.91
Herbicides	25.48	16.56	18.21	20.03
Insecticides	3.94	3.93	3.95	3.94
Subtotal inputs	185.50	111.36	113.98	136.37
Labor ($/ha)				
Land preparation	-	-	-	-
Plantation, transplantation	38.97	28.19	18.09	28.16
Weed control	25.37	14.68	14.52	18.10
Crop management	70.21	61.25	57.36	62.80
Harvest	33.68	42.11	22.36	32.46
Post-harvest	3.74	0.38	-	1.34
Subtotal labor	171.98	146.61	112.33	142.85
Services ($/ha)				
Land preparation	131.27	122.83	84.70	112.23
Plantation, transplantation	3.08	7.59	14.13	8.41
Harvest	3.08	5.10	10.71	6.41
Post-harvest	46.12	25.09	29.97	33.63
Subtotal services	183.54	160.60	139.51	160.68
Total variable costs ($/ha)	541.03	418.57	365.82	439.90
Total revenue ($/ha)	784.91	754.49	695.77	743.83
Gross margin ($/ha)	243.89	335.92	329.95	303.92
Returns to labor ($/day)	5.89	9.51	12.19	8.83

Table 84: Maize farm budget by technology use

	Level of Technology Use		
	Modern	**Traditional**	**Total**
Average cultivated area (ha)	2.91	6.74	4.83
Yield (tons/ha)	4.38	3.50	3.94
Inputs ($/ha)			
Seeds	83.62	69.66	76.64
Manure	11.69	0.01	5.85
Chemical fertilizers	58.32	1.50	29.91
Herbicides	25.26	14.81	20.03
Insecticides	6.67	1.21	3.94
Subtotal inputs	185.55	87.19	136.37
Labor ($/ha)			
Land preparation	-	-	-
Plantation, transplantation	31.85	24.46	28.16
Weed control	20.51	15.69	18.10
Crop management	58.37	67.22	62.80
Harvest	42.35	22.56	32.46
Post-harvest	2.68	-	1.34
Subtotal labor	155.78	129.93	142.85
Services ($/ha)			
Land preparation	121.08	103.37	112.23
Plantation, transplantation	7.25	9.58	8.41
Harvest	9.50	3.31	6.41
Post-harvest	37.98	29.28	33.63
Subtotal services	175.80	145.55	160.68
Total variable costs ($/ha)	517.13	362.68	439.90
Total revenue ($/ha)	913.50	574.15	743.83
Gross margin ($/ha)	396.37	211.47	303.92
Returns to labor ($/day)	10.56	6.75	8.83

Table 85: Maize farm budget by province

	Province				
	Bantey Meanchey	**Battambang**	**Kampong Cham**	**Kandal**	**Total**
Average cultivated area (ha)	11.08	2.10	3.25	1.12	4.83
Yield (tons/ha)	5.31	2.72	2.56	4.35	3.94
Inputs ($/ha)					
Seeds	91.05	67.08	57.03	84.18	76.64
Manure	1.14	5.00	-	16.29	5.85
Chemical fertilizers	5.48	46.53	-	74.83	29.91
Herbicides	15.44	19.53	18.25	26.48	20.03
Insecticides	7.18	2.94	0.99	3.81	3.94
Subtotal inputs	120.29	141.07	76.28	205.58	136.37
Labor ($/ha)					
Land preparation	-	-	-	-	0
Plantation, transplantation	3.51	36.85	37.73	40.41	28.16
Weed control	7.50	14.50	21.47	27.11	18.10
Crop management	63.97	45.88	61.04	70.29	62.80
Harvest	41.83	25.75	5.86	50.26	32.46
Post-harvest	-	1.00	-	4.05	1.34
Subtotal labor	116.82	123.98	126.10	192.12	142.85
Services ($/ha)					
Land preparation	88.72	75.50	83.59	177.29	112.23
Plantation, transplantation	24.71	-	-	3.33	8.41
Harvest	12.50	-	6.02	3.33	6.41
Post-harvest	30.48	-	31.92	52.37	33.63
Subtotal services	156.40	75.50	121.53	236.33	160.68
Total variable costs ($/ha)	393.51	340.54	323.91	634.03	439.90
Total revenue ($/ha)	838.98	401.50	370.36	1,133.65	743.83
Gross margin ($/ha)	445.47	60.96	46.46	499.62	303.92
Returns to labor ($/day)	15.83	2.04	1.53	10.79	8.83

Table 86: Vegetable (mix) farm budget by technology and farm size

	Level of Technology Use and Farm Size					
	Modern Small	**Traditional Small**	**Modern Medium**	**Traditional Medium**	**Modern Large**	**Traditional Large**
Average cultivated area (ha)	0.12	0.30		0.84	3.00	2.17
Yield (tons/ha)	12.32	6.00		6.00	1.67	8.33
Inputs ($/ha)						
Seeds	238.31	36.15		28.07	243.00	127.97
Manure	260.99	57.28		10.12	20.83	24.57
Chemical fertilizers	315.42	86.92		52.21	108.75	69.58
Herbicides	31.57	1.64		3.65	-	5.56
Insecticides	142.97	27.03		18.01	78.75	16.39
Subtotal inputs	989.26	209.02		112.07	451.33	244.06
Labor ($/ha)						
Land preparation	229.04	100.28		45.93	207.50	164.58
Plantation, transplantation	151.47	67.70		40.78	50.00	44.44
Weed control	151.29	49.47		55.11	50.00	21.11
Crop management	541.73	219.71		68.65	33.33	46.53
Harvest	158.57	31.32		30.42	-	55.56
Post-harvest	-	-		-	-	-
Subtotal labor	1,232.11	468.49		240.89	340.83	332.22
Services ($/ha)						
Land preparation	38.45	41.07		29.42	-	175.56
Plantation, transplantation	-	0.76		5.33	-	-
Harvest	-	4.55		17.06	-	6.67
Post-harvest	32.00	1.50		10.98	-	-
Subtotal services	70.45	47.88		62.79	-	182.22
Total variable costs ($/ha)	2,291.82	725.39		415.74	792.17	758.51
Total revenue ($/ha)	4,530.73	1,336.84		1,163.16	500.00	1,263.89
Gross margin ($/ha)	2,238.92	611.45		747.41	(292.17)	505.38
Returns to labor ($/day)	7.54	5.42		12.88	(3.56)	6.31

Table 87: Vegetable (mix) farm budget by farm size

	Size			
	Small	**Medium**	**Large**	**Total**
Average cultivated area (ha)	0.19	0.84	2.38	0.41
Yield (tons/ha)	9.74	6.00	6.67	9.10
Inputs ($/ha)				
Seeds	155.80	28.07	156.73	140.96
Manure	177.85	10.12	23.63	148.00
Chemical fertilizers	222.15	52.21	79.38	192.81
Herbicides	19.36	3.65	4.17	16.51
Insecticides	95.65	18.01	31.98	82.34
Subtotal inputs	670.80	112.07	295.88	580.62
Labor ($/ha)				
Land preparation	176.49	45.93	175.31	161.18
Plantation, transplantation	117.28	40.78	45.83	103.59
Weed control	109.73	55.11	28.33	97.93
Crop management	410.29	68.65	43.23	345.96
Harvest	106.63	30.42	41.67	93.41
Post-harvest	-	-	-	-
Subtotal labor	920.43	240.89	334.38	802.08
Services ($/ha)				
Land preparation	39.52	29.42	131.67	44.48
Plantation, transplantation	0.31	5.33	-	0.87
Harvest	1.86	17.06	5.00	3.84
Post-harvest	19.55	10.98	-	17.25
Subtotal services	61.24	62.79	136.67	66.45
Total variable costs ($/ha)	1,652.46	415.74	766.92	1,449.14
Total revenue ($/ha)	3,227.10	1,163.16	1,072.92	2,842.70
Gross margin ($/ha)	1,574.64	747.41	305.99	1,393.56
Returns to labor ($/day)	7.10	12.88	3.80	7.21

Table 88: Vegetable (mix) farm budget by technology use

	Level of Technology Use		
	Modern	**Traditional**	**Total**
Average cultivated area (ha)	0.21	0.61	0.41
Yield (tons/ha)	11.96	6.24	9.10
Inputs ($/ha)			
Seeds	238.47	43.45	140.96
Manure	252.99	43.01	148.00
Chemical fertilizers	308.53	77.09	192.81
Herbicides	30.52	2.50	16.51
Insecticides	140.83	23.86	82.34
Subtotal inputs	971.33	189.90	580.62
Labor ($/ha)			
Land preparation	228.33	94.03	161.18
Plantation, transplantation	148.09	59.09	103.59
Weed control	147.91	47.95	97.93
Crop management	524.78	167.14	345.96
Harvest	153.29	33.54	93.41
Post-harvest	-	-	-
Subtotal labor	1,202.40	401.76	802.08
Services ($/ha)			
Land preparation	37.17	51.80	44.48
Plantation, transplantation	-	1.75	0.87
Harvest	-	7.68	3.84
Post-harvest	30.93	3.56	17.25
Subtotal services	68.10	64.79	66.45
Total variable costs ($/ha)	2,241.83	656.45	1,449.14
Total revenue ($/ha)	4,396.37	1,289.02	2,842.70
Gross margin ($/ha)	2,154.55	632.57	1,393.56
Returns to labor ($/day)	7.44	6.53	7.21

Table 89: Vegetable (mix) farm budget by province

	Province					
	Kampong Cham	**Kandal**	**Takeo**	**Kampot**	**Battambang**	**Bantey Meanchey**
Average cultivated area (ha)	0.33	0.18	0.20	0.22	1.833	0.511
Yield (tons/ha)	6.77	9.78	10.67	10.15	6.11	5.89
Inputs ($/ha)						
Seeds	125.50	460.13	153.24	72.87	114.94	30.68
Manure	49.90	234.18	262.81	123.95	20.34	15.25
Chemical fertilizers	176.66	320.41	211.27	217.95	67.42	75.92
Herbicides	70.41	32.06	5.90	13.10	2.78	2.87
Insecticides	25.85	87.70	165.05	43.34	29.65	55.05
Subtotal inputs	448.32	1,134.47	798.28	471.22	235.13	179.76
Labor ($/ha)						
Land preparation	63.65	229.17	179.07	210.66	129.38	20.40
Plantation, transplantation	161.98	283.40	91.07	85.07	43.06	19.07
Weed control	51.55	227.06	104.23	109.35	18.89	41.09
Crop management	219.80	637.71	313.30	485.26	66.32	140.09
Harvest	40.19	105.56	32.83	200.83	40.28	47.10
Post-harvest	-	-	-	-	-	-
Subtotal labor	537.17	1,482.89	720.51	1,091.18	297.92	267.75
Services ($/ha)						
Land preparation	57.29	78.33	17.78	24.31	96.22	86.76
Plantation, transplantation	-	-	-	-	-	8.74
Harvest	-	-	-	-	3.33	35.05
Post-harvest	7.81	125.69	11.32	1.67	-	-
Subtotal services	65.10	204.03	29.10	25.97	99.55	130.55
Total variable costs ($/ha)	1,050.59	2,821.39	1,547.88	1,588.37	632.59	578.06
Total revenue ($/ha)	1,878.19	7,080.85	3,579.70	2,169.37	1,090.28	1,130.44
Gross margin ($/ha)	827.60	4,259.46	2,031.81	581.00	457.68	552.37
Returns to labor ($/day)	6.39	11.92	11.70	2.21	6.38	8.56

Detailed farm budgets by crop

Table 90: Changes in prices of commodities, Thailand and Cambodia

Thailand (Farm gate price $/ton)	**2005 ($/ton)**	**2011 ($/ton)**	**% Change from 2005 to 2011**
Cassava	33.00	87.90	166
Rice	172.20	419.80	144
Maize	118.90	250.20	110
Eggplant	211.00	413.20	96
Cucumber	160.40	367.00	129
Watermelon	138.40	243.60	76
Cambodia (Farm gate price $/ton)	**2005 ($/ton)**	**2013 ($/ton)**	**% Change from 2005 to 2013**
Cassava	19.79	59.38	200
Paddy (wet season)	124.79	237.50	90
Paddy (dry season)	118.50	209.98	77
Maize	140.43	230.39	64
Mustard	N/A	297.50	
Eggplant	125.00	200.00	60
Cucumber	86.16	187.50	118
Watermelon	83.44	277.50	233

Source: Thailand prices from FAOSTAT; Cambodia prices from 2005 and 2013 surveys.

Table 91: Change in the prices of inputs, services, and labor, Cambodia

Operations and Inputs	2005	2013	% Change from 2005 to 2013
Services			
Land preparation (tractor $/ha)	38.21	61.48	61
Land preparation (animal $/ha)	26.96	76.58	184
Combine harvester ($/ha)		95.67	
Fertilizers			
Urea ($/kg)	0.30	0.56	86
DAP ($/kg)	0.35	0.68	96
Seeds			
Paddy (wet season $/kg)	0.17	0.66	293
Paddy (dry season $/kg)	0.18	0.74	323
Cassava ($/kg)	0.02	0.10	542
Maize ($/kg)	0.61	4.06	563
Eggplant ($/kg)	4.75	11.60	144
Cucumber ($/kg)	8.52	18.00	111
Watermelon ($/kg)	10.63	53.91	407
Labor			
Dry season ($/day)	1.20	4.50	275
Wet season ($/day)	1.25	4.56	265
Unskilled labor (garment $/month)	50.00	159.00	218

Source: 2005 and 2013 surveys.

Table 92: Average use of inputs, Cambodia, 2013

	Seeds (kg/ha)	Urea (kg/ha)	DAP (kg/ha)	Herbicides ($/ha)	Insecticides ($/ha)
Cassava		9.5	0.8	33.8	3.16
Maize	22.58	27.91	16.36	20.03	3.94
Wet season rice	60.07	49.49	58.34	3.37	1.11
Dry season rice		111.28	139.12	12.22	11.34
Vegetables		158.2	137.25	20.65	49.28

Source: 2013 survey.

Table 93: Farm budget indicators by crop, farm size, and technology use, Cambodia, 2013

	Farm Size			Level of Technology Use		
Labor Use ($/ha)	**Small**	**Medium**	**Large**	**Modern**	**Traditional**	**Overall**
Cassava	211	284	200	257	214	227
Maize	212	183	131	200	147	174
Wet season rice	288	232	121	131	259	220
Dry season rice	125	66	40	17	129	73
Vegetables	921	241	334	1,190	415	802
Services ($/ha)						
Cassava	329	209	310	253	307	290
Maize	144	125	121	129	130	130
Wet season rice	135	160	234	233	144	171
Dry season rice	174	212	226	245	168	206
Vegetables	61	63	137	77	56	66
Returns to Labor ($/day)						
Cassava	10.71	6.82	10.62	11.20	8.45	9.43
Maize	5.89	9.51	12.19	10.56	6.75	8.83
Wet season rice	2.99	4.83	8.20	12.67	2.86	4.62
Dry season rice	6.15	8.27	22.83	60.04	5.85	9.58
Vegetables	7.10	12.88	3.80	7.44	6.53	7.21

Source: 2013 survey.

ANNEX 4: PROJECTION OF SELECTED ECONOMIC INDICATORS, CAMBODIA

	Indicator	Unit	Future Growth Rate	2012 (Baseline)	2015 (Short term)	2020 (Medium term)	2030 (Long term)	Comments
1	GDP	$ billion	7.2%	14.17	17.46	24.71	49.53	Baseline data is from the World Bank 2014c. The assumption of future growth is from the Cambodia Vision 2030.
2	Ag GDP	$ billion	5.0%	4.75	5.50	7.00	11.40	Baseline data is from the World Bank 2014c. Future growth is assumed to be slightly below the past rate (2004-2012).
3	Share of agriculture in GDP	%	-2.1%	34	31	28	23	Indicator #2 divided by Indicator #1
4	Agribusiness GDP	$ billion	9.7%	1.30	1.72	2.73	6.89	Baseline data is from the World Bank 2014c. The assumption of future growth is based on the target to double the ratio of agribusiness GDP to agricultural GDP.
5	Population	Million	1.1%	14.4	14.9	15.7	17.5	Baseline data is from the NIS Social Economic Surveys. The assumption of future growth is from the Cambodia Vision 2030.
6	GDP per capita	$	6.1%	986	1,180	1,600	2,900	Indicator #1 divided by Indicator #5
7	Urban population	Million	5.1%	3.1	3.6	4.7	7.7	Baseline data is from the NIS Social Economic Surveys. The assumption of future growth is from the UN population projections.
8	Rural population	Million	-0.8%	11.2	11.2	11.0	9.8	Baseline data is from the NIS Social Economic Surveys. The assumption of future growth is from the UN population projections.
9	Urbanization	%	4.0%	28	31	38	56	The assumption of future growth is from the Cambodia Vision 2030.
10	Total labor force	Million	1.26%	7.7	8.0	8.5	9.7	Baseline data is from the NIS Social Economic Surveys. The assumption of future growth is from the UN population projections.
11	Agricultural labor force	Million	-1.4%	3.9	3.8	3.5	3.0	Baseline data is from the NIS Social Economic Surveys. The assumption of future growth is from the UN population projections.

12	Labor share in agriculture	%	-2.7%	51	47	41	31	Indicator #11 divided by Indicator #10
13	GDP/labor	$/capita	5.9%	1,840	2,190	2,920	5,200	Indicator #1 divided by Indicator #10
14	Ag GDP/Ag labor	$/capita	6.4%	1,210	1,460	2,000	3,700	Indicator #2 divided by Indicator #11
15	Non-Ag GDP/Non-Ag labor	$/capita	4.2%	2,500	2,800	3,500	5,780	(Indicator #1-Indicator #2)/ (Indicator #10-Indicator #11) divided by Indicator #2/Indicator #11.

ANNEX 5: RESULTS OF POLICY SIMULATIONS

Table 94: Results of simulations on land use (baseline)

Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated Areas (Ha)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
Maize	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442
Wet Season Rice	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
Total 5 products	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Rice	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PRODUCTION (tons)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970
Maize	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841
Wet Season Rice	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164
Dry Season Rice	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232
Vegetables	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811
Total Rice	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GROSS MARGINS (Million $)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82
Maize	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48
Wet Season Rice	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70
Dry Season Rice	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43
Vegetables	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47
Total 5 products	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Rice	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**
Share of Rice	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**

Table 95: Results of simulations on land use (scenario L1)

Scenario L1	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated Areas (Ha)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
Maize	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442
Wet Season Rice	2,484,832	2,500,983	2,517,240	2,533,602	2,550,070	2,566,646	2,583,329	2,600,121	2,617,021	2,634,032	2,651,153	2,668,386	2,685,730	2,703,187	2,720,758	2,738,443	2,756,243	2,774,159
Dry Season Rice	495,465	503,888	512,454	521,166	530,026	539,036	548,200	557,519	566,997	576,636	586,439	596,408	606,547	616,858	627,345	638,010	648,856	659,886
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
	3,587,694	**3,612,268**	**3,637,091**	**3,662,165**	**3,687,493**	**3,713,079**	**3,738,926**	**3,765,037**	**3,791,415**	**3,818,065**	**3,844,989**	**3,872,191**	**3,899,674**	**3,927,443**	**3,955,500**	**3,983,850**	**4,012,496**	**4,041,442**
	-	0.7%	1.4%	2.1%	2.8%	3.5%	4.2%	4.9%	5.7%	6.4%	7.2%	7.9%	8.7%	9.5%	10.3%	11.0%	11.8%	12.6%
Total Rice	**2,980,297**	**3,004,871**	**3,029,694**	**3,054,768**	**3,080,096**	**3,105,682**	**3,131,529**	**3,157,640**	**3,184,018**	**3,210,668**	**3,237,592**	**3,264,794**	**3,292,277**	**3,320,046**	**3,348,103**	**3,376,453**	**3,405,099**	**3,434,045**
		0.8%	1.7%	2.5%	3.3%	4.2%	5.1%	6.0%	6.8%	7.7%	8.6%	9.5%	10.5%	11.4%	12.3%	13.3%	14.3%	15.2%
PRODUCTION (tons)	0	1	2	3	4	5	6	7	8	9								
Cassava	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970	6,299,970
Maize	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841
Wet Season Rice	7,181,164	7,227,842	7,274,823	7,322,109	7,369,703	7,417,606	7,465,821	7,514,348	7,563,192	7,612,352	7,661,833	7,711,635	7,761,760	7,812,212	7,862,991	7,914,101	7,965,542	8,017,318
Dry Season Rice	2,378,232	2,418,662	2,459,779	2,501,595	2,544,123	2,587,373	2,631,358	2,676,091	2,721,585	2,767,852	2,814,905	2,862,758	2,911,425	2,960,920	3,011,255	3,062,447	3,114,508	3,167,455
Vegetables	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811
Total Rice	**9,559,396**	**9,646,504**	**9,734,602**	**9,823,705**	**9,913,826**	**10,004,979**	**10,097,179**	**10,190,439**	**10,284,776**	**10,380,204**	**10,476,738**	**10,574,393**	**10,673,186**	**10,773,131**	**10,874,246**	**10,976,547**	**11,080,050**	**11,184,773**
	-	0.9%	1.8%	2.8%	3.7%	4.7%	5.6%	6.6%	7.6%	8.6%	9.6%	10.6%	11.7%	12.7%	13.8%	14.8%	15.9%	17.0%
GROSS MARGINS (Million $)	0	1	2	3	4	5	6	7	8	9								
Cassava	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82
Maize	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48
Wet Season Rice	609.70	613.67	617.66	621.67	625.71	629.78	633.87	637.99	642.14	646.31	650.51	654.74	659.00	663.28	667.59	671.93	676.30	680.70
Dry Season Rice	146.43	148.92	151.45	154.03	156.64	159.31	162.01	164.77	167.57	170.42	173.32	176.26	179.26	182.31	185.41	188.56	191.76	195.02
Vegetables	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47
Total 5 Products	**1,067.90**	**1,074.35**	**1,080.87**	**1,087.46**	**1,094.12**	**1,100.85**	**1,107.65**	**1,114.52**	**1,121.47**	**1,128.49**	**1,135.59**	**1,142.77**	**1,150.02**	**1,157.35**	**1,164.76**	**1,172.25**	**1,179.82**	**1,187.48**
	-	0.6%	1.2%	1.8%	2.5%	3.1%	3.7%	4.4%	5.0%	5.7%	6.3%	7.0%	7.7%	8.4%	9.1%	9.8%	10.5%	11.2%
Total Rice	**756.13**	**762.59**	**769.11**	**775.70**	**782.35**	**789.08**	**795.89**	**802.76**	**809.71**	**816.73**	**823.83**	**831.00**	**838.26**	**845.59**	**853.00**	**860.49**	**868.06**	**875.72**
	-	0.9%	1.7%	2.6%	3.5%	4.4%	5.3%	6.2%	7.1%	8.0%	9.0%	9.9%	10.9%	11.8%	12.8%	13.8%	14.8%	15.8%
Share of Rice	**0.71**	**0.71**	**0.71**	**0.71**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.73**	**0.73**	**0.73**	**0.73**	**0.73**	**0.73**	**0.74**	**0.74**

Table 96: Results of simulations on land use (scenario L2)

Scenario L2	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated Areas (Ha)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	337,800	348,981	360,532	372,466	384,795	397,531	410,690	424,284	438,327	452,836	467,825	483,310	499,307	515,834	532,909	550,548	568,771	587,597
Maize	215,442	217,532	219,642	221,772	223,924	226,096	228,289	230,503	232,739	234,997	237,276	239,578	241,902	244,248	246,617	249,009	251,425	253,864
Wet Season Rice	2,484,832	2,491,293	2,497,770	2,504,264	2,510,775	2,517,303	2,523,848	2,530,410	2,536,989	2,543,585	2,550,199	2,556,829	2,563,477	2,570,142	2,576,824	2,583,524	2,590,241	2,596,976
Dry Season Rice	495,465	498,834	502,226	505,641	509,080	512,541	516,027	519,536	523,069	526,625	530,207	533,812	537,442	541,096	544,776	548,480	552,210	555,965
Vegetables	54,155	54,577	55,003	55,432	55,865	56,300	56,739	57,182	57,628	58,077	58,530	58,987	59,447	59,911	60,378	60,849	61,324	61,802
Total 5 Products	**3,587,694**	**3,611,217**	**3,635,174**	**3,659,576**	**3,684,438**	**3,709,772**	**3,735,593**	**3,761,915**	**3,788,752**	**3,816,121**	**3,844,037**	**3,872,516**	**3,901,575**	**3,931,232**	**3,961,504**	**3,992,411**	**4,023,971**	**4,056,204**
	-	0.7%	1.3%	2.0%	2.7%	3.4%	4.1%	4.9%	5.6%	6.4%	7.1%	7.9%	8.7%	9.6%	10.4%	11.3%	12.2%	13.1%
Total Rice	**2,980,297**	**2,990,127**	**2,999,996**	**3,009,905**	**3,019,855**	**3,029,845**	**3,039,875**	**3,049,946**	**3,060,058**	**3,070,211**	**3,080,405**	**3,090,641**	**3,100,919**	**3,111,239**	**3,121,600**	**3,132,005**	**3,142,451**	**3,152,941**
		0.3%	0.7%	1.0%	1.3%	1.7%	2.0%	2.3%	2.7%	3.0%	3.4%	3.7%	4.0%	4.4%	4.7%	5.1%	5.4%	5.8%
PRODUCTION (tons)	0	1	2	3	4	5	6	7	8	9								
Cassava	6,299,970	6,508,499	6,723,930	6,946,492	7,176,421	7,413,961	7,659,363	7,912,888	8,174,804	8,445,390	8,724,933	9,013,728	9,312,083	9,620,313	9,938,745	10,267,717	10,607,579	10,958,690
Maize	848,841	857,075	865,389	873,783	882,259	890,817	899,458	908,182	916,992	925,887	934,868	943,936	953,092	962,337	971,672	981,097	990,614	1,000,223
Wet Season Rice	7,181,164	7,199,836	7,218,555	7,237,323	7,256,140	7,275,006	7,293,921	7,312,886	7,331,899	7,350,962	7,370,074	7,389,237	7,408,449	7,427,711	7,447,023	7,466,385	7,485,798	7,505,261
Dry Season Rice	2,378,232	2,394,404	2,410,686	2,427,079	2,443,583	2,460,199	2,476,928	2,493,772	2,510,729	2,527,802	2,544,991	2,562,297	2,579,721	2,597,263	2,614,924	2,632,706	2,650,608	2,668,632
Vegetables	492,811	496,654	500,528	504,432	508,367	512,332	516,328	520,356	524,415	528,505	532,627	536,782	540,969	545,188	549,441	553,726	558,046	562,398
Total Rice	**9,559,396**	**9,594,239**	**9,629,241**	**9,664,402**	**9,699,723**	**9,735,205**	**9,770,850**	**9,806,657**	**9,842,628**	**9,878,764**	**9,915,066**	**9,951,534**	**9,988,169**	**10,024,974**	**10,061,947**	**10,099,091**	**10,136,406**	**10,173,893**
	-	0.4%	0.7%	1.1%	1.5%	1.8%	2.2%	2.6%	3.0%	3.3%	3.7%	4.1%	4.5%	4.9%	5.3%	5.6%	6.0%	6.4%
GROSS MARGINS (Million $)	0	1	2	3	4	5	6	7	8	9								
Cassava	170.82	176.47	182.31	188.34	194.58	201.02	207.67	214.55	221.65	228.99	236.56	244.40	252.48	260.84	269.48	278.40	287.61	297.13
Maize	65.48	66.11	66.76	67.40	68.06	68.72	69.38	70.06	70.74	71.42	72.12	72.81	73.52	74.23	74.95	75.68	76.42	77.16
Wet Season Rice	609.70	611.29	612.88	614.47	616.07	617.67	619.28	620.89	622.50	624.12	625.74	627.37	629.00	630.64	632.28	633.92	635.57	637.22
Dry Season Rice	146.43	147.43	148.43	149.44	150.45	151.48	152.51	153.54	154.59	155.64	156.70	157.76	158.84	159.92	161.00	162.10	163.20	164.31
Vegetables	75.47	76.06	76.65	77.25	77.85	78.46	79.07	79.69	80.31	80.93	81.57	82.20	82.84	83.49	84.14	84.80	85.46	86.12
Total 5 Products	**1,067.90**	**1,077.35**	**1,087.02**	**1,096.90**	**1,107.01**	**1,117.34**	**1,127.91**	**1,138.72**	**1,149.78**	**1,161.10**	**1,172.68**	**1,184.54**	**1,196.68**	**1,209.12**	**1,221.85**	**1,234.89**	**1,248.25**	**1,261.94**
	-	0.9%	1.8%	2.7%	3.7%	4.6%	5.6%	6.6%	7.7%	8.7%	9.8%	10.9%	12.1%	13.2%	14.4%	15.6%	16.9%	18.2%
Total Rice	**756.13**	**758.71**	**761.31**	**763.91**	**766.52**	**769.15**	**771.78**	**774.43**	**777.09**	**779.76**	**782.44**	**785.13**	**787.84**	**790.55**	**793.28**	**796.02**	**798.77**	**801.53**
	-	0.3%	0.7%	1.0%	1.4%	1.7%	2.1%	2.4%	2.8%	3.1%	3.5%	3.8%	4.2%	4.6%	4.9%	5.3%	5.6%	6.0%
Share of Rice	**0.71**	**0.70**	**0.70**	**0.70**	**0.69**	**0.69**	**0.68**	**0.68**	**0.68**	**0.67**	**0.67**	**0.66**	**0.66**	**0.65**	**0.65**	**0.64**	**0.64**	**0.64**

Table 97: Results of simulations on land use (scenario L3)

Scenario L3	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cassava	0	1	2	3	4	5	6	7	8	9								
Cassava	337,800	353,454	369,833	386,971	404,903	423,666	443,299	463,841	485,336	507,826	531,359	555,982	581,746	608,704	636,912	666,426	697,308	729,622
Maize	215,442	218,368	221,333	224,339	227,385	230,473	233,603	236,775	239,991	243,250	246,553	249,901	253,295	256,735	260,221	263,755	267,337	270,967
Wet Season Rice	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
Vegetables	54,155	54,746	55,344	55,949	56,560	57,177	57,802	58,433	59,071	59,716	60,368	61,027	61,694	62,367	63,048	63,737	64,433	65,136
Total 5 Products	**3,587,694**	**3,606,865**	**3,626,807**	**3,647,555**	**3,669,145**	**3,691,614**	**3,715,000**	**3,739,346**	**3,764,694**	**3,791,089**	**3,818,577**	**3,847,208**	**3,877,032**	**3,908,103**	**3,940,478**	**3,974,215**	**4,009,375**	**4,046,022**
	-	0.5%	1.1%	1.7%	2.3%	2.9%	3.5%	4.2%	4.9%	5.7%	6.4%	7.2%	8.1%	8.9%	9.8%	10.8%	11.8%	12.8%
PRODUCTION (tons)	0	1	2	3	4	5	6	7	8	9								
Cassava	6,299,970	6,591,911	6,897,380	7,217,004	7,551,440	7,901,374	8,267,524	8,650,641	9,051,511	9,470,959	9,909,843	10,369,065	10,849,567	11,352,336	11,878,404	12,428,849	13,004,802	13,607,444
Maize	848,841	860,369	872,053	883,895	895,898	908,065	920,396	932,895	945,564	958,405	971,420	984,612	997,983	1,011,535	1,025,272	1,039,195	1,053,307	1,067,611
Wet Season Rice	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164
Dry Season Rice	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232
Vegetables	492,811	498,192	503,632	509,132	514,692	520,312	525,994	531,738	537,544	543,414	549,348	555,347	561,412	567,542	573,740	580,005	586,339	592,742
Total Rice	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GROSS MARGINS (Million $)	0	1	2	3	4	5	6	7	8	9								
Cassava	170.82	178.73	187.01	195.68	204.75	214.24	224.16	234.55	245.42	256.79	268.69	281.14	294.17	307.80	322.07	336.99	352.61	368.95
Maize	65.48	66.37	67.27	68.18	69.11	70.05	71.00	71.96	72.94	73.93	74.93	75.95	76.98	78.03	79.09	80.16	81.25	82.36
Wet Season Rice	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70
Dry Season Rice	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43
Vegetables	75.47	76.29	77.12	77.97	78.82	79.68	80.55	81.43	82.32	83.22	84.13	85.04	85.97	86.91	87.86	88.82	89.79	90.77
Total 5 Products	**1,067.90**	**1,077.52**	**1,087.54**	**1,097.96**	**1,108.81**	**1,120.10**	**1,131.84**	**1,144.08**	**1,156.81**	**1,170.07**	**1,183.89**	**1,198.27**	**1,213.26**	**1,228.88**	**1,245.15**	**1,262.11**	**1,279.78**	**1,298.21**
	-	0.9%	1.8%	2.8%	3.8%	4.9%	6.0%	7.1%	8.3%	9.6%	10.9%	12.2%	13.6%	15.1%	16.6%	18.2%	19.8%	21.6%
Total Rice	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Share of Rice	**0.71**	**0.70**	**0.70**	**0.69**	**0.68**	**0.68**	**0.67**	**0.66**	**0.65**	**0.65**	**0.64**	**0.63**	**0.62**	**0.62**	**0.61**	**0.60**	**0.59**	**0.58**

Table 98: Results of simulations on land use (scenario L4)

Scenario L4	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cassava	0	1	2	3	4	5	6	7	8	9								
Cassava	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
Maize	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442
Wet Season Rice	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
Total 5 Products	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PRODUCTION (tons)	0	1	2	3	4	5	6	7	8	9								
Cassava	6,299,970	6,161,873	6,026,803	5,894,694	5,765,481	5,639,100	5,515,490	5,394,589	5,276,338	5,160,679	5,047,556	4,936,912	4,828,694	4,722,848	4,619,322	4,518,065	4,419,028	4,322,161
Maize	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841	848,841
Wet Season Rice	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164
Dry Season Rice	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232
Vegetables	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811
Total Rice	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GROSS MARGINS (Million $)	0	1	2	3	4	5	6	7	8	9								
Cassava	170.82	167.07	163.41	159.83	156.32	152.90	149.55	146.27	143.06	139.92	136.86	133.86	130.92	128.05	125.25	122.50	119.82	117.19
Maize	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48
Wet Season Rice	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70
Dry Season Rice	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43
Vegetables	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47
Total 5 Products	**1,067.90**	**1,064.15**	**1,060.49**	**1,056.91**	**1,053.40**	**1,049.98**	**1,046.63**	**1,043.35**	**1,040.14**	**1,037.00**	**1,033.94**	**1,030.94**	**1,028.00**	**1,025.13**	**1,022.33**	**1,019.58**	**1,016.90**	**1,014.27**
	-	-0.4%	-0.7%	-1.0%	-1.4%	-1.7%	-2.0%	-2.3%	-2.6%	-2.9%	-3.2%	-3.5%	-3.7%	-4.0%	-4.3%	-4.5%	-4.8%	-5.0%
Total Rice	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Share of Rice	**0.71**	**0.71**	**0.71**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.73**	**0.73**	**0.73**	**0.73**	**0.74**	**0.74**	**0.74**	**0.74**	**0.74**	**0.75**
Cassava yield with L4	**18.65**	**18.24**	**17.84**	**17.45**	**17.07**	**16.69**	**16.33**	**15.97**	**15.62**	**15.28**	**14.94**	**14.61**	**14.29**	**13.98**	**13.67**	**13.37**	**13.08**	**12.80**
		-2%	-4%	-6%	-8%	-10%	-12%	-14%	-16%	-18%	-20%	-22%	-23%	-25%	-27%	-28%	-30%	-31%

Table 99: Results of simulations on land use (scenario L5)

Scenario L5	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cassava	0	1	2	3	4	5	6	7	8	9								
Cassava	337,800	329,693	321,780	314,057	306,520	299,164	291,984	284,976	278,137	271,461	264,946	258,588	252,381	246,324	240,413	234,643	229,011	223,515
Maize	215,442	210,271	205,225	200,299	195,492	190,800	186,221	181,752	177,390	173,133	168,977	164,922	160,964	157,101	153,330	149,650	146,059	142,553
Wet Season Rice	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
Total 5 Products	**3,587,694**	**3,574,416**	**3,561,457**	**3,548,809**	**3,536,464**	**3,524,416**	**3,512,657**	**3,501,180**	**3,489,979**	**3,479,046**	**3,468,376**	**3,457,961**	**3,447,797**	**3,437,877**	**3,428,195**	**3,418,745**	**3,409,522**	**3,400,520**
	-	-0.4%	-0.7%	-1.1%	-1.4%	-1.8%	-2.1%	-2.4%	-2.7%	-3.0%	-3.3%	-3.6%	-3.9%	-4.2%	-4.4%	-4.7%	-5.0%	-5.2%
PRODUCTION (tons)	0	1	2	3	4	5	6	7	8	9								
Cassava	6,299,970	6,148,771	6,001,200	5,857,171	5,716,599	5,579,401	5,445,495	5,314,803	5,187,248	5,062,754	4,941,248	4,822,658	4,706,914	4,593,948	4,483,694	4,376,085	4,271,059	4,168,554
Maize	848,841	828,469	808,586	789,180	770,240	751,754	733,712	716,103	698,916	682,142	665,771	649,792	634,197	618,977	604,121	589,622	575,471	561,660
Wet Season Rice	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164
Dry Season Rice	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232
Vegetables	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811
Total Rice	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GROSS MARGINS (Million $)	0	1	2	3	4	5	6	7	8	9								
Cassava	170.82	166.72	162.71	158.81	155.00	151.28	147.65	144.10	140.65	137.27	133.98	130.76	127.62	124.56	121.57	118.65	115.80	113.02
Maize	65.48	63.91	62.37	60.88	59.42	57.99	56.60	55.24	53.91	52.62	51.36	50.12	48.92	47.75	46.60	45.48	44.39	43.33
Wet Season Rice	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70
Dry Season Rice	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43
Vegetables	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47
Total 5 Products	**1,067.90**	**1,062.22**	**1,056.69**	**1,051.29**	**1,046.01**	**1,040.87**	**1,035.85**	**1,030.94**	**1,026.16**	**1,021.49**	**1,016.93**	**1,012.49**	**1,008.14**	**1,003.91**	**999.77**	**995.74**	**991.80**	**987.95**
	-	-0.5%	-1.0%	-1.6%	-2.0%	-2.5%	-3.0%	-3.5%	-3.9%	-4.3%	-4.8%	-5.2%	-5.6%	-6.0%	-6.4%	-6.8%	-7.1%	-7.5%
Total Rice	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Share of Rice	**0.71**	**0.71**	**0.72**	**0.72**	**0.72**	**0.73**	**0.73**	**0.73**	**0.74**	**0.74**	**0.74**	**0.75**	**0.75**	**0.75**	**0.76**	**0.76**	**0.76**	**0.77**
Cassava yield with L5	**18.65**	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65
Maize Yield with L5	**3.94**	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94	3.94

Table 100: Results of simulations on land use (scenario L6)

Scenario L6	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cassava	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	337,800	329,693	321,780	314,057	306,520	299,164	291,984	284,976	278,137	271,461	264,946	258,588	252,381	246,324	240,413	234,643	229,011	223,515
Maize	215,442	210,271	205,225	200,299	195,492	190,800	186,221	181,752	177,390	173,133	168,977	164,922	160,964	157,101	153,330	149,650	146,059	142,553
Wet Season Rice	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
Total 5 Products	**3,587,694**	**3,574,416**	**3,561,457**	**3,548,809**	**3,536,464**	**3,524,416**	**3,512,657**	**3,501,180**	**3,489,979**	**3,479,046**	**3,468,376**	**3,457,961**	**3,447,797**	**3,437,877**	**3,428,195**	**3,418,745**	**3,409,522**	**3,400,520**
	-	-0.4%	-0.7%	-1.1%	-1.4%	-1.8%	-2.1%	-2.4%	-2.7%	-3.0%	-3.3%	-3.6%	-3.9%	-4.2%	-4.4%	-4.7%	-5.0%	-5.2%
PRODUCTION (tons)	0	1	2	3	4	5	6	7	8	9								
Cassava	6,299,970	6,296,341	6,292,715	6,289,090	6,285,467	6,281,847	6,278,229	6,274,612	6,270,998	6,267,386	6,263,776	6,260,168	6,256,562	6,252,959	6,249,357	6,245,757	6,242,160	6,238,564
Maize	848,841	848,353	847,864	847,376	846,887	846,400	845,912	845,425	844,938	844,451	843,965	843,479	842,993	842,507	842,022	841,537	841,052	840,568
Wet Season Rice	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164	7,181,164
Dry Season Rice	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232	2,378,232
Vegetables	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811	492,811
Total Rice	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**	**9,559,396**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GROSS MARGINS (Million $)	0	1	2	3	4	5	6	7	8	9								
Cassava	170.82	170.72	170.62	170.52	170.42	170.32	170.23	170.13	170.03	169.93	169.83	169.74	169.64	169.54	169.44	169.35	169.25	169.15
Maize	65.48	65.44	65.40	65.37	65.33	65.29	65.25	65.22	65.18	65.14	65.10	65.07	65.03	64.99	64.95	64.92	64.88	64.84
Wet Season Rice	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70
Dry Season Rice	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43
Vegetables	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47
Total 5 Products	**1,067.90**	**1,067.76**	**1,067.62**	**1,067.49**	**1,067.35**	**1,067.22**	**1,067.08**	**1,066.94**	**1,066.81**	**1,066.67**	**1,066.54**	**1,066.40**	**1,066.27**	**1,066.13**	**1,066.00**	**1,065.86**	**1,065.73**	**1,065.59**
	-	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Total Rice	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**	**756.13**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Share of Rice	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**
Cassava yield with L6	**18.65**	19.10	19.56	20.03	20.51	21.00	21.50	22.02	22.55	23.09	23.64	24.21	24.79	25.39	25.99	26.62	27.26	27.91
		2%	5%	7%	10%	13%	15%	18%	21%	24%	27%	30%	33%	36%	39%	43%	46%	50%
Maize Yield with L6	**3.94**	4.03	4.13	4.23	4.33	4.44	4.54	4.65	4.76	4.88	4.99	5.11	5.24	5.36	5.49	5.62	5.76	5.90
		2%	5%	7%	10%	13%	15%	18%	21%	24%	27%	30%	33%	36%	39%	43%	46%	50%

Table 101: Demand for labor for environmental sustainability scenarios

DEMAND FOR LABOR (Million DAYS)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario L1																		
Cassava	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48
Maize	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75
Wet Season Rice	120.00	120.78	121.56	122.35	123.15	123.95	124.75	125.56	126.38	127.20	128.03	128.86	129.70	130.54	131.39	132.24	133.10	133.97
Dry Season Rice	13.75	13.98	14.22	14.46	14.71	14.96	15.21	15.47	15.73	16.00	16.27	16.55	16.83	17.12	17.41	17.70	18.01	18.31
Vegetables	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53
	166.51	**167.52**	**168.54**	**169.57**	**170.61**	**171.67**	**172.73**	**173.79**	**174.87**	**175.96**	**177.06**	**178.17**	**179.29**	**180.42**	**181.56**	**182.71**	**183.87**	**185.04**
	-	0.6%	1.2%	1.8%	2.5%	3.1%	3.7%	4.4%	5.0%	5.7%	6.3%	7.0%	7.7%	8.4%	9.0%	9.7%	10.4%	11.1%
Scenario L2																		
Cassava	16.48	17.03	17.59	18.18	18.78	19.40	20.04	20.71	21.39	22.10	22.83	23.59	24.37	25.17	26.01	26.87	27.76	28.68
Maize	6.75	6.81	6.88	6.95	7.01	7.08	7.15	7.22	7.29	7.36	7.43	7.51	7.58	7.65	7.73	7.80	7.88	7.95
Wet Season Rice	120.00	120.31	120.62	120.94	121.25	121.56	121.88	122.20	122.52	122.83	123.15	123.47	123.79	124.12	124.44	124.76	125.09	125.41
Dry Season Rice	13.75	13.84	13.94	14.03	14.13	14.22	14.32	14.42	14.52	14.61	14.71	14.81	14.91	15.02	15.12	15.22	15.32	15.43
Vegetables	9.53	9.60	9.67	9.75	9.83	9.90	9.98	10.06	10.14	10.22	10.30	10.38	10.46	10.54	10.62	10.70	10.79	10.87
	166.51	**167.60**	**168.71**	**169.84**	**171.00**	**172.17**	**173.37**	**174.60**	**175.85**	**177.12**	**178.42**	**179.75**	**181.11**	**182.49**	**183.91**	**185.35**	**186.83**	**188.34**
	-	0.7%	1.3%	2.0%	2.7%	3.4%	4.1%	4.9%	5.6%	6.4%	7.2%	8.0%	8.8%	9.6%	10.5%	11.3%	12.2%	13.1%
Scenario L3																		
Cassava	16.48	17.25	18.05	18.88	19.76	20.68	21.63	22.64	23.68	24.78	25.93	27.13	28.39	29.71	31.08	32.52	34.03	35.61
Maize	6.75	6.84	6.93	7.03	7.12	7.22	7.32	7.42	7.52	7.62	7.72	7.83	7.93	8.04	8.15	8.26	8.37	8.49
Wet Season Rice	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00
Dry Season Rice	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75
Vegetables	9.53	9.63	9.73	9.84	9.95	10.06	10.17	10.28	10.39	10.50	10.62	10.73	10.85	10.97	11.09	11.21	11.33	11.46
	166.51	**167.46**	**168.46**	**169.50**	**170.58**	**171.70**	**172.86**	**174.08**	**175.34**	**176.65**	**178.02**	**179.44**	**180.92**	**182.46**	**184.07**	**185.74**	**187.48**	**189.30**
	-	0.6%	1.2%	1.8%	2.4%	3.1%	3.8%	4.5%	5.3%	6.1%	6.9%	7.8%	8.7%	9.6%	10.5%	11.6%	12.6%	13.7%
Scenario L4																		
Cassava	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48
Maize	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75
Wet Season Rice	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00
Dry Season Rice	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75
Vegetables	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53
	166.51	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Scenario L5																		
Cassava	16.48	16.09	15.70	15.33	14.96	14.60	14.25	13.91	13.57	13.25	12.93	12.62	12.32	12.02	11.73	11.45	11.18	10.91
Maize	6.75	6.59	6.43	6.27	6.12	5.98	5.83	5.69	5.56	5.42	5.29	5.17	5.04	4.92	4.80	4.69	4.58	4.47
Wet Season Rice	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00
Dry Season Rice	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75
Vegetables	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53
	166.51	**165.95**	**165.40**	**164.87**	**164.35**	**163.85**	**163.35**	**162.87**	**162.40**	**161.94**	**161.49**	**161.06**	**160.63**	**160.21**	**159.81**	**159.41**	**159.02**	**158.64**
	-	-0.3%	-0.7%	-1.0%	-1.3%	-1.6%	-1.9%	-2.2%	-2.5%	-2.7%	-3.0%	-3.3%	-3.5%	-3.8%	-4.0%	-4.3%	-4.5%	-4.7%
Scenario L6																		
Cassava	16.48	16.09	15.70	15.33	14.96	14.60	14.25	13.91	13.57	13.25	12.93	12.62	12.32	12.02	11.73	11.45	11.18	10.91
Maize	6.75	6.59	6.43	6.27	6.12	5.98	5.83	5.69	5.56	5.42	5.29	5.17	5.04	4.92	4.80	4.69	4.58	4.47
Wet Season Rice	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00
Dry Season Rice	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75
Vegetables	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53
	166.51	**165.95**	**165.40**	**164.87**	**164.35**	**163.85**	**163.35**	**162.87**	**162.40**	**161.94**	**161.49**	**161.06**	**160.63**	**160.21**	**159.81**	**159.41**	**159.02**	**158.64**
	-	-0.3%	-0.7%	-1.0%	-1.3%	-1.6%	-1.9%	-2.2%	-2.5%	-2.7%	-3.0%	-3.3%	-3.5%	-3.8%	-4.0%	-4.3%	-4.5%	-4.7%

Table 102: Demand for fertilizers for environmental sustainability scenarios

DEMAND FOR FERTILIZERS (TONS)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario L1																		
Cassava	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578
Maize	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507
Wet Season Rice	294,408	296,322	298,248	300,187	302,138	304,102	306,078	308,068	310,070	312,086	314,114	316,156	318,211	320,279	322,361	324,457	326,566	328,688
Dry Season Rice	135,722	138,029	140,376	142,762	145,189	147,657	150,168	152,720	155,317	157,957	160,642	163,373	166,151	168,975	171,848	174,769	177,740	180,762
Vegetables	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646
	464,861	**469,082**	**473,355**	**477,680**	**482,058**	**486,490**	**490,977**	**495,519**	**500,118**	**504,774**	**509,488**	**514,260**	**519,093**	**523,986**	**528,940**	**533,957**	**539,037**	**544,181**
	-	0.9%	1.8%	2.8%	3.7%	4.7%	5.6%	6.6%	7.6%	8.6%	9.6%	10.6%	11.7%	12.7%	13.8%	14.9%	16.0%	17.1%
Scenario L2																		
Cassava	4,578	4,730	4,887	5,048	5,215	5,388	5,566	5,751	5,941	6,138	6,341	6,551	6,767	6,991	7,223	7,462	7,709	7,964
Maize	11,507	11,619	11,731	11,845	11,960	12,076	12,193	12,311	12,431	12,551	12,673	12,796	12,920	13,045	13,172	13,300	13,429	13,559
Wet Season Rice	294,408	295,174	295,941	296,711	297,482	298,255	299,031	299,808	300,588	301,369	302,153	302,939	303,726	304,516	305,308	306,101	306,897	307,695
Dry Season Rice	135,722	136,645	137,574	138,510	139,451	140,400	141,354	142,316	143,283	144,258	145,239	146,226	147,221	148,222	149,230	150,244	151,266	152,295
Vegetables	18,646	18,791	18,938	19,085	19,234	19,384	19,536	19,688	19,842	19,996	20,152	20,309	20,468	20,628	20,788	20,951	21,114	21,279
	464,861	**466,958**	**469,071**	**471,199**	**473,343**	**475,504**	**477,680**	**479,874**	**482,085**	**484,312**	**486,558**	**488,821**	**491,102**	**493,402**	**495,721**	**498,058**	**500,415**	**502,792**
	-	0.5%	0.9%	1.4%	1.8%	2.3%	2.8%	3.2%	3.7%	4.2%	4.7%	5.2%	5.6%	6.1%	6.6%	7.1%	7.6%	8.2%
Scenario L3																		
Cassava	4,578	4,791	5,013	5,245	5,488	5,742	6,008	6,287	6,578	6,883	7,202	7,536	7,885	8,250	8,632	9,032	9,451	9,889
Maize	11,507	11,663	11,822	11,982	12,145	12,310	12,477	12,646	12,818	12,992	13,169	13,347	13,529	13,712	13,899	14,087	14,279	14,473
Wet Season Rice	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408
Dry Season Rice	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722
Vegetables	18,646	18,849	19,055	19,263	19,474	19,686	19,901	20,119	20,338	20,560	20,785	21,012	21,241	21,473	21,708	21,945	22,184	22,427
	464,861	**465,433**	**466,020**	**466,620**	**467,237**	**467,868**	**468,517**	**469,182**	**469,865**	**470,566**	**471,286**	**472,025**	**472,785**	**473,566**	**474,369**	**475,195**	**476,044**	**476,918**
	-	0.1%	0.2%	0.4%	0.5%	0.6%	0.8%	0.9%	1.1%	1.2%	1.4%	1.5%	1.7%	1.9%	2.0%	2.2%	2.4%	2.6%
Scenario L4																		
Cassava	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578
Maize	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507
Wet Season Rice	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408
Dry Season Rice	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722
Vegetables	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646
	464,861	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Scenario L5																		
Cassava	4,578	4,469	4,361	4,257	4,154	4,055	3,957	3,862	3,770	3,679	3,591	3,505	3,421	3,339	3,258	3,180	3,104	3,029
Maize	11,507	11,231	10,961	10,698	10,441	10,191	9,946	9,708	9,475	9,247	9,025	8,809	8,597	8,391	8,189	7,993	7,801	7,614
Wet Season Rice	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408
Dry Season Rice	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722
Vegetables	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646
	464,861	**464,475**	**464,098**	**463,731**	**463,372**	**463,022**	**462,680**	**462,346**	**462,020**	**461,702**	**461,392**	**461,089**	**460,794**	**460,505**	**460,224**	**459,949**	**459,681**	**459,419**
	-	-0.1%	-0.2%	-0.2%	-0.3%	-0.4%	-0.5%	-0.5%	-0.6%	-0.7%	-0.7%	-0.8%	-0.9%	-0.9%	-1.0%	-1.1%	-1.1%	-1.2%
Scenario L6																		
Cassava	4,578	4,469	4,361	4,257	4,154	4,055	3,957	3,862	3,770	3,679	3,591	3,505	3,421	3,339	3,258	3,180	3,104	3,029
Maize	11,507	11,231	10,961	10,698	10,441	10,191	9,946	9,708	9,475	9,247	9,025	8,809	8,597	8,391	8,189	7,993	7,801	7,614
Wet Season Rice	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408
Dry Season Rice	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722
Vegetables	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646
	464,861	**464,475**	**464,098**	**463,731**	**463,372**	**463,022**	**462,680**	**462,346**	**462,020**	**461,702**	**461,392**	**461,089**	**460,794**	**460,505**	**460,224**	**459,949**	**459,681**	**459,419**
	-	-0.1%	-0.2%	-0.2%	-0.3%	-0.4%	-0.5%	-0.5%	-0.6%	-0.7%	-0.7%	-0.8%	-0.9%	-0.9%	-1.0%	-1.1%	-1.1%	-1.2%

Table 103: Total demand and average return to labor ($/day) for scenarios with environmental sustainability

DEMAND FOR LABOR (Million DAYS)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51
Scenario L1	166.51	167.52	168.54	169.57	170.61	171.67	172.73	173.79	174.87	175.96	177.06	178.17	179.29	180.42	181.56	182.71	183.87	185.04
Scenario L2	166.51	167.60	168.71	169.84	171.00	172.17	173.37	174.60	175.85	177.12	178.42	179.75	181.11	182.49	183.91	185.35	186.83	188.34
Scenario L3	166.51	167.46	168.46	169.50	170.58	171.70	172.86	174.08	175.34	176.65	178.02	179.44	180.92	182.46	184.07	185.74	187.48	189.30
Scenario L4	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51	166.51
Scenario L5	166.51	165.95	165.40	164.87	164.35	163.85	163.35	162.87	162.40	161.94	161.49	161.06	160.63	160.21	159.81	159.41	159.02	158.64
Scenario L6	166.51	165.95	165.40	164.87	164.35	163.85	163.35	162.87	162.40	161.94	161.49	161.06	160.63	160.21	159.81	159.41	159.02	158.64

RETURN TO LABOR ($/day)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41
Scenario L1	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.42	6.42	6.42	6.42
Scenario L2	6.41	6.43	6.44	6.46	6.47	6.49	6.51	6.52	6.54	6.56	6.57	6.59	6.61	6.63	6.64	6.66	6.68	6.70
Scenario L3	6.41	6.43	6.46	6.48	6.50	6.52	6.55	6.57	6.60	6.62	6.65	6.68	6.71	6.73	6.76	6.79	6.83	6.86
Scenario L4	6.41	6.39	6.37	6.35	6.33	6.31	6.29	6.27	6.25	6.23	6.21	6.19	6.17	6.16	6.14	6.12	6.11	6.09
Scenario L5	6.41	6.40	6.39	6.38	6.36	6.35	6.34	6.33	6.32	6.31	6.30	6.29	6.28	6.27	6.26	6.25	6.24	6.23
Scenario L6	6.41	6.43	6.45	6.47	6.49	6.51	6.53	6.55	6.57	6.59	6.60	6.62	6.64	6.65	6.67	6.69	6.70	6.72

Table 104: Farm budget data comparing traditional and modern technology users (revenue and modern inputs)

Revenue	Yield by technology use (tons/ha)			Output Prices by technology use ($/ton)			Revenue by technology use and total ($/ha)		
	MODERN	TRADITIONAL	TOTAL	MODERN	TRADITIONAL	TOTAL	MODERN	TRADITIONAL	TOTAL
Cassava	21.90	17.21	18.65	70.23	69.12	69.53	1,538.03	1,189.47	1,296.72
Maize	4.38	3.50	3.94	208.56	164.04	188.79	913.50	574.15	743.83
Wet Season Rice	3.32	2.70	2.89	278.76	252.46	261.43	925.47	681.65	755.53
Dry Season Rice	5.00	4.61	4.80	201.75	211.67	206.73	1,008.75	975.82	992.28
Vegetables	11.96	6.24	9.10	367.59	206.57	312.38	4,396.37	1,289.02	2,842.70
Seeds	Seeds by farm size (unit/ha)			Seed Prices by farm size ($/unit)			Costs of seeds by farm size and total		
	MODERN	TRADITIONAL	TOTAL	MODERN	TRADITIONAL	TOTAL	MODERN	TRADITIONAL	TOTAL
Cassava	25,469.00	21,703.00	22,861.00	0.01	0.01	0.01	254.69	217.03	228.61
Maize	20.60	17.16	18.88	4.06	4.06	4.06	83.62	69.66	76.64
Wet Season Rice	64.35	27.73	38.82	0.66	0.66	0.66	42.47	18.30	25.62
Dry Season Rice	166.34	125.80	146.07	0.74	0.74	0.74	123.09	93.09	108.09
Vegetables	20.56	3.75	12.15	11.60	11.60	11.60	238.47	43.45	140.96
Fertilizer	Fertilizer use by farm size (kg/ha)			Fertilizer Prices by farm size ($/kg)			Costs of fertilizers by farm size and total		
	MODERN	TRADITIONAL	TOTAL			TOTAL	MODERN	TRADITIONAL	TOTAL
Cassava	22.96	9.36	13.55	0.56	0.56	0.56	12.86	5.24	7.59
Maize	104.14	2.68	53.41	0.56	0.56	0.56	58.32	1.50	29.91
Wet Season Rice	176.36	93.32	118.48	0.56	0.56	0.56	98.76	52.26	66.35
Dry Season Rice	351.46	196.39	273.93	0.56	0.56	0.56	196.82	109.98	153.40
Vegetables	550.95	137.66	344.30	0.56	0.56	0.56	308.53	77.09	192.81
Other Inputs							Other input Costs ($/ha)		
Cassava							65.16	24.48	37.00
Maize							43.61	16.03	29.82
Wet Season Rice							21.27	29.31	26.88
Dry Season Rice							30.35	25.12	27.73
Vegetables							424.30	69.36	246.85

Table 105: Farm budget data comparing traditional and modern technology users (labor, services, and gross margins)

Labor	Labor use by technology (days/ha)			Wage rate by technology ($/day)			Costs of labor by technology and total		
	MODERN	TRADITIONAL	TOTAL	MODERN	TRADITIONAL	TOTAL	MODERN	TRADITIONAL	TOTAL
Cassava	56.45	45.40	48.80	4.56	4.56	4.56	257.41	207.03	222.53
Maize	34.16	30.49	31.33	4.56	4.26	4.56	155.78	129.93	142.85
Wet Season Rice	28.69	58.81	48.29	4.56	4.41	4.56	130.84	259.06	220.21
Dry Season Rice	3.82	51.68	27.75	4.56	4.56	4.56	17.41	235.66	126.54
Vegetables	263.68	128.11	175.89	4.56	3.14	4.56	1,202.40	401.76	802.08

Services	Service Costs ($/ha)		
	MODERN	TRADITIONAL	TOTAL
Cassava	253.12	314.08	295.32
Maize	175.80	145.55	160.68
Wet Season Rice	232.57	144.37	171.10
Dry Season Rice	245.02	167.55	206.29
Vegetables	68.10	64.79	66.45

Irrigation	Irrigation Costs ($/ha)		
	MODERN	TRADITIONAL	TOTAL
Cassava			
Maize			
Wet Season Rice			
Dry Season Rice	141.04	8.33	74.69
Vegetables			

Gross Margins	Gross Margins ($/ha)		
	MODERN	TRADITIONAL	TOTAL
Cassava	694.79	421.61	505.67
Maize	396.37	211.48	303.93
Wet Season Rice	399.56	178.35	245.37
Dry Season Rice	255.02	336.09	295.54
Vegetables	2,154.57	632.57	1,393.55

Table 106: Gross margins and NPV (million $) for TFP scenario (baseline)

GROSS MARGINS (million $) --->																			
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
Gross Margins: MODE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Cassava	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	82.15	$786
Maize	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	34.16	$327
Wet Season Rice	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	397.14	$3,801
Dry Season Rice	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	76.84	$735
Vegetables	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	46.67	$447
	636.95	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	**636.95**	$6,096
Gross Margins: TRADITIONAL																			
Cassava	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	$886
Maize	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	$262
Wet Season Rice	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	$2,545
Dry Season Rice	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	$956
Vegetables	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	$197
	506.28	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	$4,845
Gross Margins: TOTAL																			
Cassava	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	174.72	$1,672
Maize	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49	$589
Wet Season Rice	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	663.04	$6,345
Dry Season Rice	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	176.76	$1,692
Vegetables	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	67.23	$643
	1,143.23	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	**1,143.23**	$10,941
	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	1,067.90	$10,220
Share of Modern	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	

Table 107: Gross margins and NPV (million $) for TFP scenario (scenario P1)

GROSS MARGINS (million $) --->																			
Scenario T1	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
MODERN	0	1	2	3	4	5	6	7	8	9									
Cassava	82.15	83.09	84.04	85.01	85.98	86.97	87.97	88.98	90.00	91.03	92.08	93.13	94.20	95.29	96.38	97.49	98.60	99.74	$849
Maize	34.16	34.53	34.90	35.28	35.66	36.05	36.44	36.83	37.23	37.63	38.04	38.45	38.87	39.29	39.72	40.15	40.58	41.02	$351
Wet Season Rice	397.14	401.16	405.22	409.32	413.46	417.65	421.87	426.14	430.46	434.82	439.22	443.66	448.15	452.69	457.27	461.90	466.58	471.30	$4,065
Dry Season Rice	76.84	77.18	77.52	77.87	78.21	78.56	78.91	79.26	79.61	79.96	80.31	80.67	81.03	81.39	81.75	82.11	82.47	82.84	$757
Vegetables	46.67	47.76	48.87	50.01	51.17	52.36	53.58	54.82	56.10	57.40	58.74	60.10	61.50	62.93	64.40	65.89	67.43	68.99	$523
	636.95	**643.71**	**650.55**	**657.48**	**664.49**	**671.58**	**678.76**	**686.03**	**693.39**	**700.84**	**708.39**	**716.02**	**723.76**	**731.58**	**739.51**	**747.53**	**755.66**	**763.89**	$6,545
	-	1.1%	2.1%	3.2%	4.3%	5.4%	6.6%	7.7%	8.9%	10.0%	11.2%	12.4%	13.6%	14.9%	16.1%	17.4%	18.6%	19.9%	
TRADITIONAL																			
Cassava	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	92.57	$886
Maize	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	27.34	$262
Wet Season Rice	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	265.90	$2,545
Dry Season Rice	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	99.91	$956
Vegetables	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	$197
	506.28	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	**506.28**	$4,845
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
TOTAL																			
Cassava	174.72	175.66	176.61	177.58	178.56	179.54	180.54	181.55	182.57	183.61	184.65	185.71	186.78	187.86	188.95	190.06	191.18	192.31	$1,735
Maize	61.49	61.86	62.24	62.62	63.00	63.38	63.77	64.17	64.57	64.97	65.38	65.79	66.21	66.63	67.05	67.48	67.92	68.36	$613
Wet Season Rice	663.04	667.06	671.12	675.22	679.36	683.55	687.78	692.05	696.36	700.72	705.12	709.56	714.06	718.59	723.17	727.80	732.48	737.20	$6,610
Dry Season Rice	176.76	177.10	177.44	177.78	178.13	178.47	178.82	179.17	179.52	179.87	180.23	180.58	180.94	181.30	181.66	182.02	182.38	182.75	$1,713
Vegetables	67.23	68.31	69.42	70.56	71.72	72.91	74.13	75.38	76.65	77.96	79.29	80.66	82.06	83.49	84.95	86.45	87.98	89.55	$720
	1,143.23	**1,149.99**	**1,156.83**	**1,163.76**	**1,170.76**	**1,177.86**	**1,185.04**	**1,192.31**	**1,199.67**	**1,207.12**	**1,214.67**	**1,222.30**	**1,230.03**	**1,237.86**	**1,245.79**	**1,253.81**	**1,261.94**	**1,270.17**	$11,391
	-	0.6%	1.2%	1.8%	2.4%	3.0%	3.7%	4.3%	4.9%	5.6%	6.2%	6.9%	7.6%	8.3%	9.0%	9.7%	10.4%	11.1%	
	1,067.90	1,074.21	1,080.60	1,087.07	1,093.62	1,100.25	1,106.95	1,113.75	1,120.62	1,127.58	1,134.63	1,141.76	1,148.98	1,156.29	1,163.70	1,171.19	1,178.78	1,186.47	$10,640
Share of Modern	0.56	0.56	0.56	0.56	0.57	0.57	0.57	0.58	0.58	0.58	0.58	0.59	0.59	0.59	0.59	0.60	0.60	0.60	

Table 108: Gross margins and NPV (million $) for TFP scenario (scenario P2)

GROSS MARGINS (million $) --->																			
Scenario T2	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
MODERN																			
Cassava	82.15	85.43	88.85	92.40	96.10	99.94	103.94	108.10	112.42	116.92	121.59	126.46	131.52	136.78	142.25	147.94	153.86	160.01	$1,037
Maize	34.16	35.52	36.95	38.42	39.96	41.56	43.22	44.95	46.75	48.62	50.56	52.58	54.69	56.88	59.15	61.52	63.98	66.54	$431
Wet Season Rice	397.14	413.02	429.54	446.72	464.59	483.18	502.50	522.60	543.51	565.25	587.86	611.37	635.83	661.26	687.71	715.22	743.83	773.58	$5,013
Dry Season Rice	76.84	79.92	83.11	86.44	89.90	93.49	97.23	101.12	105.16	109.37	113.75	118.30	123.03	127.95	133.07	138.39	143.92	149.68	$970
Vegetables	46.67	48.54	50.48	52.50	54.60	56.78	59.06	61.42	63.87	66.43	69.09	71.85	74.72	77.71	80.82	84.05	87.42	90.91	$589
	636.95	**662.43**	**688.93**	**716.49**	**745.15**	**774.95**	**805.95**	**838.19**	**871.72**	**906.58**	**942.85**	**980.56**	**1,019.78**	**1,060.57**	**1,103.00**	**1,147.12**	**1,193.00**	**1,240.72**	$8,040
	-	4.0%	8.2%	12.5%	17.0%	21.7%	26.5%	31.6%	36.9%	42.3%	48.0%	53.9%	60.1%	66.5%	73.2%	80.1%	87.3%	94.8%	
TRADITIONAL																			
Cassava	92.57	90.58	88.51	86.35	84.11	81.77	79.35	76.82	74.20	71.47	68.63	65.68	62.61	59.42	56.10	52.65	49.06	45.32	$734
Maize	27.34	26.61	25.85	25.06	24.24	23.39	22.50	21.58	20.62	19.62	18.58	17.51	16.38	15.22	14.00	12.74	11.43	10.06	$206
Wet Season Rice	265.90	258.81	251.44	243.77	235.79	227.50	218.87	209.90	200.57	190.86	180.77	170.27	159.36	148.01	136.20	123.92	111.15	97.87	$2,004
Dry Season Rice	99.91	97.25	94.48	91.60	88.60	85.48	82.24	78.87	75.36	71.72	67.92	63.98	59.88	55.61	51.18	46.56	41.76	36.77	$753
Vegetables	20.55	20.01	19.44	18.84	18.23	17.59	16.92	16.22	15.50	14.75	13.97	13.16	12.32	11.44	10.53	9.58	8.59	7.57	$155
	506.28	**493.25**	**479.71**	**465.62**	**450.96**	**435.73**	**419.88**	**403.40**	**386.25**	**368.43**	**349.89**	**330.60**	**310.55**	**289.70**	**268.01**	**245.45**	**221.99**	**197.59**	$3,851
	-	-2.6%	-5.2%	-8.0%	-10.9%	-13.9%	-17.1%	-20.3%	-23.7%	-27.2%	-30.9%	-34.7%	-38.7%	-42.8%	-47.1%	-51.5%	-56.2%	-61.0%	
TOTAL																			
Cassava	174.72	176.01	177.35	178.75	180.20	181.72	183.29	184.92	186.62	188.39	190.23	192.14	194.13	196.20	198.35	200.59	202.91	205.33	$1,771
Maize	61.49	62.13	62.80	63.48	64.20	64.95	65.72	66.53	67.37	68.24	69.15	70.09	71.07	72.09	73.15	74.26	75.40	76.60	$637
Wet Season Rice	663.04	671.83	680.98	690.49	700.38	710.67	721.37	732.50	744.07	756.11	768.63	781.65	795.19	809.27	823.91	839.14	854.98	871.45	$7,016
Dry Season Rice	176.76	177.16	177.59	178.03	178.49	178.97	179.47	179.99	180.53	181.09	181.67	182.28	182.91	183.56	184.24	184.95	185.69	186.46	$1,723
Vegetables	67.23	68.55	69.92	71.34	72.83	74.37	75.97	77.64	79.38	81.18	83.06	85.01	87.04	89.15	91.35	93.63	96.01	98.48	$744
	1,143.23	**1,155.68**	**1,168.63**	**1,182.10**	**1,196.11**	**1,210.68**	**1,225.83**	**1,241.58**	**1,257.97**	**1,275.01**	**1,292.73**	**1,311.17**	**1,330.34**	**1,350.27**	**1,371.01**	**1,392.57**	**1,414.99**	**1,438.32**	$11,891
	-	1.1%	2.2%	3.4%	4.6%	5.9%	7.2%	8.6%	10.0%	11.5%	13.1%	14.7%	16.4%	18.1%	19.9%	21.8%	23.8%	25.8%	
	1,067.90	1,079.53	1,091.63	1,104.21	1,117.29	1,130.90	1,145.05	1,159.77	1,175.08	1,190.99	1,207.55	1,224.77	1,242.67	1,261.30	1,280.66	1,300.81	1,321.75	1,343.54	$11,107
Share of Modern	0.56	0.57	0.59	0.61	0.62	0.64	0.66	0.68	0.69	0.71	0.73	0.75	0.77	0.79	0.80	0.82	0.84	0.86	

Table 109: Gross margins and NPV (million $) for TFP scenario (scenario P3)

GROSS MARGINS (million $) --->																			
Scenario T3	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
MODERN																			
Cassava	82.15	86.41	90.90	95.62	100.59	105.81	111.31	117.09	123.17	129.57	136.30	143.38	150.82	158.66	166.90	175.57	184.68	194.28	$1,132
Maize	34.16	35.91	37.75	39.68	41.72	43.86	46.11	48.47	50.95	53.57	56.31	59.20	62.23	65.42	68.78	72.30	76.01	79.90	$468
Wet Season Rice	397.14	417.20	438.28	460.43	483.69	508.13	533.81	560.78	589.11	618.88	650.15	683.00	717.51	753.76	791.85	831.86	873.89	918.04	$5,417
Dry Season Rice	76.84	80.27	83.85	87.59	91.50	95.58	99.84	104.30	108.95	113.81	118.88	124.19	129.73	135.51	141.56	147.87	154.47	161.36	$1,003
Vegetables	46.67	49.67	52.86	56.25	59.86	63.70	67.79	72.14	76.77	81.70	86.95	92.53	98.47	104.79	111.51	118.67	126.29	134.39	$706
	636.95	**669.46**	**703.64**	**739.57**	**777.36**	**817.08**	**858.85**	**902.77**	**948.96**	**997.52**	**1,048.59**	**1,102.29**	**1,158.76**	**1,218.14**	**1,280.59**	**1,346.27**	**1,415.34**	**1,487.98**	$8,727
	-	5.1%	10.5%	16.1%	22.0%	28.3%	34.8%	41.7%	49.0%	56.6%	64.6%	73.1%	81.9%	91.2%	101.0%	111.4%	122.2%	133.6%	
TRADITIONAL																			
Cassava	92.57	90.58	88.51	86.35	84.11	81.77	79.35	76.82	74.20	71.47	68.63	65.68	62.61	59.42	56.10	52.65	49.06	45.32	$734
Maize	27.34	26.61	25.85	25.06	24.24	23.39	22.50	21.58	20.62	19.62	18.58	17.51	16.38	15.22	14.00	12.74	11.43	10.06	$206
Wet Season Rice	265.90	258.81	251.44	243.77	235.79	227.50	218.87	209.90	200.57	190.86	180.77	170.27	159.36	148.01	136.20	123.92	111.15	97.87	$2,004
Dry Season Rice	99.91	97.25	94.48	91.60	88.60	85.48	82.24	78.87	75.36	71.72	67.92	63.98	59.88	55.61	51.18	46.56	41.76	36.77	$753
Vegetables	20.55	20.01	19.44	18.84	18.23	17.59	16.92	16.22	15.50	14.75	13.97	13.16	12.32	11.44	10.53	9.58	8.59	7.57	$155
	506.28	**493.25**	**479.71**	**465.62**	**450.96**	**435.73**	**419.88**	**403.40**	**386.25**	**368.43**	**349.89**	**330.60**	**310.55**	**289.70**	**268.01**	**245.45**	**221.99**	**197.59**	$3,851
	-	-2.6%	-5.2%	-8.0%	-10.9%	-13.9%	-17.1%	-20.3%	-23.7%	-27.2%	-30.9%	-34.7%	-38.7%	-42.8%	-47.1%	-51.5%	-56.2%	-61.0%	
TOTAL																			
Cassava	174.72	176.99	179.41	181.97	184.69	187.59	190.66	193.91	197.37	201.04	204.93	209.06	213.44	218.08	223.00	228.21	233.74	239.60	$1,866
Maize	61.49	62.52	63.60	64.75	65.96	67.25	68.61	70.05	71.57	73.19	74.90	76.70	78.62	80.64	82.78	85.04	87.44	89.97	$674
Wet Season Rice	663.04	676.01	689.72	704.19	719.48	735.63	752.67	770.67	789.68	809.74	830.92	853.27	876.87	901.77	928.05	955.78	985.04	1,015.91	$7,420
Dry Season Rice	176.76	177.52	178.33	179.19	180.10	181.06	182.08	183.16	184.31	185.52	186.81	188.17	189.60	191.13	192.73	194.43	196.23	198.13	$1,756
Vegetables	67.23	69.67	72.29	75.09	78.09	81.29	84.71	88.37	92.28	96.45	100.92	105.69	110.78	116.23	122.04	128.25	134.88	141.96	$861
	1,143.23	**1,162.71**	**1,183.34**	**1,205.19**	**1,228.32**	**1,252.81**	**1,278.73**	**1,306.17**	**1,335.21**	**1,365.95**	**1,398.47**	**1,432.89**	**1,469.31**	**1,507.84**	**1,548.60**	**1,591.72**	**1,637.33**	**1,685.57**	$12,578
		1.7%	3.5%	5.4%	7.4%	9.6%	11.9%	14.3%	16.8%	19.5%	22.3%	25.3%	28.5%	31.9%	35.5%	39.2%	43.2%	47.4%	
	1,067.90	1,086.10	1,105.37	1,125.77	1,147.38	1,170.25	1,194.47	1,220.10	1,247.23	1,275.94	1,306.32	1,338.47	1,372.49	1,408.48	1,446.56	1,486.83	1,529.44	1,574.50	$11,749
Share of Modern	0.56	0.58	0.59	0.61	0.63	0.65	0.67	0.69	0.71	0.73	0.75	0.77	0.79	0.81	0.83	0.85	0.86	0.88	

Table 110: Summary of gross margins for TFP scenarios

	Gross Margins in 2013 ($ million)	Gross Margins in 2030 ($ Million)	NPV at CPI ($ Million)	% Change NPV
Baseline	1,067.90	1,067.90	10,220	
No Move + Efficiency	1,067.90	1,186.47	10,640	4.1%
Move from Traditional to Modern	1,067.90	1,343.54	11,107	8.7%
Move + Efficiency	1,067.90	1,574.50	11,749	15.0%

Table 111: Examples of costs of irrigation investment (per unit and total investment)

Examples of irrigation costs	Cost in $/ha	Newly Irrigated Areas (ha)	Total Investment (Million $) with Scenario T4
South Asia	1,400	454,543	636.36
Average	2,500	454,543	1,136.36
East Asia	4,000	454,543	1,818.17

Table 112: Demand for labor and return to labor for TFP scenarios

DEMAND FOR LABOR (Million days)																		
Baseline and P1	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68	16.68
Maize	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90
Wet Season Rice	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49	116.49
Dry Season Rice	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16
Vegetable	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90
	166.14	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**	**166.14**
Scenarios P2, P3, and P4	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	16.68	16.74	16.79	16.85	16.91	16.97	17.03	17.10	17.17	17.24	17.31	17.39	17.47	17.56	17.64	17.73	17.83	17.93
Maize	6.90	6.92	6.93	6.94	6.96	6.97	6.99	7.00	7.02	7.04	7.06	7.07	7.09	7.11	7.13	7.16	7.18	7.20
Wet Season Rice	116.49	115.29	114.04	112.74	111.39	109.99	108.53	107.01	105.43	103.78	102.08	100.30	98.45	96.53	94.53	92.45	90.29	88.04
Dry Season Rice	16.16	15.78	15.38	14.97	14.55	14.10	13.64	13.16	12.66	12.14	11.59	11.03	10.45	9.84	9.20	8.54	7.86	7.15
Vegetable	9.90	10.02	10.14	10.27	10.40	10.54	10.68	10.83	10.98	11.15	11.31	11.49	11.67	11.86	12.05	12.26	12.47	12.69
	166.14	**164.74**	**163.29**	**161.77**	**160.20**	**158.57**	**156.86**	**155.10**	**153.26**	**151.34**	**149.35**	**147.28**	**145.13**	**142.89**	**140.56**	**138.14**	**135.63**	**133.01**
		-0.8%	-1.7%	-2.6%	-3.6%	-4.6%	-5.6%	-6.6%	-7.8%	-8.9%	-10.1%	-11.3%	-12.6%	-14.0%	-15.4%	-16.8%	-18.4%	-19.9%
Share of rice	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.77	0.77	0.77	0.76	0.76	0.75	0.74	0.74	0.73	0.72	0.72
		1.00	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07
		1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.04	1.04	1.04
		0.99	0.98	0.97	0.96	0.94	0.93	0.92	0.91	0.89	0.88	0.86	0.85	0.83	0.81	0.79	0.78	0.76
		0.98	0.95	0.93	0.90	0.87	0.84	0.81	0.78	0.75	0.72	0.68	0.65	0.61	0.57	0.53	0.49	0.44
		1.01	1.02	1.04	1.05	1.06	1.08	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.28

AVERAGE RETURN TO LABOR ($/DAY)																		
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43
No Move + Efficiency	6.43	6.47	6.50	6.54	6.58	6.62	6.66	6.70	6.75	6.79	6.83	6.87	6.92	6.96	7.00	7.05	7.10	7.14
Move from Trad to Modern	6.43	6.55	6.69	6.83	6.97	7.13	7.30	7.48	7.67	7.87	8.09	8.32	8.56	8.83	9.11	9.42	9.75	10.10
Move + Efficiency	6.43	6.59	6.77	6.96	7.16	7.38	7.61	7.87	8.14	8.43	8.75	9.09	9.46	9.86	10.29	10.76	11.28	11.84
		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.08	1.08	1.09	1.10	1.10	1.11
		1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.26	1.29	1.33	1.37	1.42	1.46	1.52	1.57
		1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.27	1.31	1.36	1.41	1.47	1.53	1.60	1.67	1.75	1.84

Table 113: Demand for fertilizers for TFP scenarios

DEMAND FOR FERTILIZERS (Tons)																		
Baseline & Scenario P1	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770	4,770
Maize	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321	9,321
Wet Season Rice	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420	314,420
Dry Season Rice	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039	128,039
Vegetables	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408	16,408
	464,861	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**
Scenario P2 and P3	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020	2,021	2,022	2,023	2,024	2,025	2,026	2,027	2,028	2,029	2,030
	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	4,770	4,834	4,901	4,970	5,043	5,118	5,196	5,278	5,363	5,451	5,542	5,637	5,737	5,840	5,947	6,058	6,174	6,295
Maize	9,321	9,671	10,034	10,413	10,806	11,215	11,641	12,083	12,544	13,022	13,520	14,038	14,576	15,136	15,719	16,324	16,954	17,609
Wet Season Rice	314,420	317,721	321,155	324,725	328,439	332,301	336,317	340,494	344,839	349,357	354,055	358,942	364,024	369,310	374,807	380,523	386,469	392,652
Dry Season Rice	128,039	129,268	130,547	131,876	133,259	134,697	136,193	137,748	139,366	141,048	142,798	144,618	146,510	148,478	150,525	152,654	154,868	157,171
Vegetables	16,408	16,766	17,138	17,525	17,928	18,347	18,783	19,236	19,707	20,197	20,707	21,237	21,788	22,362	22,958	23,578	24,223	24,894
	464,861	**470,073**	**475,493**	**481,131**	**486,994**	**493,091**	**499,432**	**506,027**	**512,886**	**520,019**	**527,437**	**535,152**	**543,176**	**551,521**	**560,199**	**569,225**	**578,611**	**588,373**
		1.1%	2.3%	3.5%	4.8%	6.1%	7.4%	8.9%	10.3%	11.9%	13.5%	15.1%	16.8%	18.6%	20.5%	22.5%	24.5%	26.6%
		5,212	10,633	16,270	22,133	28,230	34,571	41,166	48,025	55,158	62,576	70,291	78,315	86,660	95,338	104,364	113,750	123,512
Share of rice	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.93
Average fertilizer kg per hectare for All	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cassava	14	14	15	15	15	15	15	16	16	16	16	17	17	17	18	18	18	19
Maize	43	45	47	48	50	52	54	56	58	60	63	65	68	70	73	76	79	82
Wet Season Rice	127	128	129	131	132	134	135	137	139	141	142	144	146	149	151	153	156	158
Dry Season Rice	258	261	263	266	269	272	275	278	281	285	288	292	296	300	304	308	313	317
Vegetables	303	310	316	324	331	339	347	355	364	373	382	392	402	413	424	435	447	460
		1.01	1.03	1.04	1.06	1.07	1.09	1.11	1.12	1.14	1.16	1.18	1.20	1.22	1.25	1.27	1.29	1.32
		1.04	1.08	1.12	1.16	1.20	1.25	1.30	1.35	1.40	1.45	1.51	1.56	1.62	1.69	1.75	1.82	1.89
		1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.21	1.23	1.25
		1.01	1.02	1.03	1.04	1.05	1.06	1.08	1.09	1.10	1.12	1.13	1.14	1.16	1.18	1.19	1.21	1.23
		1.02	1.04	1.07	1.09	1.12	1.14	1.17	1.20	1.23	1.26	1.29	1.33	1.36	1.40	1.44	1.48	1.52

Table 114: Cultivated land and gross margins for scenario P4 (TFP through irrigation)

GROSS MARGINS (million $)																		
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated Areas	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
Maize	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442
Wet Season Rice	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
	3,587,694	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**
Cultivated Land	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Scenario T4	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
Maize	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442
Wet Season Rice	2,484,832	2,435,135	2,386,433	2,338,704	2,291,930	2,246,091	2,201,169	2,157,146	2,114,003	2,071,723	2,030,289	1,989,683	1,949,889	1,910,891	1,872,674	1,835,220	1,798,516	1,762,545
Dry Season Rice	495,465	594,858	692,264	787,721	881,269	972,946	1,062,790	1,150,837	1,237,123	1,321,683	1,404,552	1,485,763	1,565,351	1,643,346	1,719,782	1,794,689	1,868,098	1,940,038
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
	3,587,694	**3,637,391**	**3,686,093**	**3,733,822**	**3,780,596**	**3,826,435**	**3,871,357**	**3,915,380**	**3,958,523**	**4,000,803**	**4,042,237**	**4,082,843**	**4,122,637**	**4,161,635**	**4,199,852**	**4,237,306**	**4,274,010**	**4,309,981**
Gross Margins	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario T4	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82
Maize	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48
Wet Season Rice	609.70	597.51	585.56	573.85	562.37	551.12	540.10	529.30	518.71	508.34	498.17	488.21	478.44	468.88	459.50	450.31	441.30	432.48
Dry Season Rice	183.44	220.23	256.30	291.64	326.27	360.21	393.48	426.07	458.02	489.33	520.01	550.07	579.54	608.42	636.71	664.45	691.63	718.26
Vegetables	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47
	1,104.90	1,129.51	1,153.62	1,177.25	1,200.41	1,223.10	1,245.34	1,267.14	1,288.50	1,309.43	1,329.94	1,350.04	1,369.75	1,389.05	1,407.98	1,426.52	1,444.69	1,462.50
	0.0%	2.2%	4.4%	6.5%	8.6%	10.7%	12.7%	14.7%	16.6%	18.5%	20.4%	22.2%	24.0%	25.7%	27.4%	29.1%	30.8%	32.4%

Table 115: Gross margins on competitiveness (scenarios C1 through C6)

GROSS MARGINS (million $)																								
Baseline						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
GROSS MARGINS (million $)						0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Cassava						170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	170.82	1,635
Maize						65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	65.48	627
Wet Season Rice						609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	609.70	5,835
Dry Season Rice						146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	1,401
Vegetables						75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	75.47	722
						1,067.90	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	**1,067.90**	10,220
						-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Scenario C1						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
GROSS MARGINS (million $)	Seeds	Fertilizers	Other inputs	Labor	Services	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Cassava	5.6%	2.0%	1.9%	4.4%	1.9%	170.82	179.63	188.80	198.35	208.30	218.65	229.41	240.62	252.27	264.39	276.99	290.09	303.70	317.84	332.53	347.79	363.64	380.10	2,309
Maize	6.7%	2.0%	1.9%	4.4%	1.9%	65.48	63.61	61.61	59.46	57.16	54.70	52.07	49.26	46.26	43.06	39.64	36.00	32.12	27.99	23.59	18.91	13.93	8.64	460
Wet Season Rice	4.6%	2.0%	1.9%	4.4%	1.9%	609.70	615.38	620.72	625.69	630.26	634.38	638.04	641.18	643.77	645.76	647.11	647.77	647.70	646.83	645.11	642.48	638.89	634.26	6,056
Dry Season Rice	4.8%	2.0%	1.9%	4.4%	1.9%	146.43	145.46	144.31	142.98	141.45	139.72	137.77	135.59	133.16	130.48	127.52	124.28	120.74	116.87	112.68	108.12	103.20	97.88	1,277
Vegetables	3.0%	2.0%	1.9%	4.4%	1.9%	75.47	77.75	80.10	82.51	84.97	87.50	90.09	92.75	95.47	98.25	101.10	104.03	107.02	110.07	113.20	116.41	119.68	123.02	884
						1,067.90	**1,081.83**	**1,095.54**	**1,108.99**	**1,122.14**	**1,134.95**	**1,147.39**	**1,159.39**	**1,170.92**	**1,181.93**	**1,192.37**	**1,202.16**	**1,211.26**	**1,219.60**	**1,227.11**	**1,233.72**	**1,239.34**	**1,243.90**	10,986
						-	1.3%	2.6%	3.8%	5.1%	6.3%	7.4%	8.6%	9.6%	10.7%	11.7%	12.6%	13.4%	14.2%	14.9%	15.5%	16.1%	16.5%	
Scenario C2						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
GROSS MARGINS (million $)	Seeds	Fertilizers	Other inputs	Labor	Services	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Cassava	11.1%	4.1%	3.9%	8.8%	3.9%	170.82	169.81	167.89	164.92	160.76	155.24	148.18	139.39	128.63	115.65	100.18	81.91	60.49	35.53	6.61	(26.74)	(65.05)	(108.91)	1,119
Maize	13.4%	4.1%	3.9%	8.8%	3.9%	65.48	60.24	54.41	47.92	40.72	32.71	23.82	13.94	2.96	(9.22)	(22.77)	(37.81)	(54.53)	(73.11)	(93.78)	(116.75)	(142.32)	(170.77)	36
Wet Season Rice	9.2%	4.1%	3.9%	8.8%	3.9%	609.70	575.61	536.85	493.00	443.58	388.09	325.96	256.59	179.32	93.43	(1.86)	(107.39)	(224.09)	(352.97)	(495.11)	(651.71)	(824.05)	(1,013.54)	1,768
Dry Season Rice	9.7%	4.1%	3.9%	8.8%	3.9%	146.43	135.63	123.66	110.40	95.76	79.62	61.83	42.26	20.75	(2.86)	(28.76)	(57.15)	(88.24)	(122.28)	(159.51)	(200.23)	(244.74)	(293.37)	247
Vegetables	5.9%	4.1%	3.9%	8.8%	3.9%	75.47	75.08	74.46	73.56	72.36	70.82	68.91	66.60	63.83	60.56	56.75	52.32	47.23	41.40	34.77	27.26	18.77	9.22	590
						1,067.90	**1,016.37**	**957.26**	**889.80**	**813.18**	**726.47**	**628.70**	**518.77**	**395.49**	**257.56**	**103.55**	**(68.12)**	**(259.15)**	**(471.43)**	**(707.01)**	**(968.17)**	**(1,257.39)**	**(1,577.37)**	3,761
						-	-4.8%	-10.4%	-16.7%	-23.9%	-32.0%	-41.1%	-51.4%	-63.0%	-75.9%	-90.3%	-106.4%	-124.3%	-144.1%	-166.2%	-190.7%	-217.7%	-247.7%	
Scenario C3						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
GROSS MARGINS (million $)	Seeds	Fertilizers	Other inputs	Labor	Services	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Cassava	0.0%	0.0%	0.0%	8.8%	0.0%	170.82	164.22	157.04	149.23	140.73	131.49	121.44	110.50	98.61	85.67	71.59	56.28	39.63	21.51	1.80	(19.63)	(42.96)	(68.32)	985
Maize	0.0%	0.0%	0.0%	8.8%	0.0%	65.48	62.78	59.84	56.64	53.16	49.38	45.26	40.79	35.92	30.62	24.86	18.59	11.77	4.35	(3.72)	(12.49)	(22.04)	(32.43)	361
Wet Season Rice	0.0%	0.0%	0.0%	8.8%	0.0%	609.70	561.66	509.40	452.56	390.72	323.45	250.28	170.68	84.10	(10.09)	(112.55)	(224.00)	(345.23)	(477.11)	(620.57)	(776.63)	(946.38)	(1,131.04)	1,104
Dry Season Rice	0.0%	0.0%	0.0%	8.8%	0.0%	146.43	140.93	134.94	128.42	121.34	113.63	105.25	96.13	86.21	75.41	63.67	50.90	37.01	21.90	5.47	(12.42)	(31.87)	(53.02)	859
Vegetables	0.0%	0.0%	0.0%	8.8%	0.0%	75.47	71.65	67.51	62.99	58.08	52.74	46.94	40.62	33.74	26.27	18.13	9.29	(0.34)	(10.81)	(22.19)	(34.58)	(48.06)	(62.72)	347
						1,067.90	**1,001.23**	**928.72**	**849.84**	**764.04**	**670.70**	**569.17**	**458.72**	**338.57**	**207.88**	**65.72**	**(88.93)**	**(257.16)**	**(440.15)**	**(639.22)**	**(855.75)**	**(1,091.30)**	**(1,347.53)**	3,655
						-	-6.2%	-13.0%	-20.4%	-28.5%	-37.2%	-46.7%	-57.0%	-68.3%	-80.5%	-93.8%	-108.3%	-124.1%	-141.2%	-159.9%	-180.1%	-202.2%	-226.2%	7,331

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Scenario C4						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
GROSS MARGINS (million $)	Seeds	Fertilizers	Other inputs	Labor	Services	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Cassava	0.0%	0.0%	0.0%	0.0%	1.9%	170.82	168.89	166.94	164.94	162.91	160.84	158.72	156.57	154.38	152.14	149.86	147.54	145.17	142.75	140.29	137.79	135.23	132.62	1,503
Maize	0.0%	0.0%	0.0%	0.0%	1.9%	65.48	64.81	64.13	63.44	62.74	62.02	61.28	60.54	59.77	59.00	58.21	57.40	56.58	55.74	54.89	54.02	53.13	52.23	581
Wet Season Rice	0.0%	0.0%	0.0%	0.0%	1.9%	609.70	601.52	593.18	584.67	576.01	567.18	558.17	549.00	539.64	530.11	520.39	510.49	500.40	490.11	479.62	468.93	458.04	446.94	5,272
Dry Season Rice	0.0%	0.0%	0.0%	0.0%	1.9%	146.43	143.75	141.02	138.23	135.40	132.50	129.56	126.55	123.49	120.37	117.19	113.94	110.64	107.27	103.84	100.34	96.77	93.13	1,217
Vegetables	0.0%	0.0%	0.0%	0.0%	1.9%	75.47	75.40	75.33	75.26	75.18	75.11	75.03	74.95	74.87	74.79	74.71	74.63	74.54	74.46	74.37	74.28	74.18	74.09	717
						1,067.90	**1,054.38**	**1,040.59**	**1,026.55**	**1,012.23**	**997.64**	**982.77**	**967.61**	**952.16**	**936.41**	**920.36**	**904.00**	**887.32**	**870.33**	**853.01**	**835.35**	**817.35**	**799.01**	9,290
						-	-1.3%	-2.6%	-3.9%	-5.2%	-6.6%	-8.0%	-9.4%	-10.8%	-12.3%	-13.8%	-15.3%	-16.9%	-18.5%	-20.1%	-21.8%	-23.5%	-25.2%	930
Scenario C5						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
GROSS MARGINS (million $)	Seeds	Fertilizers	Other inputs	Labor	Services	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Cassava	0.0%	0.0%	0.0%	0.0%	0.0%	170.82	159.64	148.75	138.14	127.80	117.72	107.90	98.33	89.00	79.92	71.06	62.43	54.02	45.82	37.84	30.06	22.47	15.08	1,010
Maize	0.0%	0.0%	0.0%	0.0%	0.0%	65.48	64.57	63.67	62.78	61.89	61.00	60.12	59.25	58.37	57.51	56.65	55.79	54.94	54.09	53.25	52.42	51.58	50.76	571
Wet Season Rice	0.0%	0.0%	0.0%	0.0%	0.0%	609.70	582.43	555.55	529.07	502.97	477.24	451.89	426.91	402.30	378.04	354.13	330.57	307.35	284.47	261.92	239.70	217.80	196.22	4,233
Dry Season Rice	0.0%	0.0%	0.0%	0.0%	0.0%	146.43	141.12	135.86	130.66	125.52	120.44	115.40	110.43	105.50	100.63	95.82	91.05	86.34	81.67	77.06	72.50	67.98	63.52	1,084
Vegetables	0.0%	0.0%	0.0%	0.0%	0.0%	75.47	72.49	69.58	66.72	63.91	61.16	58.46	55.81	53.22	50.68	48.18	45.73	43.33	40.98	38.67	36.41	34.19	32.01	551
						1,067.90	**1,020.25**	**973.42**	**927.36**	**882.08**	**837.56**	**793.78**	**750.73**	**708.40**	**666.77**	**625.83**	**585.57**	**545.98**	**507.04**	**468.74**	**431.08**	**394.03**	**357.59**	7,449
						-	-4.5%	-8.8%	-13.2%	-17.4%	-21.6%	-25.7%	-29.7%	-33.7%	-37.6%	-41.4%	-45.2%	-48.9%	-52.5%	-56.1%	-59.6%	-63.1%	-66.5%	3,537
0.0%						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
0	Seeds	Fertilizers	Other inputs	Labor	Services	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Cassava	0.0%	0.0%	0.0%	0.0%	0.0%	170.82	185.46	200.59	216.23	232.39	249.09	266.34	284.18	302.61	321.66	341.34	361.68	382.71	404.43	426.88	450.08	474.06	498.84	2,715
Maize	0.0%	0.0%	0.0%	0.0%	0.0%	65.48	71.91	78.59	85.54	92.77	100.30	108.12	116.26	124.72	133.52	142.68	152.20	162.10	172.41	183.12	194.26	205.86	217.91	1,117
Wet Season Rice	0.0%	0.0%	0.0%	0.0%	0.0%	609.70	661.74	715.21	770.17	826.65	884.70	944.36	1,005.67	1,068.68	1,133.43	1,199.98	1,268.38	1,338.67	1,410.91	1,485.15	1,561.45	1,639.86	1,720.45	9,567
Dry Season Rice	0.0%	0.0%	0.0%	0.0%	0.0%	146.43	160.68	175.35	190.44	205.97	221.95	238.40	255.32	272.73	290.65	309.08	328.05	347.57	367.66	388.33	409.59	431.48	454.00	2,430
Vegetables	0.0%	0.0%	0.0%	0.0%	0.0%	75.47	78.19	80.97	83.79	86.67	89.59	92.57	95.60	98.68	101.82	105.01	108.26	111.57	114.94	118.36	121.85	125.40	129.01	908
						1,067.90	**1,157.98**	**1,250.71**	**1,346.18**	**1,444.46**	**1,545.63**	**1,649.79**	**1,757.02**	**1,867.42**	**1,981.08**	**2,098.10**	**2,218.58**	**2,342.62**	**2,470.34**	**2,601.84**	**2,737.24**	**2,876.65**	**3,020.20**	16,739
						-	8.4%	17.1%	26.1%	35.3%	44.7%	54.5%	64.5%	74.9%	85.5%	96.5%	107.8%	119.4%	131.3%	143.6%	156.3%	169.4%	182.8%	6,519

Table 116: Summary of gross margins and NPV for Competitiveness scenarios (C1 through C6)

	Gross Margins 2019 (million $)	Gross Margins 2030 (million $)	NPV at CPI (million $)	NPV Changes
Baseline	**1,068**	**1,068**	**10,220**	
C1: Equal Increase	1,147	1,244	**10,986**	7.5%
C2:↑ Output price half of ↑ inputs	629	(1,577)	**3,761**	-63.2%
C3: Wage Rate ↑ 50%	569	(1,348)	**3,655**	-64.2%
C4: Cost of Services ↑ 25%	983	799	**9,290**	-9.1%
C5: Output price ↓ 15%	794	358	**7,449**	-27.1%
C6: Output price ↑ 15%	1,650	3,020	**16,739**	63.8%

Table 117: Return to labor for Competitiveness scenarios (C1 through C6)

RETURN TO LABOR ($/day)																		
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RETURN TO LABOR ($/day)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36
Maize	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70	9.70
Wet Season Rice	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08
Dry Season Rice	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65	10.65
Vegetables	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92
	6.67	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**	**6.67**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Scenario C1	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RETURN TO LABOR ($/day)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	10.36	10.90	11.45	12.03	12.64	13.26	13.92	14.60	15.30	16.04	16.80	17.60	18.42	19.28	20.17	21.10	22.06	23.06
Maize	9.70	9.43	9.13	8.81	8.47	8.11	7.72	7.30	6.85	6.38	5.87	5.33	4.76	4.15	3.50	2.80	2.06	1.28
Wet Season Rice	5.08	5.13	5.17	5.21	5.25	5.29	5.32	5.34	5.36	5.38	5.39	5.40	5.40	5.39	5.38	5.35	5.32	5.29
Dry Season Rice	10.65	10.58	10.50	10.40	10.29	10.16	10.02	9.86	9.68	9.49	9.27	9.04	8.78	8.50	8.20	7.86	7.51	7.12
Vegetables	7.92	8.16	8.41	8.66	8.92	9.19	9.46	9.74	10.02	10.31	10.61	10.92	11.23	11.56	11.88	12.22	12.56	12.92
	6.67	**6.73**	**6.79**	**6.84**	**6.89**	**6.94**	**6.98**	**7.02**	**7.06**	**7.09**	**7.11**	**7.13**	**7.14**	**7.15**	**7.14**	**7.13**	**7.11**	**7.09**
	-	0.9%	1.8%	2.6%	3.4%	4.1%	4.7%	5.3%	5.8%	6.3%	6.6%	6.9%	7.1%	7.2%	7.1%	7.0%	6.7%	6.3%
Scenario C2	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RETURN TO LABOR ($/day)	0	1	2	3	4	5	6	7	8	9								
Cassava	10.36	10.30	10.18	10.00	9.75	9.42	8.99	8.46	7.80	7.02	6.08	4.97	3.67	2.16	0.40	(1.62)	(3.95)	(6.61)
Maize	9.70	8.93	8.06	7.10	6.03	4.85	3.53	2.07	0.44	(1.37)	(3.37)	(5.60)	(8.08)	(10.83)	(13.89)	(17.30)	(21.09)	(25.30)
Wet Season Rice	5.08	4.80	4.47	4.11	3.70	3.23	2.72	2.14	1.49	0.78	(0.02)	(0.89)	(1.87)	(2.94)	(4.13)	(5.43)	(6.87)	(8.45)
Dry Season Rice	10.65	9.86	8.99	8.03	6.97	5.79	4.50	3.07	1.51	(0.21)	(2.09)	(4.16)	(6.42)	(8.89)	(11.60)	(14.56)	(17.80)	(21.34)
Vegetables	7.92	7.88	7.82	7.72	7.60	7.43	7.23	6.99	6.70	6.36	5.96	5.49	4.96	4.35	3.65	2.86	1.97	0.97
	6.67	**6.31**	**5.90**	**5.44**	**4.92**	**4.33**	**3.67**	**2.93**	**2.11**	**1.18**	**0.16**	**(0.98)**	**(2.24)**	**(3.65)**	**(5.20)**	**(6.92)**	**(8.82)**	**(10.92)**
	-	-5.4%	-11.5%	-18.4%	-26.3%	-35.1%	-45.0%	-56.0%	-68.4%	-82.2%	-97.6%	-114.7%	-133.7%	-154.7%	-178.0%	-203.8%	-232.3%	-263.8%
Scenario C3	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RETURN TO LABOR ($/day)	0	1	2	3	4	5	6	7	8	9								
Cassava	10.36	9.96	9.53	9.05	8.54	7.98	7.37	6.70	5.98	5.20	4.34	3.41	2.40	1.30	0.11	(1.19)	(2.61)	(4.14)
Maize	9.70	9.30	8.87	8.39	7.88	7.32	6.71	6.04	5.32	4.54	3.68	2.75	1.74	0.64	(0.55)	(1.85)	(3.27)	(4.80)
Wet Season Rice	5.08	4.68	4.25	3.77	3.26	2.70	2.09	1.42	0.70	(0.08)	(0.94)	(1.87)	(2.88)	(3.98)	(5.17)	(6.47)	(7.89)	(9.43)
Dry Season Rice	10.65	10.25	9.81	9.34	8.83	8.26	7.65	6.99	6.27	5.49	4.63	3.70	2.69	1.59	0.40	(0.90)	(2.32)	(3.86)
Vegetables	7.92	7.52	7.09	6.61	6.10	5.54	4.93	4.26	3.54	2.76	1.90	0.97	(0.04)	(1.13)	(2.33)	(3.63)	(5.05)	(6.58)
	6.67	**6.27**	**5.83**	**5.36**	**4.84**	**4.28**	**3.67**	**3.01**	**2.29**	**1.50**	**0.65**	**(0.28)**	**(1.29)**	**(2.39)**	**(3.58)**	**(4.89)**	**(6.30)**	**(7.84)**
	-	-6.0%	-12.5%	-19.6%	-27.4%	-35.8%	-44.9%	-54.9%	-65.7%	-77.5%	-90.3%	-104.2%	-119.4%	-135.8%	-153.8%	-173.3%	-194.5%	-217.6%

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Scenario C4	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RETURN TO LABOR ($/day)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	10.36	10.25	10.13	10.01	9.88	9.76	9.63	9.50	9.36	9.23	9.09	8.95	8.81	8.66	8.51	8.36	8.20	8.05
Maize	9.70	9.60	9.50	9.40	9.30	9.19	9.08	8.97	8.86	8.74	8.62	8.51	8.38	8.26	8.13	8.00	7.87	7.74
Wet Season Rice	5.08	5.01	4.94	4.87	4.80	4.73	4.65	4.58	4.50	4.42	4.34	4.25	4.17	4.08	4.00	3.91	3.82	3.72
Dry Season Rice	10.65	10.46	10.26	10.05	9.85	9.64	9.42	9.20	8.98	8.75	8.52	8.29	8.05	7.80	7.55	7.30	7.04	6.77
Vegetables	7.92	7.92	7.91	7.90	7.89	7.88	7.88	7.87	7.86	7.85	7.84	7.83	7.83	7.82	7.81	7.80	7.79	7.78
	6.67	**6.58**	**6.48**	**6.39**	**6.29**	**6.19**	**6.09**	**5.99**	**5.89**	**5.78**	**5.67**	**5.56**	**5.45**	**5.34**	**5.22**	**5.10**	**4.98**	**4.85**
	-	-1.4%	-2.8%	-4.2%	-5.6%	-7.1%	-8.6%	-10.1%	-11.7%	-13.3%	-14.9%	-16.6%	-18.3%	-20.0%	-21.7%	-23.5%	-25.3%	-27.2%
Scenario C5	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
RETURN TO LABOR ($/day)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	10.36	9.68	9.02	8.38	7.75	7.14	6.55	5.96	5.40	4.85	4.31	3.79	3.28	2.78	2.30	1.82	1.36	0.91
Maize	9.70	9.57	9.43	9.30	9.17	9.04	8.91	8.78	8.65	8.52	8.39	8.27	8.14	8.02	7.89	7.77	7.64	7.52
Wet Season Rice	5.08	4.85	4.63	4.41	4.19	3.98	3.77	3.56	3.35	3.15	2.95	2.75	2.56	2.37	2.18	2.00	1.82	1.64
Dry Season Rice	10.65	10.26	9.88	9.50	9.13	8.76	8.39	8.03	7.67	7.32	6.97	6.62	6.28	5.94	5.60	5.27	4.94	4.62
Vegetables	7.92	7.61	7.30	7.00	6.71	6.42	6.14	5.86	5.59	5.32	5.06	4.80	4.55	4.30	4.06	3.82	3.59	3.36
	6.67	**6.38**	**6.10**	**5.82**	**5.55**	**5.28**	**5.01**	**4.75**	**4.49**	**4.24**	**3.99**	**3.75**	**3.51**	**3.27**	**3.04**	**2.81**	**2.58**	**2.36**
	-	-4.3%	-8.6%	-12.7%	-16.8%	-20.9%	-24.8%	-28.8%	-32.6%	-36.4%	-40.1%	-43.8%	-47.4%	-51.0%	-54.5%	-57.9%	-61.3%	-64.6%
Scenario C6	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
RETURN TO LABOR ($/day)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	10.36	11.25	12.17	13.12	14.10	15.11	16.16	17.24	18.36	19.51	20.71	21.94	23.22	24.53	25.90	27.30	28.76	30.26
Maize	9.70	10.65	11.64	12.67	13.75	14.86	16.02	17.23	18.48	19.78	21.14	22.55	24.02	25.54	27.13	28.78	30.50	32.29
Wet Season Rice	5.08	5.51	5.96	6.42	6.89	7.37	7.87	8.38	8.91	9.45	10.00	10.57	11.16	11.76	12.38	13.01	13.67	14.34
Dry Season Rice	10.65	11.69	12.75	13.85	14.98	16.14	17.34	18.57	19.84	21.14	22.48	23.86	25.28	26.74	28.24	29.79	31.38	33.02
Vegetables	7.92	8.21	8.50	8.80	9.10	9.41	9.72	10.04	10.36	10.69	11.02	11.37	11.71	12.07	12.43	12.79	13.16	13.54
	6.67	**7.26**	**7.86**	**8.49**	**9.13**	**9.79**	**10.48**	**11.18**	**11.90**	**12.65**	**13.42**	**14.21**	**15.02**	**15.86**	**16.73**	**17.62**	**18.54**	**19.48**
	-	8.8%	17.9%	27.3%	36.9%	46.9%	57.1%	67.6%	78.5%	89.7%	101.2%	113.1%	125.3%	137.9%	150.9%	164.2%	178.0%	192.2%

Table 118: Demand for labor and demand for fertilizers with Competitiveness scenarios

	Assumptions: Price change will not affect demand for labor (Inelastic demand) - Changes are due to change on cultivated areas																	
DEMAND FOR LABOR (Million days)																		
All Scenarii	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
DEMAND FOR LABOR (Million	0	1	2	3	4	5	6	7	8	9	9	9	9	9	9	9	9	9
Cassava	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48
Maize	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75
Wet Season Rice	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00
Dry Season Rice	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75	13.75
Vegetables	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53
	166.51	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**	**166.51**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Assumptions: Price change will not affect demand for fertilizers (Inelastic demand) - Changes are due to change on cultivated areas																	
DEMAND FOR FERTILIZERS (tons)																		
All Scenarii	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
DEMAND FOR FERTILIZERS (to	0	1	2	3	4	5	6	7	8	9	9	9	9	9	9	9	9	9
Cassava	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578	4,578
Maize	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507	11,507
Wet Season Rice	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408
Dry Season Rice	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722
Vegetables	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646	18,646
	464,861	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**	**464,861**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 119: Characteristics of rice production: fragrant vs. IRRI

Revenue	Yield by technology use (tons/ha)			Output Prices by technology use ($/ton)			Revenue by technology use and total			150%
	FRAGRANT	OTHER	TOTAL	FRAGRANT	OTHER	TOTAL	FRAGRANT	OTHER	TOTAL	FRAGRANT
Wet Season Rice	2.50	2.91	2.89	444.52	254.01	261.43	1,111.29	739.30	757.90	1,587.56
Dry Season Rice	3.50	4.87	4.80	352.14	201.22	206.73	1,232.47	979.62	992.27	1,760.68
Seeds	Seeds by farm size (unit/ha)			Seed Prices by farm size ($/unit)			Costs of seeds by farm size and total			
	FRAGRANT	OTHER	TOTAL	FRAGRANT	OTHER	TOTAL	FRAGRANT	OTHER	TOTAL	FRAGRANT
Wet Season Rice	38.82	38.82	38.82	1.32	0.63	0.66	51.24	24.26	25.61	51.24
Dry Season Rice	146.07	146.07	146.07	1.48	0.70	0.74	216.18	102.40	108.08	216.18
Fertilizer	Fertilizer use by farm size (kg/ha)			Fertilizer Prices by farm size ($/kg)			Costs of fertilizers by farm size and total			
	FRAGRANT	IRRI	TOTAL	FRAGRANT	IRRI	TOTAL	FRAGRANT	IRRI	TOTAL	FRAGRANT
Wet Season Rice	118.48	118.48	118.48	0.56	0.56	0.56	66.35	66.35	66.35	66.35
Dry Season Rice	273.93	273.93	273.93	0.56	0.56	0.56	153.40	153.40	153.40	153.40
Other Inputs							Other input Costs ($/ha)			
							FRAGRANT	IRRI	TOTAL	FRAGRANT
Wet Season Rice							26.88	26.88	26.88	26.88
Dry Season Rice							27.73	27.73	27.73	27.73
Labor	Labor use by technology (days/ha)			Wage rate by technology ($/day)			Costs of labor by technology and total			
	FRAGRANT	IRRI	TOTAL	FRAGRANT	IRRI	TOTAL	FRAGRANT	IRRI	TOTAL	FRAGRANT
Wet Season Rice	48.29	48.29	48.29	4.56	4.56	4.56	220.21	220.21	220.21	220.21
Dry Season Rice	27.75	27.75	27.75	4.56	4.56	4.56	126.54	126.54	126.54	126.54
Services							Service Costs ($/ha)			
							FRAGRANT	IRRI	TOTAL	FRAGRANT
Wet Season Rice							171.10	171.10	171.10	171.10
Dry Season Rice							206.29	206.29	206.29	206.29
Irrigation							Irrigation Costs ($/ha)			
							FRAGRANT	IRRI	TOTAL	FRAGRANT
Wet Season Rice										-
Dry Season Rice							74.69	74.69	74.69	74.69
Gross Margins							Gross Margins ($/ha)			
							FRAGRANT	IRRI	TOTAL	FRAGRANT
Wet Season Rice							575.51	230.50	247.75	1,051.78
Dry Season Rice							427.64	288.58	295.53	955.84

Table 120: Cultivated land areas for fragrant rice Income Growth scenarios

CULTIVATED LAND (Ha)																			
Baseline	% by crop	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: FRAGRANT		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Wet Season Rice		124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242	124,242
Dry Season Rice		24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773	24,773
		149,015	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**	**149,015**
		-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cultivated land: OTHER																			
Wet Season Rice		2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590	2,360,590
Dry Season Rice		470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692	470,692
		2,831,282	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**	**2,831,282**
		-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cultivated land: TOTAL																			
Wet Season Rice		2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice		495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
		2,980,297	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**
		-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Scenario I1	% by crop	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: FRAGRANT																			
Wet Season Rice		124,242	129,460	134,897	140,563	146,466	152,618	159,028	165,707	172,667	179,919	187,475	195,349	203,554	212,103	221,012	230,294	239,966	250,045
Dry Season Rice		24,773	25,814	26,898	28,028	29,205	30,431	31,709	33,041	34,429	35,875	37,382	38,952	40,588	42,292	44,069	45,920	47,848	49,858
		149,015	**155,273**	**161,795**	**168,590**	**175,671**	**183,049**	**190,737**	**198,748**	**207,096**	**215,794**	**224,857**	**234,301**	**244,142**	**254,396**	**265,080**	**276,214**	**287,815**	**299,903**
		-	4.2%	8.6%	13.1%	17.9%	22.8%	28.0%	33.4%	39.0%	44.8%	50.9%	57.2%	63.8%	70.7%	77.9%	85.4%	93.1%	101.3%
Cultivated land: OTHER																			
Wet Season Rice		2,360,590	2,355,372	2,349,935	2,344,269	2,338,366	2,332,214	2,325,804	2,319,125	2,312,165	2,304,913	2,297,357	2,289,483	2,281,278	2,272,729	2,263,820	2,254,538	2,244,866	2,234,787
Dry Season Rice		470,692	469,651	468,567	467,437	466,260	465,034	463,756	462,424	461,036	459,590	458,083	456,513	454,877	453,173	451,396	449,545	447,617	445,607
		2,831,282	**2,825,024**	**2,818,502**	**2,811,707**	**2,804,626**	**2,797,248**	**2,789,560**	**2,781,549**	**2,773,201**	**2,764,503**	**2,755,440**	**2,745,996**	**2,736,155**	**2,725,901**	**2,715,217**	**2,704,083**	**2,692,482**	**2,680,394**
		-	-0.2%	-0.5%	-0.7%	-0.9%	-1.2%	-1.5%	-1.8%	-2.1%	-2.4%	-2.7%	-3.0%	-3.4%	-3.7%	-4.1%	-4.5%	-4.9%	-5.3%
Cultivated land: TOTAL																			
Wet Season Rice		2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice		495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
		2,980,297	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**
		5.0%	5.2%	5.4%	5.7%	5.9%	6.1%	6.4%	6.7%	6.9%	7.2%	7.5%	7.9%	8.2%	8.5%	8.9%	9.3%	9.7%	10.1%
Scenario I2	% by crop	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: FRAGRANT																			
Wet Season Rice		124,242	136,542	150,059	164,915	181,242	199,184	218,904	240,575	264,392	290,567	319,333	350,947	385,691	423,874	465,838	511,956	562,639	618,341
Dry Season Rice		24,773	27,226	29,921	32,883	36,139	39,717	43,648	47,970	52,719	57,938	63,674	69,977	76,905	84,519	92,886	102,082	112,188	123,295
		149,015	**163,767**	**179,980**	**197,798**	**217,380**	**238,901**	**262,552**	**288,545**	**317,111**	**348,505**	**383,007**	**420,924**	**462,596**	**508,393**	**558,724**	**614,038**	**674,827**	**741,635**
		-	9.9%	20.8%	32.7%	45.9%	60.3%	76.2%	93.6%	112.8%	133.9%	157.0%	182.5%	210.4%	241.2%	274.9%	312.1%	352.9%	397.7%
Cultivated land: OTHER																			
Wet Season Rice		2,360,590	2,348,290	2,334,773	2,319,917	2,303,590	2,285,648	2,265,928	2,244,257	2,220,440	2,194,265	2,165,499	2,133,885	2,099,141	2,060,958	2,018,994	1,972,876	1,922,193	1,866,491
Dry Season Rice		470,692	468,239	465,544	462,582	459,326	455,748	451,817	447,495	442,746	437,527	431,791	425,488	418,560	410,946	402,579	393,383	383,277	372,170
		2,831,282	**2,816,530**	**2,800,317**	**2,782,499**	**2,762,917**	**2,741,396**	**2,717,745**	**2,691,752**	**2,663,186**	**2,631,792**	**2,597,290**	**2,559,373**	**2,517,701**	**2,471,904**	**2,421,573**	**2,366,259**	**2,305,470**	**2,238,662**
		-	-0.5%	-1.1%	-1.7%	-2.4%	-3.2%	-4.0%	-4.9%	-5.9%	-7.0%	-8.3%	-9.6%	-11.1%	-12.7%	-14.5%	-16.4%	-18.6%	-20.9%
Cultivated land: TOTAL																			
Wet Season Rice		2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice		495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
		2,980,297	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**	**2,980,297**
% Fragrant		5.0%	5.5%	6.0%	6.6%	7.3%	8.0%	8.8%	9.7%	10.6%	11.7%	12.9%	14.1%	15.5%	17.1%	18.7%	20.6%	22.6%	24.9%

Table 121: Gross margins for fragrant rice Income Growth scenarios

GROSS MARGINS (million $) --->																			
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
FRAGRANT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Wet Season Rice	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	71.50	$684
Dry Season Rice	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	10.59	$101
	82.10	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	**82.10**	$786
OTHER																			
Wet Season Rice	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	544.12	$5,207
Dry Season Rice	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	135.83	$1,300
	679.95	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	**679.95**	$6,507
TOTAL																			
Wet Season Rice	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	615.62	$5,892
Dry Season Rice	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	146.43	$1,401
	762.04	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	**762.04**	$7,293
Scenario I1	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
FRAGRANT	0	1	2	3	4	5	6	7	8	9									
Wet Season Rice	71.50	74.51	77.63	80.90	84.29	87.83	91.52	95.37	99.37	103.55	107.89	112.43	117.15	122.07	127.19	132.54	138.10	143.90	$916
Dry Season Rice	10.59	11.04	11.50	11.99	12.49	13.01	13.56	14.13	14.72	15.34	15.99	16.66	17.36	18.09	18.85	19.64	20.46	21.32	$136
	82.10	**85.54**	**89.14**	**92.88**	**96.78**	**100.85**	**105.08**	**109.50**	**114.09**	**118.89**	**123.88**	**129.08**	**134.50**	**140.15**	**146.04**	**152.17**	**158.57**	**165.22**	$1,051
	-	4.2%	8.6%	13.1%	17.9%	22.8%	28.0%	33.4%	39.0%	44.8%	50.9%	57.2%	63.8%	70.7%	77.9%	85.4%	93.1%	101.3%	
OTHER																			
Wet Season Rice	544.12	542.91	541.66	540.35	538.99	537.58	536.10	534.56	532.95	531.28	529.54	527.73	525.84	523.86	521.81	519.67	517.44	515.12	$5,115
Dry Season Rice	135.83	135.53	135.22	134.89	134.55	134.20	133.83	133.45	133.05	132.63	132.19	131.74	131.27	130.78	130.26	129.73	129.17	128.59	$1,277
	679.95	**678.45**	**676.88**	**675.25**	**673.55**	**671.77**	**669.93**	**668.00**	**666.00**	**663.91**	**661.73**	**659.47**	**657.10**	**654.64**	**652.07**	**649.40**	**646.61**	**643.71**	$6,391
	-	-0.2%	-0.5%	-0.7%	-0.9%	-1.2%	-1.5%	-1.8%	-2.1%	-2.4%	-2.7%	-3.0%	-3.4%	-3.7%	-4.1%	-4.5%	-4.9%	-5.3%	
TOTAL																			
Wet Season Rice	615.62	617.42	619.30	621.25	623.29	625.41	627.62	629.93	632.33	634.83	637.44	640.15	642.98	645.93	649.01	652.21	655.55	659.02	$6,030
Dry Season Rice	146.43	146.57	146.72	146.88	147.04	147.21	147.39	147.58	147.77	147.97	148.18	148.40	148.62	148.86	149.11	149.37	149.63	149.91	$1,412
	762.04	**763.99**	**766.02**	**768.13**	**770.33**	**772.62**	**775.01**	**777.50**	**780.09**	**782.80**	**785.61**	**788.55**	**791.61**	**794.79**	**798.11**	**801.57**	**805.18**	**808.94**	$7,443
		0.3%	0.5%	0.8%	1.1%	1.4%	1.7%	2.0%	2.4%	2.7%	3.1%	3.5%	3.9%	4.3%	4.7%	5.2%	5.7%	6.2%	
Scenario I2	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
FRAGRANT																			
Wet Season Rice	71.50	78.58	86.36	94.91	104.31	114.63	125.98	138.45	152.16	167.22	183.78	201.97	221.97	243.94	268.09	294.64	323.81	355.86	$1,427
Dry Season Rice	10.59	11.64	12.80	14.06	15.45	16.98	18.67	20.51	22.54	24.78	27.23	29.93	32.89	36.14	39.72	43.65	47.98	52.73	$211
	82.10	**90.22**	**99.16**	**108.97**	**119.76**	**131.62**	**144.65**	**158.97**	**174.71**	**192.00**	**211.01**	**231.90**	**254.86**	**280.09**	**307.82**	**338.29**	**371.78**	**408.59**	$1,638
	-	9.9%	20.8%	32.7%	45.9%	60.3%	76.2%	93.6%	112.8%	133.9%	157.0%	182.5%	210.4%	241.2%	274.9%	312.1%	352.9%	397.7%	
OTHER																			
Wet Season Rice	544.12	541.28	538.17	534.74	530.98	526.84	522.30	517.30	511.81	505.78	499.15	491.86	483.85	475.05	465.38	454.75	443.07	430.23	$4,910
Dry Season Rice	135.83	135.12	134.35	133.49	132.55	131.52	130.38	129.14	127.77	126.26	124.61	122.79	120.79	118.59	116.18	113.52	110.61	107.40	$1,226
	679.95	**676.41**	**672.51**	**668.23**	**663.53**	**658.36**	**652.68**	**646.44**	**639.58**	**632.04**	**623.75**	**614.65**	**604.64**	**593.64**	**581.55**	**568.27**	**553.67**	**537.63**	$6,136
	-	-0.5%	-1.1%	-1.7%	-2.4%	-3.2%	-4.0%	-4.9%	-5.9%	-7.0%	-8.3%	-9.6%	-11.1%	-12.7%	-14.5%	-16.4%	-18.6%	-20.9%	
TOTAL																			
Wet Season Rice	615.62	619.86	624.53	629.65	635.28	641.48	648.28	655.76	663.97	673.00	682.93	693.84	705.82	719.00	733.47	749.38	766.87	786.09	$6,337
Dry Season Rice	146.43	146.77	147.14	147.55	148.01	148.50	149.05	149.65	150.31	151.04	151.84	152.71	153.68	154.73	155.90	157.18	158.58	160.13	$1,437
	762.04	**766.63**	**771.67**	**777.21**	**783.29**	**789.98**	**797.33**	**805.41**	**814.28**	**824.04**	**834.76**	**846.55**	**859.50**	**873.73**	**889.37**	**906.56**	**925.45**	**946.21**	$7,774
	-	0.6%	1.3%	2.0%	2.8%	3.7%	4.6%	5.7%	6.9%	8.1%	9.5%	11.1%	12.8%	14.7%	16.7%	19.0%	21.4%	24.2%	

Table 122: Summary of gross margins for fragrant rice Income Growth scenarios

	Gross Margins 2014 (million $)	Gross Margins 2030 (million $)	NPV at CPI (million $)	% Change NPV
Baseline	762.04	762.04	7,293	
Fragrant 10%, Price 100%	763.99	808.94	7,443	2.1%
Fragrant 25%, price 100%	766.63	946.21	7,774	6.6%

Table 123: Demand for labor, return to labor and demand for fertilizers for fragrant rice Income Growth scenarios

DEMAND FOR LABOR (Million days)																		
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario R1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Wet Season Rice	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30	120.30
Dry Season Rice	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78	13.78
	134.08	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**	**134.08**
AVERAGE RETURN TO LABOR ($/DAY)																		
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68
Fragrant 10%, Price 100%	5.68	5.70	5.71	5.73	5.75	5.76	5.78	5.80	5.82	5.84	5.86	5.88	5.90	5.93	5.95	5.98	6.01	6.03
Fragrant 25%, price 100%	5.68	5.72	5.76	5.80	5.84	5.89	5.95	6.01	6.07	6.15	6.23	6.31	6.41	6.52	6.63	6.76	6.90	7.06
DEMAND FOR FERTILIZERS (Tons)																		
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Wet Season Rice	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408	294,408
Dry Season Rice	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722	135,722
	430,130	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**	**430,130**
Land under Cultivation (Ha)																		
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fragrant (10%)	149,015	149,015	155,273	161,795	168,590	175,671	183,049	190,737	198,748	207,096	215,794	224,857	234,301	244,142	254,396	265,080	276,214	287,815
Other (90%)	2,831,282	2,831,282	2,825,024	2,818,502	2,811,707	2,804,626	2,797,248	2,789,560	2,781,549	2,773,201	2,764,503	2,755,440	2,745,996	2,736,155	2,725,901	2,715,217	2,704,083	2,692,482
Fragrant (25%)	149,015	163,767	179,980	197,798	217,380	238,901	262,552	288,545	317,111	348,505	383,007	420,924	462,596	508,393	558,724	614,038	674,827	741,635
Other (75%)	2,831,282	2,816,530	2,800,317	2,782,499	2,762,917	2,741,396	2,717,745	2,691,752	2,663,186	2,631,792	2,597,290	2,559,373	2,517,701	2,471,904	2,421,573	2,366,259	2,305,470	2,238,662

Table 124: Cultivated land areas for cassava processing Income Growth scenarios

CULTIVATED LAND (Ha)																			
Baseline	% by crop	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: PROCESSED		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava		16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890	16,890
		16,890	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**	**16,890**
		-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cultivated land: OTHER																			
Cassava		320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910	320,910
		320,910	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**	**320,910**
		-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cultivated land: TOTAL																			
Cassava		337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
		337,800	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**
		-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Scenario I3	% by crop	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: PROCESSED																			
Cassava		16,890	17,599	18,339	19,109	19,911	20,748	21,619	22,527	23,473	24,459	25,486	26,557	27,672	28,834	30,045	31,307	32,622	33,992
		16,890	**17,599**	**18,339**	**19,109**	**19,911**	**20,748**	**21,619**	**22,527**	**23,473**	**24,459**	**25,486**	**26,557**	**27,672**	**28,834**	**30,045**	**31,307**	**32,622**	**33,992**
		-	4.2%	8.6%	13.1%	17.9%	22.8%	28.0%	33.4%	39.0%	44.8%	50.9%	57.2%	63.8%	70.7%	77.9%	85.4%	93.1%	101.3%
Cultivated land: OTHER																			
Cassava		320,910	320,201	319,461	318,691	317,889	317,052	316,181	315,273	314,327	313,341	312,314	311,243	310,128	308,966	307,755	306,493	305,178	303,808
		320,910	**320,201**	**319,461**	**318,691**	**317,889**	**317,052**	**316,181**	**315,273**	**314,327**	**313,341**	**312,314**	**311,243**	**310,128**	**308,966**	**307,755**	**306,493**	**305,178**	**303,808**
		-	-0.2%	-0.5%	-0.7%	-0.9%	-1.2%	-1.5%	-1.8%	-2.1%	-2.4%	-2.7%	-3.0%	-3.4%	-3.7%	-4.1%	-4.5%	-4.9%	-5.3%
Cultivated land: TOTAL																			
Cassava		337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
		337,800	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**
		5.0%	5.2%	5.4%	5.7%	5.9%	6.1%	6.4%	6.7%	6.9%	7.2%	7.5%	7.9%	8.2%	8.5%	8.9%	9.3%	9.7%	10.1%
Scenario I4	% by crop	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: PROCESSED																			
Cassava		16,890	18,562	20,400	22,419	24,639	27,078	29,759	32,705	35,943	39,501	43,412	47,709	52,433	57,624	63,328	69,598	76,488	84,060
		16,890	**18,562**	**20,400**	**22,419**	**24,639**	**27,078**	**29,759**	**32,705**	**35,943**	**39,501**	**43,412**	**47,709**	**52,433**	**57,624**	**63,328**	**69,598**	**76,488**	**84,060**
		-	9.9%	20.8%	32.7%	45.9%	60.3%	76.2%	93.6%	112.8%	133.9%	157.0%	182.5%	210.4%	241.2%	274.9%	312.1%	352.9%	397.7%
Cultivated land: OTHER																			
Cassava		320,910	319,238	317,400	315,381	313,161	310,722	308,041	305,095	301,857	298,299	294,388	290,091	285,367	280,176	274,472	268,202	261,312	253,740
		320,910	**319,238**	**317,400**	**315,381**	**313,161**	**310,722**	**308,041**	**305,095**	**301,857**	**298,299**	**294,388**	**290,091**	**285,367**	**280,176**	**274,472**	**268,202**	**261,312**	**253,740**
		-	-0.5%	-1.1%	-1.7%	-2.4%	-3.2%	-4.0%	-4.9%	-5.9%	-7.0%	-8.3%	-9.6%	-11.1%	-12.7%	-14.5%	-16.4%	-18.6%	-20.9%
Cultivated land: TOTAL																			
Cassava		337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
		337,800	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**	**337,800**
% Processed		5.0%	5.5%	6.0%	6.6%	7.3%	8.0%	8.8%	9.7%	10.6%	11.7%	12.9%	14.1%	15.5%	17.1%	18.7%	20.6%	22.6%	24.9%

Table 125: Gross margins for cassava processing Income Growth scenarios (million $)

GROSS MARGINS (million $) --->																			
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
PROCESSED	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Wet Season	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98	$105
	10.98	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	**10.98**	$105
OTHER																			
Wet Season	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	144.55	$1,383
	144.55	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	**144.55**	$1,383
TOTAL																			
Wet Season	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	155.53	$1,488
	155.53	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	**155.53**	$1,488
Scenario I3	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
PROCESSED	0	1	2	3	4	5	6	7	8	9									
Wet Season	10.98	11.44	11.92	12.42	12.95	13.49	14.06	14.65	15.26	15.90	16.57	17.27	17.99	18.75	19.54	20.36	21.21	22.10	$141
	10.98	**11.44**	**11.92**	**12.42**	**12.95**	**13.49**	**14.06**	**14.65**	**15.26**	**15.90**	**16.57**	**17.27**	**17.99**	**18.75**	**19.54**	**20.36**	**21.21**	**22.10**	$141
	-	4.2%	8.6%	13.1%	17.9%	22.8%	28.0%	33.4%	39.0%	44.8%	50.9%	57.2%	63.8%	70.7%	77.9%	85.4%	93.1%	101.3%	
OTHER																			
Wet Season	144.55	144.23	143.89	143.55	143.19	142.81	142.42	142.01	141.58	141.14	140.67	140.19	139.69	139.17	138.62	138.05	137.46	136.84	$1,359
	144.55	**144.23**	**143.89**	**143.55**	**143.19**	**142.81**	**142.42**	**142.01**	**141.58**	**141.14**	**140.67**	**140.19**	**139.69**	**139.17**	**138.62**	**138.05**	**137.46**	**136.84**	$1,359
	-	-0.2%	-0.5%	-0.7%	-0.9%	-1.2%	-1.5%	-1.8%	-2.1%	-2.4%	-2.7%	-3.0%	-3.4%	-3.7%	-4.1%	-4.5%	-4.9%	-5.3%	
TOTAL																			
Wet Season	155.53	155.67	155.82	155.97	156.13	156.30	156.47	156.65	156.84	157.04	157.25	157.46	157.68	157.91	158.16	158.41	158.67	158.94	$1,499
	155.53	**155.67**	**155.82**	**155.97**	**156.13**	**156.30**	**156.47**	**156.65**	**156.84**	**157.04**	**157.25**	**157.46**	**157.68**	**157.91**	**158.16**	**158.41**	**158.67**	**158.94**	$1,499
		0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.7%	0.8%	1.0%	1.1%	1.2%	1.4%	1.5%	1.7%	1.9%	2.0%	2.2%	
Scenario I4	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	NPV
PROCESSED																			
Wet Season	10.98	12.07	13.26	14.58	16.02	17.61	19.35	21.26	23.37	25.68	28.23	31.02	34.09	37.47	41.18	45.25	49.73	54.66	$219
	10.98	**12.07**	**13.26**	**14.58**	**16.02**	**17.61**	**19.35**	**21.26**	**23.37**	**25.68**	**28.23**	**31.02**	**34.09**	**37.47**	**41.18**	**45.25**	**49.73**	**54.66**	$219
	-	9.9%	20.8%	32.7%	45.9%	60.3%	76.2%	93.6%	112.8%	133.9%	157.0%	182.5%	210.4%	241.2%	274.9%	312.1%	352.9%	397.7%	
OTHER																			
Wet Season	144.55	143.79	142.97	142.06	141.06	139.96	138.75	137.42	135.96	134.36	132.60	130.66	128.54	126.20	123.63	120.81	117.70	114.29	$1,304
	144.55	**143.79**	**142.97**	**142.06**	**141.06**	**139.96**	**138.75**	**137.42**	**135.96**	**134.36**	**132.60**	**130.66**	**128.54**	**126.20**	**123.63**	**120.81**	**117.70**	**114.29**	$1,304
	-	-0.5%	-1.1%	-1.7%	-2.4%	-3.2%	-4.0%	-4.9%	-5.9%	-7.0%	-8.3%	-9.6%	-11.1%	-12.7%	-14.5%	-16.4%	-18.6%	-20.9%	
TOTAL																			
Wet Season	155.53	155.86	156.23	156.63	157.08	157.56	158.10	158.69	159.33	160.05	160.83	161.69	162.63	163.67	164.81	166.06	167.43	168.95	$1,523
	155.53	**155.86**	**156.23**	**156.63**	**157.08**	**157.56**	**158.10**	**158.69**	**159.33**	**160.05**	**160.83**	**161.69**	**162.63**	**163.67**	**164.81**	**166.06**	**167.43**	**168.95**	$1,523
	-	0.2%	0.5%	0.7%	1.0%	1.3%	1.7%	2.0%	2.4%	2.9%	3.4%	4.0%	4.6%	5.2%	6.0%	6.8%	7.7%	8.6%	

Table 126: Comparison between fresh cassava and dry chips production

Cultivated land areas	2013 Level (Ha)	% Processed
Cassava	337,800	5%

Revenue	Yield by technology use (tons/ha)			Output Prices by technology use ($/ton)			Revenue by technology use and total		
	PROCESSED	OTHER		PROCESSED	OTHER	TOTAL	PROCESSED	OTHER	TOTAL
Cassava	9.15	16.90		158.60	72.32		1,451.19	1,222.21	
Costs w/o labor									
	PROCESSED	OTHER	TOTAL	PROCESSED	OTHER	TOTAL	PROCESSED	OTHER	TOTAL
Cassava	581.00	575.00		1.00	1.00		581.00	575.00	
Labor Costs									
	PROCESSED	OTHER	TOTAL	PROCESSED	OTHER	TOTAL	PROCESSED	OTHER	TOTAL
Cassava	220.00	196.78		1.00	1.00		220.00	196.78	
Gross Margins							Gross Margins ($/ha)		
							PROCESSED	OTHER	TOTAL
Cassava							650.19	450.43	

Table 127: Demand for labor and return to labor for cassava processing Income Growth scenarios

DEMAND FOR LABOR (Million days)																		
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66	14.66
Processed 5%, Price 50% higher	14.66	14.67	14.67	14.67	14.68	14.68	14.69	14.69	14.70	14.70	14.71	14.71	14.72	14.72	14.73	14.74	14.74	14.75
Processed 10%, Price 50% higher	14.66	14.67	14.68	14.69	14.70	14.72	14.73	14.74	14.76	14.78	14.80	14.82	14.84	14.87	14.90	14.93	14.97	15.01

AVERAGE RETURN TO LABOR ($/DAY)																		
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	10.61	10.60	10.60	10.60	10.60	10.59	10.59	10.59	10.58	10.58	10.58	10.57	10.57	10.56	10.56	10.55	10.55	10.54
Processed 5%, Price 50% higher	10.61	10.61	10.62	10.63	10.64	10.64	10.65	10.66	10.67	10.68	10.69	10.70	10.71	10.72	10.74	10.75	10.76	10.78
Processed 10%, Price 50% higher	10.61	10.63	10.65	10.67	10.70	10.73	10.76	10.80	10.84	10.89	10.94	10.99	11.05	11.12	11.19	11.27	11.36	11.45

Land under Cultivation (Ha)																		
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: PROCESSED 10%	16,890	17,599	18,339	19,109	19,911	20,748	21,619	22,527	23,473	24,459	25,486	26,557	27,672	28,834	30,045	31,307	32,622	33,992
Cultivated land: OTHER 90%	320,910	320,201	319,461	318,691	317,889	317,052	316,181	315,273	314,327	313,341	312,314	311,243	310,128	308,966	307,755	306,493	305,178	303,808
	5.3%	5.5%	5.7%	6.0%	6.3%	6.5%	6.8%	7.1%	7.5%	7.8%	8.2%	8.5%	8.9%	9.3%	9.8%	10.2%	10.7%	11.2%
Cultivated land: PROCESSED 25%	16,890	18,562	20,400	22,419	24,639	27,078	29,759	32,705	35,943	39,501	43,412	47,709	52,433	57,624	63,328	69,598	76,488	84,060
Cultivated land: OTHER 75%	320,910	319,238	317,400	315,381	313,161	310,722	308,041	305,095	301,857	298,299	294,388	290,091	285,367	280,176	274,472	268,202	261,312	253,740
	5.3%	5.8%	6.4%	7.1%	7.9%	8.7%	9.7%	10.7%	11.9%	13.2%	14.7%	16.4%	18.4%	20.6%	23.1%	25.9%	29.3%	33.1%

Table 128: Distribution and farm budget by farm size

Cultivated Areas	% of land cultivated by farm size				Total cultivated land by farm size (ha)			Cultivated land (ha)	Past growth Rate
	SMALL	MEDIUM	LARGE	TOTAL	SMALL	MEDIUM	LARGE		
Cassava	57%	36%	7%	100%	192,546	121,608	23,646	337,800	33.1%
Maize	47%	41%	12%	100%	101,258	88,331	25,853	215,442	9.7%
Wet Season Rice	60%	31%	9%	100%	1,490,899	770,298	223,635	2,484,832	2.6%
Dry Season Rice	60%	31%	9%	100%	297,279	153,594	44,592	495,465	6.8%
Vegetables	75%	21%	4%	100%	40,616	11,373	2,166	54,155	7.8%
					2,122,598	**1,145,204**	**319,892**	**3,587,694**	

Revenue	Yield by farm size (tons/ha)				Output Prices by farm size ($/ton)				Revenue by farm size and total ($/ha)			
	SMALL	MEDIUM	LARGE	AVERAGE	SMALL	MEDIUM	LARGE	AVERAGE	SMALL	MEDIUM	LARGE	**TOTAL**
Cassava	19.65	18.07	17.79	18.95	69.58	64.40	73.99	68.02	1,367.17	1,163.69	1,316.24	1,290.35
Maize	3.73	3.73	4.32	3.80	210.43	202.28	161.06	201.16	784.91	754.49	695.77	761.74
Wet Season Rice	2.68	2.89	3.12	2.78	285.43	266.47	229.43	274.51	764.94	770.10	715.82	762.12
Dry Season Rice	4.70	4.48	5.18	4.68	211.60	210.16	199.94	210.10	994.52	941.51	1,035.68	981.79
Vegetables	9.74	6.00	6.67	8.83	331.28	193.75	160.94	295.58	3,226.66	1,162.48	1,073.45	2,707.06

Seeds	Seeds by farm size (unit/ha)				Seed Prices by farm size ($/unit)				Costs of seeds by farm size and total ($/ha)			
	SMALL	MEDIUM	LARGE	AVERAGE	SMALL	MEDIUM	LARGE	AVERAGE	SMALL	MEDIUM	LARGE	**TOTAL**
Cassava	2,614.55	1,832.86	2,506.25	2,325.56	0.09	0.11	0.10	0.10	236.53	200.12	242.66	223.85
Maize	23.82	23.52	20.57	23.31	3.05	3.29	3.87	3.25	72.57	77.47	79.65	75.43
Wet Season Rice	53.37	40.46	106.83	54.18	0.47	0.48	0.36	0.46	24.85	19.62	38.50	24.46
Dry Season Rice	261.29	233.13	226.19	249.40	0.41	0.44	0.50	0.43	108.31	101.88	113.44	106.78
Vegetables	12.53	1.78	2.51	9.87	12.43	15.80	62.48	15.14	155.80	28.07	156.73	129.01

Fertilizer	Fertilizer use by farm size (kg/ha)				Fertilizer Prices by farm size ($/kg)				Costs of fertilizers by farm size and total ($/ha)			
	SMALL	MEDIUM	LARGE	AVERAGE	SMALL	MEDIUM	LARGE	AVERAGE	SMALL	MEDIUM	LARGE	**TOTAL**
Cassava	15.91	-	11.93	9.90	0.75		0.68	0.48	11.99	-	8.17	7.41
Maize	107.91	12.97	14.29	57.75	0.69	0.60	0.66	0.65	74.16	7.74	9.41	39.15
Wet Season Rice	126.75	106.42	89.42	117.08	0.57	0.61	0.70	0.59	72.17	64.77	62.98	69.04
Dry Season Rice	235.92	212.29	295.29	233.94	0.56	0.60	0.65	0.58	133.29	127.40	192.16	136.76
Vegetables	357.87	88.61	112.50	291.51	0.63	0.62	0.70	0.63	224.39	54.52	78.75	182.89

Other Inputs	Other input Costs ($/ha)			
	SMALL	MEDIUM	LARGE	AVERAGE
Cassava	35.14	32.50	43.49	34.77
Maize	38.77	26.15	24.92	31.93
Wet Season Rice	38.83	24.15	18.88	32.48
Dry Season Rice	31.98	19.87	31.41	28.17
Vegetables	292.85	31.79	59.77	228.70

Continued…

Labor	Labor use by farm size (days/ha)				Wage rate by farm size ($/day)				Costs of labor by farm size and total ($/ha)			
	SMALL	MEDIUM	LARGE	AVERAGE	SMALL	MEDIUM	LARGE	AVERAGE	SMALL	MEDIUM	LARGE	**TOTAL**
Cassava	46.23	58.44	43.90	50.46	4.56	4.56	4.56	4.56	210.82	266.48	200.18	230.1128
Maize	37.71	32.15	24.63	33.86	4.56	4.56	4.56	4.56	171.98	146.61	112.33	154.4203
Wet Season Rice	63.05	50.82	26.63	55.98	4.56	4.56	4.56	4.56	287.51	231.75	121.41	255.2754
Dry Season Rice	44.87	30.81	11.72	37.53	4.56	4.56	4.56	4.56	204.60	140.48	53.44	171.1184
Vegetables	201.85	52.83	73.33	165.41	4.56	4.56	4.56	4.56	920.43	240.89	334.38	754.2846

Services	Service Costs ($/ha)			
	SMALL	MEDIUM	LARGE	AVERAGE
Cassava	328.56	226.88	309.52	295.32
Maize	183.54	160.60	139.51	160.68
Wet Season Rice	134.73	160.03	234.16	171.10
Dry Season Rice	173.81	212.15	226.33	206.29
Vegetables	61.24	62.79	136.67	66.45

Gross Margins	Gross Margins ($/ha)			
	SMALL	MEDIUM	LARGE	AVERAGE
Cassava	544.13	437.71	512.23	498.89
Maize	243.90	335.92	329.95	300.13
Wet Season Rice	206.85	269.79	239.89	209.76
Dry Season Rice	306.82	283.48	297.51	283.57
Vegetables	1,571.96	744.42	307.16	1,345.72

Table 129: Gross margins with Farm Size Distribution scenario (baseline)

GROSS MARGINS (million $)																		
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SMALL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77	104.77
Maize	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70
Wet Season	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40	308.40
Dry Season	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21	91.21
Vegetables	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85	63.85
	592.92	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**	**592.92**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MEDIUM																		
Cassava	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23	53.23
Maize	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67	29.67
Wet Season	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.82
Dry Season	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54	43.54
Vegetables	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47	8.47
	342.73	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**	**342.73**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LARGE																		
Cassava	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11	12.11
Maize	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53
Wet Season	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65	53.65
Dry Season	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27	13.27
Vegetables	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
	88.22	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**	**88.22**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Gross Margins: OVERALL																		
Cassava	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11	170.11
Maize	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90	62.90
Wet Season	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86	569.86
Dry Season	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02	148.02
Vegetables	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98	72.98
	1,023.87	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**	**1,023.87**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 130: Gross margins with Farm Size Distribution scenario (I5)

CULTIVATED LAND (Ha)																		
Scenario I5	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: SMALL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	192,546	190,621	188,714	186,827	184,959	183,109	181,278	179,465	177,671	175,894	174,135	172,394	170,670	168,963	167,274	165,601	163,945	162,305
Maize	101,258	100,245	99,243	98,250	97,268	96,295	95,332	94,379	93,435	92,501	91,576	90,660	89,753	88,856	87,967	87,088	86,217	85,355
Wet Season Rice	1,490,899	1,475,990	1,461,230	1,446,618	1,432,152	1,417,830	1,403,652	1,389,615	1,375,719	1,361,962	1,348,343	1,334,859	1,321,510	1,308,295	1,295,212	1,282,260	1,269,438	1,256,743
Dry Season Rice	297,279	294,306	291,363	288,450	285,565	282,709	279,882	277,083	274,313	271,569	268,854	266,165	263,504	260,869	258,260	255,677	253,121	250,589
Vegetables	40,616	40,210	39,808	39,410	39,016	38,626	38,239	37,857	37,478	37,104	36,733	36,365	36,002	35,642	35,285	34,932	34,583	34,237
	2,122,598	**2,101,372**	**2,080,358**	**2,059,555**	**2,038,959**	**2,018,570**	**1,998,384**	**1,978,400**	**1,958,616**	**1,939,030**	**1,919,640**	**1,900,443**	**1,881,439**	**1,862,625**	**1,843,998**	**1,825,558**	**1,807,303**	**1,789,230**
	-	-1.0%	-2.0%	-3.0%	-3.9%	-4.9%	-5.9%	-6.8%	-7.7%	-8.6%	-9.6%	-10.5%	-11.4%	-12.2%	-13.1%	-14.0%	-14.9%	-15.7%
Cultivated land: MEDIUM																		
Cassava	121,608	122,571	123,524	124,467	125,402	126,326	127,242	128,148	129,046	129,934	130,813	131,684	132,546	133,399	134,244	135,081	135,909	136,728
Maize	88,331	88,838	89,339	89,835	90,326	90,813	91,294	91,771	92,243	92,710	93,172	93,630	94,083	94,532	94,976	95,416	95,852	96,283
Wet Season Rice	770,298	777,752	785,132	792,439	799,672	806,832	813,922	820,940	827,888	834,766	841,576	848,318	854,992	861,600	868,141	874,617	881,029	887,376
Dry Season Rice	153,594	155,081	156,552	158,009	159,451	160,879	162,293	163,692	165,077	166,449	167,807	169,151	170,482	171,799	173,104	174,395	175,673	176,939
Vegetables	11,373	11,576	11,777	11,976	12,173	12,368	12,561	12,752	12,941	13,129	13,314	13,498	13,680	13,860	14,038	14,215	14,389	14,562
	1,145,204	**1,155,817**	**1,166,324**	**1,176,725**	**1,187,023**	**1,197,218**	**1,207,311**	**1,217,303**	**1,227,195**	**1,236,988**	**1,246,683**	**1,256,281**	**1,265,783**	**1,275,191**	**1,284,504**	**1,293,724**	**1,302,852**	**1,311,888**
	-	0.9%	1.8%	2.8%	3.7%	4.5%	5.4%	6.3%	7.2%	8.0%	8.9%	9.7%	10.5%	11.4%	12.2%	13.0%	13.8%	14.6%
Cultivated land: LARGE																		
Cassava	23,646	24,609	25,562	26,505	27,440	28,364	29,280	30,186	31,084	31,972	32,851	33,722	34,584	35,437	36,282	37,119	37,947	38,766
Maize	25,853	26,359	26,861	27,357	27,848	28,334	28,816	29,292	29,764	30,232	30,694	31,152	31,605	32,054	32,498	32,938	33,374	33,805
Wet Season Rice	223,635	231,089	238,469	245,775	253,009	260,169	267,258	274,277	281,225	288,103	294,913	301,655	308,329	314,937	321,478	327,954	334,366	340,713
Dry Season Rice	44,592	46,078	47,550	49,007	50,449	51,877	53,290	54,690	56,075	57,447	58,804	60,149	61,480	62,797	64,101	65,393	66,671	67,937
Vegetables	2,166	2,369	2,570	2,769	2,966	3,162	3,355	3,546	3,735	3,923	4,108	4,292	4,474	4,654	4,832	5,008	5,183	5,356
	319,892	**330,505**	**341,012**	**351,414**	**361,711**	**371,906**	**381,999**	**391,991**	**401,883**	**411,676**	**421,371**	**430,969**	**440,472**	**449,879**	**459,192**	**468,412**	**477,540**	**486,576**
	-	3.3%	6.6%	9.9%	13.1%	16.3%	19.4%	22.5%	25.6%	28.7%	31.7%	34.7%	37.7%	40.6%	43.5%	46.4%	49.3%	52.1%
Cultivated land: TOTAL																		
Cassava	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
Maize	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442
Wet Season Rice	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
	3,587,694	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 131: Gross margins with Farm Size Distribution scenario (I6)

CULTIVATED LAND (Ha)																		
Scenario I6	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cultivated land: SMALL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	192,546	190,621	188,714	186,827	184,959	183,109	181,278	179,465	177,671	175,894	174,135	172,394	170,670	168,963	167,274	165,601	163,945	162,305
Maize	101,258	100,245	99,243	98,250	97,268	96,295	95,332	94,379	93,435	92,501	91,576	90,660	89,753	88,856	87,967	87,088	86,217	85,355
Wet Season Rice	1,490,899	1,475,990	1,461,230	1,446,618	1,432,152	1,417,830	1,403,652	1,389,615	1,375,719	1,361,962	1,348,343	1,334,859	1,321,510	1,308,295	1,295,212	1,282,260	1,269,438	1,256,743
Dry Season Rice	297,279	294,306	291,363	288,450	285,565	282,709	279,882	277,083	274,313	271,569	268,854	266,165	263,504	260,869	258,260	255,677	253,121	250,589
Vegetables	40,616	40,210	39,808	39,410	39,016	38,626	38,239	37,857	37,478	37,104	36,733	36,365	36,002	35,642	35,285	34,932	34,583	34,237
	2,122,598	**2,101,372**	**2,080,358**	**2,059,555**	**2,038,959**	**2,018,570**	**1,998,384**	**1,978,400**	**1,958,616**	**1,939,030**	**1,919,640**	**1,900,443**	**1,881,439**	**1,862,625**	**1,843,998**	**1,825,558**	**1,807,303**	**1,789,230**
	-	-1.0%	-2.0%	-3.0%	-3.9%	-4.9%	-5.9%	-6.8%	-7.7%	-8.6%	-9.6%	-10.5%	-11.4%	-12.2%	-13.1%	-14.0%	-14.9%	-15.7%
Cultivated land: MEDIUM																		
Cassava	121,608	122,571	123,524	124,467	125,402	126,326	127,242	128,148	129,046	129,934	130,813	131,684	132,546	133,399	134,244	135,081	135,909	136,728
Maize	88,331	88,838	89,339	89,835	90,326	90,813	91,294	91,771	92,243	92,710	93,172	93,630	94,083	94,532	94,976	95,416	95,852	96,283
Wet Season Rice	770,298	777,752	785,132	792,439	799,672	806,832	813,922	820,940	827,888	834,766	841,576	848,318	854,992	861,600	868,141	874,617	881,029	887,376
Dry Season Rice	153,594	155,081	156,552	158,009	159,451	160,879	162,293	163,692	165,077	166,449	167,807	169,151	170,482	171,799	173,104	174,395	175,673	176,939
Vegetables	11,373	11,576	11,777	11,976	12,173	12,368	12,561	12,752	12,941	13,129	13,314	13,498	13,680	13,860	14,038	14,215	14,389	14,562
	1,145,204	**1,155,817**	**1,166,324**	**1,176,725**	**1,187,023**	**1,197,218**	**1,207,311**	**1,217,303**	**1,227,195**	**1,236,988**	**1,246,683**	**1,256,281**	**1,265,783**	**1,275,191**	**1,284,504**	**1,293,724**	**1,302,852**	**1,311,888**
	-	0.9%	1.8%	2.8%	3.7%	4.5%	5.4%	6.3%	7.2%	8.0%	8.9%	9.7%	10.5%	11.4%	12.2%	13.0%	13.8%	14.6%
Cultivated land: LARGE																		
Cassava	23,646	24,609	25,562	26,505	27,440	28,364	29,280	30,186	31,084	31,972	32,851	33,722	34,584	35,437	36,282	37,119	37,947	38,766
Maize	25,853	26,359	26,861	27,357	27,848	28,334	28,816	29,292	29,764	30,232	30,694	31,152	31,605	32,054	32,498	32,938	33,374	33,805
Wet Season Rice	223,635	231,089	238,469	245,775	253,009	260,169	267,258	274,277	281,225	288,103	294,913	301,655	308,329	314,937	321,478	327,954	334,366	340,713
Dry Season Rice	44,592	46,078	47,550	49,007	50,449	51,877	53,290	54,690	56,075	57,447	58,804	60,149	61,480	62,797	64,101	65,393	66,671	67,937
Vegetables	2,166	2,369	2,570	2,769	2,966	3,162	3,355	3,546	3,735	3,923	4,108	4,292	4,474	4,654	4,832	5,008	5,183	5,356
	319,892	**330,505**	**341,012**	**351,414**	**361,711**	**371,906**	**381,999**	**391,991**	**401,883**	**411,676**	**421,371**	**430,969**	**440,472**	**449,879**	**459,192**	**468,412**	**477,540**	**486,576**
	-	3.3%	6.6%	9.9%	13.1%	16.3%	19.4%	22.5%	25.6%	28.7%	31.7%	34.7%	37.7%	40.6%	43.5%	46.4%	49.3%	52.1%
Cultivated land: TOTAL																		
Cassava	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800	337,800
Maize	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442	215,442
Wet Season Rice	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832	2,484,832
Dry Season Rice	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465	495,465
Vegetables	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155	54,155
	3,587,694	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**	**3,587,694**
	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 132: Summary of gross margins from changes on Farm Size Distribution ($ million)

	Farm Size	Gross Margins in 2013 (Million $)	Gross Margins in 2030 (Million $)	% Change	NPV	Change NPV
Baseline	Small	592.92	592.92		5,674	
Scenario I5	Small	592.92	499.80	-15.7%	5,319	-6.3%
Scenario I6	Small	592.92	499.80	-15.7%	5,319	-6.3%
Baseline	Medium	342.73	342.73		3,280	
Scenario I5	Medium	342.73	392.60	14.6%	3,470	5.8%
Scenario I6	Medium	342.73	899.84	162.6%	4,977	51.7%
Baseline	Large	88.22	88.22		844	
Scenario I5	Large	88.22	134.60	52.6%	1,021	21.0%
Scenario I6	Large	88.22	308.51	249.7%	1,497	77.3%
Baseline	Total	1,023.87	1,023.87		9,799	
Scenario I5	Total	1,023.87	1,027.00	0.3%	9,811	0.1%
Scenario I6	Total	1,023.87	1,708.15	66.8%	11,793	20.4%

Table 133: Demand for labor and return to labor for Farm Size Distribution scenarios

DEMAND FOR LABOR (Million days)																		
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82	14.82
Maize	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34
Wet Season Rice	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90	120.90
Dry Season Rice	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16
Vegetables	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79
	166.00	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**	**166.00**
Scenario I5	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario I6	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	14.82	14.82	14.83	14.84	14.85	14.86	14.86	14.87	14.88	14.89	14.89	14.90	14.91	14.92	14.92	14.93	14.94	14.95
Maize	6.34	6.33	6.32	6.32	6.31	6.30	6.29	6.29	6.28	6.27	6.26	6.25	6.25	6.24	6.23	6.23	6.22	6.21
Wet Season Rice	120.90	120.58	120.27	119.96	119.66	119.35	119.05	118.76	118.46	118.17	117.88	117.60	117.32	117.04	116.76	116.49	116.21	115.95
Dry Season Rice	16.16	16.10	16.04	15.98	15.92	15.86	15.80	15.74	15.69	15.63	15.58	15.52	15.47	15.41	15.36	15.31	15.25	15.20
Vegetables	7.79	7.74	7.69	7.64	7.59	7.55	7.50	7.45	7.41	7.36	7.32	7.27	7.23	7.19	7.14	7.10	7.06	7.02
	166.00	**165.57**	**165.15**	**164.74**	**164.32**	**163.91**	**163.51**	**163.11**	**162.71**	**162.32**	**161.93**	**161.55**	**161.17**	**160.79**	**160.42**	**160.05**	**159.68**	**159.32**
	-	-0.3%	-0.5%	-0.8%	-1.0%	-1.3%	-1.5%	-1.7%	-2.0%	-2.2%	-2.4%	-2.7%	-2.9%	-3.1%	-3.4%	-3.6%	-3.8%	-4.0%
DEMAND FOR FERTILIZER (Tons)																		
Baseline	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345
Maize	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442	12,442
Wet Season Rice	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935	290,935
Dry Season Rice	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908	115,908
Vegetables	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787	15,787
	438,417	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**	**438,417**
Scenario I5	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario I6	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cassava	3,345	3,326	3,307	3,289	3,270	3,252	3,233	3,215	3,197	3,180	3,162	3,145	3,128	3,111	3,094	3,077	3,061	3,045
Maize	12,442	12,347	12,252	12,159	12,066	11,974	11,884	11,794	11,705	11,617	11,529	11,443	11,358	11,273	11,189	11,106	11,024	10,943
Wet Season Rice	290,935	290,505	290,079	289,658	289,241	288,828	288,419	288,015	287,614	287,218	286,825	286,436	286,051	285,670	285,293	284,920	284,550	284,184
Dry Season Rice	115,908	115,961	116,013	116,066	116,117	116,168	116,219	116,269	116,318	116,367	116,416	116,464	116,511	116,558	116,605	116,651	116,697	116,742
Vegetables	15,787	15,682	15,579	15,476	15,375	15,275	15,175	15,077	14,979	14,883	14,787	14,693	14,599	14,507	14,415	14,324	14,234	14,145
	438,417	**437,821**	**437,231**	**436,647**	**436,069**	**435,497**	**434,930**	**434,369**	**433,814**	**433,264**	**432,720**	**432,181**	**431,648**	**431,119**	**430,597**	**430,079**	**429,567**	**429,059**
	-	-0.1%	-0.3%	-0.4%	-0.5%	-0.7%	-0.8%	-0.9%	-1.0%	-1.2%	-1.3%	-1.4%	-1.5%	-1.7%	-1.8%	-1.9%	-2.0%	-2.1%
Return to Labor ($/day)	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Scenario I5	6.2	6.2	6.2	6.2	6.2	6.3	6.3	6.3	6.3	6.3	6.3	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Scenario I6	6.2	6.3	6.5	6.6	6.8	7.0	7.2	7.5	7.7	8.0	8.2	8.5	8.8	9.2	9.5	9.9	10.3	10.7

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