TEHNICAL WORKING PAPER

CAMBODIA

OVERVIEW OF A CAMBODIAN SEED SECTOR

Australian AID

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Agriculture

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Content

Acronyms and Abbreviations

ABK	Aphiwad Bandanh Kasekam
ADC	Agricultural Development Community
ADI	Agricultural Development Institute
AKRR	Angkor Kasekam Roongroeung
AQIP	Agricultural Quality Improvement Program
ASOCA	Official Seed Certifying Agencies
AusAID	Australian Agency for International Development
BS	Breeder seed
CARDI	Cambodia Agricultural Research and Development Institute
CBAPP	Community Based Agricultural Productivity Program
CEDAC	Centre d'Étude et Developement Agriculture du Cambodge
CS	Commercial seed
ECOSORN	Economic and Social Rehabilitation in the Northwest Provinces
EM	Effective microorganisms
FA	Farmer Association
FS	Foundation Seed
GDA	General Directorate of Agriculture
GS	Graded seed
IDE	International Development Enterprises
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
ISTA	International Seed Testing Association
IVY	International Volunteers of Yamagata
MAFF	Ministry of Agriculture, Forestry and Fisheries
MMt	Million Metric Tons
OFAT	On-farm varietal trial
OECD	Economic Cooperation and Development
PDA	Provincial Department of Agriculture
PDE	Provincial Department of Extension
PUAC	Peri-Urban Agriculture Center
RLR	Rainfed Lowland Rice
RS	Register seed
SGAC	Seed Growers Association of Cambodia
SNV	Netherlands Development Organization
SP	Service provider(s)
UPOV	Union for the Protection of New Varieties of Plants
VBNK	Vithyieshtan Bandohbandal Neak Aphiwad Kasekam

សេចក្ដីសង្ខេបរួម

ចាំបាច់ត្រូវតែមានការផ្លាស់ប្ដូរនៅក្នុងឧស្សាហកម្មពូជដំណាំ ដើម្បីបង្កើនផលិតភាពកសិកម្ម និង ដើម្បីសម្រេចគោលដៅនៃការនាំចេញអង្ករបស់រដ្ឋាភិបាល

ស្រូវ មិនត្រឹមតែជាដំណាំមួយប៉ុណ្ណោះទេ ប៉ុន្តែក៏ជាអាហារប្រចាំនៅកម្ពុជា។ **ធាតុផ្សំ ចម្បងនៃកម្មវិធីពូជដំណាំនៅកម្ពុជា គឺពាក់ព័ន្ធជាមួយនឹងស្រូវ។ ពូជស្រូវក្នុងស្រុកមួយចំនួន មានសារៈសំខាន់ចំពោះសហគមន៍ ដែលត្រូវតែរក្សាទុក ប៉ុន្តែសំខាន់ក៏ចាំបាច់ត្រូវធ្វើការកែលំអពូជទាំងនេះផងដែរ ដើម្បីឱ្យស្រូវកាន់តែមានគុណភាពល្អជាងមុន ផ្ដល់ផលខ្ពស់ជាងមុន ធន់នឹងជំងឺ ឬបញ្ហាបរិស្ថាននានា និងមិនត្រូវការធនធានច្រើនសម្រាប់ដាំដុះ។ កសិករខ្មែរជាច្រើនរស់នៅកៀកនឹងកម្រិតត្រឹមតែចិញ្ចឹមជីវិត ហើយពូជស្រូវថ្មីអ្វីក៏ដោយ បើទោះបីជាពូជស្រូវនោះនឹងផ្ដល់ផលខ្ពស់ យ៉ាងណាក៏ដោយ អាចត្រូវបានគេចាត់ទុកថាជាការគំរាមកំហែងមួយ ចំពោះកេរ្ដិ៍ដំណែល ដែលបន្សល់ទុកនៅក្នុងមូលដ្ឋានរបស់ពួកគេ។**

ការប្រើពូជដែលមានគុណភាព គឺជាសមាសភាគដ៏សំខាន់មួយ ដើម្បីសម្រេចឱ្យបាននូវ ទិន្នផលទៅតាមសក្ដានុពល និងបង្កើនផលិតភាពកសិកម្ម។ **ឧស្សាហកម្មពូជសម័យទំនើប រួមមាន ការអភិវឌ្ឍប្រភេទពូជ ការផលិតគ្រាប់ពូជ ការត្រួតពិនិត្យ និងការកែច្នៃគុណភាព ការផ្សព្វផ្សាយ ទីផ្សារ និងការត្រួតពិនិត្យរបស់រដ្ឋាភិបាល។ ខណៈពេលដែលវិស័យនេះកាន់តែមានភាពចាស់ទុំនៅ កម្ពុជា កត្តានីមួយៗក្នុងចំណោមកត្តាទាំងនេះកាន់តែមានសារៈសំខាន់ និងបំពេញតួនាទីកាន់តែ ចាំបាច់ នៅក្នុងកំណើនរបស់វិស័យនេះ។ ដោយហេតុថាកសិករ គឺជាអ្នកប្រើប្រាស់ពូជចុងក្រោយ ឧស្សាហកម្មពូជត្រូវតែរៀបចំខ្លួនសារជាថ្មី ដើម្បីអាចឆ្លើយតបកាន់តែប្រសើរចំពោះសេចក្ដីត្រូវការ ជាក់លាក់ និងធ្វើការអភិវឌ្ឍនូវផលិតផល ដែលនឹងផ្ដល់ទិន្នផលខ្ពស់ និងលូតលាស់បានល្អ ទៅតាមលក្ខខណ្ឌទីតាំងដែលត្រូវដាំដុះ។**

ចាំបាច់ត្រូវមានការផ្លាស់ប្ដូរប្រព័ន្ធផ្គត់ផ្គង់ផលិតកម្មគ្រាប់ពូជ ដើម្បីបំពេញតាមគោលដៅ នៃការនាំចេញរបស់ប្រទេស។ **គោលដៅនាំចេញអង្ករ ១**

លានតោនរបស់រដ្ឋាភិបាល ត្រឹមឆ្នាំ ២០១៥ នាំឱ្យមានបញ្ហាប្រឈមចំពោះកសិករ ដែលបង្កបង្កើនផលស្រូវនៅកម្ពុជា។ ជោគជ័យនៃ ការអនុវត្ត អាស្រ័យទៅតាមកិច្ចសហប្រតិបត្តិការ និងកិច្ចខិតខំប្រឹងប្រែងរបស់ស្ថាប័នជាច្រើនរបស់ រដ្ឋាភិបាល។ ចាំបាច់ត្រូវមានការស្រាវជ្រាវឱ្យបានពេញលេញលើផ្ទៃដីបង្កបង្កើនផលស្រូវ ៨០០០០០ ហិចតា ដើម្បីសម្រេចគោលដៅនៃការនាំចេញប្រកបដោយមហិច្ឆតានេះបាន។ ការបង្កើនលទ្ធភាពទទួលបានការស្រាវជ្រាវ គឺជាបុរេលក្ខខណ្ឌមួយសម្រាប់ការពង្រីកផលិតកម្មគ្រាប់ពូជប្រកបដោយគុណភាព។

ឧស្សាហកម្មពូជនៅកម្ពុជា នៅមានកម្រិតខ្សោយ ដោយមិនមានរចនាសម្ព័ន្ធ និងការសម្រប សម្រួលឱ្យបានច្បាស់លាស់

ឧស្សាហកម្មពូជនៅកម្ពុជា នៅមិនទាន់មានរចនាសម្ព័ន្ធផ្លូវការ និងការសម្របសម្រួល នៅឡើយ។ ត្រឹមឆ្នាំ ២០១១ មានរចនាសម្ព័ន្ធផ្លូវការថ្មីមួយ បង្កើតឡើងដោយវិទ្យាស្ថានស្រាវជ្រាវ និងអភិវឌ្ឍន៍កសិកម្មកម្ពុជា ដែលមានតួនាទីអភិវឌ្ឍន៍ពូជស្រូវថ្មីៗ និងផលិតគ្រាប់ពូជមូលដ្ឋាន សម្រាប់ដំណាំស្រូវ។ វិទ្យាស្ថាននេះក៏ផ្ដល់ការបណ្ដុះបណ្ដាលអំពីការផលិតពូជដល់អ្នកផលិតពូជតាមសហគមន៍ និងដល់ម្ចាស់រោងម៉ាស៊ីនកិនស្រូវ ដែលចាំបាច់អារម្មណ៍ក្នុងការទិញផលស្រូវពីកសិករ ជាបន្ដបន្ទាប់។ បណ្ដាញមួយទៀត ដែលមានទំហំតូចជាងនេះ សម្រាប់ការផលិត និងការបែងចែកស្រូវពូជជាផ្លូវការ គឺក្រុមហ៊ុនផលិតពូជ AQIP ដែលជាកម្មសិទ្ធិរបស់ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ និងសមាគមអ្នកផលិតគ្រាប់ពូជនៅកម្ពុជា។ មានអ្នកផលិតពូជឯកជនខ្នាតតូចមួយចំនួនតូច ស្ថិតក្រោមការគ្រប់គ្រងផ្ទាល់របស់ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទផងដែរ។

ក្នុងចំណោមផ្ទៃដីស្រែស្រូវ មានតែ ២០ ភាគរយប៉ុណ្ណោះ ដែលមានការដាំដុះ ដោយ ប្រើប្រាស់គ្រាប់ពូជប្រកបដោយគុណភាព។ ពាក្យថា “គ្រាប់ពូជប្រកបដោយគុណភាព” សំដៅលើ ពូជស្រូវដែលគេស្គាល់ ដែលត្រូវបានផលិត ក្រោមកម្មវិធីផលិតពូជមួយចំនួន។ ប៉ុន្តែ ក៏មានកសិករ ដែលយល់ពីអត្ថប្រយោជន៍នៃពូជដែលមានគុណភាព

ប៉ុន្ដែពុំមានលទ្ធភាពទិញពូជទាំងនោះបាន។
ការបង្កើនលទ្ធភាពរបស់សហគមន៍
ដើម្បីទទួលបានពូជបន្លែបដោយគុណភាព ដែលសមស្របសម្រាប់ដីបង្កបង្កើនផល លក្ខខណ្ឌដី ។ល។ គឺជាវិធីសាស្ដ្រសំខាន់ជាងគេ ដើម្បីបង្កើនផលិតភាព។

គម្លាតរវាងតម្រូវការ និងការផ្គត់ផ្គង់ពូជបន្លែបដោយគុណភាពកាន់តែធំទៅៗយ៉ាង ឆាប់រហ័ស។ **មានការប៉ាន់ប្រមាណថា តម្រូវការពូជបន្លែបដោយគុណភាពនៅលើទីផ្សារ នឹងមាន ការកើនឡើងពី ២៣០០០ តោន នៅក្នុងឆ្នាំ ២០០៩-២០១០ រហូតដល់ ៣៨៥០០ តោន ត្រឹមឆ្នាំ ២០១៥ និងកើនរហូតដល់ ៥០០០០ តោន ត្រឹមឆ្នាំ ២០២០។ ផ្ទុយទៅវិញ សក្ដានុពលនៃការពង្រីកការផ្គត់ផ្គង់ពូជ នៅក្នុងរយៈពេល ៥ ឆ្នាំទៀត (២០១១-២០១៥) អាចកើតឡើងរហូតដល់ត្រឹមតែ ៨៥០០ តោនប៉ុណ្ណោះ។ នេះមានន័យថា ត្រឹមឆ្នាំ ២០១៥ នឹងមានគម្លាតបន្លែប្រមាណពី ៣០០០០ ដល់ ៣២០០០ តោន រវាងការផ្គត់ផ្គង់ និងតម្រូវការ។**

អ្នកផលិតពូជឯកជន និងក្រុមផលិតពូជតាមសហគមន៍ បានលេចចេញជារូបរាងឡើង ជាការឆ្លើយតបចំពោះការកើនឡើងនូវតម្រូវការពូជបន្លែបដោយគុណភាព។
អ្នកផលិតពូជ ទាំងក្នុង បន្លែពន្ធផ្លូវការ និងបន្លែពន្ធក្រៅផ្លូវការ បានទទួលការបណ្ដុះបណ្ដាលពី CARDI អំពីវិធីសាស្ដ្រផលិត ពូជ និងឃ្លាំពីភាពចាំបាច់ ដើម្បីរក្សាពូជសុទ្ធ។ នៅកម្រិតសហគមន៍វិញ កសិករមិនត្រឹមតែផលិត ពូជសម្រាប់កសិករផ្សេងទៀតប៉ុណ្ណោះទេ ពួកគេកើបង្រៀនសមាជិកសហគមន៍ដទៃទៀតអំពីរបៀប ដាំដុះ សន្ដុកទុក និងរក្សាពូជសម្រាប់ដាំដុះដោយខ្លួនឯង។ កម្មវិធីពូជតាមភូមិ គឺជាកម្មវិធីដែលមាន បន្លែសិទ្ធភាពជាពិសេស ដោយសារតែអ្នកដែលអាចមានតម្រូវការបន្លែបន្លាស់ពូជ អាចទៅទិញពូជពី អ្នកផលិតពូជ និងទៅដល់កន្លែងផលិតពូជដោយផ្ទាល់។ នៅក្នុងករណីមួយចំនួន កម្រុមសហគមន៍ទាំងនេះបានសហការជាមួយនឹងឈ្មួញអង្ករ ដើម្បីបង្កើតគម្រោង និងផលិតផលិតផលដែលមានតម្លៃបន្ថែម សម្រាប់ផ្ដល់ដល់អ្នកបន្លែបន្លាស់ចុងក្រោយ។

មូលធននៅមានកម្រិត និងឧបករណ៍ចាស់ៗហួសសម័យ គឺជាបញ្ហាបន្លឈមចម្បងនៃសំយពូជ របស់បន្លែសេកម្ពុជា

ឧបសគ្គចម្បងៗនៃការផលិត និងផ្គត់ផ្គង់គ្រាប់ពូជនៅកម្ពុជា គឺឱនភាពមូលធន ការធ្វើ ពិពិធកម្មនៅមានកម្រិតទាប និងកង្វះគ្រឿងយន្ត និងឧបករណ៍បរិក្ខារនានា។ ភាពកំហិតទាំងនេះ បង្ខំឱ្យអ្នកផ្គត់ផ្គង់ប្រើប្រាស់កម្លាំងពលកម្មដែលកាន់តែមានថ្លៃឈ្នួលខ្ពស់ទៅៗ ដែលមិនឱ្យអាចឱ្យពួកគេមានឱកាសផលិតពូជដែលមានគុណភាពខ្ពស់ ក្នុងតម្លៃថោកបាន។ កង្វះមូលធនសម្រាប់ ប្រតិបត្តិការ គឺជាឧបសគ្គធ្ងន់ធ្ងរជាងគេ ដោយសារតែរវៃពន្យឺតការអភិវឌ្ឍ និងការបញ្ចេញពូជថ្មីៗ។ ដោយសារតែផែនធាននៅមានកម្រិត CARDI អាចផលិតបានត្រឹមតែពូជសម្រាប់ការទិញដែលមាន ការធានាប៉ុណ្ណោះ។ នេះនាំឱ្យគេមិនអាចបំពេញតាមការបញ្ជាទិញបាន នៅក្នុងឆ្នាំ ដែលមានតម្រូវការខ្ពស់ និងនាំឱ្យមានការខាតបង់យ៉ាងគំហុក នៅក្នុងឆ្នាំដែលមិនសូវមានតម្រូវការ នៅពេល ដែលគ្រាប់ពូជដែលមានតម្លៃថ្លៃ ត្រូវលក់ ដើម្បីកិនជាអង្ករ ដែលនាំឱ្យមានការខាតបង់ធំធេង។

អាកាសធាតុក្ដៅ ហើយសើមនៅកម្ពុជា ធ្វើឱ្យមានខូចខាតពូជយ៉ាងឆាប់រហ័ស ទាំងនៅ ដំណាក់កាលដាំដុះ និងដំណាក់កាលរក្សាទុក។ ការស្រាវជ្រាវបង្ហាញថា កម្រិតនៃការចេញពន្លករបស់ស្រូវ ធ្លាក់ចុះក្រោម ៨០-៨៥ ភាគរយ នៅក្នុងកំឡុងរយៈពេល ៦-៨ ខែ ក្រោយការប្រមូល ផល។ ដូច្នេះ ពូជទាំងឡាយដែលផលិតលើសពីតម្រូវការសម្រាប់ការដាំដុះ ត្រូវបានប្រើសម្រាប់ កិនជាអង្ករ។ ចំណាយសម្រាប់ការផលិតពូជទាំងនេះ មិនអាចសង្គ្រោះមកវិញបានឡើយ។ នៅពេល ដែលអ្នកផលិតពូជជួបប្រទះបញ្ហាថវិកា ជារឿយៗ ពួកគេគ្រោងការផលិតពូជរបស់ពួកគេ ផ្អែកទៅ តាមការប៉ាន់ប្រមាណបែបអភិរក្សនិយមលើបរិមាណគ្រាប់ពូជដែលអាចលក់បាន ។

ទីផ្សារពូជនៅកម្ពុជា មានលក្ខណៈសមាហរណកម្មចូលគ្នា ក្នុងកម្រិតខ្សោយ។ ព័ត៌មានអំពី ពូជ និងការប្រើប្រាស់ពូជ ត្រូវបានផ្សព្វផ្សាយមិនមានប្រសិទ្ធភាព នៅក្នុងសង្វាក់ផ្គត់ផ្គង់ទាំងមូល ទាំងក្នុងក្របខណ្ឌវិស័យសាធារណៈ និងរវាងវិស័យសាធារណៈ និងវិស័យឯកជន។ ឈ្នួញលក់ ឧបករណ៍សម្ភារកសិកម្ម មិនមានព័ត៌មានច្រើន

ដើម្បីផ្ដល់សេវាដល់កសិករប្រកបដោយផលិតភាព ឡើយ ហើយក៏ពុំមានការបង្ដដេញ្ញាចិត្ដ ដើម្បីបំពេញទៅតាមតម្រូវការរបស់កសិករនោះដែរ។

បព្ធំនូផផ្គត់ផ្គង់គ្រាប់ពូជ ក៏នៅខ្វះសង្គតភាពខាងគុណភាព និងការគាំទ្រដល់អតិថិជនផង ដែរ។ បព្ធំនូផលិតកម្មសម្រូវប្រើប្រាស់សម្រូវដលែផលិតតាមមូលដ្ឋាន និងដលែភាគច្រើន មិនត្រូវបានកលែំអជាពូជ ដោយមានគុណភាពផ្សេងៗគ្នា ដើម្បីផលិតចញេជាដំណាំ ដោយមានទិន្នផលទាប និងគុណភាពទាប។ ជារឿយៗ កសិករមិនបានទទួលដំបូន្មានល្អៗខាងផ្នកែកសតេ្រសាស្ដ្រ និងសវោក្រោយការលក់ពីតាមហាងនៅមូលដ្ឋានឡើយ។ ដូច្នេះ កសិករជាច្រើននាក់យកពូជដលែមាន គុណភាពទាបមកដាំដុះ ដោយមិនប្រើដី និងបដិសធេមិនទិញផលិតផលផ្សេងទៀត។

ច្បាប់ពូជ ត្រូវបានអនុម័ត នៅក្នុងឆ្នាំ ២០០៤។ រចនាសម្ព័ន្ធដំបូង សម្រាប់កម្មវិធីពូជជាតិ ត្រូវបានបង្កើតឡើង ដោយពុំមានវិធាន និងលិខិតបទដ្ឋានគតិយុត្ដិសម្រាប់គាំទ្រអនុវត្ដនៅឡើយ ហើយនៅមិនទាន់មានការបកស្រាយច្បាប់នេះសម្រាប់ការអនុវត្ដនៅឡើយ ។ ស្ដង់ដាជាតិខាង គុណភាពរបស់ពូជ នៅមិនទាន់ត្រូវបានកំណត់ ក្រោមច្បាប់នេះនៅឡើយ។

អនុសាសន៍អំពីសកម្មភាពគោលនយោបាយ

អនុសាសន៍

សម្រាប់រៀបចំរចនាសម្ព័ន្ធឧស្សាហកម្មពូជសម្រូវនៅកម្ពុជា រួមមានដូចខាងក្រោម ៖

១. ពង្រឹងការអនុវត្ដច្បាប់ពូជ តាមរយៈការជួយដល់អគ្គនាយកដ្ឋានកសិកម្ម ក្នុងការរៀបចំសេចក្ដីព្រាងវិធាន និងលិខិតបទដ្ឋានសម្រាប់គាំទ្រដល់ការអនុវត្ដច្បាប់ពូជ

បទ្រសេកម្ពុជាបានអនុម័តលើច្បាប់ពូជ ប៉ុន្ដមែិនទាន់មានការបកប្រចែ្បាប់នេះជាភាសា អង់គ្លេសឱ្យបានសមស្របនៅឡើយ។ ច្បាប់នេះតម្រូវឱ្យមានការបកប្រជែាភាសាអង់គ្លេស មុន ពលេគរោចធ្វើការវាយតម្លលៃើច្បាប់នេះឱ្យបានសមស្រប។

ចាំបាច់ត្រូវមានសកម្មភាព ដូចខាងក្រោម ៖

- ចាំបាច់តម្រូវដួលទីបម្រឹកម្សាបចម្ចកេទសេខាងផ្នែកចម្បាប់ និងគោលគោលនយោបាយពូជ ឱ្យធម្រើការសម្រាវជម្រាវអំពីចម្បាប់នេះ បកសម្រាយអត្ថន័យរបស់ចម្បាប់នេះចំពោះឧសម្សាហកម្មគម្រាប់ពូជ នៅកម្ពុជា
  ធម្រើការពិគម្រោះយោបល់ជាមួយនឹងមន្ដ្រីកម្រសួងកសិកម្ម រុក្ខាបម្រមាញ់ និងនេសាទ មន្ដ្រីរបស់វិទ្យាសម្ថាន CARDI និងបុគ្គលិករបស់ឧសម្សាហកម្មពូជ និងរៀបចំវិធាន និងលិខិត បទដ្ឋានគតិយុត្ដិ ដើម្បីគាំទ្រដល់អនុវត្ដច្បាប់ពូជ។
- ទីបម្រឹក្សានេះគួរយល់ចម្បាស់ពីកម្មវិធីពូជ នៅក្នុងបម្រទេសជិតខាង ដូចជា បម្រទេសថៃ ជាដើម (ដែលបម្រើបម្រាស់បម្រពឹន្ធពូជរបស់សហរដ្ឋអាមេរិច)។
- អគ្គនាយកដ្ឋានកសិកម្មគម្រូវចាប់ផ្ដើមរៀបចំកម្មវិធីសិទ្ធិអ្នក បង្កាត់ពូជដំណាំ ដែលត្រូវមាន ដាក់បញ្ចូលនូវបម្រុបញ្ញត្ដិមួយ សម្រាប់ឱ្យមច្ចាស់ពូជអាចពង្រឹងការអនុវត្ដសិទ្ធិរបស់ពួកគេ តាម រយៈនីតិវិធីរដ្ឋបបម្រវណី។ ប៉ុន្ដែ ការអនុម័តដាក់ស្ដែងលើវិធាននេះ និងលើការចូលជា សមាជិក UPOV (សហពន្ធអន្ដរជាតិការពារពូជរុក្ខជាតិថ្មីៗ) គឺជាអ្វីដែលនៅឃ្លាតទៀតទៅ ថ្ងៃមុខ។
- ការបញ្ចូផាក់ពូជ គឺជាកម្មវិធីធម្មតា សម្រាប់តម្រួតពិនិត្យគុណភាពនៃពូជដែលផលិត នៅក្នុង បម្រទេសមួយ។ ដោយសារតែការផលិតពូជដំណាំកសិកម្មបច្ចុបបន្ន នៅមានទម្រង់ទម្រាយតូច នៅឡើយ កម្មវិធីបញ្ចូផាក់គុណភាពពូជ នៅមិនទាន់មាននៅឡើយនាពេលនេះ ហើយអាច បន្ថមែការិយាធិបតយ្យដោយមិនចាំបាច់ដល់បម្រពឹន្ធនេះ។
  ជាអនុសាសន៍ គួរមាន រចនាសម្ពន្ធផ្ដល់ការបញ្ចូផាក់ដោយសម្ថគម្រចិត្ដមួយ ជាការបន្ថមែលវិធាន និងលិខិតបទដ្ឋាន នានា ដើម្បីឱ្យគអោចបម្រើការបញ្ចូផាក់នេះបន្ថមែទៅតាមការចាំបាច់។

២. បង្កើតសន្ដង់ដាគុណភាពពូជថ្នាក់ជាតិ

និងបង្កើតមន្ទីរពិសោធន៍សម្រាប់ធម្រើតេសដ្ដពូជតាមបបែទំនើបមួយដោយ **CARDI** ដែលនឹងបំពញ្ចេមុខងារក្នុងការអនុវត្ដកម្មវិធីបញ្ចូផាក់គុណភាពពូជ បម្រុបញ្ញត្ដិកម្មពូជ និងអភិវឌ្ឍពូជ

មន្ទីរពិសោធន៍សម្រាប់ធ្វើតេស្តពូជ ដែលមានសមត្ថភាពរឹងមាំ និងដំណើរការបានល្អ មាន សារៈសំខាន់ សម្រាប់ស្រង់យល់ពីគុណភាពរបស់ពូជ ដែលកំពុងជួញដូរនៅក្នុងបរិវេណសេមួយ។ មន្ទីរពិសោធន៍ពូជកម្រិតមូលដ្ឋាន ធ្វើតេស្តលើពូជ ខាងការដុះពន្លកពូជ (germination) ភាពសុទ្ធជាក់ស្តែង និងសំណើមពូជ និងសហការជាមួយនឹងកម្មវិធីបញ្ជាក់ និងធ្វើបញ្ជីតាមដានពូជ។ មន្ទីរពិសោធន៍ កំអាចបន្ថែមសេវាផ្សេងទៀត សម្រាប់ពិនិត្យលើភាពគង់វង្ស និងសក្តានុពលក្នុងការរក្សាទុកពូជ និងអាចជួយដល់ការស្រាវជ្រាវពូជផ្សេងទៀតផងដែរ។ មន្ទីរពិសោធន៍ពូជ គួរបង្កើតឡើង នៅក្នុង CARDI។ CAVAC កំពុងពិចារណាផ្តល់ថវិកាដល់ការបញ្ចប់មន្ទីរពិសោធន៍គុណភាពស្រូវ ដែលមានស្រាប់នៅក្នុង CARDI។

ចាំបាច់តម្រូវមានការអនុវត្តដូចខាងក្រោម៖

- នៅពេលដែលផែនការគម្រោង
  និងផែនការការងារទទួលបានការអនុម័តជាផ្លូវការ គួរមាន
  ការជួលទីប្រឹក្សាខាងពូជម្នាក់ ដើម្បីជួយដល់ CARDI
  ក្នុងការធ្វើឱ្យមន្ទីរពិសោធន៍នេះមាន ដំណើរការ។
  ទីប្រឹក្សានេះគួរចាប់ផ្តើមចុះមកបរិវេណសេកម្ពុជា
  នៅពេលដែលគម្រោងចាប់ ផ្តើមអនុវត្ត។
- ក្នុងកំឡុងពេលចុះមកដំបូងនេះ
  ទីប្រឹក្សានេះគួររៀបចំផែនការសកម្មភាពរបស់ខ្លួន
  សម្រាប់បញ្ចប់ការរៀបចំមន្ទីរពិសោធន៍ពូជ
  រាយតម្លៃលើតម្រូវការរបស់ឧស្សាហកម្មនេះ និងលើទីតាំងរបស់
  CARDI និងចងក្រងបញ្ជីសម្ភារ
  និងតម្រូវការនៃការបណ្តុះបណ្តាល។ ទីប្រឹក្សា
  នេះក៏គួរពិនិត្យផងដែរលើរបៀបដំណើរការរបស់មន្ទីរពិសោធន៍នេះ
  និងរបៀបទាក់ទាញអតិថិជនឱ្យបង្កើបង្រាស់សេវារបស់ខ្លួន។
  មកដល់ពេលនេះ គួរមានការជ្រើសរើសបុគ្គលិក
  និងបុគ្គលិករបស់មន្ទីរពិសោធន៍នេះឱ្យហើយ
  ហើយពួកគេត្រូវចាប់ផ្តើមធ្វើការងារជាមួយនឹងទីប្រឹក្សានេះ។
  គួរមានការរាយតម្លៃលើតម្រូវការនៃការបណ្តុះបណ្តាលនៅពេល
  នេះ។

- បុគ្គលិកត្រូវទទួលបានការបណ្តុះបណ្តាល ដែលអាចសម្រេចទៅបាន តាមរយៈការបញ្ជូន អ្នកបច្ចេកទេសទៅកាន់មន្ទីរពិសោធន៍ ដែលកំពុងតែដំណើរការ (អាចនៅក្នុងប្រទេសថៃ) ជា ចុះខែនសបាដហ៏។ ពួកគេត្រូវត្រឡប់មកវិញ មុនពេលដែលទីប្រឹក្សារូបនេះចុះមកដល់ខែកទី ២។
- តម្រូវមានការរៀបចំជាមួយនឹងកសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ ឬសុខាំនផ្សេង ទៀត ដើម្បីផ្តល់ថវិកាដល់ការបន្តប្រតិបត្តិការរបស់មន្ទីរពិសោធន៍ពូជនេះ នៅក្នុងរយៈពេលមួយ។
- បញ្ជាទិញឧបករណ៍ផ្សេងទៀតសម្រាប់មន្ទីរពិសោធន៍ពូជនេះ និងរៀបចំអគារ ឬបន្ទប់មន្ទីរ ពិសោធន៍ ដែលត្រូវសាងសង់ ឬរៀបចំគំរូឡើងវិញ សម្រាប់ប្រើប្រាស់ក្នុងមន្ទីរពិសោធន៍។
- បន្ទាប់ពីឧបករណ៍សម្ភារនេះមកដល់ ការរៀបចំ និងការចាប់ផ្តើមដំណើរការមន្ទីរពិសោធន៍ ពូជនៅនឹងកន្លែងតែម្តង គួរធ្វើឡើង នៅកំឡុងពេលចុះមកប្រទេសកម្ពុជាដាលខែកទី ២ របស់ទីប្រឹក្សាខាងពូជ ដែលនឹងធ្វើការជាមួយនឹងបុគ្គលិកមន្ទីរពិសោធន៍រយៈពេលពីរបីថ្ងៃ ដើម្បីផ្តល់ការណែនាំបច្ចេកទេស និងការគាំទ្រនានាដែលចាំបាច់។

៣. ផ្តល់ជំនួយថវិកាដល់ CARDI ដើម្បីបង្កើនការផលិតគ្រាប់ពូជមូលដ្ឋាន និងផ្តល់នូវឧបករណ៍ សម្ភារមួយចំនួន ដើម្បីធ្វើឱ្យកម្មវិធីផលិត និងសារធារពូជរបស់ទីស្ថាសថាននេះកាន់តែមាន ប្រសិទ្ធភាព និងមិនស្ថិតក្រោមអាសុីយលើកម្លាំងពលកម្មដែលធ្វើការងារដោយដៃ

- CARDI ចាំបាច់ត្រូវពង្រីកសមត្ថភាពសារធារណៈរបស់ខ្លួន ដើម្បីឈានទៅកាន់ពូជ ដែល សមស្របសម្រាប់តម្រូវការផ្សេងៗ ក្រៅពីអង្ករដែលមានគុណភាពខ្ពស់។ ពូជ ដែល សមស្របសម្រាប់គោលបំណងចិញ្ចឹមជីវិត និងដែលអាចបន្សាំទៅនឹងលក្ខខណ្ឌអាកាសធាតុ និងលក្ខខណ្ឌនៅមូលដ្ឋានខុសៗគ្នា កំពុងតែមានតម្រូវការយ៉ាងខ្ពស់ (៧៩000 តោន)។
- CARDI ចាំបាច់ត្រូវបង្កើតទំនាក់ទំនងឱ្យបានល្អ និងត្រូវធ្វើការងារជាមួយនឹងអ្នកពាក់ព័ន្ធ ខាងពូជឱ្យបានច្រើន

ទាំងអ្នកដលែមានរចនាសម្ព័ន្ធគ្រឹមគ្រូវផង
និងអ្នកដលែមិនទាន់មាន រចនាសម្ព័ន្ធផង ជាពិសសេ សូថាបំនឯកជន
និងសូថាបំនរដ្ឋប ជាពិសសេ សូថាបំនខ្នាតធំ និងខ្នាតមធ្យម
ដលែមូបីធានាយ៉ាងណាឱ្យបត្រូតិបត្តិការបច្ចេកទេសនានាមានតម្លៃ
ភាព សមរ្ថាប់ធានាគុណភាពពូជ
ដោយសារតសែូថាបំនទាំងនេះកំបុ្រលែបុ្រាស់ពូជពី CARDI ផងដរែ។

- ការគាំទ្រដល់ការផលិតពូជរបស់ CARDI មាននយ័ថា
  នឹងមានពូជកាន់តចែុ្រលែនជាងមុន សមរ្ថាប់កសិករ
  ហលែើយគអោចទទួលបានបុ្រាក់ចំណញេមកវិញចុ្រលែនពីការផលិតពូជ CS។
  (ពូជមូលដ្ឋាន ១ គីឡ អាចនាំឱ្យបានបុ្រាក់ចំណញេបុ្រមាណជា ៧០០
  ដុល្លារ)។

៥. បង្កលែើនការិនិយោគលលែើការសុ្រាវជ្រាវកសិកម្ម
ដលែើមបូីពង្រឹងទំនាក់ទំនងរវាងសវោសុ្រាវជ្រាវ និងសវោផ្សពុ្រផ្សាយ
ដោយសារតសែវោទាំងពីរនេះចុ្រលែនតធ្វែើការងារដោយឡែកពីគ្នា

ការិនិយោគនេះនាំឱ្យអ្នកសុ្រាវជ្រាវអាចបង្កលែើតបច្ចេកវិទ្យា
ឬពូជថ្មីៗ សមរ្ថាប់ភ្នាក់ងារផ្សពុ្រ ផ្សាយ ដលែអាចមិនយល់
ឬពុំចនេះយកបច្ចេកវិទ្យាទាំងនេះមកអនុវត្តដនលែើកុ្នងសូថានភាពជាក់សូដងែ
ក្នុងកសិដ្ឋានបាន។

ចាំបាច់ត្រូវអនុវត្តដសកម្មភាព ដូចខាងក្រោម៖

- រលៀបចំផនែទីបង្ហាញផ្លូវអំពីសមាហរណកម្មការសុ្រាវជ្រាវ
  និងការផ្សពុ្រផ្សាយជាមួយគ្នា ដលែបង្ហាញពីទសុ្សនទាន
  និងក្របខ័ណ្ឌអំពីសមាហរណកម្ម តួនាទី និងការបុ្រជុជេញ្ញាចិត្តរបស់
  សវោនីមួយៗ និងអភិក្រមការងារ។
- មនុ្ដរីផ្សពុ្រផ្សាយមួយចំនួនគួរចាត់តាំងឱ្យចូលរួម
  នលែើកុ្នងការងារសុ្រាវជ្រាវរបស់ CARDI-OFAT
  ហលែើយអ្នកសុ្រាវជ្រាវរបស់ CARDI គួរត្រូវបានចាត់តាំងឱ្យចូលរួម
  នលែើកុ្នង សកម្មភាពផ្សពុ្រផ្សាយផងដរែ។
  ការចូលរួមនេះគួរធ្វែើឡែើង សមរ្ថាប់គ្រប់កម្មវិធីសុ្រាវជ្រាវ និង
  ផ្សពុ្រផ្សាយទាំងអស់
  ហលែើយសកម្មភាពទាំងនេះគួរដាក់បញ្ចូលទលែើកុ្នងផនែការ
  សកម្មភាព។ តាមរយៈការធ្វែើបបែនេះ បញ្ហានានា

ដែលពាក់ព័ន្ធជាមួយនឹងព័ត៌មាន និង បច្ចេកវិទ្យា ក៏ដូចជាដំណើរការស្រាវជ្រាវ-ផ្សព្វផ្សាយ ដែលមាន អាចធ្វើឡើងបានទាន់ ពេលវេលា និងប្រកបដោយប្រសិទ្ធភាព។

- នៅក្នុងការរៀបចំសំណើគម្រោងស្រាវជ្រាវ CARDI ចាំបាច់ត្រូវមានសមាសភាគមួយ សម្រាប់ធ្វើការផ្សព្វផ្សាយលទ្ធផលនៃការស្រាវជ្រាវ និងធ្វើការសិក្សាថាតើលទ្ធផលដែលទទួលបានពីការស្រាវជ្រាវនេះគួរយកទៅអនុវត្ដ នៅក្នុងស្ថានភាពជាក់ស្ដែងក្នុងកសិដ្ឋាន ដោយរបៀបណា។ ភ្នាក់ងារផ្សព្វផ្សាយអាចចូលរួម នៅក្នុងសមាសភាគនេះ ចាប់ពីពេល ចាប់ផ្ដើមធ្វើការស្រាវជ្រាវដំបូង។ ពួកគេមិនគួររង់ចាំរហូតដល់ពេលលទ្ធផលទៅហើយនោះទេ ដោយសារតែវាយឺតពេក ដើម្បីរៀបចំនូវវិធីសាស្ដ្រ សម្រាប់ធ្វើការផ្សព្វផ្សាយ។
- នៅក្នុងកម្មវិធីពូជ វិទ្យាស្ថាន CARDI មន្ទីរកសិកម្ម និងមន្ដ្រីផ្សព្វផ្សាយនៅថ្នាក់ខេត្ដ មាន ឱកាសសហការគ្នា ដើម្បីអនុវត្ដគម្រោងស្រាវជ្រាវ-ផ្សព្វផ្សាយរួមគ្នា អំពីបច្ចេកទេសផលិត ពូជតាមសហគមន៍។ តាមរយៈដំណើរការលើកកម្ពស់ការផលិត និងការផ្គត់ផ្គង់ពូជតាម សហគមន៍ អ្នកស្រាវជ្រាវ និងភ្នាក់ងារផ្សព្វផ្សាយ អាចស្វែងរកលទ្ធភាព ដើម្បីភ្ជាប់ទំនាក់ ទំនងរវាងសេវាស្រាវជ្រាវ និងសេវាផ្សព្វផ្សាយនានា។

៥. ផ្ដល់ការបណ្ដុះបណ្ដាល និងបង្កើតបណ្ដាញអ្នកលក់ដូរធនធានកសិកម្ម ដើម្បីឱ្យវិស័យឯកជន អាចផ្ដល់សេវាផ្សព្វផ្សាយបន្ថែមទៀត ដល់កសិករខ្មែរ

កសិករ ដែលបង្កបង្កើនផលស្រូវ និងបន្លែ ដែលទិញពូជ និង/ឬធនធានផ្សេងទៀត កំពុង ទទួលបានផលិតភាពក្នុងគុណភាពខុសៗគ្នា ដោយពុំមានសេវាប្រឹក្សាត្រឹមត្រូវ។

ចាំបាច់ត្រូវអនុវត្ដសកម្មភាព ដូចខាងក្រោម៖

- បង្កើតបណ្ដាញអ្នកលក់ដូរធនធានកសិកម្មក្នុងវិស័យឯកជន ដែលបានទទួលការបណ្ដុះ បណ្ដាលអំពីការប្រើប្រាស់ពូជ ជី ថ្នាំកសិកម្ម ជាងជួសជុលគ្រឿងយន្ដ និងអ្នកដែល បង្ហាញពីផលិតផលរបស់ខ្លួនដល់អតិថិជនសក្ដានុពល។

បណ្តុះបណ្តាលអ្នកលក់ដូរទាំងនេះ
ជាសរោងសព្វផ្សាយបន្ថែមពីខាងវិស័យឯកជន
ដែលតម្រូវផ្តល់កម្រៃយោយពេលលក់ផលិតផលរួច ដើម្បីជួយ
និងរក្សាអតិថិជន។

- លើកទឹកចិត្តដឱ្យមានការបង្កើតសមាគម/បណ្តាញវិជ្ជាជីវៈ
ដែលអ្នកលក់ដូរធនធានកសិកម្ម ដែលចូលរួម
អាចបម្រើបម្រាស់អំណាចកម្រុមរបស់ខ្លួន ដើម្បីជួយដល់កសិករ
និងមានឥទ្ធិពលលើអ្នកតាក់តែងគោលនយោបាយ។
នៅក្នុងប្រទេសកម្ពុជា IDE បានបង្កើតនូវបណ្តាញ
សហគ្រាសអាជីវកម្មកសិដ្ឋាន (FBE) សម្រាប់អ្នកដាំបន្លែ។
នៅកម្រិតអន្តរជាតិ IFDC និង CNFA
គឺជាអង្គការមិនមែនរដ្ឋាភិបាលចំនួនពីរ ដែលបានបម្រើបម្រាស់គំរូនេះ
នៅក្នុង ប្រទេសផ្សេងទៀត។

៦. បង្កើនការយល់ដឹងអំពីពូជដែលបានកែលំអ និងគ្រាប់ពូជដែលមានគុណភាពល្អ
ជាកត្តាសំខាន់ សម្រាប់កែលំអផលដំណាំ

គាំទ្រ
និងជម្រុញលើកកម្ពស់សកម្មភាពបណ្តុះបណ្តាលកសិករ/អ្នកផលិតពូជ
ដែលធ្វើឡើង ដោយ CARDI និងសថាប័នសមសង្របដទៃទៀត។
ចាំបាច់តម្រូវអនុវត្តដសកម្មភាព ដូចខាងក្រោម ៖

- ជួយ និងពង្រីកកម្មវិធីបណ្តុះបណ្តាល
និងអភិវឌ្ឍន៍បច្ចុប្បន្នរបស់ CARDI ដើម្បីជួយដល់
កសិកររនៅតាមសហគមន៍ ដូចជា (i) ការបន្សុទ្ធ ការផលិត
និងការរក្សាពូជក្នុងសង្រុក និង (ii) ការដាំ ការរក្សា និងការបង្កែចកែពូជ
ដែលបញ្ចូចញេដោយ CARDI តាមរយៈ OFAT។
- កម្មវិធីដទៃទៀត នៅកម្ពុជា ដូចជា CEDAC (មជ្ឈមណ្ឌលសិក្សា
និងអភិវឌ្ឍន៍កសិកម្ម កម្ពុជា)
មានគោលបំណងផ្តដោតលើការផលិតពូជតាមសហគមន៍
ដើម្បីបន្ថែមតម្លៃដែលអង្ករសរីរាង្គ។
គអោចផ្តដល់ការគាំទ្រដល់កម្មវិធីទាំងនេះ។ ជម្រើសមួយទៀតគឺគអោច
រៀបចំនូវកម្មវិធីផលិតពូជ/បន្ថែមតម្លៃទៅតាមសហគមន៍
ដែលអាចលក់ផលិតផលអង្ករក្នុងសង្រុក ដោយផ្ទាល់ទៅកាន់អតិថិជន

ដលែផ្ដល់ឱ្យកសិករនូវចំណូលកាន់តែច្រើនជាងមុន
សម្រាប់ផលិតផលរបស់ពួកគេ។

៧. ជម្រុញសមាហរណកម្មឧស្សាហកម្មពូជ
តាមរយៈការពង្រឹងទំនាក់ទំនងនៅក្នុងវិស័យ សាធារណៈ និងទំនាក់ទំនងរវាងវិស័យសាធារណៈ
និងវិស័យឯកជន

ចាំបាច់តម្រូវមានការធ្វើការងារ
ដើម្បីកំណត់រកអ្នកដលែមានតួនាទីសំខាន់ៗ និងណានៃាំ
ពួកគឱ្យសន្តានទៅវិញទៅមក
និងធ្វើការសម្របសម្រួលកិច្ចខិតខំប្រឹងប្រែងនានា។ នេះក៏រាប់បញ្ចូលការធ្វើតេស្តពូជសម្រួនៅនឹងកសិដ្ឋានជាក់ស្តែង ការអនុវត្តដបងហាញ
និងការរៀបចំទស្សនកិច្ចជាក់ស្តែង
មិនត្រឹមតសែមរាប់កសិករប៉ុណ្ណោះទ ប៉ុន្តែមែទាំង
ដើម្បីឱ្យមានការសហការគ្នារវាងតួអង្គសំខាន់ៗ
ដលែធ្វើការងារពាក់ព័ន្ធនឹងអង្ករផង។

ចាំបាច់តម្រូវអនុវត្តដសកម្មភាព ដូចខាងក្រោម ៖

- CAVAC គឺជាគម្រោងមួយ ដលែធ្វើការងារខាងការផ្សព្វផ្សាយ
និងការលើកកម្ពស់សង្វាក់ ផ្គត់ផ្គង់
ហើយមានលទ្ធភាពអាចឱ្យគរៀបចំការសម្របសម្រួលការងារផ្សព
ព្វផ្សាយ និងការ បណ្តុះបណ្តាលជាមួយ CAVAC
ក៏ដូចជាមួយនឹងអង្គការស្ថាប័នផ្សេងទៀត។ កម្មវិធីនេះ
គួរសហការជាមួយនឹងក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនសោទ CARDI
និងនាយកដ្ឋាន ផ្សព្វផ្សាយ ដើម្បីធ្វើការងាររួមគ្នា
ដើម្បីសម្របសម្រួលសកម្មភាពផ្សព្វផ្សាយ នៅក្នុង
សង្វាក់ផ្គត់ផ្គង់ទាំងមូល។
- ជួលទីប្រឹក្សាម្នាក់
ដលែមានបទពិសោធន៍ច្រើនខាងការធ្វើតេស្តដំណាំ
ការបងហាញនៅនឹង កសិដ្ឋានជាក់ស្តែង
ការជួបប្រជុំជាមួយនឹងកសិករ និងការរៀបចំទស្សនកិច្ចទៅទីរាលជាក់
ស្តែង ដើម្បីធ្វើការងារជាមួយនឹងក្រសួងកសិកម្ម រុក្ខាប្រមាញ់
និងនសោទ CARDI នាយកដ្ឋានផ្សព្វផ្សាយ កសិដ្ឋានផលិតពូជ
និងមន្ទីរកសិកម្ម ដើម្បីសម្រងរកព័ត៌មានពាក់ព័ន្ធ

ដលែអាចបង្ហាញដល់កសិកររអំពីជម្រើសពូជ
និងធនធានដលែពួកគេត្រូវយកទៅបម្រើ បម្រាស។

- ផ្ដល់ថវិកាដល់ CARDI ដើម្បីពង្រីកការធ្វើតេស្ដសាកល្បង
និងកន្លែងសម្រាប់បង្ហាញដល់ កសិករ
នៅកន្លែងតំបន់បង្កបង្កើនផលស្រូវរបស់បម្រទេស។

ផ. លើកកម្ពស់សមត្ថភាព និងការគ្រប់គ្រងកសិដ្ឋានផលិតពូជ ដូចជា ពូជស្រូវ ពូជបន្លែ និងពូជ ធញ្ញជាតិផ្សេងទៀត នៅថ្នាក់សហគមន៍

ការគ្រប់គ្រងជាចម្រើនលើកសិដ្ឋានទាំងនេះ
មានបម្រភពចញ្ចើពីក្រសួងកសិកម្ម រុក្ខាបម្រមាញ់ និងនេសាទដោយផ្ទាល់។
គដេឿៀ ការគ្រប់គ្រងនៅមូលដ្ឋានកាន់តចែម្រើនជាងនេះ នឹងរួមចំណែក
បង្កើនបម្រសិទ្ធភាពរបស់បម្រតិបត្ដិការ ក៏ដូចជាបង្កើនផលិតភាព។
ការគ្រប់គ្រងផ្ទាល់នៅមូលដ្ឋានលើ កសិដ្ឋានទាំងនេះ
អាចជួយឱ្យកសិដ្ឋានផលិតពូជអាចផ្ដល់សរោដល់កសិករដលែជាអ្នកទិញពូជ
កាន់តបែម្រសើរជាងមុន ជាមួយនឹងពូជដលែមានគុណភាពខ្ពស់
និងពំតមានកាន់តបែម្រសើរជាងមុន។

ចាបាច់ត្រូវអនុវត្ដសកម្មភាព ដូចខាងក្រោម៖

- រាយតម្លៃលើកសិដ្ឋានផលិតពូជរបស់ក្រសួងកសិកម្ម
រុក្ខាបម្រមាញ់ និងនេសាទ និងនៅក្នុងករណីសមស្រប
រៀបចំរចនាសម្ព័ន្ធកសិដ្ឋានទាំងនេះឡើងវិញ
ដើម្បីឱ្យកសិដ្ឋានទាំងនេះ
ផ្ដល់សរោកាន់តបែម្រសើរដល់កសិករដលែជាអតិថិជនរបស់ខ្លួន។
- សរសរេផនែការអាជីវកម្ម សម្រាប់កសិដ្ឋាន ដលែផ្ដល់សរោ
និងផលិតផលកាន់តចែម្រើនដល់កសិករនៅមូលដ្ឋាន
និងផ្ដល់ឱ្យកសិដ្ឋានទាំងនេះនូវមូលដ្ឋានហិរញ្ញវត្ថុ។ ផនែការ
នេះ
ត្រូវពិនិត្យលើគ្រប់ទិដ្ឋភាពទាំងអស់នបែម្រតិបត្ដិការរបស់កសិដ្ឋា
ន និងត្រូវកំណត់ពីផ្នែកែ ដលែផ្ដល់នូវបម្រាក់ចំណញ
ដើម្បីឱ្យកសិដ្ឋានទាំងនេះកាន់តទទួលបានជោគជ័យ។ នេះទំនង
ជានឹងត្រូវមានការដាក់បញ្ចូលចំណាយផ្សេងៗ
ដលែត្រូវទូទាត់ទៅឱ្យក្រសួងកសិកម្ម រុក្ខាបម្រមាញ់ និងនេសាទ។
គួរមានទីបម្រឹក្សាក្នុងសុរុក ដើម្បីជួយដល់ដំណើរការនេះ។

Executive Summary

Changes in seed industry are needed to increase agricultural productivity and meet the government's rice export targets

Rice is not just a crop but also the staple food in Cambodia. A major thrust of the seed program in Cambodia involves rice. Some local rice varieties are important to communities and must be maintained, but it is crucial that they are also improved for better grain quality, higher yields, resistance to diseases or environmental stresses, and less farm input requirement. Many Khmer farmers live near the subsistence level and any new rice variety, even if it promises higher yields, could be seen as a threat to their local heritage.

The use of quality seeds is a main component for realizing the yield potential and increasing agricultural productivity. A modern seed industry contains a variety development, seed production, quality control and processing, marketing and governmental oversight. As the sector matures in Cambodia, each of these factors becomes more important and plays a more prominent role in the growth if the agricultural sector. As farmer is the final user of seed, the seed industry has to reshape itself to better respond to the specific needs and develop products, which will yield well and thrive in the conditions where they will be planted.

Changes in the seed production supply system are required to meet country's export targets. The government's target to export 1 million tons of milled rice by 2015 poses challenges for Cambodian rice farmers. Successful implementation depends on the cooperation and efforts of several government agencies. Full irrigation of ca 800,000 ha of rice-cultivated area is required to meet this ambitious export target. Improved access to irrigation is prerequisite for expanded production quality seed.

Cambodia's seed industry is weak without clear structure and coordination

The seed industry in Cambodia lacks any official structure and overall coordination. As of 2011, there is a fledgling formal structure by the Cambodian Agricultural Research and Development Institute (CARDI), which develops new rice varieties and produces foundation seeds for rice. The institute also provides seed production trainings to community seed producers as well as rice millers, who are interested in buying consistent rice products from farmers. Another smaller network for formal rice seed production and distribution is AQIP Seed Company, which is owned by the Ministry of Agriculture, Forestry and Fisheries (MAFF) and Seed Growers Association of Cambodia. There are also a few small-scale private producers, who work directly under MAFF.

Only 20 percent of total rice land is cultivated using quality seed. The term "quality seed" refers to known varieties, which are produced under some type of seed production program. There are farmers, however, who understand the benefits of quality seed but cannot afford to buy it. Improving community access to quality seed suitable for their plantation area, land conditions etc, is one of the most essential methods to increase productivity.

There is a fast-growing gap between the demand and supply of quality seed. It is estimated that the market demand for quality seed will grow from 23,000 metric ton (Mt) in 2009-2010 to 38,500 Mt by 2015, and it will top 50,000 Mt by 2020. In the contrast, the potential expansion of the seed supply within the next five years (2011-2015) could reach about only 8,500 Mt. This means by 2015, there is going to be a gap of some 30,000 - 32,000 Mt between supply and demand.

Private seed producers and community based seed production groups have emerged as a response to increased demand for quality seed. The seed growers involved in both the formal and informal systems have been trained by CARDI in seed production methods and understand the need to maintain pure seed lines. At the community levels, farmers don't only produce seed for other farmers but also teach other community members how to grow, store, and maintain their own planting stock. Village seed programs are especially effective because potential seed users have direct access to the seed grower and seed fields. In some cases, these community groups have worked with rice traders to create projects and produce a value added product directly to the final consumer.

Limited capital and outdated equipment are main challenges of the Cambodia's seed sector

The main constraints of the seed production supply in Cambodia are a capital deficit, low diversification, and a lack of mechanized equipment and facilities. These limitations force suppliers to use increasingly expensive hand labor, which evades opportunities for higher quality seed production at a cheaper price. A lack of operational capital is the most serious constraint as it greatly slows down the new variety development and release. Due to limited resources, CARDI can produce only seeds for guaranteed purchases. This has resulted in unfilled orders during the high demand years and in sharp losses in the poor years, when expensive supply seed has to be sold for milling at a great loss.

Cambodia's hot and humid climate rapidly deteriorates seeds both in growth and storage phases. Research shows that the level of rice germination falls below 80-85 percent within 6-8 months after harvest. Therefore, any seed produced beyond immediate planting needs is used for milling. Production costs of these seeds cannot be recouped. When seed producers' budgets are constrained, they often plan their seed production based on conservative seed sales estimates.

Cambodia's seed market is weakly integrated. Information about seeds and seed use is ineffectively communicated through the value chain, within the public sector and between public and private sectors. Agro-input dealers are often ill equipped to serve farmers in a productive manner and aren't committed to servicing the farmer's needs.

Seed supply system also lacks consistency in quality and customer support. The rice production system uses locally produced and mostly unimproved grain as seed with variable quality to produce a crop with lower yields and poor quality. Farmers often fail to receive sound agronomic advice and post-sale services from local shops. Therefore, many farmers plant low quality seed without fertilizers and refuse to buy other products.

The National Seed Law was passed in 2004 already. The raw structure for the national seed program has been established, but without its accompanying Rules and Regulations, the operational interpretation does not yet exist. No national seed quality standards have yet been developed under the law.

Recommendations for policy actions

Recommendations for structuring the rice seed industry in Cambodia include the following:

1. **Enforce the implementation of the seed law by assisting the General Directorate of Agriculture in drafting the Rules and Regulations of the Seed Law**.

Cambodia has passed a seed law but an appropriate English translation of the law does not exist yet. The law will require a proper English translation before it can be assessed appropriately. The following actions are needed:

- An expert consultant on seed law and policy will have to be hired to research the law; interpret its meaning for the Cambodian seed industry; consult with MAFF, CARDI, and seed industry officials; and write the Rules and Regulations to accompany the Seed Law.
- It is strongly recommended that the consultant be familiar with the seed programs in neighboring countries like Thailand (which is based on the United States seed system)
- The General Directorate of Agriculture has to begin putting together a program of plant breeders' rights that will include a provision for variety owners to enforce their rights through civil proceedings. However, actual enactment of that rule and UPOV (the International Union for the Protection of New Varieties of Plants) membership is still a distance into the future.

- Seed certification is the normal program for seed production quality control in a country. Because of the current small-scale agricultural seed production, a seed certification program is not warranted at this time and would possibly add unneeded bureaucracy to the system. It is recommended that the structure of a voluntary certification be added to the rules and regulations so that it can be added as needed.

2. **Develop a national seed quality standard and establish a modern seed-testing laboratory by CARDI that will function in seed certification, regulation, and variety development programs**.

A strong and functional seed-testing laboratory is essential to understanding the quality of the seed being traded in a country. Basic seed laboratories test seed for germination, physical purity, and seed moisture and work in conjunction with seed certification and seed regulatory programs. Labs can also add further services that look at viability and storage potential of seed and can aid in other seed research as well. A seed laboratory should be established and placed at CARDI. CAVAC is considering the funding of the completion of an existing rice quality laboratory at CARDI. The following actions are needed:

- As soon as the project and work plan are officially approved, a seed consultant should be contracted to assist CARDI in making the lab functional. The consultant should make his initial visit as the project implementation starts.
- During this initial visit, the consultant should prepare his action plan for the complete seed lab establishment, assess the industry needs and the CARDI location, and compile a list of equipment and training needs. The consultant should also look at how the lab will function and solicit business. At this point, the laboratory director and staff should already be selected and have begun working with the consultant. Their training needs should also be assessed at this time.
- Staff will have to be trained, which can be accomplished by sending the technicians to a functioning lab (possibly Thailand) for a number of weeks of training. They should be scheduled to return back before the second visit of the consultant.
- Arrangements will have to be with MAFF or other agencies to fund the on-going operation of the seed laboratory over time.
- Order seed laboratory equipment and arrange for the laboratory building or rooms to be built or remodeled for lab use.
- After the equipment arrives, an on-site set-up and start-up of the seed lab should be done in the second visit by the seed consultant, who will work with the lab staff for a few days in order to provide the necessary technical orientation and support needed.

3. Provide CARDI with budgetary assistance for increased production of Foundation seed and supply them with some equipment that would make their seed production and research programs more efficient and less dependent on manual labor.

- CARDI needs to expand its research capacity toward improved varieties that are suitable to different needs beside premium rice. The varieties that are well suited for subsistence purposes and that are adaptable to varied climate and field conditions are in high demand (79,000 Mt)
- CARDI needs to establish good links and to work with many seed stakeholders including structural and non-structural, particularly large and medium scale, private, and state institutions to ensure a transparent technical operation for seed quality assurance as they are using seed sources from CARDI.
- Support to CARDI's seed production would mean that greater amounts of seed would be available to rice farmers and significant returns could be generated in CS production (Each kg of FS planted could generate around $700 profit).

3. **Increase investments in agricultural research to strengthen linkages between research and extension services, as they tend to work separately.**

This results in researchers generating technologies and new varieties for the extension workers who may not understand or be able to apply these technologies in the real farm conditions. The following actions are needed:

- Develop a roadmap for research and extension integration, which provides concept and framework of integration, their respective roles and commitments, and the working approach.
- Some extension officers should be assigned to join the CARDI-OFAT research activities and CARDI's researchers should be assigned to join the extension activities as well. This participation should be done for all research and extension programs, and they should be integrated in their action plan. In this way, any issue related to information and technologies as well as research-extension process that arise can be addressed in a timely and effective manner.
- In designing a research proposal, CARDI needs to have one component on extension of research results to research on how its research results should be applied in real farm conditions. The extension worker can participate or join this component from the onset of research; they should not wait until the results are generated because it will be too late to develop an extension approach.
- In the seed program, there is opportunity for a Joint Research Extension Project on Community Based Seed Production Technique operated by collaboration among CARDI, PDA, and Extension Officers at the provincial level. Through the process of promoting community based seed production supply, the researchers and extension workers can explore possibilities to develop linkages between research and extension services.

5. Provide training and establish an agro-input dealers' network in order to provide additional private sector extension services to the Khmer farmers.

Rice and vegetable farmers who purchase seed and/or other inputs are receiving products of variable quality, without proper advisory services. The following actions are needed:

- Establish a network of private sector agro-input dealers who have been trained in the use of seed, fertilizers, pesticides, mechanics, and who will demonstrate their products to potential customers. Use these dealers as additional private sector extension service that will perform after sales service to help and retain customers.
- Encourage development of a professional association/network that participating input dealers can use their group power to help farmers and influence policy makers. In Cambodia, IDE has established a network of Farm Business Enterprises (FBE) for vegetable growers. Internationally, IFDC and CNFA are the two NGO's who have used this model in other countries.

6. Increase awareness on improved varieties and quality seed as the key factors for crop improvement.

Support and promote the farmer/seed grower training activities by CARDI and other appropriate institutions. The following actions are needed:

- Assist and expand CARDI's current training and development programs to assist farmers at the community level in the following: (i) Purifying, growing, and maintaining local varieties; and (ii) growing, maintaining, and distributing CARDI seed released varieties through OFAT.
- Other programs in Cambodia such as CEDAC (Cambodian Centre for Study and Development in Agriculture) are aimed at community seed production to add a value added approach for organic rice. Support could be given to these programs. Alternatively, a community seed production/value added program could be instituted that would market local rice products more directly to consumers giving farmers a greater return for their product

7. Improve the integration of the seed industry by strengthening connections within the public sector, and ties between public and private sectors.

Work must be done to identify the key players, and to introduce them to each other, and to coordinate their efforts. This also would include on-farm rice seed tests, demonstrations, and field days—not only for the farmer, but also to unify the key rice players. The following actions are needed:

- CAVAC is a project that is working within extension and value chain enhancement, and there is a possibility to do extension coordination and training with CAVAC—others may exist as well. This program should work

with MAFF, CARDI, and the Department of Extension to work together to coordinate extension activities within the value chain.

- Procure a consultant who has extension experience in crops testing, on-farm demonstrations, farmer meetings, and field days to work with MAFF, CARDI, Extension, seed farms, and PDA's to uncover pertinent information that can be presented to farmers about their seed and input choices.
- Fund CARDI in expanding its test plots and farmer demonstration plots in rice growing areas of the country.

8. Improve capacity and management of seed production farms, including rice, vegetable and other cereal seed, at the community level.

Much of the current control of theses farms comes directly from MAFF. It is believed that increased local control would contribute to increased operational efficiency and greater productivity. More local control of these facilities may help the seed farms to better service farmer seed buyers with increasing amounts of high quality seed and better information. The following actions are needed:

- Evaluate the MAFF seed production farms and where appropriate, restructure them so that they can better serve their farmer clientele.
- Write a business plan for the farm that would provide increasing service and products to local farmers and give the farm a financial basis. This plan would look at all aspects of farm operation and identify the aspects that are profitable so that the farm can be more successful. This would most likely include reasonable overhead payments to MAFF. Local consultants should be available to assist in this process.

1. Introduction

1. The use of quality seed is a major component of increased yields in crop production. Quality seed and seed programs in a country does not emerge by happenstance; it is created by a combination of many factors that include variety development, seed production, quality control, processing, marketing, and governmental oversight. As the seed sector in a country matures, each of these factors becomes more important and plays a more important role in the growth of the agricultural sector.

2. The seed program in Cambodia is interestingly different from that in many other developing countries. In many nations, especially those of the former Soviet Union bloc, traditional seed programs are in place; however, they are often mired with antiquated procedures and unworkable practices. Moreover, they are frequently staffed with bureaucrats, making for an existing system that simply does not function. Cambodia's system is nearly the antithesis: there is almost no vestige of the former system, but production and sales of seed continue with a strong belief in the need for quality seed.

3. Even without a true seed program in Cambodia, farmers understand the need to plant quality seed to increase crop yields. Also, seed growing farmers often understand the methods employed to maintain genetic and physical purity of their seed crops. Furthermore governmental bodies understand the need for oversight of the industry without instituting burdensome regulatory scrutiny that would hamper its growth. That being said, it is imperative that Cambodia's seed industry—still in its infancy— be structured correctly, so that it can grow from many, small groups of locally selling seed growers to an industry capable of functioning in the international market.

4. When structuring this growing seed industry, it is important to look at current practices and to incorporate these practices into programs. Starting new programs, which may use steps that are alien to participants in the industry, are ineffective. For example, it would be prudent to build on the current quality control systems of seed production rather than to start a new type of seed certification program. It is critical to use good workable programs and to build them into national programs without confusing the farmer participants with new procedures or rules they cannot comprehend.

5. Since a major thrust of the seed program in Cambodia involves rice, it is important to consider its role in the average Cambodian's life. Rice is not just a crop: it is the staple food.. Specific rice types and flavors are important and must be maintained, but it is important that they are also improved. Local varieties are important to individual communities and the loss of those varieties for the sake of an

increased yield would be considered a loss of local heritage. Many farmers exist at or near the subsistence level and may be unwilling to give up known varieties for new, superior types because they understand the capabilities and restrictions of their own variety. Any new type, even if it was a higher yielding variety, could be a threat to their lifestyle. The fear is that its agronomic needs could cause it to fail and to bring on a local food crisis. These factors that tie the rice to the people must be considered when designing a seed system in Cambodia. This is especially true when rice is being produced at a subsistence basis or on a small family plot; a major part of any farmer's decision will include how a change in variety or field practice will affect the field's ability to produce sufficient amounts of food and cash to his or her family.

6. Cambodia's climate must also be accounted for in any decisions regarding seed. Its heat and humidity causes rapid deterioration of seed viability and germination in rice and other seeds in both the growth and storage phases. CARDI research has shown that the level of rice germination falls below 80-85 percent within 6-8 months after harvest; this means that seed must be planted during the growing season following harvest. Therefore, any seed produced beyond immediate planting needs for the next crop is used for milling; seed production costs for that seed cannot be recouped. When seed producers' budgets are constrained, they often plan their seed production based on conservative seed sales estimates.

2. Government Oversight

8. It is often the goal of governmental officials to control the seed industry through seed laws and programs. However, the role of government regarding seed laws, seed certification, seed laboratories, and other seed offices should be limited to protecting the farmer and the final seed buyer from inadvertent quality lapses or fraudulent acts. If the government can fulfill this role without burdening the industry, it allows the seed industry to grow and to be flexible in its development.

2.1. General directorate of agriculture (GDA)

9. The individuals involved with seed programs at the GDA grasp the proper type of governmental oversight needed in the Cambodian seed industry. There was no indication of a need or desire to establish burdensome oversight mechanisms. They seemed to believe that programs that allow for the production of quality seed for planting should be their role; moreover, they seem to understand that producing this seed without major governmental interference will be most effective method to do so.. The current seed law does not contain rules and regulations for its enforcement often creating situations where individuals have differing opinions about procedures. This is further evidence to draft and to approve the rules and regulations for the seed law.

2.2. Seed law

10. A seed law gives the structure for seed sales within a country. The true purpose of a seed law is to protect the final seed buyer from a product that will not perform up to expectations. The law will usually provide for certain quality standards and adherence to seed production and quality control activities. .

11. Cambodia has passed a seed law, which could possibly be similar to nearby countries; however, it is impossible to determine because no official or accurate translation exists at the time of this writing. A 2004 version of a seed law written in English was obtained–this version was much like European seed laws that include substantial governmental oversight and would not allow for the emerging seed industry to function as it is currently. . It is not known how or why this earlier version was changed prior to enacting the current law. Discussions with seed officials from the GDA imply that the current seed law is not the same as this earlier draft. There are no rules and regulations for the law at this time; for a law to be interpreted and enforced, consistent rules and regulations are required. The first step for a seed program in Cambodia would be to translate the law into English. A qualified

consultant would then be needed to assist the GDA, MAFF and CARDI in drafting and approving the regulations.

2.3. Plant breeders rights

12. With the advent of private sector plant breeding companies, a system had to be installed that would allow variety owners to maintain control over the use of their varieties and to derive an income from them. Laws for the establishment of Plant Breeders Rights (also known as Plant Variety Protection) were written for this purpose. To standardize these laws between countries, the International Union for the Protection of New Varieties of Plants (UPOV) treaty was established.

13. Individual countries that wish to establish a set of plant breeders' rights must enact a law that complies with the UPOV treaty and then apply to UPOV for acceptance as a treaty signatory. UPOV membership would allow for the importing of many current private varieties that would grow well in this country.

14. Since Cambodia does not have a functioning seed law with accompanying rules and regulations, it is still at some distance from UPOV membership. The General Directorate of Agriculture has begun putting together a program of plant breeders' rights that will include a provision for variety owners to enforce their rights through civil proceedings. However, actual enactment of that rule and UPOV membership is still a distance into the future.

15. A plant breeders' rights position is important to the growth of the seed industry in Cambodia. Multi-national seed companies are often hesitant to allow their varieties to be shipped into a country because of the fear of the loss of control of that variety. Loss of control means that subsequent generations of that variety could be planted without compensation to the parent company. Since the best and newest crop characteristics are often contained in these new varieties, a lack of plant breeders' rights laws would mean that large seed companies would not be entering Cambodia. More importantly, the best seed would not be reaching the farmers.

16. Enforcement of plant breeders' rights must also be addressed. Although some governmental regulatory oversight in the form of border control, stop sales, and seizures might be important, a system that would allow for civil remedies by the seed company to stop infractions would most likely have to be included in the seed regulations.

2.4. Seed certification

17. Seed certification is a program of quality control in seed production that establishes procedures and minimum quality standards in seed production. Seed production within a certification system does not guarantee that certified seed is high quality, but instead says that the seed has been subjected to certain practices,

procedures, and rules. Thus, because seed has been subjected to the certification process, it has a good chance that it is of high quality. Seed certification is based on a generational system: i) Foundation seed (FS) is the most closely controlled class and grown from seed supplied by the breeder or owner of the variety; ii) Registered seed (RS) is grown from Foundation seed and is a multiplication class of seed that has standards that are less strict than Foundation class; iii) Certified class or the Commercial seed (CS) is the progeny of Registered seed and uses standards less stringent than Registered seed. Many countries use a system called the limited generation system: the three classes are all that are allowed and that Certified/Commercial seed can only be grown for grain and not for further seed production. Where the limited generation system is not used, as is the case in Cambodia, Commercial seed can be continually used for further production as long as minimum standards are met. In this case, successive generations of Commercial seed might be given a classification of C_1, C_2, C_3, C_4…and so forth. The possibility of genetic contamination and therefore lower field performance increases with more generations from the Foundation seed to the current Commercial level. Generally, it is recommended to renew the Commercial seed every three years.

18. The seed law authorizes seed certification systems in a country with certification standards often written into the rules and regulations. A Certification system in a country can either be mandatory or voluntary. Mandatory systems are common in Europe and Central Asia and are usually operated through ministries of agriculture. Mandatory systems require that all seed produced in the country must go through a certification program to assure that the seed produced has some assurance of good quality. A mandatory seed certification program works best in a country that has a strong structure and is able to identify and control the seed grown and planted within its borders. In countries where the government does not have this level of control, seed production and importation often goes unnoticed by the governmental authority and therefore much of the seed being distributed to farmers for planting is not subject to any third-party oversight.

19. Voluntary seed certification programs exist in other parts of the world including the United States, Canada, and as near to Cambodia as Thailand. Voluntary seed certification is used at the discretion of the owner of the seed variety. Seed certification is managed by a governmental agency or designated to be operated by a non-governmental group—often a seed grower's association and subject to oversight under the seed law. The final seed product is tagged with an official label that is recognized as quality seed. Non-certified seed produced in those countries with voluntary programs is most often produced by private companies under their own quality control programs and are backed by the producing company's reputation. This is not to say that there is no governmental oversight over non-certified seed in countries with voluntary certification programs. Governmental seed regulatory programs (described later) are necessary to monitor seed production quality systems, especially in countries with a voluntary seed certification program because of the possibility of non-complying seed—either inadvertent or intentional.

20. Seed certification programs use standards and procedures that are consistent from internationally so that seed labeled in one country can easily be shipped to another. It is also done so that seed buyers in the country of import can be assured that the seed they purchased is comparable to that produced in their own country. In the current world of multi-national seed companies and international trade, seed certification is a major tool used to insure the quality and consistency of seed shipped across borders. Most often countries with active seed certification programs are members of multi-national seed certification groups or trade treaties such as the Association of Official Seed Certifying Agencies (ASOCA) or the Organization for Economic Cooperation and Development (OECD) that establish uniform standards for seed in international commerce.

21. A most likely scenario for seed certification in Cambodia would be the use of the voluntary system. It is the system used in Thailand, a major seed power in the region. Current seed production is more informal in Cambodia and much of current seed production would never even be exposed to true certification. This system would also be the logical extension of the current quality control program (formal and informal) now used in the country by seed producers.

22. Although seed certification is an excellent program that protects the seed buyer, it is currently not necessary to implement a seed certification here at this time. The following are the reasons for this recommendation:

- Farmers are already aware of the value of using good seed in their crop production;
- Increasing amounts of rice and other crop seeds are being produced by trained farmers under quality seed production systems;
- Small holder agriculture allows for farmers to scrutinize seed production plots;
- Increasing amounts of rice seed is produced by community farmer associations where potential seed buyers and users are able to watch the seed production process of the local seed grower;
- A seed certification program would impose added costs on either the government or the seed grower for programs that are already evolving without expenditures;
- Production of seed for the international market is not a possible option at this point; and
- The system would be virtually unused.

23. The biggest possible beneficiary of a seed certification program would be the AQIP Seed Company. However, they currently use their own quality control system that seems to be working for them. The company said that if such a system was in place they would use it, but it is not currently essential to their needs.

2.5. Seed regulatory programs and truth in labeling

24. Seed regulatory programs designated under the seed law provide for truth in labeling oversight programs in the seed trade. This requires that any seed sold must conform to the information listed on its label. Governmental regulatory inspectors can sample seed. If germination, mechanical purity, or other labeled information is found to be incorrect, the seed lot can be removed from sale, destroyed, or fines can be issued to labelers for infractions. Additionally, regulatory oversight handles customer complaints for seed non-performance. Seed buyers in countries with voluntary certification programs tend to be more informed about seed choices because they may be relying on the reputation of a seed company rather than the independent third party quality control of a seed certification program.

25. Since seed quality is difficult to ascertain by simply looking in the bag, the seed label is the method that seed buyers use to understand the quality of the seed they buy. It therefore becomes important that the label information is correct; a governmental seed regulatory program can help to insure that mislabeling, either inadvertent or intentional, does not occur. Truth in labeling does not insure that the seed is of good quality; it states that it conforms to the label information. For instance, a seed label saying 0 percent germination would be truthfully labeled and often legal, but the seed would be of poor quality.

26. In countries such as Cambodia where the level of farmer sophistication is lower than in other countries, it would be necessary to establish minimum levels for germination, purity, and weed content on the labels. These levels are often set by crop type and are designated in the Seed Law Rules and Regulations. Minimum label requirements would be essential in Cambodia.

2.6. Seed testing laboratory

27. A seed laboratory is an integral part of seed system. Physical characteristics such as seed purity, moisture, germination, presence of disease, and weed seed content are determined through an analysis in a laboratory. Seed analysts are trained and in some circumstances are specialists in specific areas of analysis. A seed laboratory is essential to the operation of an official seed certification programs and for seed regulatory functions. Results from seed tests are used for seed labeling purposes. In addition, a seed laboratory can also function as an aid in a variety of development and research programs.

28. Consistency of results over time and location is important because of the possible movement of seed lots from place to place. Seed laboratories are accredited through the International Seed Testing Association (ISTA) to provide consistent test results through approved methods and testing apparatus. Accreditation means that the laboratory has the correct testing equipment, consistent procedures, and its analysts have the training and expertise to perform consistent and accurate seed tests.

29. There is no seed laboratory in Cambodia, and to have a functioning seed industry in the country, one will be necessary at some point. The lack of a seed laboratory does not imply that little is known about the physical quality of rice seed. Close work in small seed plots means that farmers can easily remove contaminating impurities. Also, sun drying of the seed insures storable seed moistures. Farmer seed growers have been trained to perform a simple and fairly accurate germination test on their seed before the planting season. Seed is soaked in water for a day and then 100 seeds are counted and rolled into a cloth towel. After 24 hours a reasonable indication of germination can be read by counting the number of shoots beginning to emerge. Almost universally, farmers growing seed for distribution or sale performed this test one or more times before planting the seed.

30. A seed laboratory is essential for a country with a seed program. Placing a lab at CARDI would be the logical step, especially since they are anticipating a grant to complete CARDI's existing rice quality lab as part of a CAVAC project. (The recommendations are for a consultant to help setup the seed lab; this consultant would have to look at the needs in light of existing equipment). The addition of the seed testing lab to the quality lab would seem to be a good fit. According to the Seed Bureau Equipment Company, a prominent lab equipment supplier in the US, a complete lab capable of meeting ISTA standards including a double chamber germinator could be purchased and delivered for $110,000. Supplies for yearly operations would be about $1,000 to $1,500 per year using existing CARDI staff.

2.7. Variety testing and registration

31. At this point, the only new rice varieties being developed in Cambodia come through the CARDI system. There currently seems to be little chance for any other entities to develop and release new varieties; AQIP would like to have their own variety development program, but their sales and financial position seem to preclude that possibility for some time to come.

32. In most national seed programs, potential new public varieties being considered for release go through a program of testing and review to see if the potential variety qualifies for release. There are two components to this testing known as DUS and VCU. The first, DUS is the acronym for Distinctiveness, Uniformity, and Stability. In other words, the variety must have some differences from existing varieties, those characteristics must be similar in all plants of that variety, and the plants of that variety must maintain that uniqueness over generations. The second, VCU testing, stands for 'Value for Cultivation' meaning that, the plant of the variety must grow, thrive, and yield well in its area of adaptation.

33. In most cases a body independent of the developing agency performs this review of potential varieties. However, in Cambodia, CARDI both develops the varieties and approves their release. The potential problem is that if and when other

entities begin to produce new varieties, there may be a conflict of interest for CARDI, being in a position to approve or reject those new varieties. The potential for this in the near future is low, and CARDI seems to be performing this duty because of the lack of involvement by any other body.

34. Many countries have official seed lists that limit the use of varieties to those that have been tested for use within their borders. These lists are created to protect the farmer from varieties that will not grow well in the local environment, but the lists are often restrictive and inclusion may be arbitrary. A major problem with variety lists in countries like Cambodia is that much of the cultivated land is often planted with varieties not on the list. Local varieties or those brought into the country through unofficial means are often not on the list. Hence, the purpose of protecting the farmers from bad varieties often does not cover most of the seed planted. Sometimes the inconvenience or the cost of testing to be put on the list may be more than seed companies want to deal with, thereby keeping good varieties out of the country.

35. The 2004 draft for the seed law contained wording that would establish such a list, but discussions with the GDA led to the belief that it does not want to have such a list to allow farmers to have easier access to new varieties. CARDI's variety test program is a viable alternative to this list. CARDI tests for variety adaptability on its new varieties; it also allows this information to be available to seed buyers. The list becomes a recommended list of available varieties, but it does not restrict the sales of other, non-tested varieties. If at some time in the future, seed companies wanted to provide seed in Cambodia, CARDI could also make this testing service available for a fee for other, outside varieties..

2.8. Analysis on paddy production and rice export policy of the RGC

36. The RGC Policy (RGC, 2010) to promote paddy production and rice exports sets forward a number of policy measures related to paddy production, collection and processing, logistics, and marketing. The following actions are related to the quality of seed production: (i) increasing paddy productivity by using high yielding seed and modern farming techniques; (ii) addressing the issues of standards, classification, and quality according to international norms; (iii) strengthening institutional capacity of the government in defining the rice quality standards in Cambodia; and (iv) creating the independent certification system.

37. Specific actions for the implementation of these policy measures include the following:

- Facilitating import procedures for rice seeds, fertilizers, agricultural inputs, and machineries, as well as to provide tax incentives for the importation of materials and equipments;
- Providing incentives to local seed producers and distributors through a determination by MAFF of a number of prioritized varieties to be promoted

and disseminated, and a preparation of a legal framework and mechanisms by MAFF to promote seed production and distribution by the end of 2010[1]; and

- Strengthening and expanding the capacity of CARDI, agricultural experimentation stations, and the Agricultural Development Center for Seed Production, Research, and Technical Training.

2.8.1. Action related to seed legal framework

38. Seed law is developed with the purpose to protect the ownership rights and quality control of seeds. Both MAFF and GDA are responsible for the implementation of seed law including the development of detailed articles. Simultaneously, the ownership rights of new seeds are being certified by MIME after all technical tests are completed and officially approved by MAFF. In case of seed importation from abroad, MAFF will be responsible for seed tests. The registration of private seed companies is done by the Ministry of Commerce; the registration of seed associations is done by the Ministry of Interior; and the registration of community seed based organizations is done by MAFF.

40. The feedback from private seed producers on the new seed law indicates that they would like to see the establishment of a clear legal framework for seed production. The producers hope that this will facilitate their businesses; some producers have faced difficulties in registration in its absence. Although seed quality and ownership rights are concerns for the seed producers, the perception of the private sector is that new law would support the development of the seed sector. The feedback indicates that the private sector would like to see the continued open trade policy of the government and improvements in the general business environment.

2.8.2. Actions related to seed production supply

41. MAFF, through GDA, is currently producing quality seed for distribution to farmers with the support of the ADB funded Pilot Seed Production Project (2010-2011). A total of 450 ha of seed production is taking place in the following three GDA sites: Tuol Samrong Seed Farm in Battambang Province (200 ha); contract farming in Trapeang Thmar in Banteay Meanchey Province (50 ha); and Kampong Thom Province (200 ha). It is expected that a few thousands metric tons of good seed (IR66) produced from this project will be available for the farmers in the coming season 2010-2011. The project will end in June 2011; the continuity of this seed production is not known.

[1] The following ten varieties developed and released by MAFF are being promoted: (i) Sen Pidor, Chulsar and IR66 for early duration varieties; (ii) Phka Roumduol, Phka Roumdeng, Chan Sen Sar, and Phka Romiet for medium duration varieties; and (iii) Reang Chey, CAR4 and CAR6 for late duration varieties. The legal framework and mechanisms to promote these seeds for production and distribution is being prepared.

43. Discussions with key individuals revealed that GDA seed production is not being perceived as undermining private seed production—at least not in the short term. It is seen as an additional source of supply of seed to fill the unmet demand by farmers who have had difficulty accessing quality seeds. In the long-term, GDA seed production is not perceived to be sustainable due to limited financial support, which is dependent on donor funding. Maintaining the on-going seed production and distribution activities for free seed distribution, coupled with the limited human resources to coordinate and facilitate the quality seed production are problematic. The Government's role in seed production is therefore primarily related to providing services, and creating an enabling policy environment, promoting the use of good quality seeds, ensuring quality control, and strengthening seed law enforcement. Other responsibilities of the government would include promoting the use of high quality seed among smallholder farmers; producing a foundation seed for seed producers; and supporting the private seed producers with necessary technical assistance to enable them produce high quality seed.

3. Rice Seeds Production Supply System in Cambodia

3.1. Rice seed production supply chain

47. Rice seed is produced and distributed through a formal, although small, seed production network consisting mostly of the AQIP Seed Company, MAFF's Tuol Samrong Seed Farm, OFAT Farmers Cooperators, NGOs, and a few rice exporters that have recently emerged. At the same time, a less formal rice seed production system is also producing quality seed and functioning at the community level with individuals who have been trained by CARDI, NGO's, projects, or by rice exporters or millers seeking to buy a consistent product from a farmer network. At present, existing farmer networks are still small—some have about 90 members. Champei and the other eight Agricultural Development Communities, along with the CEDAC Farmers Seed Associations are some examples that can be promoted and empowered.

48. Geographically, quality seed is distributed within the 15 provinces of the country where AQIP's sales network is developed. This includes the provinces of Kandal, Takeo, Kampong Speu, Prey Veng, Svay Rieng, Kampong Cham, Kampong Thom, Kampong Chhnang, Kampot, Pursat, Battambang, Banteay Meanchey, Siem Reap, Kratie, and Stung Treng, which are the major rice growing areas of the country. Farmers buying AQIP seed are not the only users of that seed. They also share some quality seed from the first season production with neighboring farmers; however, it is difficult to estimate their numbers accurately. For an accurate expansion of quality seed use, a more thorough assessment must be conducted.

3.1.1. The formal rice seed production system

The Cambodian Agricultural Research and Development Institute (CARDI)

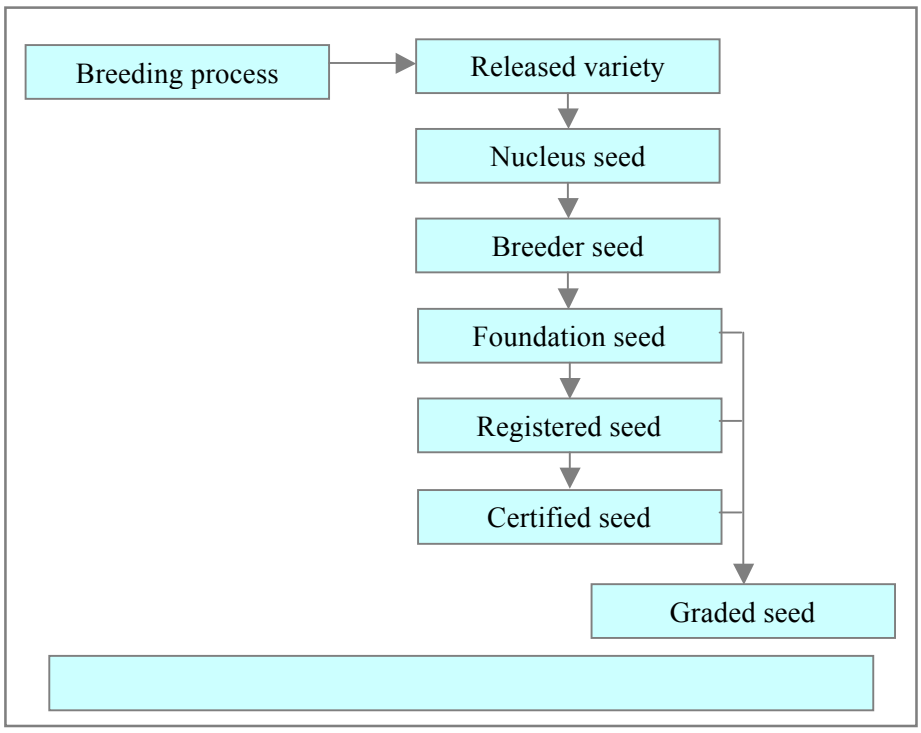
49. CARDI's mandate within the seed system is to maintain local genetic variability, to develop new rice varieties, to release those varieties, to produce and maintain a supply of parent seed (breeder and foundation) to supply to private seed growers, and to educate farmers and seed growers about those rice varieties and production techniques.

50. CARDI maintains a long-term genetic seed bank for rice. An amount of 2,557 samples of current seed varieties, local landraces, and wild rice relatives are maintained in freezer units for breeding purposes. The main purpose of this facility is to maintain the genetic variability of the rice genome for the country. This collection

is actively used in their breeding program and samples are periodically checked for viability and samples are regenerated when necessary. The International Rice Research Institute (IRRI) maintains a backup set of samples for everything stored at the CARDI facility.

51. CARDI's variety development program used the following process to select superior plants from existing varieties. Selection is a slow process that relies on plants that exhibit superior traits to be hand selected and then propagated. Since 2006, a backcrossing program has been used where a popular variety is hand crossed with another for the purpose of introducing one new, superior trait into that variety. After five successive generations, all plants not conforming to the parent variety with the one new trait are culled and the subsequent pure line is replanted. After the fifth year, most of the genetic variation is removed from the resultant variety and the new variety can be released. More recently, a genetic test is now being performed that can identify the desired plants in earlier generations; this can eliminate several years from the development process. The backcross method of variety development is important because it uses the existing varieties that farmers are familiar with and know how to grow. It then adds a single trait that will make the new variety superior to the former. By using these existing varieties, it is hoped that farmers will accept these new varieties more readily because of the similarity to the varieties they are using presently. CARDI has been doing variety development for over 15 years. I that time, it has released 39 new varieties—including both wet and dry season strains. However, only the more popular varieties are being grown for Foundation seed production at this time. Varieties development and seed production process at CARDI are presented in Figure 1.

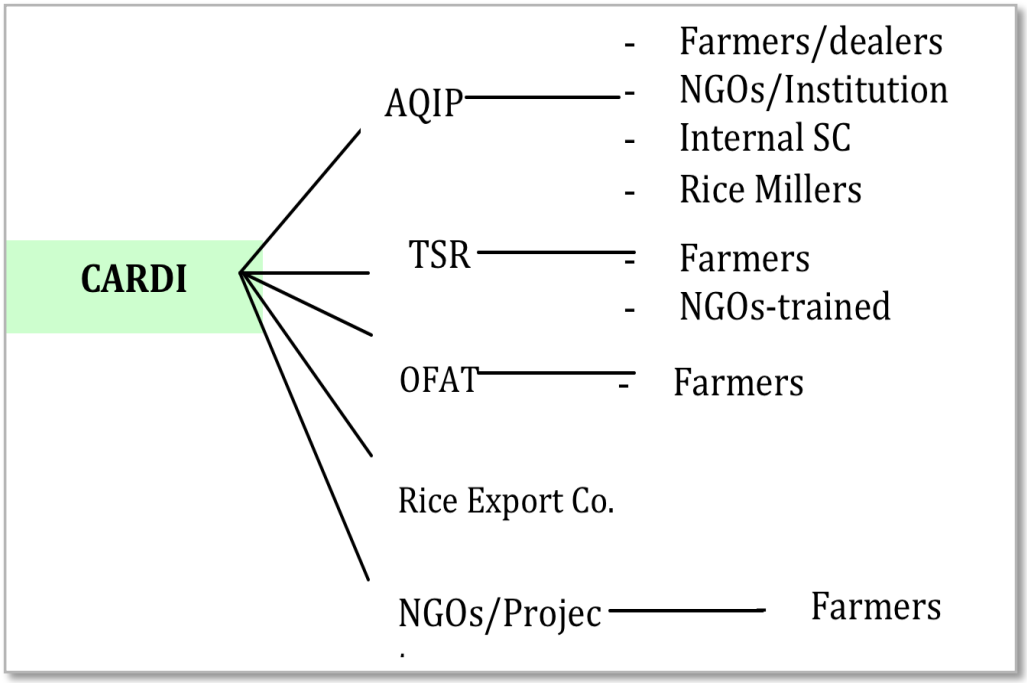
Figure 1: Process for seed production in Cambodia (CARDI, 2007)



52. Currently, CARDI is producing about 5Mt of FS on 2.5ha of land base on order. Much of the fieldwork is performed via hand labor. In addition to this being a comparatively expensive option (detailed are discussed in Section 3.3.1), hand labor will also become a major challenge when the demand for high quality FS will inevitably increase in the future. To ensure quality seed, all fieldwork must be completed timely in accordance with both varieties and the seasons. Moreover, seed processing after harvest must be completed quickly. According to theory, seed lots should begin the drying process within 24 hours after harvest. Field operations like transplanting, harvesting, and threshing are important activities that require heavy hand labor. These operations should be mechanized, not only for effectiveness and efficiency, but also for applying quality production procedures and ensuring good results. Roguing and other seed field maintenance jobs involved in quality seed production will remain as hand labor—even after mechanization.

53. Produced rice seed is being sold to AQIP Seed Company, MAFF's Tuol Samrong Seed Farm, NGOs, and a few rice export companies at USD$3.5/kg. FS is also used in research: OFAT with Farmers Cooperators for new varieties' adaptation and introduction. CARDI also produces small amounts of RS and GS for customers who have such needs. In 2009, quality seed (including 2.3Mt of FS, 3.1Mt of RS and 11Mt of GS) was sent out from CARDI through sale, research, and for other reasons.

Figure 2: Formal rice seed production system supply chain



54. CARDI currently has four major constraints in the production of FS that need to be improved. These constraints will need to be addressed because of the impending demand for quality seed in the near future. The four constraints are as follows:

1) **The first is institutional constraints**. These include (a) coordination and integration with other departments of MAFF, (b) logistics arrangements as a semi-autonomous institution, and (c) high staff turnover.

    a) In regards to *coordination and integration* with other departments, both MAFF and CARDI need to cooperate with the GDA for enhancing production. They must also cooperate with the Department of Extension for promoting the released seeds and research findings. Presently, the activities and roadmap for institutional linkage and integration of these departments is not clear, nor is it well coordinated.

    b) Regarding logistics *procedures*, the process of logistics procedures is very complicated and time consuming. As a seed source service institution, CARDI needs to establish good links and to work with many seed stakeholders including structural and non-structural, particularly large and medium scale, private, and state institutions to ensure a transparent technical operation for seed quality assurance as they are using seed sources from CARDI.

    c) *Turnover at CARDI* is high. When trained staff members leave CARDI, the retraining and capacity building of new staff is costly and time consuming. In addressing this problem, CARDI must improve staff salary and create an attractive employment program.

2) **The second is Technical physical constraints**. One of the technical issues for CARDI is the unclear chain with AQIP in seed quality control. Because this private company uses the seed source from CARDI, developing transparent operation processes and a clear chain for seed inspection is crucial.

3) **The third constraint lies in the existing facilities and equipment**. CARDI lacks adequate storage facilities for keeping seed in good condition. In terms of equipment, CARDI needs a tractor, plough, thresher, and seed grader for cleaning and grading seeds. A facility for seed quality testing will also be needed—this can be a simple laboratory with the requisite capacity building to ensure the operation and functionality of the seed lab.. Improved access to facilities and equipment will allow for faster and more accurate planting and harvesting of seed fields—while using less hand labor. Both of these constraints are interrelated to the last constraint: a lack of capital.

4) **The last constraint is the lack of operating capital.** Because of its current financial situation, CARDI is unable to plant extra FS without assurances of selling all that is produced. Production of additional seed would allow for more available seed for sale in good years. The current lack of capital creates a problem in poor years: surplus seed with high production costs has to be sold as milling rice because germination rates reduce quickly after six months. This causes CARDI to be conservative in its projection estimates for production.

55. CARDI not only develops varieties and produces quality seeds, but also introduces new seeds to farmers through On-farm Trial (OFAT) and provides for farmers' education on seed purification as part of its seed service activities. These objectives of these activities have been done with the following objectives: i) to introduce and extend new quality seeds to farmers and other stakeholders, ii) to build farmers' knowledge and skills on purified seed, and iii) to promote the use of quality seeds to increase production and to add value. Experiences from these activities have shown that OFAT farmers who demonstrated good performance and achieved good results attracted other farmers and dealers from neighboring villages, communes, districts, and even other provinces. In this way, quality seed is produced and spread throughout the country. However, because of a limited budget for conducting OFAT activities, the number of OFATs has been reduced from 700 per year during CIAP period to only 50 OFATs per year at the time of this writing. A reactivation of this activity would increase community-based access to quality seed.

The AQIP Seed Company

56. AQIP began as a project to produce seed in 2001. In 2007, it became an independent company when the project ended. Owners include the MAFF, the Seed Growers Association of Cambodia, company employees, and some trustees.

57. AQIP acquires its parent seed from CARDI, and Foundation seed is priced at $3.50/kg. This seed is sold to contract farmers at 3000 KHR/kg (about $0.80/kg) because farmers have a difficult time realizing the value of this seed at $3.50/kg and the cost of the seed can be prohibitive. The value of paddy rice is about 1,000 KHR/kg: the seed is priced to the farmers at about triple the grain value. Farmers are also sold RS for Commercial seed production at 3000 KHR/kg. The CS sold at AQIP ranges from 2400 KHR /kg to 2,800 KHR/kg depending on early/medium fragrant or non-fragrant varieties.

58. Production began in four provinces with stations in each; although one province was determined unsuitable for seed production and has been eliminated. AQIP uses over 1000 farmers to produce its seed; the average farmer grows seed on 0.5 to 1 ha fields; although some fields are nearly 3 ha and some are much larger (40 ha in Baray, Donkeo District, Takeo province). Registered seed is produced on the larger fields—usually 1ha or larger. In order to break the capital constraints of the seed-growing farmers, AQIP organizes farmers into seed producers groups and contract farming to ensure high quality and quantity seed production.

AQIP provides seed purchase on credit, in addition to its own agricultural extension services and its own market information services. To achieve this, AQIP has hired qualified and experienced agronomy and engineering experts to train farmers and to ensure agricultural quality improvement.

59. Each of the three production stations has two seed production supervisors who provide oversight to the field operations. For RS production, farmers are required to plant a nursery with vigorous seedlings, which are then transplanted at the rate of one tiller per hill. This is done because of the high value of the seed, purity control, and the desire to use it efficiently. Farmers have the option of using transplants in the growth of the Commercial class of seed. Farmers are required to keep fields free of off-type plants and undesirable weeds during the growing season. There is no requirement for fertilizer or pesticide application although most understand the value of trying to optimize yields using these products. Additional management and costs above the cost of grain production to the seed-growing farmer are for field management activities, especially the removal of off-type plants. Farmers receive a premium of up to 200 KHR/kg of seed delivered based on a contract with a priced tied to the market price at harvest.

60. Seed is harvested using traditional methods. Farmers are expected to supply seed to AQIP that is relatively clean, which might mean that some traditional winnowing is necessary at the farm level before transport to AQIP. Seed is scheduled for shipment to the AQIP seed facility so that it can be processed in a one to two day period after delivery. Once at AQIP, the seed is tested for moisture content and usually dried down to 12-13 percent moisture. Seed dryers are bins with screen bottoms where warm air is blown through. In most cases, the dryers are fueled by burning rice hulls, so drying costs are low. During the drying and other parts of the processing cycle, methods are used to continually identify the seed lot so that loss of product identity is not compromised.

61. AQIP has a means of testing the seed for germination and purity. Their lab and their procedures may not be accredited or well trained, but they do have the ability to perform an adequate test that should give acceptable results. All seed is labeled to a minimum of accepted levels. Germination is labeled at 80 percent, physical purity at 98 percent, and levels up to 3 percent of off type plants are tolerated. All of their standards are similar to normally accepted levels.

62. After drying, the seed goes directly to the air/screen grader for cleaning and the seed is bagged in clean bags at the back of the cleaner. After cleaning, each seed lot is sampled for seed analysis. Each seed bag is printed with the variety name, seed class, individual lot number, seed analysis information, a 30-day warranty, and telephone contact information. Seed is stored on pallets in a warehouse and plastic sheets are used to protect bags and minimize bird and rodent losses. The warehouse is enclosed and ventilated so that extreme conditions are moderated, but the seed is still exposed to the warm and humid conditions that can have a negative effect on seed viability.

63. AQIP has a dealer network with 800 active dealerships in 15 provinces. Seed is shipped to them just before planting time; the timing of the shipments helps AQIP to maintain control of the seed in its own warehouse where the quality of storage is known. Seed is priced at a rate that is approximately 2 to 2.3 times the cost of rice in the market. As part of the sales agreement, the farmer is told to perform a basic germination test on the seed in the days before planting. The 30-day warranty therefore allows farmers to return seed with reduced viability before planting. Although the warranty is listed at 30 days, claims against seed performance are investigated and compensation can be awarded if the seed is at fault. Most often, loss of viability is the only claim and any field problems are usually attributed to mismanagement by the farmer. AQIP trains its dealers in handling its seed and how to deal with seed customers. Beyond rice seed, AQIP personnel have little knowledge of other products sold by their dealers or how the dealers relate to their customers.

64. In the past several years, sales of rice seed have ranged from around 40Mt in 2001 to over 2,000Mt in 2009 in the targeted area. The main AQIP customers include rice farmers/dealers, NGOs/Institutions, and rice millers. The sales goal for 2010 is around 4,500Mt, which was one third sales of the objective equivalent to one third of the high quality seed market (AQIP, 2007). AQIP could achieve this goal if it is awarded contracts acquired by FAO and the ADB that could add 2,400Mt of sales to the 2,000Mt sales in 2009.

65. AQIP uses varieties produced and distributed by CARDI. The varieties available have some good characteristics, but are often older varieties, and are available to all farmers from CARDI, meaning that this product line does not give AQIP a competitive advantage. AQIP would like to see the development of new varieties with advanced yield and resistance traits; although, at this time, CARDI is at best just upgrading old varieties via backcrossing. It is AQIP's goal to have its own variety development program so that it can offer seeds with traits needed by its customers. Before a development program can be established, AQIP will need an increase of seed sales and will also need to acquire some financial backing—both of which are not forthcoming at this point. AQIP's longer-term goal for 2014 is 4,000Mt of seed sales. There are no immediate plans to acquire any rice varieties from sources beyond CARDI, and there are no thoughts of expanding seed production and sales beyond rice.

66. In terms of coordination and contract arrangements for the long term, AQIP faces some real challenges to reach the goal of twice its current seed sales (4,000Mt per year). In order to achieve this goal—while facing constraints and

challenges such as shortage of working capital, old machines, competition with Vietnamese market and others—AQIP has indicated some approaches to deal with these problems. For example, AQIP wishes increase arrangements with larger scale (land) farmers to ease quality control management, to reduce time, and to increase seed uniformity. This would be a direct result of dealing a reduced number of farmer seed growers. At the same time, they will change their pricing strategy with farmers from a fixed price at the onset of contract to a more variable price pegged to the market price at harvesting time (always with 200-300 KHR/kg higher than market). This situation may not be favorable for the farmers, particularly the smallholder farmers. However, it should be recognized that as a private company, AQIP also needs to strive for efficiency and profit. AQIP also needs to upscale the seed processing facilities and storage capacity, and ensure quality standards.

67. The Seed Growers Association of Cambodia (SGAC) was formed in conjunction with the AQIP project; when AQIP became a seed company, SGAC was named a co-owner. Currently, SGAC plays a limited role in the oversight of AQIP. Four board members oversee the association; one is on the AQIP board of directors. SGAC membership is static with original founding seed growers still listed as members even though they may not be producing seed. Also, newer AQIP seed growers are not being solicited into membership. It is believed that there are no currently functioning programs within the association that would benefit members.

68. AQIP seems to have adequate tools to function as a rice seed company although their processing facilities are aging and losing efficiency. Their largest problem is that they are selling open pollinated varieties of rice that are also available to farmers from CARDI and other sources. Essentially, they are selling based on the fact that they have a bagged, ready-made product of purportedly good quality seed. Their segment of the market seems to be mostly farmers with 1 hectare or larger of rice production (larger farmers). They also sell to smaller farmers; however, this is usually in smaller amounts and to those farmers who will use that seed to maintain that variety over a period of several years without purchasing additional seed.

69. For AQIP to survive, it must expand its product line to those varieties currently not available to the public. Its desire to have its own variety development program is unfeasible in the near future, but it might be possible to acquire exclusive rights to its own variety. Still, they would be selling a product that farmers would most likely use to grow their own seed for several generations. A better way to function would be to sell a more full line of seed products, vegetable, and hybrid maize seed. For instance, they could become a dealer for other seed companies.

70. AQIP serves a significant purpose for the seed industry in Cambodia. First, it supplies good quality seed to its segment of the market. Second, it supplies local community farmers groups with parent seed when they don't have a connection directly to CARDI. Third, and maybe most important; it is essential for a nation's seed industry to develop smaller, private sector seed companies. AQIP is the only example of a private sector seed company at this time; it can serve as an example to the seed industry. If AQIP is allowed to fail, it will undoubtedly send a message that small seed companies are not viable in Cambodia. It could be a long time before

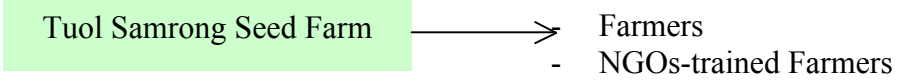
another would start. This information was conveyed to AusAID; they did see that importance. It is hoped that they will continue some support to AQIP.

The Tuol Samrong Seed Farm

71. This is a 200+ha farm in Battambang Province devoted to rice seed production. About 50ha of land is devoted to seed production with and average total production of about 70Mt. seed per year. The rest of the farm produces rice for milling or other crops. Foundation seed of selected varieties is acquired yearly from CARDI based on demand from local farmers. This seed is planted for Registered Seed production and then the next season, Commercial Seed is produced. Commercial seed orders of over 1 Mt must be made a year in advance, but smaller orders are handled on a spot basis.

72. The farm uses normal field seed production techniques in order to produce the best and purest quality seed. Foundation seed is transplanted to make the best use of expensive seed. Seed is hand harvested, laid out to dry, and is normally hand cleaned. Seed is bagged and stored, and simple germination tests are performed monthly through the sales season. Germination levels tend to rise for about the first five months after harvest (normally due to a breaking of seed dormancy), and then it begins decreasing. The minimum germination level for seed to be sold is 80 percent and no seed is stored longer than one year.

73. Farmers come to the farm to purchase seed, usually in amounts to plant up to 3 ha. The goal in seed sales is to provide seed for local farmers; therefore it is sold at just 1.2 times the price of the rice market. The RS is sold at KHR 2,500/kg and the GS at KHR 1,600/kg. The service can be, for at least one individual who serves as a dealer, buying seed from them and selling it to farmers in his area. Some sales have been made to NGO's, but local farmers are serviced first and any orders over a ton must be made before the previous planting season to assure that ample seed is available to regular customers. In recent years, they have had some orders of up to 10Mt sold to NGO's for distribution based on in-kind payment with grain at harvest. Because of reduced price and quality, more farmers buy seed yearly. The sale record indicates that the farm has a 10 percent increase of seed customers per year. The rice millers in the area were impressed with the seed farm's effort, as well as with the superior quality rice sold by the farmers to them.



74. The Toul Samrong Rice Seed Farm was part of a previous World Bank project that supplied tractors, a seed grader, a length grader, a seed treater, and

a dryer. Much of this equipment is going unused because it does not meet the farm's needs or there are not adequate funds for operation. Therefore, most of the seed related activities are performed manually using more traditional methods. (Management of these seed farms were not involved in the selection of equipment and it is obvious that individual needs of the various farms were not considered. Any potential help for the seed farms will be based on their own needs as seen by an external consultant and the perceived ability of the management and staff to use what is supplied). Improving equipment and facilities will enable the seed farm to efficiently upscale quality seed production; therefore, more quality seed of a cheaper price will be available for the farmers who use larger amounts of seed for direct seeding method.

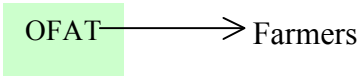
75. Presently, the farm does very little to promote seed use; it mainly focuses on production. CARDI plants some farmer test plots in the area to assess new varieties, but the farm has not been involved with these plots. Favorable new varieties are recommended by CARDI to be grown and farmers purchase those varieties because they saw them in CARDI's tests or in the seed farm's fields. Since farmers tend to come to the seed farm to buy seed, it would be an excellent place to perform variety testing, field trials, and demonstration plots. It would seem that the opportunities for seed sales in this area are greater than at current levels. Production is mired in the same methods that have worked for years. Farm management may not have the tools or understanding of how to expand its seed sales or of how to increase its service and extension activities to farmers; however, there is an interest at the farm to learn this and to do a better job. The Toul Samrong Rice Seed Farm along with other MAFF seed units are operated directly with most decision authority and financial aspects handled by MAFF. The logistics are complicated and time consuming. Facility budgets have little to do with farm income; therefore, incentive for staff to produce more efficiently, to perform extension activities that would benefit seed buyers, or to increase seed production and sales volume is low. A management system that would be more autonomous would allow more incentive and flexibility to provide quality seed and extension services to farmer customers.

Farmers Cooperators of the CARDI-OFAT

76. On-farm trials (OFAT) are conducted through collaboration between CARDI, PDA, and farmers. The activity consists of growing 1kg each of three improved varieties released by CARDI on a 100m² rice plot in contrast with another plot grown to the farmer's variety for comparison. CARDI provides all technical support for rice production and lets the farmers manage the trial by combining new ideas with local knowledge. Regular visits were made from the onset of the trials until harvesting time when a 'field day' is established to demonstrate the results of improved varieties to the neighboring farmers.

77. When the specified amount of seed is produced, the farmers continue producing and keeping that seed for their own use. They also share the seed with other farmers in their communities or others who have an interest in the newly released seeds. The farmers normally practice this seed production sharing system

when they obtain a good, new variety. It is a suitable management system within the capacity of small to medium scale farmers of the village, commune, and district levels.



78. The extent to which this chain of quality seed supply can reach depends on the following factors: i) the adaptation and performance of this new variety to the farm condition; the number of farmer cooperators CARDI can support in the area; the extension skill; and particularly, the rice trade dynamic in such an area. The successful case of OFAT at Sre Ampil rice growing area in Kien Svay District, Kandal Province is a good example. A favorable environment for rice business development is created by the key players, the key farmer (or growers' leader), the farmers themselves, the rice traders, and the CARDI staff. Generally, at harvesting time, most farmers in this area do not need to transport paddy rice to store at home; the traders purchase the rice from them and take it straight from the farm. OFAT farmer cooperators were ordered to keep rice seeds by other farmers at a very early time before the growing season. Afterwards, farmers from other districts of the same province and from Svay Rieng and Prey Veng Provinces booked orders as well. Today, many key farmers in this area are being contracted by AQIP to grow quality seed, including RS and CS for the company.

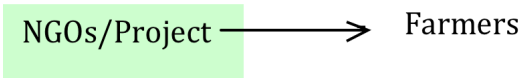
79. This type of rice and seed production supply system through OFAT can be promoted in all parts of rural Cambodia as one way of building awareness about newly improved varieties and to promote them to wider communities. As has been discussed earlier, at present, this activity is less active and reduced to a restricted number because of a limited budget. The project's support of this program could generate two useful outcomes: First, it will improve community-based seed service and productivity increase. Second, it can create a sustainable rice research and extension program, which will be on-going and spread through the rural community.

Rice export companies

80. Akphiwad Bandanh Kasekor (ABK) is in the early stages of setting up a system of high value rice growers that plant the famous CARDI Phka Roumduol variety for market and exportation. The farmers are formed into associations and are contracted under ABK. All services—ranging from seed and other farm inputs (credit in kinds), farming techniques (CARDI) and capacity building—are provided. ABK purchases Foundation seed from CARDI and produces quality seed for their own premium rice production. Damnok Teuk Rice Export Company is doing something similar for rice exportation.

NGOs/Projects

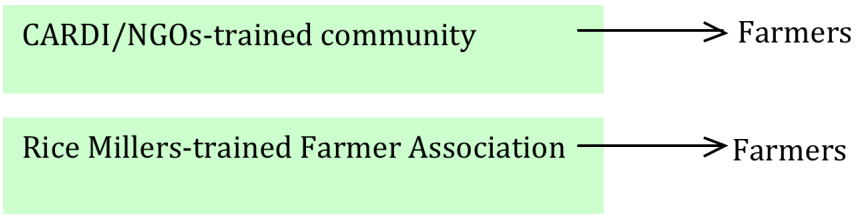
81. Some NGOs are promoting food security and/or agricultural enterprises. They form the farmers into Farmer Associations and assist them in seed and rice production of quality seed from CARDI (RS). Through these Farmer Associations, sub-contracted extension workers supervise and inspect their rice crop as well as provide training to the farmer members. Field days are organized by the project to promote seed business to the surrounding farmers. According to some farmers, producing seed for sale would be profitable, but they do not have enough good land for this purpose. Generally, this seed production system is small in scale, for organic or non-organic rice. Under this seed production program, the farmers could sell their seed to the farmers within their village or nearby villages; at the same time, they produce high quality rice for subsistence and for market.



3.1.2. The Community Based Rice Seed Production Supply System

82. A major portion of rice seed production in Cambodia is done on a more informal basis with various types of local farmer groups providing improved seed to the local community. There are a large number of these production groups which have received some training through CARDI and NGO's. Some examples are CEDAC, local agricultural departments, extension groups, or from other sources. The training stressed selection and maintenance of high quality seed during field production, seed storage, and other seed production activities. Since there are many of these groups using various structures, a general description highlighting the variations illustrated below (CARDI has played a lead in helping to develop these local groups).

Figure 3: Less formal rice seed production supply system



Community Based Seed Production of Popular Local Varieties

83. This is done with the objective of assisting those farmers who want to maintain their local varieties and those who could not afford to purchase quality seed. With the popularity of local varieties, CARDI has started a training of community-based organizations to maintain, grow, and purify local varieties. They begin with initial training of a small number of progressive farmers in seed purification and production. These farmers grow a small plot of their local variety, and with their training, they select individual panicles that best display the qualities of the local variety. All other plants in this small seed purification plot are removed. At harvest, the selected plants are threshed, dried, and maintained. In the subsequent season, they are planted in a seed production block. Again, all off-type plants are removed from the seed field during the growing season. At harvest time, there should be enough seed produced for planting a field with a surplus for distribution of smaller amounts to other member farmers. During the first two growing years, the other trained farmers monitor the field to provide assurance that the seed produced will be true-to-type to the original variety. In addition, the locally trained farmers allow all the village farmers to see the seed field and provide some training to those farmers in how to maintain their own seed production plot.

84. In this system, one or two local farmers serve as purifiers of the variety, growing what would be considered breeder seed. A small group of farmers use that seed and their training to produce foundation seed and distribute that to the bulk of the farmers in the group who grow and maintain their own commercial seed and then grow rice for milling. Almost universally, farmers who sold or distributed seed to others would test the seed for germination levels before planting. All have been trained either by CARDI, often through the local PDA's, or by those trained farmers themselves. Other trained farmers in the group always monitor parent seed growth.

Community Based Seed Production of CARDI Released varieties

85. In a program similar to the one described above, CARDI would train individual farmers to grow seed of its released varieties. They would supply 1Kg of Foundation seed (USD$3.5/Kg) to a trained farmer who would grow and carefully maintain the variety over the growing season. The sponsoring group trained these farmers in the techniques of intensive seed production, namely field roguing, panicle selection, isolation to prevent out-crossing, clean harvest techniques, seed cleaning, and storage. Near harvest, the farmer in conjunction with the local PDA and/or CARDI would hold a field day for community farmers. Here farmers would learn about the qualities and benefits of this new variety.

86. In the next production season, the farmer would use this seed to produce a larger amount of seed for distribution to community farmers. In some cases, a few other farmers would take a small amount of the first generation produced seed and grow a production block as well. As described in the first production system, trained farmers would have monitored all seed produced in the field and each

community farmer would get some training to produce their own seed plot. In subsequent production years, the initial farmers could continue producing starting with the 1Kg of seed, or they could skip that generation and buy enough FS from CARDI to produce a field worth of seed. Most often starting with the 1Kg of seed was preferable because the purchase of seed in larger amounts was prohibitive at $3.50/kg.

87. These two seed production systems instituted by CARDI and employed at the community level may not have been true seed certification programs, but they seemed to be excellent programs to produce and distribute seed throughout the local area. The initial, progressive seed growing farmers were well trained and proud of the quality of the seed product they grew. Additional local farmers were trained to inspect the seed field as a means of quality control. Additionally, local farmers who were potential seed buyers looked at the field during the crop growth stages and decided at that time if the seed crop being grown was worthy of being planted in their own production fields. Those farmers who purchased commercial seed had some training in producing their own seed and could maintain their seed over some generations without much cost.

88. A real advantage of this system over larger and more formal programs is that seed is produced in very small areas, from a few square meters for higher classes of seed to a field of a hectare or less for commercial production. This means that planting, field maintenance, harvest, and seed cleaning would be performed manually. At this level, seed can be scrutinized very closely and impurities down to the plant or individual kernel level can be removed resulting in a very pure, consistent seed product. These initial seed growers would often supply seed to the others in the local association at a minimal cost—maybe as an even trade for grain or for a minimal fee of 1.2 to 1.5 times the cost of rice grain.

89. Local farmers in the association would also have the opportunity to see the seed production field, either informally by seeing it with the farmer/grower, or more formally during a field day. Almost universally, farmers said that they purchased seed and acquired new varieties because of seeing it grow in other farmers' fields or in demonstration plots. It is important to mention here that there was not one farmer or seed grower that was interviewed during this consultancy that did not realize the value of using good quality seed and how that seed would have a positive effect on crop performance. Some farmers may have had a lower understanding of what seed quality was and others may have had other reasons not to use improved seed, but all recognized its value.

Other Community Bases Seed Production System

90. In addition to the above community-based production groups trained by CARDI, there are other community-based production supply systems for the local interest. Angkor Kasekam Roongroeung is a large scale private enterprise and is an exception. Most used seed purification or production systems with techniques similar to those instituted by CARDI. Below is brief description of those techniques encountered.

- **CEDAC** promotes community seed production by training progressive farmers in Organic Rice Farmer Associations (from 9 to around 50 farmers) to purify and maintain local varieties and produce parent seed for all association members. There are two seed producers per village. The method of purification is thus: with local varieties selected (Red Malis and White Malis), the farmer selects the 10 best quality grains, peals their husk to make sure that grain is in good shape and without damage and grows them in a small box at home to ease watering and care. After 10 days of growth, the seedlings are pulled and transplanted in the field with the following conditions: transplant is in a row, one tiller per hill, 20 cm between hills, and no chemical fertilizers or pesticides are applied. This is done in June when wet season rice is due. Within 125 days, the crop is harvested and he obtains 2 kg of high quality seed (pure, healthy, and high yield). In next season, he uses half the amount of seed for his own seed production and the other half is shared with his members. To produce seed, small plots with well prepared land are recommended to ease crop management. Each seed producer has to produce key seed every year as a reserve. The seed obtained from this process is used for production at a rate of 10kg/ha. The yield obtained from this quality seed doubles to yield of normal seed (up to 6Mt/ha). The seed growers meet regularly to report on seeds produced for sale coordination. Because it is organic rice seed and aromatic, the price is much higher. The key seed is sold at KHR 6,000/kg while the next generation seed is KHR 4,000/kg. This is in comparison to the normal seed at only KHR 1,500/kg. This method has been practiced for four years, and there is still limited production for sale.

- **Champei Agricultural Development Community (CADC)** is located in Baty District in Takeo Province: It is organized with the purpose to produce high quality rice for market. The CADC was founded in 2005 by a group of farmers (now 96 members) who joined together an amount of cash forming cooperative capital for an agricultural enterprise (at present mainly rice). The benefits the members gained include input services (such as low cost seed, fertilizers, machinery, etc.), capacity building, extension services, a market for their products (CAVAC Assistance), and a reasonable value added. The enterprise activities are coordinated by a Chairman who is assisted by a Board Committee (five members). The Chairman and some members undertook the famous IPM Farmer Field School Program funded by DANIDA in cooperation with MAFF during early 2000. They are therefore knowledgeable of the whole cycle of IPM-based rice production, including seed production, and are very open to agro-enterprise initiatives. The CADC purchases seed from AQIP, produces quality seed, and after keeping it for two years, renews the seed again. A good record was obtained in 2009 from 10 kg of RS bought from AQIP; they were able to produce 1Mt of quality seed for their members. Their rice products are well packed and sold to Lucky Super Market, and the quality seed is sold to the farmers within their communities and those outside their province (farmers from Koh Thom and S'aang Districts in Kandal province) at KHR 2,500/kg. The added value they receive is that all members share and obtain valuable information, and the cooperative keeps upgrading and growing. There are around five or six cooperatives like CADC operating in different districts of Takeo province (See Annex 3). This is a good example

of farmer-owned value added coordination. This structure and mechanism of community based agro-enterprise is recommended for agriculture development programs in rural Cambodia.

- **Angkor Kasekam Roongroeung (AKRR):** The purpose of seed production for AKRR is to produce premium price rice (Aromatic organic rice) for market and exportation. The rice seed "Phka Malis" is particularly important to the company. The arrangement of production is based on contracted-farming with farmers' groups. There are 1,000 seed growers who grow enough quality seed to supply 37,000 farmers producing this specific aromatic rice for planting on 46,000 hectares of rice land. The company coordinates all services for the farmers' seed growers, as well as the rice producers, inputs on credit (paid back during harvest), and farming techniques. The farmers are requested to strictly follow quality instruction techniques during the cropping period until harvest to ensure seed and rice purity and to meet international quality standards. This is done under supervision of the company agencies. At harvesting time, the company directly transports the seed and rice produced from the farm to be processed with mechanized facilities. The seed farmers grow and maintain their own registered seed using individual panicle selection. Most of the rice produced is destined for markets in Europe, China, and Japan. This will expand to Middle Eastern countries in the future.

3.1.3. The emergence of private seed production supply system

91. A private seed production supply system has emerged in Cambodia over last 3-5 years in response to the demand for a quality seed for local varieties and imported varieties (mainly from Vietnam and Thailand). The private seed production system can be differentiated into tree main groups: i) the formal private seed producers; ii) the informal private seed producers; and iii) the informal seed producer groups.

Formal private seed producers

92. This group of private seed producers emerged from the need to have good quality seeds for rice exports. The producers generally have good agricultural training, significant work experience, and are knowledgeable in business management. Their seed production practices are operated through contract farming arrangements with the farmer producers who cultivate some 0.5 to 5ha of land. Seed production steps follow the same formal technical procedures as practiced by AQIP. Coordination for value added rice production is applied, including cropping, inputs, credit, training and extension, market, transport services, and seed processing. The companies have registered with the Ministry of Commerce for a 10 year period. Their supply capacity is still small (100-200 MT/year), but it is expected to expand rapidly.

93. The number of producers in this group is still small, and they are currently operating mainly in Takeo and Kampong Thom Provinces. This group emerged from private rice producers who produce large quantities of rice paddy for local market and/or exportation. It consists of individual producers, who own large cultivated land, and produce up to 100 Mt of seed. They operate seed production on their land using spot labor. Seed production practices follow either the same technical steps as AQIP, or traditional practices (namely, selection of vigorous panicles with uniform grains). Almost all production activities from land preparation to threshing are mechanized, but seed processing is done manually. Access to services, irrigation, labor, and knowledge in production and marketing exist for such farms. Access to finance is the main constraint for this group, particularly for upgrading their businesses and transforming the groups into more formal seed companies. The produced seed is sold at more competitive prices than offered by AQIP attributable to lower production and overhead costs. These groups of seed producers believe that they can successfully compete with AQIP, especially after they have upgraded their processing equipment to achieve similar quality standards.

The informal seed producer groups

94. This group of seed producers can be found in Kandal, Kampong Cham, Kampong Thom, and Battambang Provinces. These are farmers who have had former work experience in seed production supply with either PRSAC or with AQIP through contract farming arrangements. Farmers normally cultivate 0.5-2 ha of land and seed production using an approach that follows technical procedures that are similar to AQIP. The sole difference is that the seed processing activities are done manually. These groups tend to start with small working capital to produce less than 100 Mt of seed in the first year, and they then expand up to around 300 Mt at present. A few technical staff are employed to assist farmers in seed production, quality work monitoring, and collecting harvested products. The final products are sold with a price equal or lower than that of AQIP's price. Most of these producers plan to expand cultivated land and invest in seed processing equipment and seed storage; this is expected to increase the quality of seed. Their main constraint is a lack of working capital.

Options and constraints of private seed production supply systems

95. Seed production has proven to be profitable business in Cambodia. The emergence of these private seed producers indicates that there is sufficient interest from both the private sector and the farmers. The case of Cambo Seeds is an example of a success story of a formal private seed producer. The future of the private sector in seed production supply depends on their ability to maintain profitability of their businesses while facing increased competition. Since the demand for seeds is

driven by profitability of general rice production systems—either for local markets or for export—the private seed producers need to respond to wider range of demands. These demands include local premium rice, which tends to be wet season varieties, as well as for low quality rice, which tends to be short duration and non-photoperiod sensitive dry season (e.g IRRI) varieties. AQIP will remain one of the largest producers of seed for some time to come. Moreover, AQIP is confident of its competitive position in this increasingly crowding business.

96. The main constraint for private seed producers is a lack of access to finance. Other constraints faced by private seed producers—particularly those who are involved in contract farming arrangements—include the following:

- Uncertainties associated with seed markets;
- Difficulties in preparing good business plans;
- Lack of equipment for seed processing, which affects the quality of seed;
- Side selling by some contract farmers;
- Uncertainties of seed prices for next farming seasons; and
- The lack information about seed quality standards attributable to the lack of knowledge and information for identifying different seed varieties and maintaining its purity; and
- Lack of awareness among smallholders of the importance and benefits of good quality seeds, which restricts their demand.

3.2. Seed processing

3.2.1. Seed conditioning

98. Seed conditioning is a general term used to include all the processes applied to seed that makes it ready for planting. Seed conditioning for rice often begins with seed drying, which can be accomplished with automated dryer units. More often it is done by spreading it out for air-drying. Primary seed conditioning for rice often uses a machine referred to as an 'air/screen cleaner' or a 'grader' that uses a blast of high speed air to blow out light material, and a series of reciprocating, perforated screens that remove impurities both larger and smaller than the seed. A machine with rotating cylinders is used to remove particles both longer and shorter than the desired seed. Additionally, chemical seed treaters, bag fillers, and scales can be a part of the seed conditioning system.

99. In Cambodia, the only seed conditioning equipment used on a regular basis is located either at CARDI or at AQIP Seed's three locations. Several of the MAFF Seed farms also had seed conditioning equipment, but the ones that were seen were barely used. The vast majority of rice seed produced in Cambodia is conditioned manually: It is done by using a woven screening basket that drops out small particles from the seed mass, and then a winnowing process whereby wind blows fine particles

as the seed is poured from one basket to another. Chemical seed treatment was not observed—except for some use with vegetable seeds.

3.2.2. Seed storage

100. Most commonly, rice for seed is replanted within 5-7 months after it has been harvested. Seed can be appropriately stored for this period as long as harvest, seed drying, and cleaning procedures are used. The high temperature and humidity in Cambodia can reduce seed storage times; studies by CARDI have shown that seed storage times beyond 6 months will usually reduce viability below the 85 percent standard for saleable seed. It is therefore a common practice to dispose of seed for milling after the subsequent planting season. Although this may seem to be a workable system, it does not allow for the maintenance of a seed reserve—resulting in some surplus higher value seed that has to be sold at a lower market grain price.

101. Farmer seed is stored in bags usually made of woven polypropylene and covered with a tarp or plastic sheet in a building under a roof—protected from rain. Some farmers indicated that jute bags for storage would allow for better air movement thereby helping to maintain seed viability levels longer, but these bags are more expensive. Although it would seem that insects and rats would cause damage to seed stored this way, most farmer seed growers didn't see these as major problems.

102. Farm seed storage seems rather primitive; although, seed usually does remain viable until the next planting season. All farmers who were interviewed said that they performed a basic seed germination test before seed was sold or planted. Better storage methods would allow for more options in seed use—but in reality—any better storage methods would have to maintain that seed for another 12 months (the next planting season). However, at present, it seems unlikely that such advances can be made while continuing to store seed at the farm level in this country.

3.3. Cost of seed production

103. Production of quality seed follows technical practices of seed purification to ensure quality. Planting rice for seed follows the same steps as normal rice production: it requires quality work from field operation to seed processing and storage; the use of quality resources (including rice land, soil type, seeds/breeding materials, fertilizers, etc.), and high attention in purification techniques and control. Practically, quality seed production should be based on technical knowledge and modern facilities and according to seed regulations and scientific rules. CARDI is the only source of breeding materials, and has provided research, selection, production, and education in seed service. After going through variety the development process (Figure 1), successive class of Foundation seed, Register seed, and Graded seed for the supply system are produced. The discussion of seed production here focuses on the formal system only. It is important to note the following two points. First, the cost

of FS was provided by CARDI detailing all activities, labors, and inputs incurred from the field to the end product in storage. In contrast, the costs of RS and GS were computed based on information provided by the respondents. Second, the costs computed in this study only cover field production or raw products.

3.3.1. Cost of Foundation seed production

104. Based on the scientific rules, the breeder must produce the FS by using BS; it needs to be planted in rows with a rate of 1 tiller/hill. All plants that present identical characteristics of the BS plants are harvested for the next class of seed production.

105. Although mechanized field work such as land preparation, harvesting, and threshing can be used, FS production still requires a lot of hand labor. This is attributable to the need to implement purification activities, which include transplanting 1 tiller/hill and in a row, rouging, weeding, bird watching, and cleaning. It costs CARDI a total of USD$ 7,352.9 to produce a hectare of FS. Hand labor cost is the highest component cost at $3,402 covering nearly one half (46 percent) of the total cost per ha; two-thirds of which ($2,250) covers the breeder cost. CARDI suggested that this breeder cost must be accounted for because of the need to address staff movement. The transplanting, harvesting, and threshing work ($541.9/ha or 47 percent) accounts for about half of the other labor cost ($1,152). If transplanting is mechanized with the assumption of a 50 percent cost reduction per ha ($180); and harvesting and threshing can be done using a combined costs of $90/ha; it is possible to reduce the cost by $270 per hectare of FS produced. This equates to $0.12 per each kg of FS produced. Although this reduction may not be as significant as expected and 175 casual laborers would lose jobs, the importance of mechanization's efficiency and effectiveness in service returns—including time saving, fast field operation, and quality assurance—outweigh its negatives.

106. Since CARDI makes no benefit from its FS production, it is useful to analyze the profit contributed by funding the FS. There are significant contributions that can be appreciated from funding. If one kilogram of FS can produce 6Mt of CS in the second step of seed production, the seed growers could make a minimum of $560 in profit per growing season. (Assuming CS is sold at $0.25/kg.) Thus, each kg of FS funded to CARDI will allow the seed grower to generate around $100/month from seed production. From this analysis, it was observed that small holder producers can increase profits by intensifying their production per unit area.

3.3.2. Cost of Registered seed production

107. RS must be produced by using FS and planted in row with the rate of 1 tiller per hill. The seed rate used is 20kg/ha. Overall, this stage of seed production is similar to FS production; the difference being that it covers a larger scale area. The FS is required to be renewed every 2-3 years for ensuring purity and high quality seed.

108. AQIP, Tuol Samrong Seed Farm, NGOs, and rice exporters use FS from CARDI to produce RS first before producing the CS. By so doing, the investment in seed inputs is cheaper while the cost of GS or CS production is even cheaper. To produce one hectare of RS (during 2009-2010 crop season), the required investment was from about $600 to $700/ha for field production including inputs, mechanized field operation, and hand labor. The cost of inputs tends to be higher than the cost of mechanized works and hand labor (Table 1). For all AQIP contracted farmers, inputs—in terms of seed—is paid for via in kind credit. Chemicals are paid for via cash credit. Mechanizing the harvesting, threshing, and bagging work can reduce the cost of hand labor. Although the difference is not very significant ($10 difference), mechanized work increases operational efficiency and ensures quality. The cost of seed conditioning and storage covered by AQIP was around $50/Mt. If compared with the cost of RS production for IR66 and Phka Roumduol varieties (Table 1 below), it was observed that seed production cost is about a $100 difference attributable to a higher quality fertilizer used in the IR66 rice crop. The yield of IR66 is generally higher (5Mt/ha) than the Phka Roumduol Variety (2Mt/ha). Profit from IR66 by the contracted farmers is worth approximately $800/ha; the Tuol Samrong Seed Farm with the Phka Roumduol variety is worth approximately $700/ha.

3.3.3. Cost of Commercial seed production

109. Commercial seed or GS is produced from the RS, and a pure high quality source is always encouraged. Overall, this seed production follows the same practice as normal rice production by planting more than 1 tiller/hill (2-3 tillers/hill). However, it still requires following principles of other pure seed production including rouging, seed storage, and so forth. This class of seed production is only practiced in Cambodia because of the need to reduce production costs to attract farmers to use quality seed.

110. To produce a hectare of CS, it costs the farmer seed producer to invest approximately $450 to $600 per ha—excluding labor. Overall, there is not a significant difference in cost for RS and CS production for field production in the same location. This is illustrated in the comparison of RS and CS production of the Phka Roumduol variety at Tuol Samrong Seed Farm with the RS and CS production of IR66 at the Sre Ampil Farming Area (See Table 1 below). However, when compared to the "large scale" farming (40 ha cultivated land) in Baray and Takeo Provinces with the smaller scale farmers in Sre Ampil farming area, the CS production of the larger scale farming cost is around $100-150/ha cheaper. This is because of the larger scale farmer's access to inputs, their access to their own fertilizer, and their access to their own machinery. Their costs are also lower because they have fewer permanent laborers.

111. The direct seeding method is one way to reduce the cost of CS production because it reduces hand labor costs in transplanting. In addition, high yield variety also reduces the cost of seed per kilogram. For these reasons, the cost of a kilogram of CS produced at a lower yield was nearly $0.30; the cost of a kilogram of higher yield was $0.07. Compared with the farmers' community in Thailand, the seed production

cost is similar (Thitima et.al, 2007). The famrer's sales price at the farm gate to AQIP is KHR 1,300/kg for local medium duration variety and KHR 1,200/kg for short duration variety. CS produced by CARDI is sold at $0.60/kg; CS from AQIP is $0.60/kg for short duration variety and $0.65/kg for medium duration variety and $0.70/kg for medium aromatic variety. Compared to the cost of the Vietnamese seed that is currently entering the market at $1/kg, the Cambodian CS sale price is not expensive—with the IR66 being even cheaper. Contracted farmers can make profits from around $800 to $1,400/ha from CS production. These contracted farmers make more profit with CS production than RS production; although, the Tuol Samrong Seed Farm makes more profit from the RS production than the CS production (See Table 1).

Table 1. Cost of seed production in the field per ha (US$)

	RS Production		**GS Production**			
	TSR (PRD)	***SA (IR66)***	***TSR (PRD)***	***BR (PRD)***	***SA (IR66)***	***BR (SPD)***
Input cost	209.03	321.95	168.30	212.04	364.7	224.24
Mechanized cost	109.76	143.90	109.76	121.95	134.15	170.73
Labor cost	248.79	214.63	224.40	131.10	104.88	45.73
Cost per ha	**567.58**	**680.48**	**502.46**	**465.09**	**603.73**	**440.70**
Cost per kg	**0.28**	**0.14**	**0.25**	**0.12**	**0.12**	**0.07**
Sale per kg	***0.62***	***0.29***	***0.37***	***0.37***	***0.29***	***0.31***
Profit per kg	***0.34***	***0.15***	***0.10***	***0.25***	***0.17***	***0.24***

Note: TSR: Tuol Samrong, SA: Sre Ampil, BR: Baray; PRD: Phka Roumduol variety, SPD: Sen Pidor variety

3.4. Reasons for low demand for improved seed by small holder producers

112. The majority of the rice agro-ecosystem in Cambodia is rainfed, low land rice (RLR). Although it is only one rice agro-ecosystem, based on the landscape, topography, soil and land conditions, and rain distribution, diverse rice seeds are being used by the farmers in different regions and locations of the country. This is the issue of seed in Cambodia. The farmers (small holder producers) know well which varieties best suit their rice field conditions and meet their family and community objectives. They like new ideas, particularly ideas related to quality seed, because all acknowledge that seed is a very important factor for production increase. To select varieties for growing, the farmers consider three main criteria: i) suitability of seed to their field conditions, ii) high yield and volume expansion when cooked, and iii) taste and nutritional preference. Unfortunately, CARDI concentrates on high quality rice for market when developing varieties and producing quality seeds. Therefore, not all of the newly released varieties are suitable to the different rice agro-ecological conditions in the country.

113. The reasons for the low demand of quality seed can be explained in two farming purposes: the first is family subsistence; the second is a market purpose.

- For the small holder producers who mainly produce for subsistence purpose, the reasons for low demand of quality seed are that some CARDI seeds cannot meet criteria 2 and 3. The reason for this is that with small the rice farm they have, criteria 2 is important for having enough rice to feed large families; criteria 3 is important for nutrition because they cannot afford other protein sources. Also, the good taste of rice fulfills their meals. To meet the farmers' seed preference, CARDI provides training on seed purification to farmers.
- For those small holder farmers who have more rice plots and can produce for market, the reason for low demand is an unwillingness to take risks. , In such cases, it is possible that they are not aware of quality seed. If they are aware, the problems may stem from a lack of trust in the new seed. Alternatively, the problem could also stem from the cost of the quality seed. Some farmers fear such an investment when they are not sure about market security for their rice. For these reasons, it is not a surprise that many agricultural projects and farming contracts provide seed input to the farmers in the form of credit. However, interviewed farmers said that they would invest in quality seed if they were completely sure that they would make higher profits.

4. Expansion Scenario of Future Seed Production Supply

4.1. Analysis of demand projections for certified/good seed

114. The demand for improved rice seed in Cambodia is not known. The demand for improved rice seed is determined by following factors: (i) farmers' capacity to adopt proper agronomic practices; and (ii) farmers' capacity to access markets and finance. The demand is also affected by specific agro-ecological conditions, which determine the type of varieties grown and soil types. These factors could have a significant role in farmers' demand for improved varieties over using traditional varieties, which have lower yields, but may be better adapted to local conditions. In order for farmers to adopt improved seed, it is required that improved cultivars outperform local varieties under local agro-ecological and climatic conditions or in conditions that allow farmers to overcome agro-ecological and climatic constraints, such as irrigation. It is thus assumed that the demand for improved rice seed is higher in areas of favorable agro-ecological conditions and in areas with higher agriculture potential in general. For example, based on the MAFF's statistics on rice production in 2009 and MOWRAM's statistics on irrigated areas in 2009 approximately only 0.6 million ha is under irrigation of the current 2.6 million ha cultivated ha of rice crop (Table 2). With the assumption that improved seed will be cultivated only in an area with access to irrigation, a total amount of approximately 30,000 Mt of seed would be needed when using a seeding rate of 50 kg/ha.

115. From a socio-economic viewpoint, the adoption of improved seed will depend on farmers' endowment of human capital and productive assets, such as land. On the human capital side, improved seeds respond better to good farming practices and input use. Thus farmers with higher levels of human capital are more likely to demand improved seeds. Access to land is also important. The average rural family needs about 1 ha of rice field to sustain itself. It is thus assumed that rural households with more than 1 ha of rice field are likely to demand more improved seeds than those with smaller land holdings. It is further assumed that some 18,000 Mt of improved seeds are needed for an area of 357,883 ha with a seeding rate of 50 kg/ha.

Table 2. Estimated improved seed needed for current rice production in Cambodia based on agro-ecological conditions

Province	Wet season cultivated rice area (ha)	WS rice area (ha) under supplementary irrigation	Dry season cultivated areas (ha)	Estimated areas planted to improved seed (ha)	Estimated demand for improved rice seed (Mt)
Banteay Mean Chey	214,340	9,144	2,350	11,494	575
Battambang	245,127	50,987	4,839	55,826	2,791
Kampong Cham	166,285	10,753	52,993	63,746	3,187
Kampong Chhnang	105,222	5,050	22,914	27,964	1,398
Kampong Speu	105,190	7,757	146	7,903	395
Kampong Thom	164,279	17,557	20,468	38,025	1,901
Kampot	125,605	1,166	2,375	3,541	177
Kandal	43,634	3,978	57,170	61,148	3,057
Kep Town	3,000	0	0	0	0
Koh Kong	9,619	95	0	95	5
Kratie	29,778	1,656	13,979	15,635	782
Mondulkiri	16,506	729	0	729	36
Otdar Mean Chey	50,390	753	57	810	41
Pailin Town	2,750	0	1,950	1,950	98
Phnom Penh City	5,031	450	200	650	33
Preah Sihanouk Town	12,747	86	0	86	4
Preah Vihear	37,855	512	18	530	27
Prey Veng	250,339	44,920	72,654	117,574	5,879
Pursat	98,810	9,310	3,465	12,775	639
Rotanakiri	24,906	355	0	355	18
Siem Reap	178,790	25,507	16,000	41,507	2,075
Stueng Treng	23,045	858	0	858	43
Svay Rieng	160,413	7,809	14,828	22,637	1,132
Takeo	181,443	30,185	74,224	104,409	5,220
Total	2,255,104	229,617	360,630	590,247	29,512

116. These two scenarios for calculation of seed demand have resulted rather different outcomes. However, they demonstrate that the demand for improved rice seed in Cambodia could be in the range of 17,894 – 29,512 Mt. As shown in Table 2, based on prevailing agro-ecological conditions, it is anticipated that the demand for improved rice seeds are likely to come from the 590,247 ha of rice cultivated areas that are irrigated. Similarly, as shown in Table 3, only about 357,883 ha of rice field are likely to demand improved seeds based on the assumptions of access to land.

Table 3. Estimated improved seed needed for current rice production in Cambodia based on socio-economic conditions of the rice farmers' households (2009)

Province	Households	Rice farmer households	Rice farmer households own rice field >1 ha	Area covered (ha)	Seed demand (tons)
Banteay Meanchey	141,509	124,737	6,677	8,947	447
Battambang	205,351	176,236	36,347	75,247	3,762
Kampong Cham	380,083	242,294	16,630	8,459	423
Kampong Chhnang	100,411	56,999	7,778	8,400	420
Kampong Speu	146,850	76,610	13,323	15,322	766
Kampong Thom	135,332	88,212	14,343	17,642	882
Kampot	126,012	59,562	5,959	6,912	346
Kandal	250,112	155,559	29,630	31,112	1,556
Kep	7,517	5,379	0	0	0
Koh Kong	23,183	20,449	1,058	1,090	54
Kracheh	64,060	49,292	7,144	9,858	493
Mondul Kiri	12,149	11,246	1,785	2,249	112
Otdar Meanchey	40,836	36,986	1,918	2,397	120
Pailin	12,446	12,150	422	430	22
Phnom Penh	201,140	193,611	296	322	16
Preah Sihanouk	36,415	30,328	678	766	38
Preah Vihear	28,761	24,225	575	845	42
Prey Veng	241,659	152,161	24,542	30,432	1,522
Pursat	83,153	64,308	9,320	12,862	643
Ratanak Kiri	30,254	27,333	1,033	1,467	73
Siem Reap	165,304	124,832	22,291	24,966	1,248
Stung Treng	20,819	18,749	2,534	3,750	187
Svay Rieng	120,873	84,470	14,564	16,894	845
Takeo	186,247	87,564	67,402	77,513	3,876
Total	2,760,476	1,923,292	286,248	357,883	17,894

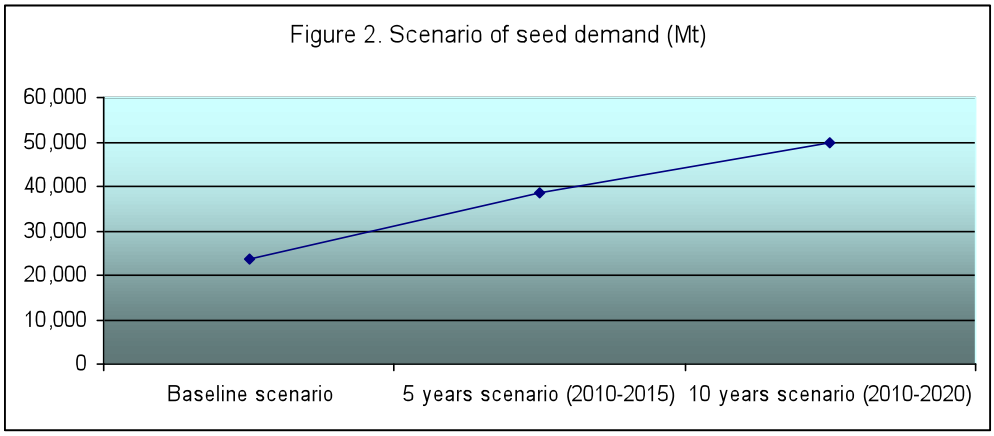
117. The five year scenario for improved seed demand can be estimated in the context of the government's rice export policy, which calls for exports of 1 million Mt of white rice by 2015. Estimation of the five year scenario for seed demand therefore starts with the amount of paddy rice to be produced over this period (See box below).

Box 1: Estimation of five-year scenario for seed demand in Cambodia

Parameters	Implications
One million Mt of white rice	An equivalent to 1,548,462 Mt of paddy rice exported (with the assumption that 100 kg of paddy can yield 65 kg of white rice)
To produce 1,548,462 Mt of paddy rice	Requires 769,231 ha of rice fields (with the assumption that the average yield is 2 Mt/ha)
To have 769,231 ha of rice fields planted	Requires 38,462 Mt of seeds
Is this plan achievable?	Yes, but under two conditions: (i) the capacity to produce improved seeds by 2015 has well exceeded 38,500 Mt annually, and (ii) at least about 770,000 ha will be brought under full irrigation by 2015. To have these required conditions under control, a concerted effort between MAFF and MOWRAM is needed. So far, the MOWRAM strategy is to increase 20,000 ha of irrigated rice area per year (MOWRAM, 2010). If MOWRAM could double this effort to 40,000 ha per year, the plan could be achieved.

118. The seed demand scenario for 2020 could be estimated based on the following conditions:

1) There will be significant interest to grow rice for market in response to increased exports of milled rice.
2) There will be a possibility for expanding more area cultivated to early wet season rice and/or dry season rice because access to irrigation will be increased significantly. If MOWRAM could expand irrigated areas at the rate of 40,000 ha per year, by 2020, about 1 million ha of rice cultivated area will have access to irrigation and could thus become the source for the demand for improved seed for up to 50,000 Mt per year. The three scenarios for seed demand are as presented in Figure 2 below.



4.2. Analysis of expansion potential for market supply

119. CARDI, AQIP Seed Company and its contracted seed growers, the private seed producers, and to some extent, the Tuol Samrong Seed Farm are the key players of seed production that targets the potential seed market using CARDI released varieties. The estimate of the expansion potential for market supply would thus provide a potential on the gap, which needs to be addressed from supply side.

120. AQIP Seed Company, as a Cambodia's leading supplier of high quality seed, suggested that no more than 2,000 Mt of quality seed was used in 2005. In 2009, AQIP sold nearly 2,300 Mt of high quality seed. The company planned to sell an amount of 4,500 Mt of high quality seed in 2010 (AQIP Corporate Plan 2007); their future goal is to reach 4,000 Mt sales potential in 2014 (Recent Communication, 2010). Thus, the potential expansion of seed supply in the short term future (2010-2014) for AQIP will be between 4,000 Mt to 4,500 Mt. A smaller proportion—less than 100 Mt/year of quality seed—is sold by Tuol Samrong Seed Farm in Battambang Province. Without promotion, there is no hope for significantly increasing demand. In addition to AQIP and Toul Samrong Seed Farm, it is estimated that about 1,000 Mt/year of CARDI "quality seed" (short duration varieties from Vietnam produced in Takeo and Kampong Thom Provinces are not included) could be sold by a few private seed producers.

121. All key players of the seed production supply chain have face considerable constraints. These are mainly capital deficits, limited irrigation, lack of equipment and facilities, and risky rice growing conditions attributable to uncertain rainfall, flood, and drought. These constraints are determining factors for farmers' adoption of new ideas and technologies in the RLR farming system (Mak, 1998). For this reason, research and extension efforts to promote high quality seed use have not been achieved. This is despite the 2.3 Mt (enough for 28 percent of country's rice growing area) of the total 5 Mt of FS produced by CARDI that is spread throughout the production supply chain and the various research programs throughout the country. Except for some proportions of wet season RLR and dry season rice

farming areas that have better irrigation access, the remainder of the country has lower and un-secure opportunities for increasing productivity. Therefore, opportunities for quality seed use need to be created in parallel with the promotion process.

122. Expansion potential for market supply that can be materialized is assessed by looking at possibilities for meeting this goal. For this purpose, a scenario composed of three key elements: trends, challenges, and interventions are presented. "Trends" is the tendency of market expansion that likely takes place within a certain period of time based on sale records, the rice trade situation, socio-economic and environmental factors, and interventions. While "Challenges" projects the situations and risks to be faced during that period. "Interventions" describes the possible actions that are going to take place through planned projects/programs, as well as likely emerging actions that will be proposed according to given circumstances. Within this framework, three main scenarios of supply expansions are proposed that depart from the baseline scenario (expansion capacity from 2001-2009): Scenario One is the short term low expansion scenario of seed production supply for the next five years (2010-2014), Scenario Two is also a short term but medium expansion scenario, and Scenario Three is a high expansion scenario.

4.2.1. Baseline scenario of seed production supply

123. The sale record from 2001 to 2009 collected from AQIP and Tuol Samrong Seed Farm provides baseline information on seed production supply. Based on the sale record, it is observed that since efforts have been made, the market of high quality seed is being increased although there were some falls in 2007 and 2008 (290 Mt/year). This increase is subject to the fact that there are farmers who have decided to purchase the quality seed every crop after their first experience with it. The real cases gathered during the study are evident:

- Through a few years experience of high yield gained from using quality seed, a few interviewed farmers in Koktrop Village near AQIP Center in Kandal Province said that they prefer to purchase quality seed from AQIP rather than keeping their own seed because the quality differences are outstanding; and

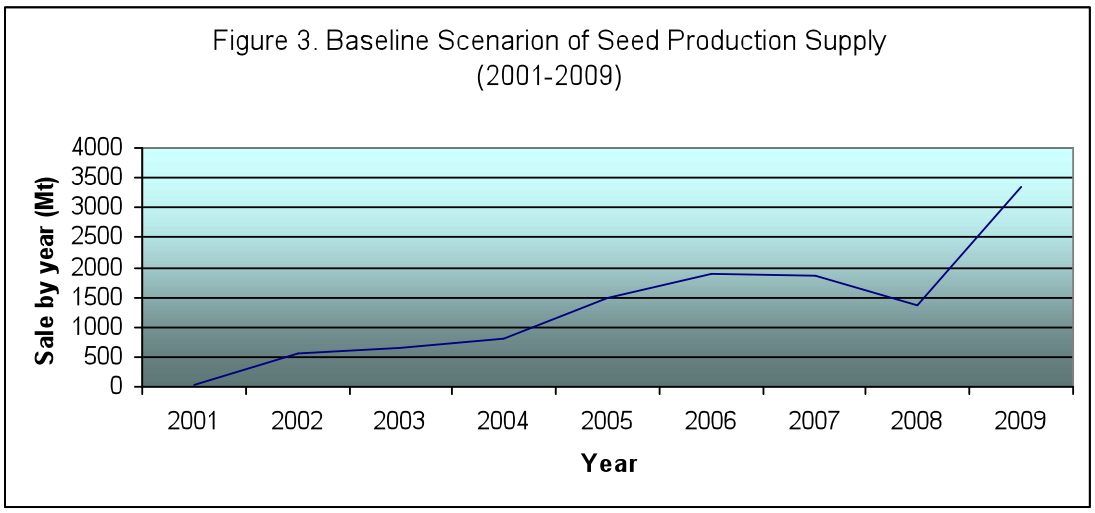
- The farmer seed producer in Chong Samnay Village, Battambang Province who uses the RS from Tuol Samrong Seed Farm to produce CS said that he wanted to use the RS immediately for his rice production because it performed very well.

In addition to AQIP and Toul Samrong supplies, about 1,000 Mt of "quality seeds" were estimated to be sold by the private seed producers. In total, the potential supply in 2009 was 3,359 Mt (Table 4) and this can be adopted as a baseline scenario of the potential seed supply (Figure 3).

Table 4. Baseline scenario of seed production supply

Year	AQIP Sale Record (Mt)	TSR-SF Sale Record (Mt)	Private producer (Mt)	Total (Mt)	Annual Increment (Mt)
2001	13	30	-	43	
2002	540	25	-	565	522
2003	627	30	-	657	92
2004	768	25	-	793	136
2005	1467	35	-	1502	709
2006	1,862	33	-	1895	393
2007	1,780	90	-	1870	-25
2008	1,282	81	-	1363	-507
2009	2,279	80	1,000	3359	1996

Sources: AQIP and Tuol Samrong Seed Farm (2010)



Risks/challenges

124. Rainfall irregularity and limited access to irrigation (despite slight improvement) remain to be important constraints for both the seed producers and the rice farmers. A lack of working capital is the most challenging factor for the key players of the seed production supply system, ranging from CARDI, AQIP, Tuol Samrong Seed Farm, contracted farmers, and rice exporting companies. Rice seed production through contracted farming requires large capital mobilization during planting time and even higher capital mobilization at harvesting time. This constraint needs to be resolved soon to support the expansion of the production supply that will take place within the next five years.

Interventions

125. Seed production supply has progressed up to present. This is attributable to the financial support from AusAID in implementing the RGC's policy. Increasing the seed market was due to an increase in the rice market, both locally and internationally. This only includes local wet or dry season rice that was sold to Vietnam and Thailand, or exported to other countries in Asia. (This does not include fragrant rice). Demand for purer products with uniform grains from the rice dealers and millers induce the rice producers to use quality seed. Other interventions include CARDI seed purification training and OFAT Programs; the IPM Farmers' Field School, the ECOSORN project, and other agricultural projects that have provided capacity building and extension services and promoted rice enterprises. Moreover, there was good coordination between AQIP and farmer seed growers, as well as among rice exporting companies and contracted farmers.

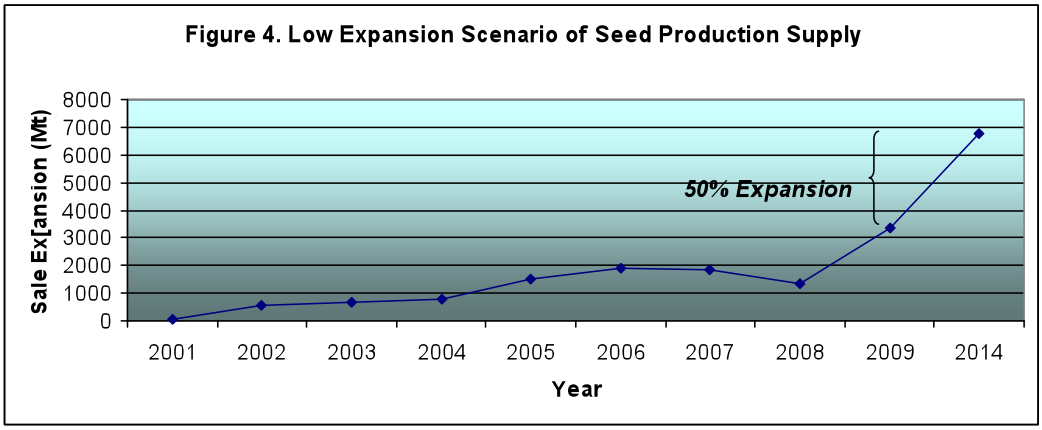
4.2.2. Scenario One: Low expansion scenario of seed production supply

Trends

126. In the next five years (2010-2014), the demand for both medium and high quality rice (wet season and dry season varieties) for both the international and the local market will continue to increase. The AQIP Sale Officer opined an increasing demand for quality seed in the next short term period. Rice exportation to Vietnam is expected to keep growing—both formally and informally. For example, recently a registered organization worth $8 million in the form of Cambodian Rice Joint Ventures has been made with Vietnam Southern Foods (33 percent), VINA Food II (37 percent), the Green Trade Company (30 percent); and CAVI Foods for rice (for 99 years). The agreement was signed in October 2009. During this time, a number of agriculture and food security programs such as the on-going CAVAC, those WB/IFAD, ADB, and USAID funded programs, etc. will be implemented. With this development event, it is assumed that the potential market for seed production supply will rise up to at least 6,750Mt (50 percent) as shown in Figure 4.

This amount of expansion is subject to the following assumptions:

- AQIP can reach only 3,800Mt;
- Tuol Samrong Seed Farm can sell 160 Mt;
- The rice seed program implementation will be able to promote farmers' decisions to purchase quality seed up to 40 Mt;
- HARVEST Project can promote the use of high quality seed up to 250Mt;
- Private producers can sell 1,500 Mt; and
- The government seed production supply can contribute about 1,000 Mt.



Risks/challenges

127. In the next five years, the RLR farming system—where the majority of rice seed and rice grain are produced—will likely face more serious droughts because of climate change. Predictions by scientist state that there will be a shorter duration and a limited amount of rainfall. Seed production can be affected if there is no supplementary irrigation. Despite interventions, access to irrigation will be limitedly improved. This will limit the application of intensification to the seed producers and to the seed users. Limited capital will provide low opportunities for seed market expansion.

128. At the same time, the Cambodian seed production supply system is going to conflict with the growing potential of mobilization of Vietnamese seeds supply. Presently, the Vietnamese seeds are wining popularity in Takeo Province. This is because these seeds can cover up to 50 percent of the dry season seed used in this province while covering about 70 percent of total dry season rice area. At the same time, they are being spread to other provinces such as Kandal, Kampong Cham, Kampong Thom, and Prey Veng because of the characteristics of these varieties including short duration, non-photoperiod sensitive, aromatic, and high yield. Also, the Vietnamese rice dealers provide further services and incentives including seed purchase on credit and markets for all rice produced at high prices—without any strict conditions. The invasion of Vietnamese seed will create two challenging situations for the Cambodian seed production supply system: the first will be protecting local seed and market potential; the second will be the ability to ensure that the optimal expansion of seed production supply will materialize. Capital is particularly important for the main players of the seed production supply system such as AQIP and CARDI. This issue must be resolved at this stage in order to tackle the two aforementioned situations.

Interventions

129. The RGC's policy on rice exportation and the MAFF's goal to double the production to 15 Mt through intensification by 2015, despite difficulties, could

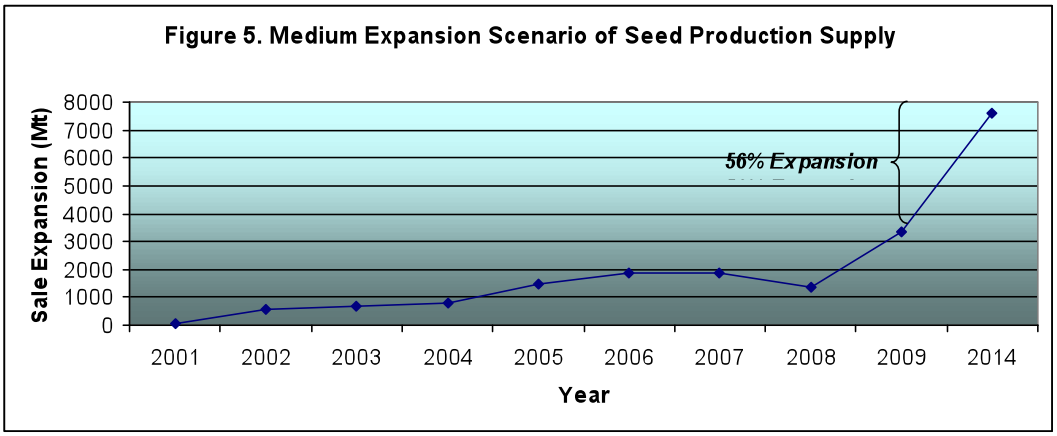
motivate the participation of some projects and activities. It is hoped that WB/IFAD and AusAID funded CAVAC projects and the USAID funded HARVEST and other rice related projects will help the key players to overcome constraints and risks; moreover, it is hoped that this will create opportunities for meeting the market expansion objective. It is expected that agricultural services and some small-scale irrigation will be improved while more extension and business development services will reach the small holder producers. It is also expected that the RGC's Action Plan to reach the CMDG target in 2015 will benefit the smallholder producers—particularly access to water for irrigation.

130. In order to meet the expansion objective while ensuring local seed security for future rice trade development; all interventions should consider improving coordination of another step of rice enterprise: the rice market. The rationale being that improving coordination will ensure that the rice produced will be sold at reasonable prices. This will encourage and attract farmers to use quality seed. While good coordination between seed growers and seed dealers has been taking place for a quality seed production supply system, another step is needed. Thus far, coordination between the quality seed users (rice farmers) and rice traders has not been functioning well. For this reason, the market for rice produced is not ensured. Successful experience from the Vietnamese rice dealers—who are mobilizing their seeds sales in Cambodia—shows that buying all of the rice produced from the farmers who use their seeds promotes their seed market.

4.2.3. Scenario Two: Medium expansion scenario of seed production supply

131. The seed production supply will go through the same trends, risks, and interventions. However, if there are more successful results from interventions and projects, good opportunities for quality seed market expansion and farmers' use will be created. Therefore, it will enable the expansion to reach 7,600Mt (56 percent) as shown in Figure 5, subject to the following assumptions:

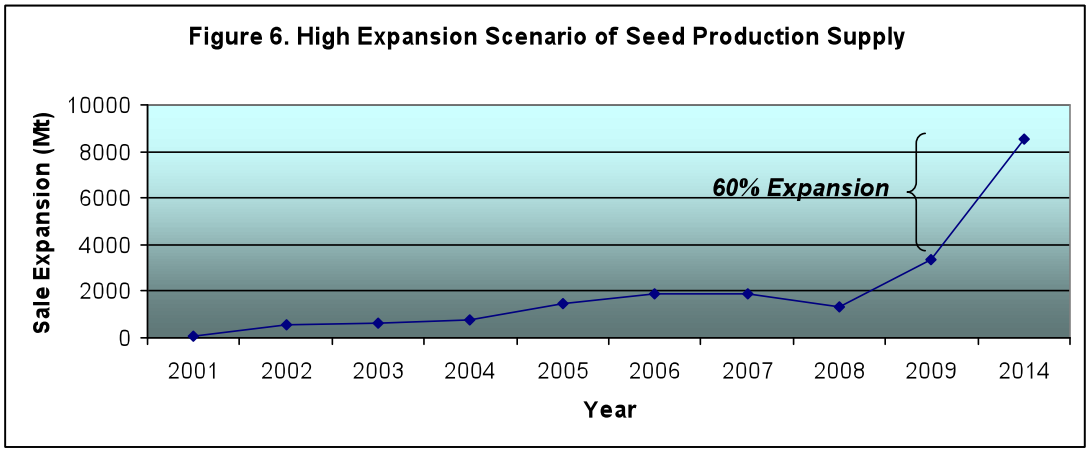
- AQIP can reach its objective to sell 4,000Mt as planned;
- Tuol Samrong Seed Farm can sell 160 Mt;
- The rice seed program implementation will influence farmers' decisions to purchase up to 90 Mt of quality seed;
- HARVEST Project can promote the use of high quality seed up to 250Mt;
- The private seed producers will be able to sell 1,800 Mt; and
- The government will be able to produce 1,300 Mt.



4.2.4. Scenario Three: High expansion scenario of seed production supply

132. Similar to the situations of low and medium scenarios of expansion, the 53 percent expansion of production supply could be materialized within the five year period. This is condition upon all of the interventions discussed above. Moreover, this is condition upon CARDI developing and releasing more varieties that would attract both farmers and rice dealers according to the CARDI-GDA-IRRI-CAVAC rice germplasm project. Lastly, some inroads must be made to curtail the Vietnamese seed market expansion. If these aforementioned assumptions are realized, the expansion will reach up to 8,500 Mt (60 percent) as shown in Figure 6, subject to the following assumptions:

- AQIP can reach its objective to sell 4,000Mt as planned;
- Tuol Samrong Seed Farm can sell up to 240 kg;
- The rice seed program implementation will influence farmers' decisions to purchase up to 260 Mt of quality seed, thereby making inroads into the Vietnamese seed sales in the targeted areas;
- HARVEST will be very successful in improving opportunities for the market and the use of high quality seed, thereby enabling expansion up to 500Mt;
- The private seed producers will be able to double their efforts to 2,000 Mt;
- The government will be committed to produce 1,500 Mt .



133. When compared to the expansion of potential of seed production, the gap between supply and demand could approach 30,000-32,000 Mt in 2015. The gap could be between 6,750 Mt to 8,500 Mt in 2014, with estimated demand in 2015 of some 38,500 Mt. This gap could be reduced with the entry of more private producers in seed production supply.

4.3. Rice seed program

4.3.1. Investment activities for improving community seed access

134. As discussed earlier, not all CARDI released varieties or all quality seeds are well suited to all field conditions, nor are they preferable to the farmers. On the other hand, not all farmers buy seed for every crop. For these reasons, farmers' access to quality seed is still low. According to CARDI, presently about40 percent of the rice growing area in Cambodia is cultivated with quality seed.

135. In order to enable long-term farmers' seed accessibility, the following investment activities are suggested:

i) Optimal expansion and diversification of Foundation seeds production supply;
ii) Building awareness and distributing quality seed to those farmers who cannot afford to buy while ensuring awareness about availability and use through OFAT;
iii) Provide training and capacity building to those farmers who cannot afford to buy or who want to maintain their suitable varieties; and
iv) Community based seed production extension program

Optimal expansion and diversification of Foundation seeds production supply

136. CARDI plays important roles in breeding and varieties improvement and development. Based on the scenario presented above, CARDI needs to expand its research capacity toward improved varieties that are suitable to different needs beside premium rice. The varieties that are well suited for subsistence purposes and that are adaptable to varied climate and field conditions are in high demand (79,000 Mt). CARDI can produce 10 Mt of FS in five years, starting with 1ha in the first year, 2 ha in the second and third year, 3 ha in the fourth year, and 2 ha in the fifth year. The allocation of the amount of production is based on the need to use FS for OFAT, the Seed Purification Training Program, and the Extension Program. The total amount of funds needed for this activity is $73,530. The returns from this investment would be an increase in improved varieties released for the country. The returns would also create seed capital and training for around 5,000 OFAT farmer participants in the 300 targeted villages of the Seed Production Extension Program in the five targeted provinces.

Equipment and facilities

137. Improvement of CARDI facilities and equipment will help increase seed access to poor farmers who are in need through contribution to the expansion of the potential seed market. Investment to improve facilities and equipment requires around $120,000. About $113,000 is needed for the establishment of a seed lab (Table 5), which would begin in year 3 of the project.

On-farm Adaptive Trial

138. **Enhancing and expanding this investment could increase farmers' interest and demand for improved seed through farmer-to-farmer extension**. Generally, OFAT is conducted in collaboration among CARDI, PDA, and farmers. This activity should be integrated into the Farmer Community after the project. If OFAT receives this investment, each OFAT will cost around $540 (Table 5) and will enable at least 20 neighboring farmers to learn about different varieties. It is expected that after five years of OFAT, in each location where an OFAT is conducted, awareness about improved seeds will be created and will spill over into neighboring communities. At the same time, at least 20 percent of the farmers in the community will adopt improved seed; 5-20 farmers will decide to purchase the quality seed. If five provinces are targeted, it is suggested that 20 OFATs are conducted in each province, starting with five OFATs per district in the first year. The fifth year should be left for integrating OFAT activities into the Community Program. The integration should take place proactively from the third year of the project, so that any support needed can be provided during the first two years.

Table 5. Estimated cost for five years CARDI-OFAT in five provinces

On-farm trial (100 fields) during five years				
Description	**Unit**	**Qty**	**UC (USD)**	**Total (USD)**
CARDI (A)				
Per diem	Day	240	100	24000
Transport	km	14000	0.5	7000
Field materials	Field	100	50	5000
Office supply	Set	1	500	500
Farmer's workshop	Set	5	1500	7500
Meeting and Workshop (10%)				4400
Sub-Total (A)				*48400*
PDAs (B)				
DSA	Day	160	20	3200
Office supply	Set	5	500	2500
Sub-Total (B)				*5700*
Grand Total				**54100**

CARDI Training Program on Seed Purification and Quality Improvement

139. This training program can enhance farmers' capacity in producing quality seed for their own use. Details are also discussed in Section 3.1.1. The training program will be implemented through CARDI and PDA cooperation. In each province, 20 training courses will be conducted; 20 farmer participants will be invited to each training course. The training will consist of technical explanations and field practices for the whole cycle of the seed production. Field practices will be conducted on selected farmer's field (0.2 ha) for skill demonstration and practice. After the training, if the participants want to have seed, it will be given to them.. After completing the training course, it is expected that 2,000 farmers will be able to grow pure seeds and spread information to other farmers in their communities. It is expected that at least three framers will want to buy FS. Detailed costs of this investment are proposed in Table 6.

Table 6. Estimated cost for seed purification and quality improvement training program

Training the Farmers in seed purification (100 fields + 2000 Participated farmers)				
	Unit	**Qty**	**UC (USD)**	**Total (USD)**
CARDI (A)				
Trainer fee	Day	300	100	30000
Transport	km	20000	0.5	10000
Field materials	Field	100	50	5000
Training materials	Set	1	500	500
Farmer's Notes	Piece	10000	0.4	4000
Farmer's incentive	Person	2100	6	12600
Meeting and Workshop (10%)				6210
Sub-Total (A)				*68310*
PDAs (B)				
DSA	Day	320	20	6400
Office supply	Set	10	500	5000
Sub-Total (B)				*11400*
Grand Total				**79710**

140. The four CARDI investment activities and costs are scheduled in Table 7.

Table 7. Estimated cost for all CARDI investment activities in five years

Description	**Y1** (USD	**Y2** (USD	**Y3** (USD	**Y4** (USD	**Y5** (USD	**Total (USD**
Activity 1: Varieties dev. and FS Production	7,353	14,706	14,706	22,059	14,706	73,530
Activity 2: Training on seed purification	15,942	15,942	15,942	15,942	15,942	79,710
Activity 3: On-farm trial	10,820	10,820	10,820	10,820	10,820	54,100
Activity 4: Equipment and facilities						
- Tractor (John Deere 6603-MFWD)	30,000	1,000	3,000	3,000	3,000	40,000
- Plot-transplanter (Japan/Korea)	30,000	1,000	3,000	3,000	3,000	40,000
- Mini-combined harvester (Thailand/Korea)	30,000	1,000	3,000	3,000	3,000	40,000
- Establishment of seed lab	0	0	110,000	1,500	1,500	113,000
Total	**124,115**	**44,468**	**160,468**	**59,321**	**51,968**	**440,340**

Extension Program on Seed Production Technique

141. The program will be implemented in collaboration between Extension Officers at the provincial level, CARDI, and PDA. The extension program will be integrated with the rice market coordination process. It is hoped that through Farmer Associations, services will be improved, particularly business development for rice. The investment on this program is estimated at about $230,000 for Year One (Table 8). Annex 4 provides a more detailed cost breakdown for Year One implementation. The cost from the second year to fifth year is for covering 30 percent expansion of the target area per year, and it will be reduced by 20 percent of the Year One cost. The total cost of this investment program within five years will be $876,402. It is expected that at the end of five year projects, five farmers associations will be formed in each village, and they will be moving toward an on-going seed production supply association and their benefits will materialize. It is also expected that 20-50 farmers per village will purchase the quality seed.

Table 8. Estimated cost for seed production extension program

Descriptions	**Total Cost (USD)**
Output 1: 4 Provincial staff and 18 district staff formed for facilitating the project implementation	466
Output 2: Provincial and district facilitators access to transport, office and necessary office equipments facilities for project implementation	40950
Output 3: Identify 6 targeted districts, 24 communes, 60 villages & 180 ha rice area	10600
Output 4: 21 Provincial and district facilitators trained with more with seed production techniques	3507
Output 5: Rice seed, fertilizers, pesticides, and farming tools are ready for implementing seed production on 180 ha area	69127.56
Output 6: 180 ha area under cultivation—according to seed production techniques	65200
Output 7: 5 Seed Production Supply Associations per village will be formed and functioned	16050
Output 8: Monitoring system being applied to control project implementation quality	3765
Sub-total	209,665.56
Contingency	20,957.56
Year 1	***230,632.12***
Year 2 (20% reduced from Year 1 budget)	161,442.48
Year 3 (20% reduced from Year 1 budget)	161,442.48
Year 4 (20% reduced from Year 1 budget)	161,442.48
Year 5 (20% reduced from Year 1 budget)	161,442.48
Total	**876,402**

4.3.2. Options for establishing local (village) groups of certified CS Program

142. Cambodia has gone through long years and various experiences with cooperatives, interest groups, community organizations, or resource management committees, as well as other organizations. Lessons learned show that none of these organization or projects have worked. If the members do not understand the objectives of the organization, benefits will not materialize. These are two requirements for deciding on options to establish local groups for seed production supply, and the group should build them up constructively.

143. The key players of the association are very important; they need to be analyzed and their respective roles identified. The key players—including CARDI, which is the main source supplier of BS and FS; extension workers; and the seed farmers' associations—need to be in place. These are stakeholders within the seed production circle who are involved directly in seed production. In addition to these key players, there is a need to establish relationships and to arrange services coordination with other stakeholders who are indirectly involved in seed and rice production. This would include providers of inputs supply services (such as fertilizer, pesticides and equipments supplies), financial services, and business development services.

144. At present, farmers associations or cooperatives, which are led and managed by the farmers themselves, have emerged in the rural community for a value added approach. The real example that can be cited is Champei Agricultural Development Community and another eight similar to ADC in Samrong, Prey Kabas, Tramkok and Kirivong Districts in Takeo province (Annex 3). Detailed discussions on Champei ADC can be found in Section 3.1.2. Farmer associations like Champei ADC are a suitable local group with a simple approach that could work well for the community based seed program.

4.3.3. Options how to improve linkages between research and extension services

145. Generally, researchers and extension workers work separately in Cambodia. CARDI, for example needs to provide research findings from their research programs to the Department of Extension in order to transfer technical knowledge to the farmers. If the extension approach works well, it is still questionable whether the extension workers could fully understand about technologies to be transferred by simply reading or studying documents provided by the researchers. Experiences have shown that it is more successful for extension programs if the researcher is working at the same time as the extension worker. To provide reliable and updated information on CARDI's productivity enhancing technologies, as well as the skills needed to more effectively demonstrate the benefits of these technologies, CARDI's researchers and extension workers of the Department of Extension must develop linkages. They could achieve this by building into each other's integrated

research and extension activities. Some appropriate outreach activities to make these linkages work in practice could be as follows:

- Develop a roadmap for research and extension integration. The roadmap should provide concept and framework of integration between their respective roles and commitments, as well as the working approach. This roadmap should be improved and modified as necessary based on real practical experience and consensus between the two bodies.
- There should be one or two extension officers assigned to join the CARDI-OFAT activities, and CARDI' researchers should be assigned to join the extension activities. In this way, the extension workers will learn and practice technical aspects from the research, thereby finding ways to help farmers apply research results, who can then extend their knowledge and skills to other farmers successfully. At the same time, the researchers can look at how the results or research findings can be applied by the farmers in their real farm conditions. This activity should be done for all research and extension programs, and they should be integrated in their action plan.
- In designing a research proposal, CARDI needs to have one component on extension of research results to research on how results should be applied in real farm conditions. The extension worker can join this component from the onset of research—not after the results are generated.
- In the seed program, there is opportunity for a joint research-extension project on Community Based Seed Production Techniques operated through collaboration among CARDI, PDA and the Provincial Extension Officers. Through the process of promoting community based seed production supply, the researchers and extension workers can explore possibilities to develop linkages between research and extension services.

5. Vegetable and Other Seed Production Supply System

146. In Cambodia, there is only one vegetable research station: the Kbal Koh Vegetable Research Station located in Kbal Koh Commune, Kien Svay District, Kandal Province. There is one seed farm dedicated mainly to soybean and mung bean seed production supply: the Chamkar Leu Seed Farm located in Chamkar Leu District, Kampong Cham Province.

5.1. Kbal Koh Vegetable Research Station

147. The tasks of the Kbal Koh Vegetable Research Station include the following: i) to conduct research on imported seeds; ii) to compare and select the best seeds/varieties that are suited to the growing conditions and that have market potential; and iii) to purify and expand selected seeds. The station work on string bean, mustard, tomato, local cucumber, chilly, long and round egg plants, and some cereals such as mung bean, soy bean, glutinous corn/sweet corn. According to the station director, the market demand and potential is more important than the seed price. For this reason and due to domination of imported seeds from Vietnam and Thailand, the station will make selections from those lines that will produce vegetables with characteristics more acceptable to local demands.

148. In seed purification and production, the station receives parent seeds mainly from Taiwan, Japan, Vietnam, and Thailand. After initial testing, selection and seed multiplication, a foundation seed production block is grown. Seed from this could be distributed directly to farmer customers, or more commonly used to grow subsequent generations of Registered and Commercial seed. The vegetable seeds are produced in this station and a larger quantity of GS is produced by contract growers because of limited land capacity. The cereal seeds, after research and selection, are produced at Chamkar Leu Seed Farm. All seed that is produced is returned to the Kbal Koh station for processing and distribution. It costs the contracted grower about $3,439/ha to produce one hectare of string bean GS, and the profit is worth $2,600.

149. The Kbal Koh Station works with open pollinated vegetables seeds only. The disadvantage of this versus hybrids is that hybrids usually have higher yield potential than the open pollinated varieties. Since hybrids come from other countries, their characteristics may not meet local demand. For instance, local demand for eggplant is for long, deep purple fruits; the Thai hybrids do not exhibit these traits. In many cases, the demand for the ideal type is the primary reason for acceptance rather than price or yield potential. In addition to desirable types, the selection of these varites would also have to be made for these varieties to perform better in local field conditions.

150. Additionally, the Kbal Koh Station had an extension mandate to make the more distant farmers aware of the use of good quality seed. To this end, they distributed about 40 percent of their yearly seed production to the farmers in different provinces without cost. However, there is a high demand for vegetable diversities from the market and many of those quality vegetable seeds cannot be produced in Cambodia, nor can they be produced at the Kbal Koh Station. For this reason, imported vegetable seeds have been allowed; there have been an increasing number of active importation and distribution networks—even down to local areas by the private sector. Vietnam and Thailand seed companies have the most potential in Cambodia because many of these seed companies are run by former students who undertook their Agriculture Degrees in these countries—particularly Vietnam. They are able to provide all the necessary technical extension and capacity building activities needed to the vegetable growers and farmers.

151. Farmers using hybrid seed from Vietnam or Thailand were extremely satisfied with these products. The shops also sold pesticides, fertilizer, and other supplies for crop production and were able to supply some information to the farmers about crop production techniques. Farmers gained most of their new information from other farmers in the area or from more progressive farmers in other regions. Purchases could be made in cash at the time of sale or by credit with payment at harvest. As might be expected, crop failures or low prices would make credit pay-offs more difficult, but payment would be expected after the payment of subsequent crops.

152. Internationally, seed for vegetable production is dominated by hybrid seeds supplied by large multinational seed companies. In Cambodia, most of the seed comes from companies in Vietnam and Thailand with some production coming from as far as northern Europe. Kbal Koh serves some purpose to the farmers where it supplies seed, but it is very limited. Their present reliance on hybrid vegetable seed from international seed companies is strong; this will be the basis for a vegetable seed program in the future. Therefore, support for this station on seed production at this stage is not recommended because of the following reasons:

- First, there are very limited seeds diversities that the station or the country can produce attributable to the unfavorable climatic conditions (namely, the heat and moisture)). Many vegetable plants cannot produce seeds, or they are able to produce seeds, but with poor quality. Thus, on the one hand, the station cannot respond to the high and diverse vegetable seed demands in the country despite the fact that it functions well. On the other hand, the few local varieties of vegetable cover only small proportion of the seeds used in the country; with minimal support, the station is able to maintain them.
- The marketing and seed distribution systems of the international seed production companies are superior to the program of the station and can meet both the increasing present and future demands.
- The consistent seed quality and yield capabilities of international hybrid seed are superior to the open pollinated vegetables produced at the station

- Farmers have confidence in the hybrid seed they are now using and believe that the cost of that seed is worth the price.

5.2. Chamkar Leu Seed Farm

153. This is an MAFF owned facility that mainly produces soybean and mung bean seeds. They are two of the four main subsidiary and industrial crops in Cambodia. Parent varieties of soybean are mainly B3039, brought from Hungary, and DT84, brought from Taiwan. As discussed earlier, seeds of mung bean and soybean are selected and developed at Kbal Koh research station and bulk seeds are produced from those parent lines. Becasue the B3039 variety presents unfavorable characteristics: long duration, sensitive to disease, small grain and low production, it was replaced by Phka Sar variety (bigger grain and high yield) brought back from farmers nearby the farm.

154. Mung bean: 10 ha of the farmland is devoted to seed production. The farm produces about 1Mt of mung bean seed in a year. It is possible to produce more, but farmers tend to reuse their seed from year to year—rather than buying new seed. This is especially true since mung bean seed is relatively easy to produce.

155. Soybean: 20 ha of the farmland is devoted to seed production. It is possible to grow two soybean crops per year: early June and late July. It is difficult to produce soybean seed during the wet season because rain and humidity make it difficult to produce a product with acceptable viability. Since seed moisture is a problem, most soybeans for seed must be dried in the most common manner: air-drying. Airdrying of soybean seed can be a problem because the seed is produced in the rainy season. Exposing the seed for drying at this time can expose it to humid air, which can make the seed wet, moldy, and subject to viability problems. For this reason, the farm cannot meet the increasing soybean seed demand, particularly when there are increasing soybean growers in the northeastern provinces (Ratanakiri and Mondulkiri Provinces) who desire the farm seed.

156. There is greater demand for soybean seed, but because of a low-tech seed production approach and weather constraints, recent production has been about 2-3Mt per year. In better years, the farm has been able to produce up to 10 Mt/year. Seed is normally sold at KHR 6,000/kg, but in 2009, because of high demand, seed was sold at KHR 10,000/kg. With an amount of $450/ha cost of production and recent sale price for 1Mt/ha seed produced, soybean seed production is highly profitable (nearly $2000/ha). Demand for seed can be up to the 30 Mt/year (in difficult seed production years), but these are also the same conditions that limit soybean seed production on the seed farm. Seed from the local market, usually supplied from Thailand, fills the rest of the seed demand in the area. Although the seed from Thailand is KHR 2,000 cheaper (KHR 4,000/kg), the growers prefer the seed from the Seed Farm because they trust the quality and good characteristics of the variety: shorter duration, higher yield, bigger grain, and lighter color.

157. Besides rain, the major constraints that make the seed farm unable to function effectively and efficiently have been capital shortages linking with complicated logistics procedure, a lack of equipment for completing field operations on time and as planned, a lack of operational facilities, and a lack of capacity to address these constraints. These problems have led to late crop production, a decrease in the area planted, and harvest time falling during unfavorable conditions (heavier rainy season).

158. The farm does possess some field machineries and seed processing facilities, but they are not useful. Under a separate WB project, the seed farm was given a number of pieces of equipment to help in the mechanized seed production process. The two Massey Ferguson tractors on the farm were currently not useable because spare parts are not available; some tillage equipment was also there. When asked about the tillage equipment, the farm stated that they were not workable. This was doubtful after inspection of the equipment revealed that it had never been used (e.g. the paint was still pristine and the equipment unworn). The seed processing plant had a drier that would have been able to process soybean seed in ample time, but they did not have money to fuel it. Furthermore, it cannot work for seed drying because the temperatures cannot be set low enough to dry seed without overheating the seed and thereby hampering germination. The air/screen cleaner (seed grader) was supplied with only one set of screens; these appeared to be screens to clean rice, which are ineffective for soy or mungbeans. Therefore, soybeans and mung beans are not being cleaned efficiently. The facility also had a length grader that was designed to be attached to the seed grader. This machine had never been attached or used. Moreover, a length grader is a totally inappropriate piece of equipment to be used in the processing of the round/oval soybeans and mung beans. The facility also included a seed treater that was installed, but that had never been used. Soybean and mung bean seeds are not chemically treated here.

159. Most of the work—from field operation to seed processing—is done manually. The farm manager wishes to improve the functionality of the mechanized equipment and facilities in order to increase soybean seed production to meet the increasing demand for improved seed. The manager also wishes to have better budget flow management in order to get inputs and crop production operated on time. The farm seed alone could not do this improvement; it requires a commitment from all institutions involved, including PDA/MAFF and the Ministry of Economic and Finance (MEF). The small amount of seed produced here would seem to be easily replaced by imported seed.

5.3. Vegetable seed supply through seed importation

160. Fresh vegetable production by local farmers is a profitable and important crop in Cambodia. Vegetable farming uses more intensive practices and more inputs than rice, but it can also lead to larger returns. Farmers can often grow several crops a

year on the same field, and they can be timed to meet market demand. Marketing of the vegetable products can be done locally or more often through traders who buy from individual farmers or community farmers groups and sell to urban markets. Because of the value of the final vegetable product, farmers have learned the importance of planting good seed to grow their crops.

161. In Cambodia, as in many parts of the world, vegetable seed production companies primarily supply vegetable seed: much of this seed is hybrid. Most of the companies that supply vegetable seeds in Cambodia are from either Vietnam or Thailand. In either case, the seed may have been grown in one of those countries, or it may have been grown and imported from as far away as northern Europe.

162. Local distributors import seed to Cambodia by local distributors and sell it in local shops at the village level. This seed is often packaged in containers printed in Vietnamese or Thai—often not understood by the farmer customers. The purchasers must rely on the pictures on the containers and the word of the seed seller for specific product information. Seed is most often packed in sealed containers, either in cans or packets that are labeled to maintain the stated germination (usually 80-85 percent) for two years. Most seed containers viewed at distributors' locations or at local stores had expiration dates of at least 2011, so they were basically current. The larger cans of seed are usually opened at the store and seed is sold in amounts according to the farmers' needs. Once these cans are open, they are exposed to the ambient climatic conditions of high temperatures and high humidity that can reduce seed viability. In most cases seed store operators said that open cans of seed were sold within a few months of the cans being opened—decreasing the chance for major germination damage.

163. Presently, the more advanced vegetable seed dealers increasingly provide demonstration and capacity building as an extension method to induce the vegetable growers to use quality seeds and other farming inputs. In addition, they also provide technical assistance when required. This manner of services attracts the growers' interest. Beside vegetable seed, the vegetable growers also purchase seed treatment materials, fertilizer, pesticides, water, straw mulch, composted manure, services for cultivation—both mechanical power and animal—and hand labor. Some cropping information was received from the dealers, but most of it came from other growers within the area and from farther distances. These seed dealers are also working closely with the vegetable association, for example, Sre Meas Seed Company (makes direct deals with Tang Nong Company in Vietnam) joined the Vegetable Association in Svay Rieng Province, with various NGOs and PDA in Svay Rieng Province.

164. The ease and economics of producing seed on a farm—or even small seed company/research station can vary with the type of vegetable. Vegetables can roughly be grouped into one of three categories when dealing with seed production. First are those where the actual food product is the seed itself: for example, corn or mung beans. The production methods of seed here is almost identical to the production method of the food product; therefore, extra seed production costs and

expertise are not necessary. Farmers will often produce their own seed from these crops. The second group would be those vegetables where the food product is actually the fruit of the plant where the seed must be extracted from the fruit. Some examples are tomatoes, cucumbers, or eggplant.

165. Once again the actual field production is similar for seed and food purposes, but the retrieval of the seed from the fruit requires extra steps, more ripening time, and expertise. Some farmers would grow their own seed of these crops; however, those that understand the added value of good purchased seed are unlikely to do so. The third category is plants where vegetative material (often leaves) is the food product. Leafy vegetables like cabbage, kale, and mustard are some examples. Broccoli and cauliflower could also be considered in this category. The food parts from these crops are removed well before the reproductive stage of growth is reached. Therefore, any seed production would take an additional 4-6 weeks of field production time that might be more profitably used for the growth of the next vegetable crop. This is the group of crops where farmers are least likely to produce their own seed.

166. The potential for a farmer's own seed production to fill his seed needs is not great. Many farmers will purchase seed every year because they believe it is better quality. In addition, the trade-off of not selling vegetables to the market at favorable prices versus retaining them for seed is often not economically sound. Additionally, farmers also may not have the skills and equipment needed to produce and harvest the seed, and maintaining the seed in the warm, humid Cambodian environment is difficult with viability losses. This can be explained based on experience from interviewed vegetable growers in Koh Thom District:

- When vegetable farmers tried to grow seed from their own production, they did not get good quality seed and yields were not as good. For farmers who are used to growing vegetables for food, seed production of these crops takes additional time after the vegetables would have been harvested. This is in addition to management skills that farmers do not possess. Vegetable seed cannot be easily produced in the wet season because of seed sprouting on the plant and mold damaging the seed.
- Farmers are not likely to produce vegetable seeds for local distribution beyond their own farm. They know that the seed they produce may have the possibility to be of a lower or at least a more variable quality than purchased seed. In addition, the production of seed takes land and product away from their primary vegetable production scheme. The cost of seed is normally not a prohibitive factor: a mustard grower said that seed costs for his 0.22 ha field were about $5 or about 1.5 percent of the value of the crop. He found this to be a reasonable figure because he knew the quality and potential of the seed he was planting and could expect a reasonable return on that investment. Tomato seed would ranges from $30 to $100 for 100gm (enough to plant an average field) for open-pollinated vs. hybrid seed; however, in both cases, this was offset by seed quality and high yield potential.

167. Vegetable seed production is normally handled by seed companies using their own varieties, and employing their own marketing networks. Vegetable seed production requires special expertise and equipment that are not available in Cambodia. Vegetable seed is required in smaller amounts; therefore, transportation logistics are not difficult and not very costly. Therefore, the startup of production for good vegetable seed does not seem very practical, nor is there much demand.

168. There could be some production of tomatoes, beans, or melons this is because the actual edible part is also the portion of the plant that contains the seed. But even here, there is little knowledge in production and the learning curve might be extensive. In addition, the best varieties may not be available and the marketing network is not existent. It seems logical that farmers would not use this seed over the product that they already use—furthermore, the cost of production is nearly the same as buying the seed. Moreover, it is important to note that the vegetable growers are less likely to practice risk avoidance compared with the rice farmers. They are more likely to be open to new ideas.

6. Conclusions and Recommendations

6.1. Conclusions

169. The seed industry in Cambodia is characterized by some lack of overall structure, but it is populated by individuals who understand the need for quality seed. Farmer seed growers and seed buyers have begun to understand the advantages of good quality seed and have been learning the techniques to produce it.

170. Based on agro-ecological conditions and socio-economical conditions of the rice production systems in Cambodia, it is estimated that the quality seed demand in 2009-2010 was about 23,000 Mt. The scenario of seed demand in 2015 is estimated to be about 38,500 Mt and 50,000 Mt in 2020. Because the potential expansion of the supply in the next five years could reach about only 8,500 Mt, there is a gap of some 30,000 -32,000 Mt between supply and demand.

171. At the grassroots or community levels, farmers are not only producing seed for other farmers but also are teaching other community farmers how to grow, store, and maintain their own planting stock. In some cases, these community groups have worked with rice traders—creating projects to produce a value added product directly to the final consumer. However, there are also those who are still unaware of the quality seed on sale, as well as those who have no access to it.

172. Private seed producers have emerged as a response to increased demand for quality seed. They can be grouped into three main categories: i) the formal seed producers, which are registered with the MoC and have adopted a production system similar to AQIP, but at smaller scale (100-200 Mt/year); ii) informal seed producers, who have well coordinated (and managed) small production systems (up to 100 Mt/year); and iii) informal seed producer groups, which are not registered, operate in a smaller scale (100-300 Mt/ year) and are also adopting a production system similar to AQIP. Some of these producers could be expected to upgrade and expand their seed production systems in near future.

173. The main constraints of seed production supply in Cambodia are capital deficit, diversification, and the lack of mechanized equipment and facilities for effective and efficient production. Capital deficit is the most serious constraint, particularly for mobilizing the seed purchase at harvesting time. At the same time, the major constraints faced by the demand side are also very important because the farm conditions where the quality seeds are planted, the irrigation access, the purpose of using quality seeds, and the rice markets are determinant factors for farmers'

decisions to purchase seed. These constraints are also important factors in determining potential expansion for the production supply to materialize.

174. A major problem in the vegetable seed supply system in Cambodia is the flow of seed and other inputs, extension information, and customer services from suppliers to the farmers and feedback from the farmers to those suppliers. Not only is there a lack of value chain awareness, but also there is often a fear to purchase inputs because of low quality inputs or a lack of concern by suppliers of products and services.

6.2. Recommendations

175. CARDI's mandate in the development of new varieties and Foundation seed production is being hampered by limited capital and outdated equipment. These constraints create increasingly expensive hand labor that must be used for precise fieldwork and thereby reduces options in seed production. Currently, CARDI can only afford to grow seed that it is assured it can sell. In years where demand is greater, orders go unfilled because of production restrictions. Support of CARDI's seed production would mean that greater amounts of seed would be available to rice farmers and significant returns could be generated in CS production (Each kg of FS planted could generate around $700 profit). The following actions are needed:

- Provide support to the CARDI seed production and seed research programs according to scheduled activities: 1 ha in the first year, 2 ha in the second and third year, 3ha in the fourth year, and 2 ha in the fifth year (Table 5).
- Plot equipment is needed in the first year of the project that would decrease hand labor and make fieldwork more efficient. A tractor, plot planter, rice seedling transplanter, and plot combine should be supplied to CARDI. This investment amounts to $120,000.

176. A strong and functional seed testing laboratory is essential to understanding the quality of the seed being traded in a country. Basic seed laboratories test seed for germination, physical purity, and seed moisture and work in conjunction with seed certification and seed regulatory programs. Labs can also add further services that look at viability and storage potential of seed and can aid in other seed research as well. A seed laboratory should be established and placed at CARDI. CAVAC in considering the funding of the completion of an existing rice quality laboratory at CARDI; the addition of a seed testing facility would be a good compliment to this lab. The following actions are needed:

- As soon as the project and work plan are officially approved, a seed consultant should be contracted to assist CARDI in making the lab functional. The consultant should make his initial visit as the project implementation starts.

- During this initial visit, the consultant should prepare his action plan for the complete seed lab establishment, assess the industry needs and the CARDI location, and compile a list of equipment and training needs. The consultant should also look at how the lab will function and solicit business. At this point, the laboratory director and staff should already be selected and have begun working with the consultant. Their training needs should also be assessed at this time.
- Staff will have to be trained; this is often accomplished by sending the technicians to a functioning lab (possibly Thailand) for a number of weeks of training. They should be scheduled to return back before the second visit of the consultant.
- Arrangements will have to be with MAFF or other agencies to fund the on-going operation of the seed laboratory over time.
- Order seed laboratory equipment and arrange for the laboratory building or rooms to be built or remodeled for lab use.
- After the equipment arrives, an on-site set-up and start-up of the seed lab should be done in the second visit by the seed consultant. He should plan to work with the lab staff for a few days in order to provide the necessary technical orientation and support needed.

177. Community based rice seed production groups have been established in many areas. Usually a few progressive farmers are selected to grow and maintain popular local varieties. They are also trained in field seed production practices including single panicle selection, field rouging, hand harvest, seed processing, and seed storage. Other farmers are trained to grow CARDI seed varieties for distribution at the community level. In either case, these farmers use their fields as variety demonstrations and provide on-going training to other village farmers who will be maintaining their own seed stock. This kind of program is especially effective because it is village based with potential seed users having close access to the seed grower and his seed fields. Additional funding should be made available to expand this type of program to additional communities. The following actions are needed:

- Assist and expand CARDI's current training and development programs to assist farmers at the community level in the following: i) Purifying, growing, and maintaining local varieties; and ii) growing, maintaining, and distributing CARDI seed released varieties through OFAT.
- Other programs in Cambodia such as CEDAC are aimed at community seed production to add a value added approach for organic rice. Support could be given to these programs. Alternatively, a community seed production/value added program could be instituted that would market local rice products more directly to consumers giving farmers a greater return for their product.

178. Linkages between research and extension need to be upgraded, as each tends to work separately. This results in researchers generating technologies or new varieties for the extension workers who may not understand or be able to apply these technologies in the real farm conditions. The following actions are needed:

- Develop a roadmap for research and extension integration, which provides concept and framework of integration,, their respective roles and commitments, and the working approach.
- Some extension officers should be assigned to join the CARDI-OFAT research activities and CARDI's researchers should be assigned to join the extension activities as well. This participation should be done for all research and extension programs, and they should be integrated in their action plan. In this way, any issue related to information and technologies as well as research-extension process that arise can be addressed in a timely and effective manner.
- In designing a research proposal, CARDI needs to have one component on extension of research results to research on how its research results should be applied in real farm conditions. The extension worker can participate or join this component from the onset of research; they should not wait until the results are generated because it will be too late to develop an extension approach.
- In the seed program, there is opportunity for a Joint Research Extension Project on Community Based Seed Production Technique operated by collaboration among CARDI, PDA, and Extension Officers at the provincial level. Through the process of promoting community based seed production supply, the researchers and extension workers can explore possibilities to develop linkages between research and extension services.

179. Connections within the public sector and public/private ties are very weak in the Cambodia seed industry. We found a seed farm and a private buyer of soybeans who did not know each other while advocating different varieties with differing traits for the same market; a seed farm manager who grew CARDI rice varieties who never saw CARDI test plots grown in his area; and seed producing farms that had no contact with farmer customers—except at the point of sale. Work must be done to identify the key players, and to introduce them to each other, and to coordinate their efforts. This also would include on-farm rice seed tests, demonstrations, and field days—not only for the farmer, but also to unify the key rice players. The following actions are needed:

- CAVAC is a project that is working within extension and value chain enhancement, and there is a possibility to do extension coordination and training with CAVAC—others may exist as well. This program should work with MAFF, CARDI, and the Department of Extension to work together to coordinate extension activities within the value chain.
- Procure a consultant who has extension experience in crops testing, on-farm demonstrations, farmer meetings, and field days to work with MAFF, CARDI, Extension, seed farms, and PDA's to uncover pertinent information that can be presented to farmers about their seed and input choices.
- Fund CARDI in expanding its test plots and farmer demonstration plots in rice growing areas of the country.

180. Rice and vegetable farmers who purchase seed and/or other inputs are receiving products of variable quality. These farmers often fail to receive sound agronomic advice and many get poor post-sale service from local shops. In many cases, farmers will plant low quality seed without fertilizers or pesticides because of low product quality or lack of product performance. Shops that sold the products will not stand behind their sale, which means that farmers become disillusioned and reluctant to buy products that will give better field performance. The following actions are needed:

- Establish a network of private sector agri-input dealers who have been trained in the use of seed, fertilizers, pesticides, and mechanics. Use these dealers as an additional private sector extension service that will demonstrate their products to potential customers. These dealers will perform after sales service to help and to retain customers. Help these dealers to combine into an association so that they can use group power to help farmers and influence policy. In Cambodia, IDE has established a network of Farm Business Enterprises (FBE) for vegetable growers. Internationally, IFDC and CNFA are two NGO's who have used this model in other countries.

181. MAFF has several seed production farms that provide rice, vegetable, and other cereal seed to area farmers and to other provinces. Much of the current control of theses farms now comes directly from MAFF; it is believed that increased local control would contribute to increased operational efficiency and greater productivity. More local control of these facilities may help the seed farms to better service farmer seed buyers with increasing amounts of high quality seed and better information. A study to evaluate the possibilities is the main focus of this recommendation. The following actions are needed:

- Write a business plan for the farm that would provide increasing service and products to local farmers and give the farm a financial basis. This plan would look at all aspects of farm operation and identify the aspects that are profitable so that the farm can be more successful. This would most likely include reasonable overhead payments to MAFF. Local consultants should be available to assist in this process.

182. The National Seed Law has been written and the legislation passed. This means that the raw structure for the national seed program has been established, but without its accompanying Rules and Regulations, the operational interpretation does not yet exist. The following actions are needed:

- An appropriate English translation of the law does not exist. The law will require a proper English translation before it can be assessed appropriately.
- An expert consultant on seed law and policy will have to be hired to research the law; interpret its meaning for the Cambodian seed industry; consult with MAFF, CARDI, and seed industry officials; and write the Rules and Regulations to accompany the Seed Law. Since the

recommendations here are to incorporate a system similar to Thailand's (therefore the United States seed system) it is strongly recommended that the consultant be familiar with the seed programs in those countries.

- Seed certification is the normal program for seed production quality control in a country. Because of the current small-scale agricultural seed production, a seed certification program is not warranted at this time and would possibly add unneeded bureaucracy to the system. It is only recommended that the structure of a voluntary certification be added to the rules and regulations so that it can be added as needed.

7. References

ACI (2002). Rice Value Chain Study: Cambodia. Phnom Penh, Cambodia, Agrifood Consulting International.

ACI (2005). Cambodian Agrarian Structure Study. Bethesda, Maryland, Prepared for the Ministry of Agriculture, Forestry and Fisheries, Royal Government of Cambodia, the World Bank, the Canadian International Development Agency (CIDA) and the Government of Germany / Gesellschaft für Technische Zusammenarbeit (GTZ).

Agrifood Consulting International and CamConsult (2006) Diagnostic Study, Phase 1 of Design, Agricultural Program, Cambodia, 2007-12 – Program Concept Document Final Report. Prepared for AusAID by Agrifood Consulting International. Bethesda, Maryland.

Aide Memoir of Consultation between SNEC and IFAD on Enhancing the effectiveness of rural productive service delivery system in Cambodia: A review of experiences, issues, and options, 30 May 2008.

AusAID (2006). Independent Completion Report for Cambodia-Australia Agricultural Extension Project (CAAEP). Phnom Penh, Cambodia, AusAID.

Bauer, E (2003). Managing Agricultural Extension in the Community Based Rural Development Project. Consultancy Report to the CBRDP, Kampot, Kampong Thom, Berlin.

Bergeron Emeline and Le Anh Tuan (2006). Market Access for the Poor - North West Programme: Case study of Local Rice Seed Production in Yen Chau district, Son La province. Netherlands Development Organization, Vietnam.

CARDI (2009). Ten years research achievement (1999-2009).

CARDI (2007). Rice production in Cambodia.

CEDAC (2003). Final Report on Farmer Promoter Program in Kampot, Pilot Program conducted by CEDAC under collaboration with GTZ/RDP. Phnom Penh, Cambodia.

Chea, S. (2002). Economics of Rice Double-Cropping in the Rainfed Lowlands of Cambodia. School of Natural and Rural Systems Management. Brisbane, Australia, University of Queensland.

Cuaderno de Nuestra Finca (2007). Procesos de produccion sostenible y competitiva (3ra Edicion). Editorial del Norte, Costa Rica.

Economic Institute of Cambodia (2006). Cambodia's export diversification and value addition. Economic Institute of Cambodia, Phnom Penh, Cambodia.

Economic Institute of Cambodia (2006). Cambodia's agricultural exports and standards: Trade facilitations or trade barriers? Economic Institute of Cambodia, Phnom Penh, Cambodia.

ECOSORN (2007). 3rd Progress Report January - June 2007. Siem Reap Angkor, Cambodia, ECOSORN Project, MAFF.

EDC (2001). Rice Milling Enterprise Survey and Credit Study (Kandal, Takeo, Prey Veng and Svay Rieng Provinces). Phnom Penh, Cambodia, Enterprise Development Cambodia for Agriculture Quality Improvement Project.

Goletti, F. (2004). The Participation of the Poor in Agricultural Value Chains. A Draft Research Program Proposal. Ha Noi, Viet Nam, Agrifood Consulting International for Making Markets Work Better for the Poor Project, Asian Development Bank.

Heiko Bammann (2007). Participatory value chain analysis for improved farmer incomes, employment opportunities and food security. In Pacific Economic Bulletin Volume 22 Number 3 October 2007, Asia Pacific Press.

Hundley, C. J. (2005). Cambodia Agribusiness Development Facility: Strategic Framework. Phnom Penh, Cambodia, Emerging Markets Consulting for NZAID.

Jürgen Anthofer (2004). Potential of the System of Rice Intensification (SRI) for Cambodia. Phnom Penh/Spaichingen, GTZ.

Kanol, H. (2004). Value Added and Yields in Cambodia Crop Production. Phnom Penh, Cambodia, National Institute of Statistics.

MAFF (2009). Agricultural Products Export Promotion Action Plans for 2009-2013.

MAFF (2009). Annual Conference on Agriculture, Forestry and Fisheries 2008-2009 and Perspective for sector development 2009-2010. MAFF Conference April, 2009. Phnom Penh, Cambodia,

MAFF (2009). Annual progress report 2008-2009. MAFF, Phnom Penh, Cambodia.

MAFF (2004). Draft Seed Law. MAFF, Phnom Penh, Cambodia.

Michael Roberts, Anthea Long and Nathalie Baxter (2008). Provision of agricultural support services to small farmers through private-sector agents: A review of selected field experience in Cambodia. IDE, Phnom Penh.

MoC (2006). Cambodia National Export Strategy 2007-2010. Ministry of Commerce and International Trade Center, Phnom Penh, Cambodia.

MoP (2008). Commune Database 2008.

MOWRAM (2010). Irrigation development in Cambodia: Status as of March 2010. Ministry of Water Resources and Meteorology and Japanese International Coorperation Agency, Phnom Penh.

MOWRAM (2009). Irrigation Sector Review. Ministry of Water Resources and Meteorology, RGC.

MOWRAM. (2006). Strategic Development Plan 2006-2010. Ministry of Water Resources and Meteorology, RGC.

Ngin Chhay (2004). Impact of IPM Programme - Cambodia. Phnom Penh, Cambodia, Ministry of Agriculture, Forestry and Fisheries.

Padgham, Jon (2009). Agricultural development under a changing climate: Opportunities and challenges for adaptation (Joint Discussion Paper, August 2009—Issue 1). Agriculture and Rural Development and Environment Department, the WB.

RGC (2010). Policy Paper on The Promotion of Paddy Production and Rice Export (Approved by the Council of Minister on 25 July 2011). Royal Government of Cambodia, Phnom Penh.

Schmerler, Claudia (2006). Value Chain Promotion: Experiences with Organic Rice from Cambodia. Phnom Penh, Cambodia, GTZ.

Thitima Jeamsavasd1, Am-on Aungsuratana1, Vatcharee Lertmongkol2 and Sontichai Chanprame3 (2007). Self-reliance capability of rice seed production group members: A Case Study of Ban Makok Tai seed multiply field group, Phatthalung Province. Kasetsart Journals: Social Sciences, Volume 028, Issue 1, January 2007- April 2007, Pages 94-105, ISSN: 0125-8370.

USDA (2010). CAMBODIA: Future growth rate of rice production uncertain. Commodity Intelligent Report, Foreign Agricultural Service, USDA.

Virmani S.S., Mao, C.X. Toledo R.S., Hossain M. and Janaiah A. (2002). Hybrid Rice Seed Production Technology and Its Impact on Seed Industries and Rural Employment Opportunities in Asia. International Rice Research Institute, Philippines.

Yim Bunlong and Yi Kim Than (2007). Completion Report of Farmer Promoter Project June 2006-january 2007, Community Based Rural Development Program Kampot. Phnom Penh, Cambodia, CEDAC.

Ypma, P. (2005). Market Survey of Svay Rieng Vegetable Market. Phnom Penh, Cambodia, Agriculture Quality Improvement Project.

8. Annexes

Annex 1. Characteristics of seed production system studied, as of February 2010

Characteristics	AQIP-FSP	CARDI-to-Farmers-to-Farmers	Tuol Samrong Seed Farm	ECOSORN-FA
Value chain practices				
Type of institution	structural	structural	structural	non-structural
Producer organization	Farmer association	individual farmers	N/A	Farmer association
Value chain arrangement	Contract farming	None	None, State farm operation	non-contract farming
Training &Extension services	AQIP Training service	CIAP/CARDI on-farm varietal trial	Technical advice from CARDI	Sub-contract service
Financial service	AQIP credit	Farmer own capital	MOEF through MAFF	ECOSORN financial assistance
Inspection responsibility	Production Manager	No inspection	GDA	Field manager follow up
Person in charge of field supervision	Group leader, AQIP Field Manager	CARDI	Farm Manager	Head of FA
Type of production system	open system	open system	open system	open system
Farm size	From 2 to 40 ha	Small farm (0.5-2ha)	state farm (large farm)	small farm (0.5-2ha)
Business development service	market guaranteed by AQIP, premium price	No seed market price or equal exchange, often cheaper than other seed dealers	Market guaranteed, price higher than market price but lower than AQIP price	No Price at KHR200/kg higher than market price
Coordinator and Coordination approach for value added	AQIP is the main value chain coordinator. This is done by providing technical assistance and including field supervision, credit services (seeds and fertilizer inputs), and business development service as AQIP buys seeds produced back from the farmer seed producers.	No coordination for value added. CARDI Conducts OFAT with 2-3 selected farmers in their rice fields to get the new released varieties adopted to their rice fields, and to provide technical information and practical technique on new varieties to the farmers.	No coordination for value added. The farm manager prepares seed production plan based on order and estimated amount that would be demanded by the farmers nearby the farm area and in Battambang province. The farm normally sells all rice seeds produced.	ECOSORN provides 20 kg of Phka Roum Duol seed bought from Tuol Samrong Farm. Through FA, Sub-contracted extension workers provide training to the members of FA, supervise and inspect their rice crop. Field days organized by ECOSORN promotes seed business for the surrounded farmers. According to the farmers, produce seed for sale worth high benefit, but they do not have enough good land for this purpose.
Other key players	Farmer Seed Producers	Farmer Seed Producers	Farm staff and laborer	Farmer Seed Producers
	Fertilizer & pesticides dealers	Fertilizer & pesticides dealers	Fertilizer & pesticides dealers	Fertilizer & pesticides dealers

	AQIP Field Manager	CARDI OFAT staff	Farm Manager	NGO sub-contractor
	Seed customers: farmers, NGOs, IOs	Seed customers: Rice farmers	Seed customers: rice farmers, NGOs	Seed customers: Rice farmers
Farming practices				
Land preparation	Special	Traditional way	Special	Special
type of planting	direct-seeding for CS, transplanting for RS	Transplanting	direct-seeding for CS, transplanting for RS	Transplanting for RS
Type of fertilizer	Both (chemical fertilizer with CARDI rate	Both (chemical fertilizer with CARDI rate	Chemical fertilizer with CARDI rate	Cow manure and low rate chemical fertilizer
pesticide application	Yes	Yes	Yes	both
harvesting	manual or mechanized	manual	Manual	manual
threshing	Manual for RS, and manual or semi-mechanized for GS	manual	semi-mechanized	manual
Seed keeping technique	Follow CARDI procedure	Farmer's practice	Follow CARDI procedure	Follow CARDI procedure
Constraints				
Capital	lack of capital	No	Tuol Samrong faces capital shortage and most of the time the budget flow is logistically complicated, slow and late which make difficulties in the production management.	N/A
Facilities	Old equipments, low capacity for seed operation	N/A	The spar parts of the tractors (provided by WB during APIP) are very costly, consume high fuel. To increase production, facilities need to be improved.	N/A
Quality Control	In working with many small rice land farmers, AQIP experiences with time and budget consuming and at the same time faces difficulties in ensuring standard and quality uniformity. For this reason, the company tries to deal more with larger land farmers.	No	No	No
Land	No	No	No	Generally, the farmers has small land (between 0.5-1 ha). They wish to produce more seed for market, but it is not possible. In producing seed, they select the good land nearby the village because it is good land and it eases them to take care of their crop.

Value added				
Seed cost	reduced for rice farmers	reduced for rice farmers	reduced for rice farmers	reduced for rice farmers
Production gained	up to 50% increased	20% increased	up to 50% increased According to Tuol Samrong Seed Farm Director, 50% of the farmers who use quality seed can get 3t/ha which is 50% higher, and the majority 2t/ha depending on farm and crop management and pest incidence.	up to 50% increased
level of benefit	Satisfied	high	worthwhile	High

Characteristics	CEDAC-FA	CHAMPEI ADC	AKRR-FA	ABK-FA
Value chain practices				
Type of institution	non-structural	non-structural	non-structural	non-structural
Producers Organization	Farmer association	Farmer cooperative	farmer associations	farmer associations
Value chain arrangement	non-contract farming	contract farming	Contract farming	Contract farming
Training &Extension services	CEDA service	PDA service	AKRR Training service	ABK Training service
Financial service	Farmer own capital	shared finance	AKRR Credit	ABK credit
Inspection responsibility	Field manager follow up	No inspection	AKRR staff, Group Leader follow up	ABK staff
Person in charge of field supervision	Head of FA	Head of FC	Head of FC	Head of FA
Type of production system	open system	open system	very close system	Close system
Farm size	small farm (0.5-2ha)	Small farm (1.5 ha)	small farm (0.5-2ha)	small farm (0.5-2ha)
Business development	Coordinated by FA, premium price market price ($1/kg-$1.5/kg)	Coordinated by FA, premium price	Premium price	Premium price
	CEDAC facilitated the farmers to form an association for helping each other in farming and improve their livelihoods. Head of FA coordinates his members for technical learning on organic seed and rice production and other organic crops, and other association activities. CEDAC provides them technical assistance in these activities, and in organic rice market. They have meeting every month to report on seed and rice produced and news on farming through several … sale of seed selection for pure and high quality seeds. According to Head of FA, despite high benefits from seed production his members still do not want to produce seed for sale because they have small rice land and afraid that they cannot produce …	Champei ADC is an example of the Farmer own value chain management which emerged after IPM Farmer Field School Program of MAFF (18 weeks intensive training course on rice production). So far, there are 8 more ADC like this in Baty, Tamkok, Samrong, Kirivong and Prey Kabas districts in Takeo province (Annex 2). Head of Champei ADC coordinates the value added process for seed and rice production. He manages the shares to improve the purchase of inputs (such as seed, fertilizer, pesticides … money saving for his members (value added), brings extension workers to provide technical assistance (increase value through improved techniques), and coordinates market (e.g. Lucky Super Market) for quality seed and rice grain produced by the farmer members (for higher price).	AKRR Company is main coordinator of value chain. The company provides inputs, credit, extension, market and transport services to the farmer seed producers. The seeds produced are for the AKRR contracted farmer rice producers use in rice production. The rice produces are sold to the company for local market and exportation. AKRR is an example of a full service delivery system and a closed production system.	ABK is main coordinator of value chain for rice production. ABK provides inputs, credit, training and extension, market and transport services. Due to the need to produce uniform grain for international standard and high quality rice produces for local market and exportation, ABK starts producing quality seeds as well. This is an … service delivery system and a closed production system.
Other key players	Farmer Seed Producers	Farmer Seed Producers	Farmer Seed Producers	Farmer Seed Producers
	prepare compost by themselves	Fertilizer & pesticides dealers	prepare compost by themselves	ABK
	CEDAC field manager	Provincial extension workers	AKRR Field Manager	ABK T&E Officers
Coordinator and coordination approach for …	Rice farmers	Rice farmers	AKRR produces seeds for their own use, but not for sale	ABK produces seeds for their own use.
Technical activities				
land preparation	special	special	special	special
type of planting	transplanting	transplanting	transplanting	transplanting
type of fertilizer	compost/cow manure	both	organic	very low fertilizer
pesticide application	organic pesticide	yes	no	very low
harvesting	manual	manual	manual	manual
threshing	manual	manual	manual	manual
Seed keeping technique	CEDAC technique For the highest purity, first they peal the husk of the seed	Follow CARDI procedure and farmers practices	Company's practices	CARDI procedure

Seed keeping technique	CEDAC technique. For the highest purity, first they peal the husk of the seed to ensure good grain and sew several grains in wooden box at home. The 1st harvest from this production are selected and kept as main seed, the rest are re-planted for seed and for use in rice production.	Follow CARDI procedure and farmers' practices	Company's practices	CARDI procedure
Constraints				
Capital	N/A	lack of capital	lack of capital	lack of capital
Facilities	N/A	N/A	no	no
Quality Control	no	no	no	no
Land	Yes Generally, the farmers has small land (between 0.5-1 ha). They wish to produce more seed for market, but it is not possible. In producing seed, they select the good land near by the village because it is good land and it eases them to take care of their crop	Yes. Generally, the farmers has small land (between 0.5-1 ha). They wish to produce more seed for market, but it is not possible.	No	No
Value added				
Seed cost	reduced for rice farmers	reduced for rice farmers	reduced for rice farmers	reduced for rice farmers
Production gained	double According to the farmers from CEDAC, they obtain 2t/ha when they use seed kept by traditional way. With purified seed, they can get 4t/ha with organic fertilizer.	30-100% According to the farmers, using purified seed they can gain from 1t to 3 t/ha higher than using normal seed.	up to 50% However, some time the farmers could have yield reduced due to drought. In god rain year, Neang Malis (seed from Angkor Kasekam Roongroeung) yields lower (2t/ha) than CARDI Reangchey	Double According to ABK Director, the farmers normally obtain 1.5 to 2t/ha. With quality seed they can produce from 3-4 t/ha.

Annex 2: Characteristics of private seed producers studied, as of January-February 2011

Characteristics	Formal private seed producers	Informal private seed producers	Informal seed producer groups
Production organization			
Type of institution	Private Company	Private producer	Small seed producer
Producers Organization	Farmers association	None (use weigh labors)	Farmer groups/communities
Value chain arrangement	Contract farming	Self operation with laborers employment	Contract farming
Training & Extension services	Company training service	Own knowledge and acquire knowledge through learning experience as a large scale farmer. Some time hired technical expert is used	Employ technical staff
Financial service	Company capital +loan	Producer own capital + small loan	Producer own capital
Inspection responsibility	Company staff	Producer own responsibility	Own inspection responsibility: small group of technical staff
Person in charge of field supervision	Company staff	Producer supervises laborers	Own inspection responsibility: small group of technical staff
Type of production system	Close system	Close system	Close system
Farm size	Small farm (0.5-5ha) with tendency to larger farm in the future	Large farm up to 40 ha	Small farm (0.5-2ha)
Business development	Registered with the Ministry of Commerce for 2 years already Tax requirement Rice exporter: (Due to the need to produce uniform grain for international standard and high quality rice produces for local market and exportation, the company starts producing quality seeds as well)	Not registered Rice miller or rice farmer	Not registered Agricultural technical staff from the provinces with PRSAC and AQIP working experience
Coordinator and coordination approach for value added	Company has its full coordination of value chain for rice production. Inputs, credit, training and extension, market and transport services are provided by the company. This is an example of a full service delivery system and a closed production system.	Self coordination All services are ensured	The producers coordinate the technical experts and contracted farmers, inputs, provide training and extension, market and transport services
Other key players	Farmer Seed Producers	Farmer Seed Producers	Farmer Seed Producers
	CARDI as foundation seed supplier And other sources	CARDI as foundation seed supplier Other seed source supplier	CARDI as foundation seed supplier
	Fertilizer company	Fertilizer company	Fertilizer company
	Vietnamese seed company	Bank as financial service provider	
	Bank as financial service provider		

Characteristics	CAMBO Seed (Registered Company)	Small private producers	Small producers through contracted farmers
Technical practices			
land preparation	Standard for seed production	Standard for seed production	Standard for seed production
type of planting	transplanting	Transplanting / Direct seeding	transplanting
type of fertilizer	Commercial fertilizer based on technical standard	AQIP standard / Commercial fertilizer based on farmer experience	Commercial fertilizer based on technical standard
pesticide application	Based on technical standard	Based on technical standard / based on farmer experience	Based on technical standard
harvesting	manual	Mechanized	manual
threshing	Manual	Mechanized	manual
Seed processing and storage	Seed processing equipment similar to AQIP (technical standard) Or manual with technical standard, will be upgraded with high standard equipment and technique	Manual, will be upgraded with high standard equipment and technique	Manual with technical standard, will upgrade in the future
Constraints			
Capital	Working capital shortage for collection of products back from the farmers Looking for lower interest rate loan Or looking for partnership with financial power	Lack of capital for upgrading the business, however, unless interest rate is 0.5%	Lack of capital for expansion and upgrading the business
Facilities/services	No	Seed processing Seed storage	Seed processing Seed storage
Quality Control	No	No	No
Land	No Generally, the farmers has small land (between 0.5-6 ha). the company recognizes that working with the farmers who have larger field eases quality control	Not at all	No
Customers	Some farmers still consider no differences between seed and normal rice, therefore are reluctant to pay additional price	No	No
Market	Uncertain	Uncertain	Uncertain
Value			
Production per year	100-200 t	100 t	100-300 t
Seed price	Same as AQIP	Cheaper	Same as AQIP and cheaper
Benefit	Company growth Higher Income and knowledge on seed production, livelihood improvement	Producer growth	Producer growth Higher Income and knowledge on seed production, livelihood improvement
Future perspective			
Growth tendency	Company expansion	Will become into a private seed company	Will expand production, upgrade seed processing
Growth potential	High capacity or wants partner with good financial power	High capacity	Needs partner with good financial power

Annex 3. Activities and cost breakdown for community based seed production extension, 2010

Description		Unit	Quantity	Unit price (USD)	Total USD
Output 1: 4 provincial staff and 18 district staff selected for facilitating the project implementation					
Activities:					
1.1.	Forming 4 Provincial facilitators				
1.2.	Forming 18 District facilitators	per./day	18	15	366
1.3.	Developing guideline for project implementation	per./day	2	50	100
Output 2: Provincial and District Facilitators access to transport, office and necessary office equipments facilities for project implementation					
Activities:					
2.1.	Office facilities (desk, shelves, laptop, Videocamera+printer) for the provincial facilitators	Set	1	3150	3150
2.2.	Office facilities computers, printers+Photocopier, shelves for District facilitators	Set	6	1650	9900
2.3.	Motobycicles	Piece	18	1550	27900
Output 3: Identify 6 targeted districts, 24 communes, 60 villages and 180 ha rice area					
Activities:					
3.1.	District level meeting to select communities or farmer seed producers	Meeting	18	15	270
3.2.	Field assessment on Socio-economic situation of the communities or group of farmer seed producers	Field ass.	6	1500	9000
3.3.	Data analysis on participation from farmer community or farmer seed producer groups			500	500
3.4.	Launching the project implementation to farmers participants at each commune	launch	24	20	480
3.5.	Determining and mapping targeted production area by district and province	map	7	50	350
3.6.	Preparing agreement with the farmer seed producers				
Output 4: 21 Provincial and district facilitators trained with seed production techniques					
Activities:					
4.1.	Determine training topics to be additionally trained				

4.2.	Organize training program	course	1	617	617
4.3.	Organize study tour at the rice seed production area in Longseang, Vietnam	tour	1	2890	2890
Output 5: Rice seed, fertilizers, pesticides and farming tools are ready for implanting seed production on 180 ha area					
Activities:					
5.1.	Purchase 6300 kg of CS for 180 ha area	kg	6300	1.8	11340
5.2.	Purchase 9 tons of Urea, 18 tons of DAP and 9 tons of Potassium for 180 ha	ton			12,967.56
5.3.	Purchase pesticides for BPH and other worms for 180 ha area	liter	360	2.5	900
5.4.	Purchase 6 pesticide sprayers (1 per district) for intervention on 180 ha area	piece	6	120	720
5.5.	Purchase 12 hand harvesting machines (2 per district) for intervention on 180 ha area		6	1800	10800
5.6.	Purchase 6 threshing machine locally made (1 per district) for intervention on 180 ha area		6	5000	30000
5.7.	Purchase 12 winnowers (2 per district) for intervention on 180 ha area		12	200	2400
Output 6: 180 ha area under cultivation according to seed production techniques					
Activities:					
6.1.	Organize 20 batches Farmer Field Schools for 500 farmer participants (25 farmers per batch for 16 days)	batch	20	1800	36000
6.2.	18 district facilitators lead the on-farm seed production practice within the 6 districts (1 farmer per 3 communities) which cover the 180 ha targeted area	per/day	432	15	6480
6.3.	18 district facilitators follow up and supervise seed production plots regularly 1 time/week for 16 weeks to address any emerging problems that can occur	pers/day	288	15	4320
6.4.	Organize 20 Farmer Study Tours to exchange experiences (2 days each)	tour	20	800	16000
6.5.	2 Subject Matter Specialist Officers provide guidance and assist in addressing any field problems of the communities 1 visit/community for 4 months	pers/day	120	20	2400
Output 7: Farmers in 30 communities will be supported for their seed promotion					
Activities:					
7.1.	Organize 30 Farmers Field Days with 3000 farmer participants (100 participants/Field Day) to extend the information about community based quality seed production to other farmers.	Field Day	30	300	9000
7.2.	Organize Seed production Documentary Video				1800

7.3.	Broadcasting information through TV in Agriculture Program 1 time/month	time	5	30	150
7.4.	FM Radio live broadcasting 2 times/year	time	2	200	400
7.5.	Publication of the magazine on community based quality seed production in Takeo province 1 publication/trimester	copies	1000	1	1500
7.6.	Seed bag + labeling	piece	10000	0.2	2000
7.7.	Prepare banderole for 60 Community Seed Shop	piece	60	20	1200
Output 8: Monitoring system being applied to control the project implementation quality					
Activities:					
8.1.	The provincial facilitators conduct monitoring and evaluation in the target area every month	M&E	6	480	2880
8.2.	Prepare monitoring sheets for monthly evaluation of each community				
8.3.	Monthly and Annual Wrap up Meeting	Meeting	12		885
Sub-total					209,665.56
Contingency (10%)					20,966.56
Grand total					***230,632.12***

Notes: Above are outputs and respective activities for the first year project implementation. For the consecutives years, the activities will remain the same, but for expanded target villages and communes. Therefore, additional facilities are needed