Value Chain Analysis for Rice and Potato Seed System in Vietnam: Case study from four provinces

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Abstract

The seed value chain analysis study on rice and potato was conducted during August to December 2019 to assess the composition, distinctiveness, strengths and weaknesses of Vietnam's seed sector. The study examines relevant secondary sources of information and primary data obtained through field surveys using focus group discussion and key informant interviews in four provinces, namely: Bac Ninh and Thai Binh in the north; Quang Binh in the center and Can Tho in the south. The study results indicate that Vietnam has developed a robust seed sector with the involvement of diverse stakeholders throughout the seed value chain of rice and potato. The seed sector has contributed significantly to the success of Vietnam crop production over the past three decades. However, the existing seed sector has also shown many weak areas that need to be addressed for growth of crop production with increased efficiency, innovation, diversification and value addition. To support this goal, the study suggests several interventions and technological improvements in crop breeding, seed production and seed use especially for inbred rice, hybrid rice and potato. The study also proposes a detailed survey and analysis of Vietnam seed legislation to help make the seed sector more dynamic.

Keywords

Seed Value Chain, Rice, Potato, Vietnam

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Acronyms

AGI	Agricultural Genetic Institute
AMS	Agricultural Material Supplier
ARP	Agricultural Restructuring Plan
BI	Breeding Institution
BNSC	Bac Ninh Provincial Seed Company
CH	Central Highlands
CLRRI	Cuu Long Rice Research Institute
CPD	Crop Production Department
DSTE	Department of Science, Technology and Environment
FCRI	Field Crops Research Institute
FGDs	Focus group discussions
GDP	Gross Domestic Product
GSO	General Statistical Office
IAS	Institute of Agricultural Sciences for the South
KIIs	Key informant interviews
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Commerce
MOF	Ministry of Finance
MRD	Mekong River Delta
NCAE	National Center for Agricultural Extension
NCC	North Central Coast
NCVTSC	National Center for Variety Testing and Seed Certification
NGO	Non-government organization
NMM	North Mountainous Midland
NSC	National Seed Company
PDARD	Provincial Department of Agriculture and Rural Development
PSC	Provincial Seed Company
QBSC	Quang Binh Provincial Seed Company
RCBD	Random Complete Block Design
RRD	Red River Delta
SC	Seed Company

SCC	South Central Coast
SES	South East South
SSC	Southern Seed Company
VCU	Value of Cultivation and Use
VINASEED	Vietnam National Seed Joint Stock Company
VND	Vietnam currency
VNUA	Vietnam National University of Agriculture
WB	World Bank

Introduction

Seed is an important entry point for promoting productivity, nutrition and resilience among smallholder farmers. Seed can be the conduit for moving new varieties, giving farmers access to more productive and yield-enhancing traits. New seed can be linked to strategies for improving nutrition with bio-fortified varieties selected for elevated micro-nutrient levels. In response to climate variation, stress-tolerant varieties or clusters of diverse varieties are promoted as “good practice” to enhance system resilience: multiple options can allow farmers to shift crop or variety portfolios in response to changing conditions. To summarize, seed is a vehicle linked to promoting productivity, nutrition and resilience: one entry point that can potentially move forward multiple goals.

The importance of good seed holds true for Vietnam as well, a major rice producing country of the world where rice is commonly grown in two seasons of the year. In the northern provinces, rice is also rotated with potato as a temperate crop in the cool winter months (from October to February). Of all the inputs, quality seed is most crucial to increase productivity and production of rice and potato and, aiming to improve national food security and livelihood of rice and potato growing farmers.

Thus, this study aims to understand the composition, distinctness and variations within the seed sector of Vietnam with a focus on rice and potato as the two case-study crops. The study analyzes the roles of the formal and informal seed systems and complexity within each. It helps to identify specific seed systems by their domain of operation (farmers, public, private, non-government organizations, others), the types of crops and varieties in general, and for rice and potato crops in particular; types of farmers targeted, types of seed quality assurance and seed dissemination mechanisms. The results of this study are expected to identify the challenges in the existing seed system and develop specific interventions for improving the rice and potato seed systems

Methodology

The methodology of this study follows several systematic steps (Dominic, Smith et al 2008; Subedi and De Boef 2013). It started with secondary data collection through a detailed desk review of the most relevant publications such as reports, articles, and secondary information. The next step was collecting primary data through qualitative data collection methods like focus group discussion (FGD) and key informant interviews (KIIs). Two sets of guiding questions were prepared for conducting the FGDs and the KIIs. The format of these interviews was semi-structured; although standard questions were also asked to each participant, follow-up questions varied based on spontaneous responses from the individual participants. The interviews were later transcribed in their entirety. The FGDs were conducted to gather data from the farmers and the KIIs were carried out to interview other various stakeholders from the seed value chain of rice and potato crops.

Four communes each in one district of each of the four provinces were chosen for FGDs and KIIs. These include two provinces *Bac Ninh* and *Thai Binh* representing the North of Vietnam where both rice and potato are grown. For the centre and the south; Q*uang Binh* province and *Can Tho* province were chosen, respectively. In these two latter provinces, only rice was studied because potato is not grown there due to warm climatic conditions.

In each commune (village), two to three groups comprising of 8-10 farmers per group were formed for FGDs. Four to five KIIs were also conducted with various levels of government employees and officers at each province.

Interviewees included officers and senior staff of the provincial department of agriculture and rural development (PDARD), district crop production offices, district agricultural extension station, cooperative crop production managers and senior staffs of the provincial seed agencies. At the national level, selected KIIs were also conducted with the representatives of the Crop Production Department (CPD) of the Ministry of Agriculture and Rural Development (MARD), national research institutions and research centers.

The field surveys were conducted from 24 October to 28 November 2019. Based on objectives of the study, several FGD meetings and key informant interviews with the various stakeholders and actors in the rice and potato seed value chain were conducted. Annex 1 and Annex 2 provide the questionnaires for FGDs & KIIs; and Annex 3 presents a list of the stakeholders who participated in the discussions and interviews. The discussions were aimed at collecting

qualitative and quantitative information; exploring the bottlenecks and their causes and identifying opportunities for future interventions and improvement.

Entire seed value chain was mapped to find out value addition at each stage and the relationship between various stakeholders at these stages. The stakeholders include input suppliers, seed producers, seed distributors and end consumers/ food processors.

Data analysis and verification

Qualitative and quantitative information collected from this study was used for analysis by linking it to the study framework and objectives. Any information requiring clarification was verified by further discussion with selected stakeholders on an individual basis. Based on these, the report presents key conclusions and recommendations.

Main Findings

1. The Importance of Agricultural Sector in Vietnam

1.1. Agro-ecological Conditions

Located along the eastern edge of the Indo-Chinese peninsula, Vietnam is a narrow, S-shaped country with a north to the south distance of more than 1,600 km, covering an area of 330,000 km^2 (not including islands) with hilly and mountainous areas accounting for nearly 75% of the whole territory.

Vietnam consists of three main zones. North Vietnam, or *Bac Bo,* covers about 35% of the total territory and 40% of the country's population. This is the region of extremes, with mountains of over 3,000 meters, and lowland of just 1-3 meters above sea level. While the Northern provinces have the lowest population density in the country, the Red River Delta (RRD) has the highest population density. Central Vietnam (*Trung Bo)* is the 900 km long and narrow "stiff" which shares a mountainous backbone with Laos and Cambodia. Although this region makes up 40% of Vietnam's landmass, it contains only some 25% of the total population, concentrated on narrow coastal areas. South Vietnam (*Nam Bo*) is relatively smaller, making up about 25% of the country's territory, but 35% of the total population. The Mekong River and its Delta, located in the South, is the most important agricultural production region of Vietnam.

Vietnam has a tropical climate with a pronounced winter season. The Northern part (including the RRD) has a cold winter (November - February) with an average temperature of about 16^{o}C, influenced by winds blowing southwards from Central Asia. Summer in the North is characterized by hot and monsoon conditions. The more varied climatic conditions in the North compared with that of the South allow farmers to grow different kinds of crops at different times of the year.

The Southern part, however, has a typical tropical climate with a mean temperature ranging from 25 to 30^{o}C. It has three seasons: *1) the summer season* (May-October) is very wet; *2) the beginning of the winter monsoon* (November-February) is dry and relatively cool period, and *3) the end of monsoon* (February-April) is a dry and hot period.

The climatic conditions of central Vietnam are cooler than in the south, and the dry and rainy season is not pronounced.

Vietnam consists of 7 agro-ecological regions (Figure 1) viz. *1) North Mountainous Midland (NMM), 2) Red River Delta (RRD), 3) North Central Coast (NCC), 4) South Central Coast (SCC), 5) Central Highlands (CH), 6) South East South (SES); and 7) Mekong River Delta (MRD).*

Figure 1: Seven agroecological Regions of Vietnam

1.2. Agricultural GDP

In 2017, agriculture, forestry, and fishery accounted for 15.34% of the GDP (measured in current price), providing a living for 64.97% of the total population of 95 million people (General Statistical Office 2018). The share of industry and construction was 33.40% and the service sector was 41.26%. Agricultural production met not only the country's food demand but also functioned as one of the main sources to export earnings. The value of agricultural export accounted for 17.1% (36.6 billion US$) of the total export earnings (214 billion US$).

2. Production of Major Food Crops

2.1. Farming systems and cropping patterns

Agricultural production in Vietnam is essentially based on food production, especially on annual crops. Farming and cropping patterns, as well as cropping intensity, vary in the different agro-ecological regions. For food crop cultivation, it was found in 2017 (General Statistical Office 2018) that the double-cropped area was predominant in the RRD and the MRD with rice as the major annual crop. The next common is the single cropping pattern while the triple and quadruple ones are not very common but can be found in regions with a high population and/or better soil and climatic conditions.

2.2. Production of major food crops

Similar to other Asian countries, rice is the most important food crop in Vietnam. The cultivation is concentrated mainly in the RRD in the North and the MRD in the South. During 2015-2017, rice was cultivated on an average total of 7.758 million ha (Table 1) with an average yield of 5.63 ton/ha and a total production of 43.67 million tons. The spring rice season is the most important cultivation window with regard to cultivation area, yield, and total production. Within two decades, rice production went up from 27.64 million tons in 1997 to 42.76 million tons in 2017, mainly due to the spectacular improvement in yield (from 3.9 tons/ha in 1997 to 5.63 tons/ha in 2017), making the country the second-largest rice exporter in the world (5.789 million tons of rice in 2017, amounting 2.616 billion US$).

Table 1: Planted area, yield and production of major food crops in Vietnam during 2015-2017

Crop	Area planted '000 ha				Yield (tons/ha)				Production (mil tons)			
	2015	2016	2017	Ave.	2015	2016	2017	Ave.	2015	2016	2017	Ave.
Rice[1] Total	7828	7737	7708	7758	5.76	5.58	5.55	5.63	45.09	43.16	42.76	43.67
Spring Rice	*3168*	*3128*	*3117*	*3138*	*6.66*	*6.28*	*6.23*	*6.39*	*21.09*	*19.64*	*19.41*	*20.05*
Summer Rice	*2869*	*2872*	*2878*	*2873*	*5.35*	*5.30*	*5.37*	*5.34*	*15.34*	*15.23*	*15.46*	*15.34*
Winter Rice	*1790*	*1735*	*1713*	*1746*	*4.83*	*4.78*	*4.60*	*4.74*	*8.65*	*8.28*	*7.88*	*8.27*
Maize[1]	1179	1152	1099	1143	4.48	4.55	4.67	4.57	5.28	5.24	5.13	5.22
Cassava[1]	568	569	535	557	18.91	19.17	19.33	19.14	10.74	10.91	10.34	10.66
Sweet potato[1]	127	120	122	123	10.52	10.58	11.07	10.72	1.336	1.269	1.351	1.32
Potato[2] Total	21.7	21.2	20.5	21.3	14.6	14.3	14.8	14.57	318	302	303	307

Source: [1] General Statistical Office, 2018; [2]FAO STAT, 2019

According to the CPD of MARD (2018), most of the total rice area was planted with conventional (inbred) rice varieties and the area of high grain quality rice has been increasing in recent years. In contrast, the hybrid rice area occupied only 7.4% of the total rice area and decreased from 610,000 ha in 2015 to 538,000 ha in 2017. The yield of hybrid rice ranged from 6.7 - 6.8 ton/ha which is not much higher than that of conventional rice. The decreasing area under hybrid rice cultivation was attributed to the high incidence of pest and disease, high seed cost (80 - 100 thousand VND/kg which is 3-4 times higher than that of inbred rice seed), and lack of varieties with good grain quality. Farmers also complained about dependence on imported seed sources which are varying in quality and not always timely available with the right varieties familiar to them.

Maize is the second most important food crop and it was grown on 1.143 million ha/year during 2015-2017, producing 5.22 million tons. The production is concentrated mainly in NMM, SES, and the RRD.

Among the three major root and tuber crops, cassava is the most important and it was grown on 557,000 ha, producing 10.66 million tons of cassava storage roots which is then mostly processed into cassava flour for export mainly to China. Sweet potato was grown on 122,000-127,000 ha/year with an average yield of 10.72 ton/ha. There has been a decreasing tendency of sweet potato production in the recent years, probably due to the low profitability of the crop compared to that of several other upland crops grown on the same sandy coastal lands such as soybean and groundnut.

As a temperate crop, 90 percent of the country's potato is grown as a winter upland crop under the rice-based cropping system of the Red River Delta which has cool climatic conditions during late October - early February suitable for the crop. The annual planted area ranged from 20,500 ha to 21,700 ha during 2015-2017 at an average yield of 14.57 tons/ha. The potato area under *spring crop* (planting in December and harvesting in March) is quite small and is mainly used for seed multiplication for the next winter crop.

2.3 Future Prospective of Food Crop Production

Over the past quarter-century, Vietnam's agriculture sector has made enormous progress. Steady advances in smallholder rice productivity and intensification through the 1990s and beyond have played a central role in Vietnam's success in poverty reduction, national food security, and social stability. Vietnam's average rice yield now trails only that of China among

Asia's emerging economies. The country has also achieved explosive growth in agriculture export and now ranks among the top five global exporters of rice, coffee, cashews, black pepper, and fruits.

The country's performance in terms of agriculture yields, output and exports, however, has been more impressive than its gain in efficiency, farmer's welfare, and product quality (World Bank 2016). Most of Vietnam's agricultural trade is in the form of raw commodities, typically sold at prices lower than those of leading competitors due to quality and other differences.

More output has come from more and more inputs' usage, at increasing environmental cost. A large proportion of Vietnam's agricultural growth has stemmed from the expanded or more intensive use of land and other natural resources, and relatively heavy use of fertilizer and other agro-chemicals. As a result, aspects of Vietnam's agricultural success have been resulting in growing incidence of land degradation and water pollution.

For better future prospects, the country's agricultural sector needs to generate "more from less" i.e. it must generate more economic value from less natural and human capital and less harmful intermediate inputs. Future growth should rely primarily on increased efficiency, innovation, diversification, and value-addition. This strategic shift was highlighted in the government's Agricultural Restructuring Plan (ARP), approved by the Prime Minister in November 2017 (Decision 1879/QD-TTg). The ARP defines sector goals in terms of the triple bottom line of economically, socially, and environmentally sustainable development. For achieving these goals, great efforts and breakthrough initiatives should be pursued effectively.

3. The Seed Sector - An Overview

3.1. The role of the seed sector

Like in many other agriculture-based countries, seed is often considered as the essential input for improving crop production in Vietnam. Seed is a medium through which a new crop variety of high yielding potential, high adaptability and stress tolerance, disease resistance and other desirable economic traits is transferred to farmers. When farmers have access to more and better seed sources, there is a higher probability of adoption of improved varieties. Therefore, enhanced seed availability through formal or informal sources will help smallholder farmers improve their food security, family income, and household livelihood. Thus, farmers' access to quality seed, as well as the introduction and adoption of improved varieties is crucial.

Recognizing the importance of good seed for improving agricultural production, the Vietnamese Government has been paying great attention and efforts to improve the country's seed sector. As a result, the established seed system has made great contributions to meeting the country's food demand and security of its continuously expanding population; while producing a large surplus of rice for export. Positive effects of such an improved seed system were also found in other crops such as coffee, cashews, black pepper, fruits and even cassava each of which has its annual export value of more than a billion US$ in recent years.

A good seed system has also helped farmers in diversifying their crop production, thanks to the availability of different crops varieties for their choice in crop production planning and rotation. As a result, the improved crop diversification has changed daily diets of Vietnamese people, improving their living standards and promoting tourism of foreign visitors.

From a future prospective, a well-developed seed industry will continue to play a crucially important role in enabling the country's food security, especially under the growing pressure of population increase, high rate of loss of agricultural land for expanding population, industrialization, urbanization and land degradation caused by salinity and climatic change. Under such circumstances, a climate-smart seed system needs to be developed, to produce more high-quality food at limited expense of natural and human resources, while still contributing significantly to protect and conserve the environment.

3.2. Opportunities and Challenges for Rice and Potato Production Improvement

The great achievements in rice production have opened several opportunities for future improvement in production and marketing. Farmers have gained considerable experience in growing and managing the crop for high yield and economic returns under different agro-ecological conditions. Farmers have also gained experience in growing good quality rice to meet the demands of international markets.

However, the rice industry of Vietnam still faces a lot of challenges for future development (Demont and Rutsaert 2017). In recent years, the role of rice as an engine for rural growth and poverty reduction has subsided. Rising input costs, including those of fertilizer, fuel, and labor, have outpaced nominal increases in producer paddy prices (World Bank 2012). According to the World Bank Report, 40% to 50% of the costs of exportable rice are associated with imported fertilizer and agro-chemicals. Due to increasing production costs, the Vietnamese rice export sector can no longer rely on cost-competitiveness, a strategy it has successfully maintained for decades. Farm households with very small landholdings are no longer able to

advance their standard of living by making incremental productivity gains in rice mono-cropping. Consequently, they have to rely increasingly on off-farm sources of income and employment.

The Vietnamese rice sector is also dealing with severe environmental issues. Strategies for increased production have mainly focused on intensified rice farming systems, using high-yielding varieties and increased use of agrochemicals. The overuse of fertilizers led to high pest and disease infestations and resulted again in even higher usage of pesticides. Also, future problems should not be ignored. The Mekong Delta has been identified as significantly vulnerable to climate change, which is leading to increasing water shortages in the dry season.

All these factors suggest that the sector needs urgently to move towards structural quality-based competitiveness, to be prepared well to tackle global competition, increase standards of food safety and hygiene, and adapt to reduced international demands for imports from countries that are implementing ambitious national food self-sufficiency programs.

Unlike the rice crop, much smaller improvements have been made in the potato crop in the past three decades with regards to the production area, tuber yield, and total production. The current planted area is only some 20,000 ha a year and does not expect an increase in the future. This can be explained by the fact that due to the climatic conditions, potato can only be grown once a year during cool winter months in the Red River Delta. These conditions make it difficult for farmers to keep the seed for 9 months for the next crop, leading to increased potato production cost and lowering crop profitability. Therefore, continued efforts should be pursued to make the potato seed available at affordable prices to farmers, and to apply mechanization in crop production practices, making the crop more attractive and profitable to farmers.

4. Seed Value Chain for Major Food Crops

4.1. Value chain map of crop seed in Vietnam

According to Kaplinsky and Morris (2000) value chain mapping enables one to visualize the flow of the product from conception to end consumer through various actors. It helps to identify different actors involved in the value chain and to understand their roles and linkages. This is also to visualize networks to get a better understanding of connections between actors and processes, demonstrate interdependency between actors and processes in the value chain (Dominic Smith et al 2008).

Considering different dimensions and sources of information, a value chain map of rice and potato seed in Vietnam is depicted in Figure 2.

The key processes of seed value chain in Vietnam are: *1)* input supply; *2)* seed production; *3)* seed distribution; *4*) seed use for commercial production, and *5)* crop produce utilization. In each process, several actors perform different activities and add value to the seed chain. Some processes are performed by more than one actor, and some actors perform in more than one process.

The time required for completing each process of the seed value chain varies. The process of breeding a new variety is the longest one. In general, it often takes 8 - 10 years from the time when a breeder initiates crosses until a new variety is successfully developed. Thanks to the help of advanced biotechnology such as marker-assisted-selection, the breeding process of a new variety can nowadays be significantly shortened to 6 - 8 years.

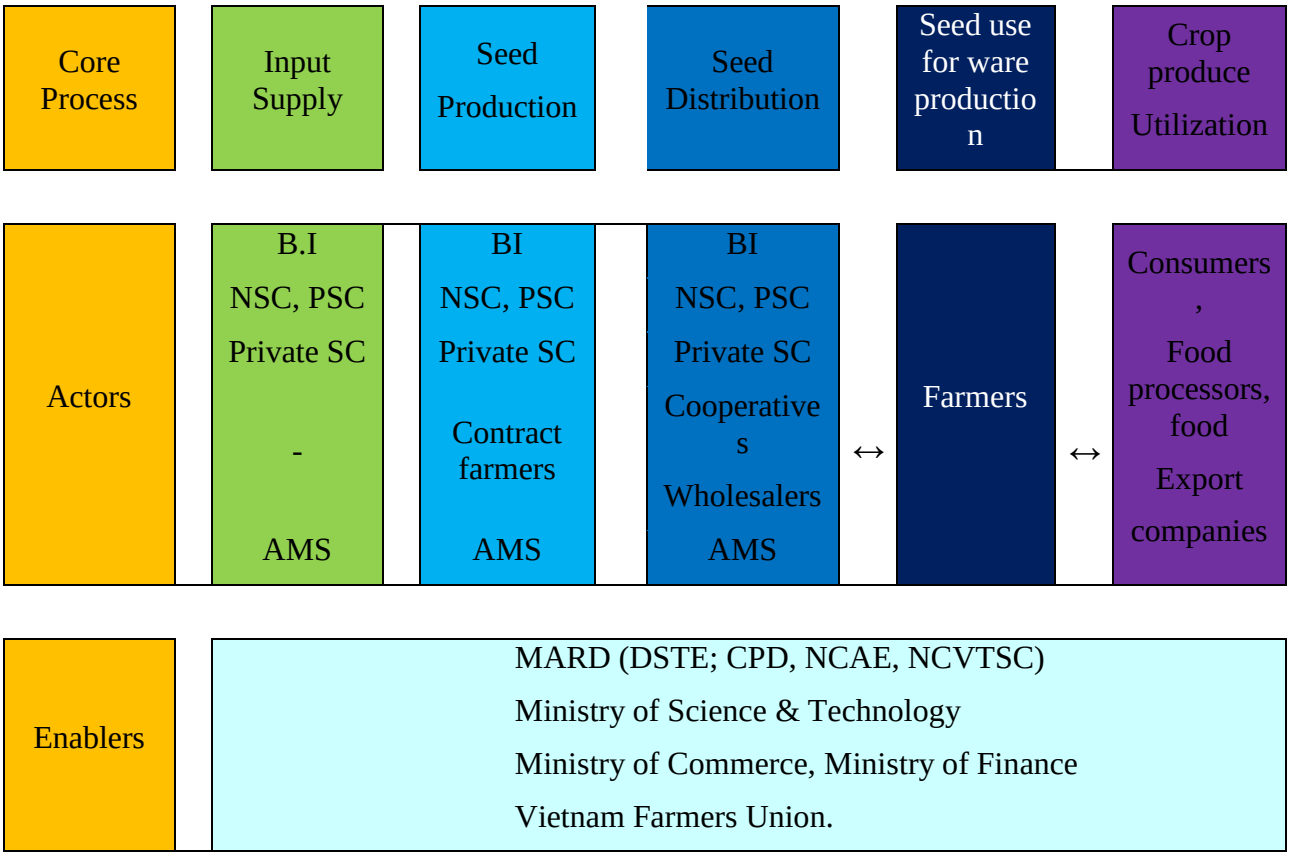

Figure 2: Value chain map of crop seed in Vietnam

Note: BI = breeding institution, NSC = national seed company, PSC = provincial seed company, Private SC = private seed company, AMS = agricultural material supplier, MARD = Ministry of Agriculture & Rural Development, DSTE = Department of Science, Technology and Environment, CPD = Crop Production Department, NCAE = National Center for Agricultural Extension, NCVTSC = National Center for Variety Testing and Seed Certification.

Once a variety has been officially released and its breeder seed is made available, it normally takes just 3 - 4 cropping seasons to multiply enough certified seed which can then be distributed timely to farmers for use in commercial rice production. The seed production process often takes 2 years for the northern provinces of Vietnam where rice is grown in only 2 cropping seasons a year, and it takes a shorter time for the southern provinces because this region can grow three rice crops a year. It often takes a short time in 1 to 2 weeks for distributing the ready-to-use seed to farmers for their commercial rice production.

Detail discussion on the value chain actors and activities involving in each process are presented below.

4.1.1. Input Supply

For *Seed Production* of the seed value chain to take place, there is a need to provide essential production inputs which are of 2 types: seed-related inputs and the non-seed-related inputs. The seed-related inputs include varieties as genetic diversities of a crop; and seed as planting material to maintain such a crop from one generation to another. The non-seed inputs include fertilizers, water, insecticides, and even solar radiation which help raise a crop under the field condition to produce seed.

There are two groups of crop varieties for seed production purposes. These include the group of well-established varieties which have been used by farmers for a very long time. Varieties of this group are often traditional varieties or the ones that were originally bred/ introduced by a research institution a long time ago but now have become “public goods”. Such varieties often possess several preferred characteristics such as high quality and adaptability to the local conditions; however, they also have several weaknesses such as low yield, low crop purity, high incidence of disease and pests. To help farmers in improving or overcoming such weaknesses, several actors such as breeding institutions and public seed agencies have undertaken activities to purify and rejuvenate such varieties, enabling farmers to have cleaner and healthier varieties to produce.

The second group of crop varieties includes all improved varieties which are bred or introduced mainly by public breeding institutions, national seed companies, and recently also by some strong provincial seed companies and private/ foreign seed companies. In Vietnam, there are several institutions working intensively on *rice* breeding. Of the state’s own research institutions, the most important ones include Field Crops Research Institute (FCRI), Vietnam National University of Agriculture (VNUA), Cuu Long Rice Research Institute (CLRRI),

Agricultural Genetic Institute (AGI), Institute of Agricultural Sciences for the South (IAS). These are also some seed companies working on breeding new varieties, such as Vietnam National Seed Joint Stock Company (VINASEED GROUP), Southern Seed Cooperation (SSC), Thai Binh Seed Company and An Giang Seed Company which conduct their own breeding and import certain rice varieties to contribute to meet the seed demand of the country. In addition, there are also several multi-national or international seed companies such as Syngenta, Bioseed, C.P, Bayer, Advanta India, that currently have their business in Vietnam, including the introduction of new hybrid varieties of rice, maize, vegetables.

For the non-seed inputs such as fertilizers, insecticide, farm implements, and other materials, there are many actors involved. Farmers have easy and timely access to all kinds of production materials subject to their purchasing ability or negotiating credit terms with the supplier.

4.1.2. Seed production

Vietnam employs 4 seed quality classes which are breeders, pre-basic, basic, and certified seed. The criteria for different quality classes for rice seed are specified by *National Technical Regulation on Seed Quality of Rice* QCVN 01-54 2011/BNNPTNT and that for potato tuber seed are by *Technical Regulation on Seed Tuber Quality of Potato* QCVN 01-52 2011/BNNPTNT. Table 2 summarizes the quality criteria for rice seed and potato tuber seed that are required by these regulations.

Table 2: Quality criteria for rice seed and for potato tuber seed as set by Vietnam's technical regulation on seed quality

Rice Seed				
Criteria	Seed Quality Class			
	Pre-basic	Basic	Cer* 1	Cer 2
1. Physical cleanliness, % by wt, ≥	99.0	99.0	99.0	99.0
2. Detectable seed of other variety, % by total seed number, ≤	0	0.05	0.3	0.5
3. Number of weed seed/kg of rice seed, ≤	0	5	10	15
4. Germination rate, % by seed number, ≥	10	80	80	80
5. Seed moisture, % by wt, ≤	13.5	13.5	13.5	13.5

Note: Cer* = certified, wt = weight

Potato Seed Tuber			
Criteria	Seed Quality Class		
	Pre-basic	Basic	Cer
1. Virus infection rate, % by tuber number, ≤	5	8	-
2. Tuber with symptom of *Fusarium* spp. & *Sclerotium* rolfsii, % by tuber number, ≤	0	1.0	1.5
3. *Pseudo coccus citri* Russo, number of thrips/ 100 seed tubers, ≤	0	0	2
4. Defect tubers, % by number, ≤	2	2	5
5. Detectable tubers of other variety, % by tuber number, ≤	0	0.5	2.0
6. Seed of < 30 mm size, % by tuber number, ≤	-	-	5

The national regulations also encourage every stakeholder to take part in seed production and supply. It is commonly found in practice that:

- Breeder seed is produced by an original breeding institution which is the author of such a given crop variety. These can be the state's own breeding institutions such as FCRI, CLRRI, AGI; national and provincial seed companies such as VINASEED, Thai Binh Seed, Quang Binh Seed; or private seed companies.
- Pre-basic and basic seed are produced by all breeding institutions and provincial seed agencies.
- Certified seed is mainly produced by national and provincial seed companies and private seed companies. Lately, some state-owned breeding institutions also produce certified seed to raise funds for supporting their breeding activities.

Photo 1. Rice seed produced by CLRRI

Photo 2. Certified Seed of Variety Jasmine 85 produced by An Giang Seed Company

Photo 3. Typical rice seed bag design of 40 kg used by Can Tho Provincial Seed Company.

Interestingly, it was found from field surveys that contract farmers play an important role and are involved extensively in producing basic and certified seed through contacts with national or provincial seed companies. In this collaboration, the seed companies provide farmers with the core seed source and technical supervision in seed production. Some companies also provide farmers with other production inputs such as fertilizers and pesticides at favorable prices, low or no interest and easy credit terms. The seed companies will buy all the harvested seed (grain for rice and tubers for potato) and bring it to their seed collecting site for processing, seed quality testing, storing and packing for later seed supply and distribution.

4.1.3. Seed Distribution

For rice seed, there are various actors involving in the process of seed supply and distribution. These include seed producers of all kinds (breeding institutions, formal and informal seed companies/ agencies) and their marketing strategies are different from each other. There are also some differences from one region to another. The survey results in the two northern provinces, for example, show that in Thai Binh province, rice seed from the breeding institution and provincial seed companies are often distributed to the authorized seed agents who then contact the farmers cooperatives or individual farmers for marketing seed. In *Bac Ninh* province, however, the predominant mechanism involved seed supplier contacting District's Agricultural Extension Office for seed distribution to farmers or farmers representative at the village level. In Quang Binh - a typical province of the central region of Vietnam, *Quang Binh Provincial Seed Agency* markets their rice seed directly to farmers and farmers cooperatives at the communal or village level. This way, they have been able to eliminate several middle-men

led transactions in marketing their seed. However, the agency did not share any further information on their rationale behind this practice.

Compared to rice seed, potato seed distribution is much simpler. As commercial potato is grown only one crop a year and the production and storage of potato seed is more difficult, there are just a few actors involved in potato seed multiplication and marketing. These include Root and Tuber Crops Research Center of the FCRI, some private companies such as Huong Que Company, Hoa Nam Company, Nam Dinh Provincial Seed Company. The stakeholders often import seed tuber of certified quality class from Germany, Netherlands, and Australia. The imported seed is then multiplied in the spring season (from December to March) to economize the costly imported seed and the harvested seed is put into cold storage until early October for the next winter commercial potato production.

These seed providers can market their potato seed tuber directly to individual farmers or farmers cooperatives. Also, because the seed tubers must be stored in cold storage, there is no opportunity for other actors who do not have such storage facility to get involved in potato seed business. This also explains the fact that farmers have almost no choice in selecting different potato varieties for their commercial production as the availability of any particular variety is a function of what is available with cold storage facilities.

4.1.4. Seed use for commercial production

Farmers are the end-users of rice and potato seed for commercial production and their knowledge and skills in crop cultivation practices are critically important in adding values into the seed value chain. These include their capabilities in identifying the right rice and potato varieties to cultivate and raising a crop productively and profitably. Farmers' practices for crop production also differ from one province to another, and from the northern region to the central region and so on. These differences will be elaborated further in relevant sections of this report.

4.1.5. Crop Produce Utilization

In the process of crop produce utilization, consumers, food processors and food exporters often greatly influence the value chain of rice and potato seed. Their preferences on the crop produce will affect the rice and potato varieties chosen for commercial production, quality standards/ criteria of the crop produce, and even the competitive production cost to be offered, especially nowadays when Vietnam is open to and is entering deeper into the international markets with a lot of competitive pressures.

4.1.6. Enabling stakeholders

The indirect actors are those that provide financial or non-financial support services, such as credit agencies, business service providers, government, NGOs, cooperatives, researchers and extension agents. There are several supporting actors involved in the value chain of rice and potato seed in Vietnam.

The first and most important is the Ministry of Agriculture and Rural Development (MARD), of which:

- Department of Science, Technology and Environment (DSTE) is responsible for supervising and directing rice and potato breeding work. It also supervises different varietal demonstration and pilot production projects, providing scientific basis and information for considering official recognition and release of a developed variety into production.
- Crop Production Department (CPD) is supervising the production nationwide, licensing seed import and export, carrying out the national variety testing program for the four most economically important crops (rice, maize, soybean, and groundnut); and examining and proving national crop quality standards. It also administers the Central Office of National Program for Crop Seed and Animal Husbandry Breed Improvement Program.
- National Agricultural Extension Center is responsible for the extension of new varieties, rice and potato production promotion program from the central to provincial levels.

Aside from MARD, there are also other supporting organizations for variety development and high-quality seed production and use. These include: (a) Ministry of Science & Technology provides funding and administers several national programs for variety research and development; (b) Ministry of Finance for providing loan funds for seed enterprises and farmers and (c) Ministry of Commerce for managing and promoting seed import and rice exportation.

4.2. Value chain governance

According to Kaplinsky (2000), the dominant value chain actors play a facilitation role. They determine the flow of commodities and the level of prices. The results of this study, especially of the field surveys reveal that the major formal and strong seed companies such as National Seed Company (NSC), Southern Seed Company, and Thai Binh Seed are key value chain governors. The seed market was heavily dependent on the rice seed supply and therefore the rice seed value chains were highly influenced by these companies. The predominating influence is also reflected in the large volumes of rice seeds supplied by them to farmers every year. According to a report of the Crop Production Department of MARD (2019), only the four

biggest formal seed companies, including *NSC, SSC, Thai Binh and An Giang Seed Company,* have been satisfying 40% of the national rice seed demand. The NSC produces and supplies nearly 30,000 tons of rice and maize seed each year, covering 1000,000 ha of rice and maize grown in the North. SSC supplies some 10,000 tons of seed every year, mainly hybrid maize, hybrid rice and vegetable seed. Thai Binh Seed is a very strong seed company that supplies a large quantity of seed, and their seed market is expanding in different regions of the country.

4.3. Seed marketing channels

A Marketing channel is a business structure of interdependent organizational activities that starts from the point of product origin to the final consumer with the purpose of moving products to their final consumption destination (Kotler and Armstrong, 2003). Analysis of marketing channels is intended to provide a systematic knowledge of the flow of goods and services from their origin (producer) to the destination (consumer).

As a case study from the survey with three provincial seed companies in *Bac Ninh, Quang Binh* and *Can Tho* provinces, the rice marketing channels of these companies are presented in Table 3.

The results indicate that there are four main channels through which provincial seed companies often market their seed. These include 1) Farmers and farmers cooperatives; 2) Seed agencies/ seed shop/ wholesalers; 3) by advanced seed contract, and 4) other channels. The most common channels are through farmers and farmers cooperatives (as much as 78.4% and 87.4% of the seed marketed by *Quang binh* and *Can Tho* Seed Company, respectively; and through seed agencies/ seed shop/ wholesales (as high as 70% of the total seed marketed by *Bac Ninh* Seed Company). These survey results imply that each provincial seed company has its own strategies and effective approach in seed marketing, which have been long developed from their own experiences and partnership with their local collaborators.

Table 3: The quantity of rice seed marketed by Bac Ninh, Quang Binh and Can Tho Seed Companies in 2018

	Marketing Chanel	Seed Volume marketed (tons)			Percentage (% of the total)		
		*BNSC**	*QBSC**	*CTSC**	*BNSC*	*QBSC*	*CTSC*
	Total rice seed sold	500	3190	716	100	100	100
	Of which, sold via:						
1	Farmers and farmers cooperatives	70	2.500	696	15	78.4	87.4
2	Seed agencies/ seed shop/ wholesalers	350	690	100	70	21.6	12.6
3	Sold by advanced contract	50	0	0	10	0	0
4	Other channels	30	0	0	5	0	0

* *BNSC = Bac Ninh Seed Company, QBSC = Quang Binh Seed Company, CTSC = Can Tho Seed Company*

Photo 4. Interviewing a seed dealer in Thai Binh Province

Photo 5. Interviewing a seed dealer in Bac Ninh Province

Photo 6. Meeting with Director of Quang Binh Seed Company

The marketing channel for potato seed tubers is much simpler than that of rice seed. It was found from interviewing several potato specialists and potato seed businessmen that when the seed tuber is imported into Vietnam, the seed dealers distribute it as soon as possible to the seed multiplication areas. Then the large seed tubers are cut into 2-3 longitudinal pieces for seed multiplication, to reduce the seed cost. The imported seed is multiplied in winter-spring crop (planting December and harvesting in March). The resulting seed is then sorted, stored in cold storage until October for raising commercial ware potato. Many farmers also informed that they retain small size tubers of the winter potato crops as seed, then send to the contract cold storage to prepare seed tuber for the next winter potato crop. The seed is used for 1 to 2

crops for commercial potato production, due to a high rate of disease and pest infection and fast degeneration of seed under tropical humid conditions of North Vietnam.

4.4. Production Costs and Selling Prices of Rice and Potato Seed

4.4.1. Rice seed

To investigate the cost-and-return relationship in rice seed production, surveys and interviews have been made with *Bac Ninh Provincial Seed Company* (BNSC) and *Quang Binh Seed Company (QBSC)* and the results are presented in Table 4. It was found that in 2018, BNSC and QBSC produced a total of 496 and 3190 tons of rice seed, respectively; of which BNSC produced mainly basic seed whereas that of QBSC is the certified class. No further information was obtained in the detailed expenses including the mentioned production cost as well as several other expenses that have not been deducted from the selling seed prices presented in this Table. The two companies also did not share answers on profit per unit of rice seed from their business. The results of this study, therefore, provide only an estimated monetary figure of the cost-and-return difference in the rice seed business.

Table 4. Produced rice seed volume, seed cost and selling price in 2018 of Bac Ninh and Quang Binh Seed Companies

Seed Quality Class	Prod'd Volume (tons)		Prod'n Cost (VND)		Selling Price (VND)		Difference (VND)	
	BNSC[1]	QBSC[1]	BNSC	QBSC	BNSC	QBSC	BNSC	QBSC
1. Prebasic	26	73	20,000	30,000	30,000	20,000	-10,000	10,000
2. Basic	420	587	10,000	12,000	15,000	20,000	5000	8,000
3. Certified	50	2,530	-	11,000	-	16,000	-	5,000
Total	496	3,190	-	-	-	-	-	-

[1] BNSC = *Bac Ninh Seed Company*, QBSC = *Quang Binh Seed Company*

Photo 7. Rice seed produced by contract farmers and transported to cleaning and processing area.

Photo 8. Processed rice seed in 10-kg- bags are ready for distribution.

Photo 9. One-kg-sized bag of rice seed Variety SV181 Certified Quality Class.

Photos 7-9. Rice seed produced and supplied by Quang Binh Provincial Seed Company

When asked for elaboration, QBSC has provided the following information:

- The production costs of 12,000 VND/kg for basic rice seed and 11,000 VND/kg for certified seed have already covered: payment cost to contract farmers for the raw seed they produced (which is ranging from 1.2 - 1.5 time of the paddy rice, depending on production seasons and rice varieties), salary for the company's staff who worked with contract farmers in seed production, administrative cost for the local partners and transportation cost to bring raw seed from the farmers' place to the company processing area/ stores
- The differences between seed production cost and selling price are not the net profit. Payments are still needed for the following expenses/costs: processing, quality testing, and certification, seed storing, packing with colored printed labels/ trademark (1,700 VND for a 1-kg sized bag and 1,080 VND for a 10-kg sized bag), seed lost after storing (3.5-4.0% of the initial volume), bank interest (0.6-0.7% per 12 months), transportation cost during seed marketing, depreciation cost, commission to the seed dealers/ wholesaler, taxes, staff salary, and company's operation cost. Hence, the net profit for each kg of rice seed sold is not very high. The Company reported selling paddy rice at cost or even negative profit in cases where produced seed is not sold completely.

4.4.2. Potato seed tubers

It was found from the KIIs with potato specialists/ seed dealers that during 2015-2018, each year Vietnam imported 2130 tons of potato seed tubers, which are all of the certified seed class. The shares of different varieties were: Marrabel (59%); Atlantic 29.7%, Solara 1.9%, and the two Dutch varieties Rosegold and Marki 9.4%. The imported seed prices ranged from 22,000-

24,000 VND/kg which was very competitive among the seed dealers. Except Atlantic arriving in Vietnam in late October, seed of all the other varieties often arrive in late November which is then used to plant winter-spring potato for seed. Farmers informed that the purchased seed price ranged from 27,000-29,000 VND/kg. It is therefore speculated that purchased price is not high, because the seed dealers have to pay many other expenses similar to those of the mentioned rice seed. The loss of potato seed tubers is even much higher when the seed is taken out of containers to transport to farmer's farms under ambient low moisture conditions.

5. Variety Release Process

5.1. Variety Development

5.1.1. Breeding cycle and time requirement

Vietnam has a diverse and complex agricultural system with highly variable soil, precipitation pattern, temperature and cultivation systems, as well as increasingly complex input supply and marketing conditions. A diversified ecosystem of research institutions and universities is functional in Vietnam. Several of these institutions have the task to develop new improved varieties to meet the demands of a rapidly changing agricultural system and to ensure a continuous supply of core elite seed to seed producers for further multiplication.

Rice breeding is a long process and It generally takes at least 10 years to develop and release a new rice variety (Acquaah, 2007). The breeding process consists of three stages: hybridization, line fixation and field trials (Figure 3). Plant breeding is a large-scale logistical operation that may involve hundreds of thousands of plants in the initial line fixation stage, but numbers are greatly reduced to a select few advanced breeding lines by the end of the breeding process. Nearly 99% of the original starting material in a breeding program is rejected and discarded in the selection process. Most countries have an independent government-led system for evaluating the "best" advanced breeding lines compared with the current varieties, which usually requires two years of testing.

One key time-consuming component is the "line fixation" stage. Since breeding material is not genetically uniform or "stable" (i.e. plants are not homozygous) until at least 6 to 8 generations (i.e. self-pollination events), homozygous lines required for advanced field trials take time to develop. Furthermore, time is required to produce enough seed during the breeding process (i.e. for subsequent field trials) because seed of a new breeding line originates from only a single plant. Therefore, it generally takes about 10 years to develop a new field crop variety,

although there are differences between crop species and varietal testing requirements across countries (Acquaah, 2007).

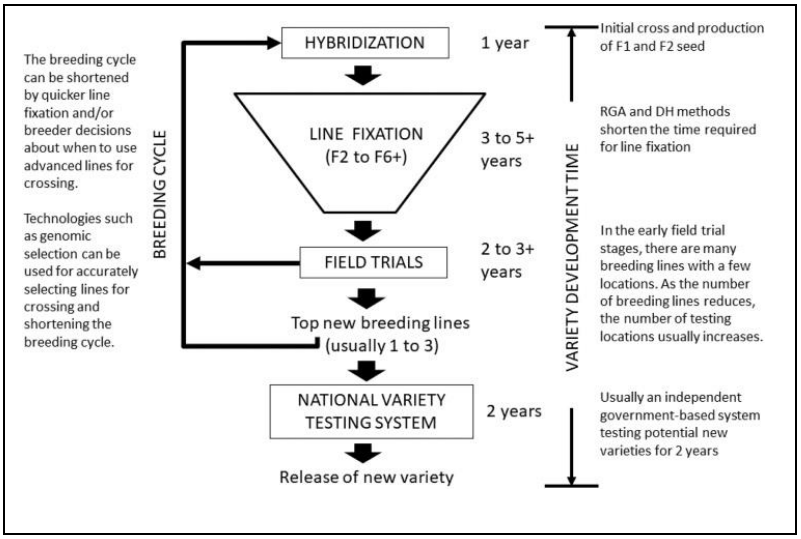

Figure 3: Overview of a typical breeding and variety release scheme for self-pollinated field crops. Source: Bert Lenaerts et al 2019.

The mentioned process is also commonly followed by Vietnamese rice breeding institutions. Breeding objectives are based on the study of the agricultural context and farmers' preferences, they are usually agro-ecosystem-specific and are increasingly demand-driven and oriented toward export opportunities. Conventional breeding methods are commonly used at all research institutions. The common steps of the breeding process include crossing, selection of segregating generations by pedigree or bulk methods, pure line selection, testing for disease and pest resistance and for tolerance to unfavorable growing conditions such as salinity, drought, cold stress; chemical testing for product quality; yield potential, followed by on-station and on-farm yield trial and multi-location testing in replicated trial systems. Once a promising line is developed, it undergoes the process of evaluation and approval, before it can be released for farmers' applications in commercial rice production. A large number of promising rice and potato varieties are evaluated over-location annually. Several rice crop varieties with high yield, short duration, good grain quality and resistance to major pests and diseases are being developed, especially in the Red River Delta and the Mekong River Delta. Improved rice varieties introduced to the local farmers during the last two decades have contributed to sharp increase in yield and total production of the country.

It is generally recognized that varietal and crop diversification may contribute to controlled pest infection, reduced pesticide application through integrated pest management and improvement, and stabilization of the agricultural production.

5.1.2. Evaluation and approval of new varieties

At the national level, the evaluation and testing process are mainly carried out by the research institutions themselves through NCVTSC. The breeders and research institutions send their promising varieties for testing under different conditions. Due to the limited human resources and funding, only testing programs for four major crops *rice, maize, soybean and groundnut* have been conducted by NCVTSC so far. The center, however, plays a role only as a referee in the evaluation process. Promising varieties reported by the breeders are reviewed by the Council of Science and Technology of MARD which makes the exclusive decision of recognizing a certain variety as "Testing variety" or Regional variety" or "National variety".

For new crop varieties in general, the detailed national regulation on recognition of new crop varieties is promulgated and specified in Decision No 95/2007/QD-BNN issued by Ministry of Agriculture and Rural Development on 27/11/2007.

Under this regulation, for a crop variety to be released, it must pass through requirements set by National Technical Regulation for testing of Value of Cultivation and Use (VCU varietal trials) which includes 3 steps:

Step 1) Regional on-location yield trials conducted in RCBD with 3 - 4 reps; over at least 3 cropping seasons of which 2 are in the same season (winter or spring for potato for example) and over at least 3 locations each of which represents one province of the same agro-ecological region (the RRD for example).

Step 2) Regional on-farm trials on at least 500 m^2/farmer-farm; preferably with several farms per location. To shorten the process, *regional on-farm trials* can be conducted at the same time as the *regional on-location yield trials*

Step 3) Demonstration trials (1-2 ha/location with a farmer field day to be organized) to showcase the results. The total *accumulated* demonstration area must be at least 50 ha (for example with potato) if a variety is recognized to complete the regional testing and at most 200 ha (for example with potato) before being considered for official release.

Once the above *3* steps are completed, the variety breeder (either organization or individual) must:

- Apply for an official certification and evaluation from each Provincial Department of Agriculture and Rural Development (PDARD) where the variety was tested. In that paper comments are given on strengths and weaknesses of the variety and recommendation for releasing or not.
- Make an application to MARD for consideration to officially recognize and release the proposed variety. Among several other needed documents of this application, the key one is the scientific report which clearly shows the origin of such variety, the comprehensive results of on-station advanced yield trials (if any), regional trials with certificate of all the related PDARDs.

After receiving the completed application, MARD Minister or his Deputy forms a scientific committee for peer review of the application and make recommendation for the MARD leader to decide on release of the variety.

A variety is recognized at 2 levels. The first one is a temporary (candidate) variety for pilot demonstration (*Step 3*) before formal release and the second is a formal released variety. Within a maximum period of 3 years, if a candidate variety is not promoted to a formal one, the variety ceases to be listed as the candidate.

For rice and potato, national technical regulation on testing for value of cultivation and use (VCU) of new varieties is promulgated and specified in QCVN 01-55: 2011/BNNPTNT and QCVN 01-59: 2011/BNNPTNT, respectively. The key technical specifications and requirements of these two guidelines are presented below.

Table 5: National technical regulation on testing for value of cultivation and use (VCU) of new varieties

	Technical Requirements	QCVN 01-55: 2011/BNN for rice variety	QCVN 01-59: 2011/BNN for potato variety
1	Total number of crop agronomical traits to be evaluated and reported.	29 traits, covering the whole process of crop growth until harvesting, including degree of pest and disease incidence, stress tolerance, rice grain quality.	29 traits, covering the whole process of crop growth until harvesting, including degree of pest and disease incidence, stress tolerance, potato tuber quality.
2	Required types of yield trials to be conducted		
2.1	*Regional on-location yield trials*	Conducted in RCBD with 3 - 4 reps; over at least 3 cropping seasons of which 2 are in the same season and over at least 3 locations.	Conducted in RCBD with 3 - 4 reps; over at least 3 cropping seasons of which 2 are in the same season and over at least 3 locations.
2.2	*Regional on-farm trials*	Conducted with at least 1000 m^2/farmer-farm; preferably with several farms per location	Conducted with at least 500 m^2/farmer-farm; preferably with several farms per location
2.3	*Demonstration trials*	1-2 ha/location with a farmer field day to be organized to showcase the results. The total *accumulated* demonstration area must be at most 150 ha if a variety is recognized to complete the regional testing; from at least 500 ha to at most 2000 ha before being considered for official release.	1-2 ha/location with a farmer field day to be organized to showcase the results. The total *accumulated* demonstration area must be at most 50 ha if a variety is recognized to complete the regional testing; from at least 50 ha to at most 200 ha before being considered for official release.
3	Other technical requirements	Details are presented, including methodology for data gathering, report format, application forms for proposing recognition and release.	Details are presented, including methodology for data gathering, report format, application forms for proposing recognition and release.

At the provincial level, each PDARD also has its own program for variety testing that evaluate adaptability and yielding ability of the new varieties introduced by breeders/ research institutions to find out the most suitable ones to be recommended for growing under their provincial conditions.

5.2. Variety Dissemination

According to Crop Production Department of MARD (2019), a total of 184 rice varieties comprising of 110 conventional (inbred) varieties and 74 hybrid rice varieties have been nationally recognized, approved and released into production thus far. These varieties have generally satisfied the farmers' demand for new rice varieties suited to production in different agro-ecological conditions of Vietnam, contributing significantly into the improvement of rice yield and quality, farmers' income, meeting the country's food security and increasing rice export values.

Photo 10. Meeting with the Director (middle) and key leaders of *Can Tho Provincial Seed Company*

Photo 11. Interviewing Head of *Thoi Lai District's Extension Station of Can Tho Province.*

Once a new variety is approved for production, it is disseminated by various actors involved in the seed value chain. These include breeding institutions and seed companies which provide the highest quality core seed stock (breeder seed) from which the national seed companies will further multiply (pre-basic seed) to distribute to the seed agencies (for production of basic and certified seed). The extension system facilitates demonstration trials and pilot production. Technical information about new varieties is also provided to farmers through trainings, field days, and mass media. These actions have been helping farmers considerably in learning about and adopting new varieties in their production.

5.3. Change of variety and farmers' opinion

Though several rice varieties have been nationally recognized and released into production, only a dozen of such varieties have been well established and extensively used by farmers in commercial production. According to a report published by Crop Production Department of MARD (CPD, 2015) on rice varieties used by farmers, 12 major rice varieties used by Vietnamese farmers accounted for 8.66 million ha of rice in 2015. These include: IR50404

(covering 13% of the total rice area), OM5451 (7%); OM4900 (6%); Khang Dan 18 (4%); OM6976 (4%); BC15 (3%); Jasmine 85 (2%); OM4218 (2%); Bac Thom 7 (2%); OM5954 (2%); Nhi Uu 838 (1%); TH3-3 (1%). The remaining area (53% of the total) were planted with 54 other common varieties.

This data indicates that farmers are wary of using new rice varieties and tend not to readily change a variety that has been well established and they are familiar with. Farmers express diverse opinions related to the frequency and reasons for changing to a different variety for a given crop. For varieties that are well adapted to local conditions, farmers are reluctant to change them in order to avoid any perceived risk. Farmers often keep a large portion of their field with familiar, well established variety/ies and may try out new varieties in smaller fields.

Some farmers keep a part of their field for testing new varieties every season and multiply the best performing ones in the following seasons for their own use. In cooperatives, a group of advanced farmers is responsible for variety testing, selection and multiplication to supply to others.

In general, farmers across Vietnam are aware of the implications of a varietal change, but farmers in the Mekong River Delta have more opportunities to get seed of different sources, than those in the coastal region.

Photo 12. FGD with farmers in Thai Binh Province

Photo 13. FGD with farmers in Bac Ninh Province

Photo 14. FGD with farmers in Quang Binh Province

Farmers' preferences for varietal characteristics

For rice

Commonly, farmers prefer the following characteristics in rice variety: 1) High yielding ability; 2)Good grain quality (long and translucent grain; preferably with aroma; high rice recovery

rate after milling; especially for export); 3) high disease and pest resistance (mainly to rice blast; leaf sheet blight, brown plant hoppers); 4) high cold tolerance during seedling stage for spring rice grown in the northern provinces, 5) other desired characteristics include resistance to water logging, good tilling and short growth duration.

However, farmers preferences of a rice variety are also very location specific. For example, the survey results in Quang Binh province found that farmers in the region still use the very old rice variety *VN20* in a large area of their commercial production in spite of it being considered as very low quality rice variety for human consumption. The reasons that *Quang Binh* farmers still use it is the high amylose content which makes the variety highly suitable for making rice noodles and vermi-noodle. Farmers also state that this variety has high adaptability to local growing conditions and fits well to the existing cropping systems of the region.

Another example is the case of rice variety IR50404 which is covering 13% of the total rice area, equivalent to 1.13 million ha a year and is mainly grown in the Mekong River Delta. This is an IRRI variety introduced into the region more than 20 years ago. IR50404 has a low grain quality which is suitable only for processing rice noodle and rice vermi-noodle and fetches rather low exporting price. The government at different levels has tried to persuade farmers to shift to other varieties. However, farmers in *Can Tho* province reasoned that they found several desirable traits in IR50404 that are not observed in many other newly developed varieties. These include a shorter growing duration of 95 days which enables them to grow three productive rice crops a year, low level of fertilizers required, high adaptability to local conditions and to different growing conditions. Farmers have appreciated their long familiarity with this variety, where there is minimal risk of crop failure due to pest and disease attack and erratic unfavorable growing conditions.

Photo 15. Travelling on boat to meet farmers in a remote village of Can Tho Province for FGD

Photo 16. FGD with farmers in *Thoi Lai District of* Can Tho Province

Photo 17. FGD with extension workers and farmers in *Thoi Lai District of* Can Tho Province

For potato: Some of the key preferred traits for potato varieties include: 1) High tuber yield; 2) high disease and pest resistance (late blight and bacterial wilt); 3) early maturing (85-90 days in winter crop); large-sized and smooth tuber skin; tuber skin and tuber flesh are in dark yellow color; high dry matter and starch content.

6. Seed Replacement and Certification Procedure

6.1. Seed Multiplication System and Certification Procedure

Vietnam seed regulations use international definitions for the various generations of seed: breeder seed, pre-basic seed, basic seed and certified seed.

For rice seed, quality management of different seed categories is currently regulated by Circular No 42/20009/TT-BNNPTNT dated July 10th 2009 which species the management, marketing and use of inbred rice seed in 5 classes (breeder's, pre-basic, basic, certified 1 and certified 2); and of hybrid seed (parental lines and F1 hybrid).

- The national regulation for *inbred* rice seed covers 4 categories of seed quality: Breeder's seed, pre-basic seed, basic seed and certified seed. There are two sub-categories for certified seed: Certified 1 is the seed multiplied from basic seed, and Certified 2 is the seed multiplied from Certified 1. For the hybrid rice seed, the regulation covers the management and use of rice parental lines and F1 hybrid seed.
- The regulation also specifies technical conditions and infrastructure facilities to be maintained by organization/ individual to be eligible to produce and market any kind of rice seed quality categories.

- For seed quality inspection and certification, it is specified that the production of pre-basic rice seed and multiplication of hybrid rice parental lines must be field inspected and quality is to be laboratory tested by the NCVTSC of MARD. Rice seed of basic class, hybrid parental lines and F1 hybrid seed must undergo field and laboratory inspection and quality certification by a certifying body. Production of Certified 1 and Certified 2 rice seed is also mandated to include the field and laboratory quality inspection, but not compulsorily quality-certified by an independently certifying body.
- To implement the core seed quality regulation document, seed producers also have to refer to several other related technical and managing regulations to meet all requirements, such as 1) National Standard TCVN 8547:2011 *Crop Seed - Method for control plot test*¸ specifying procedures for pre-control, post-control, defining standard sample, trueness of a variety, seed purity, off-type plants; 2) National Standard TCVN 8548:2011 *Crop Seed - Testing Methods;* 3) National Standard TCVN 8550:2018 *Crops seed and seedling - Field inspection method*; 4) *Technical procedure* TCVN 12181:2018 *for self-pollinated seed production* which is applied mainly for rice (inbred), groundnut and soybean; 5) *Technical procedure* TCVN 11840:2017 *for hybrid rice seed production;* and 6) *National Technical Regulation* QCVN 01-65:2011/ BNNPTNT *on Testing for Distinctness, Uniformity and Stability of Rice varieties.*
- Due to limitations of laboratory seed testing in most provincial seed agencies, proper field inspection is considered the most feasible and effective means to ensure the quality of the seed produced. In general, seed produced by national as well as provincial institutions satisfy the minimum requirements for formal production.

6.2. Seed Replacement

Most of the farmers interviewed in FGDs in the four survey provinces (*Thai Binh, Bac Ninh, Quang Binh,* and *Can Tho)* reported using farm saved seed in the past. However, it is no longer their routine practice and they change seed source every planting season, because: *1)* rice seed is always available in place and in time; *2)* seed cost forms a small share of the total production cost for a rice crop; *3)* farmers do not have to process and keep their farm-saved seed and pay attention to maintaining seed purity and seed health. Farmers also stated that the benefit from using their own saved seed could never be as high as that from the seed they purchase every cropping season. Their opinion is in line with a report of CPD that reports that 80% and 65% of the planted rice area in the north and the south respectively in 2018 had been planted with certified quality seed class supplied by the formal and informal seed players. It could be

speculated that the remaining 20% and 35% of the rice area was planted with farmers own farm saved seed or the seed they exchanged with neighbors or cooperatives.

As discussed in the earlier Section 4.2.2, for potato seed tubers, it was found from the FGDs and KIIs that farmers still use a large proportion of farm-saved seed which is multiplied in winter-spring potato crop for raising next winter crop.

7. Seed Trade and Market

7.1. Seed demand

There is a big difference between the northern part and the southern part of the country in rice growing practices. In the north, transplanting is extensively employed wherein farmers raise rice seedlings in the nursery and transplant them into the field when rice seedlings are at 14 - 20 days old stage (depending on planting seasons). The results from the surveys indicate that farmers nowadays can manage to use only 35 kg (ranging from 27 to 41 kg) of rice seed to raise enough seedling for transplanting one ha.

In the south, however, broadcasting is employed by all farmers at a seed rate of 150 kg/ha for spring rice crop and 165 kg/ha for summer and autumn rice crop. The reasons for using a higher seed rate in summer and autumn rice crops are explained by farmers that the unfavorable weather conditions in the summer- and autumn rice are more severe than that in the spring crops, especially during the broadcasting time, which may cause some rice seed fail to establish into rice plants. By employing this practice, farmers can therefore save spending time in re-transplanting the missing plants caused by bad weather conditions.

The survey results also reveal that for growing potato crop, 1350 kg of potato seed tuber is commonly applied to grow one ha of potato.

Considering the mentioned seed rates, the estimated total seed demands for rice and potato crops are presented in Table 6. It is found that the whole country need 952,250 tons of rice seed to grow 7.758 million ha of rice every year, of which all the northern provinces need around 90,500 tons to grow 2,348,000 ha of rice, mainly in spring and winter crops and with a small area of autumn rice; and the southern provinces need 861,750 tons to grow 5.410 million ha of rice per years.

Table 6: Estimated total demand of rice seed and potato tuber seed per year in Vietnam

Crop	Planting Season	Planted Area (1000 ha)	Seed Rate* (kg/ha)	Seed Demand (tons)
1. Rice	**Total**	**7758**	**-**	**952,250**
In the North	*Subtotal*	*2348*	-	*90,500*
	Spring	1089	35	38,115
	Autumn	128	100	12,800
	Winter	1131	35	39,585
In the South	*Subtotal*	*5410*	-	*861,750*
	Spring	2049	150	307,350
	Autumn	2745	165	452,925
	Winter	615	165	101,475
2. Potato	**Total**	**20**	**1350**	**27,000**

For potato, the total seed demand to grow 20.000 ha is 27,000 tons of potato seed tuber a year.

Of the total annual rice seed demands, it is also estimated from different sources that the formal seed sector now can meet 70% of rice seed in the North and 45% in the South, 45-50% for maize seed and 50-60% for potato seed tubers. The remaining demands are basically supplied by farmers farmed saved seed, suggesting that technical assistance to farmers are highly needed for improving their seed production and quality.

Farmers' explanations for their use of high seed rate do not seem very convincing and need further efforts from research institutions and extension organizations to help them reduce it. Initiatives have already been started at *Cuu Long Rice Research Institute, Can Tho Seed Company* and some others, aiming at introducing transplanting practices to farmers, by teaching them to raise seedlings on concrete yards or in plastic boxes and transplant in the fields, even with using transplanting machines. These efforts should be further encouraged, so that farmers can learn and benefit faster, not only in reducing in seed rate, but also save working labors, free women from hard work of manual broad-casting or transplanting.

Photo 18. Rice seedlings raised on concrete yard by CLRRI for transplanting with machines

Photo 19. Rice seedlings raised in trays by *Can Tho Seed Company* for transplanting with machines

7.2. Seed Import and Export

Seed import/export is controlled by MARD under Circular No 43/2018/TT-BNNPTNT dated 28/12/2018. The Department of Crop Production (DCP) of MARD is mandated to license the seed import and export of plant/ crop varieties for both research and commercial production purposes; however, the implementation of seed import and export is supervised by General Department of Vietnam Customs under Ministry of Finance.

According to International Seed Foundation, Vietnam imported 53,300 tons of seed for sowing in 2017, amounting 49 million US$ of which the shares of vegetable seed and field crop seed were 12 and 37 million US$, respectively. This report did not mentioned in detail different kinds of field crop seed were imported, however, it is speculated that they include mainly hybrid maize and hybrid rice seed.

According to the Crop Production Department of MARD (2018), 92% of the total 7.758 million ha of rice area in 2017 was planted with conventional (inbred) rice varieties, hence the hybrid rice area is only 620,000 ha, accounting for 8% of the total rice area. Farmers often use 50 kg of hybrid rice seed to grow one ha, hence the demand for hybrid rice seed is some 30.000 tons.

Vietnam has already been satisfying and will continue doing so for its demand of conventional rice seed. For hybrid rice seed, however, it is reported that the country can meet only 35% of the total demand. The remaining is imported from China and India, amounting some 35 million US$ a year. The National Program for Crop Variety and Seed Production Improvement set a goal for 2025 that 75% of the total hybrid rice seed demand will be produced locally.

For potato crop, as mentioned Section *4.2.2.* that during 2015-2018, the country imported 2130 tons of potato seed tuber each year and this amount is multiplied in spring potato crop to provide seed for the next winter ware potato crop. Assuming that an optimistic multiplication

rate of 3 is achieved, this imported seed will satisfy 6390 tons of the total demand of 27,000 tons of seed each year. It is also mentioned from different source that some 10,000 - 15,000 tons of table potato is imported from Yunnan China every year to be used as seed for growing winter ware potato crop in the Red River Delta. The remaining of the total demand 27,000 tons is satisfied by the local seed system, including farm-saved seed stored in the cold stores for 9 months. It has therefore generally agreed that the unavailability of high quality seed tubers has long been the major constraint for improving potato production in Vietnam, and that no significant effort in the field of potato seed research and development has been made in many years, leaving great potential of potato unexploited as a profitable crop for farmers.

Conclusions

Vietnam agriculture is mainly based on food crop production with rice as the most important crop grown nationwide. In the Red River Delta, rice is also rotated with potato as a temperate crop in the cool winter months. Over the past 30 years, the crop production sector has achieved great progress, contributing to the country's success in poverty reduction, national food security and social stability. Vietnam now produces not only enough food for its growing population but has become one of the world's top exporters of rice, coffee, cashews, black pepper and several other crop commodities.

The great achievement in crop production has been a result of several factors of which improvements in crop seed sector have been a major contributor. Vietnam has a mature seed sector with a diverse range of stakeholders, including more than 25 public breeding institutions, 63 national and provincial seed companies, 192 small seed enterprises, with an extensive national and local agriculture and seed extension network. The seed sector has developed and introduced for production 184 rice varieties; meeting the total demand of inbred rice seed and 35% of hybrid rice seed for growing 7.758 million ha of rice annually. It also satisfies 50-60% of the national tuber seed demand to grow 20,000 ha of commercial potato each year. The seed sector therefore plays a crucial role in improving crop production in different agro-ecological conditions of Vietnam, contributing significantly to the improvement of crop yield and quality, farmers income, national food security and export earnings.

The country's great achievement in terms of crop yields, output and exports, however, has outpaced its gain in efficiency, farmers welfare, and product quality. This fact could, among

several others, be attributed to the drawbacks of the existing seed system, which is reflected in the fact that very few rice varieties out of a large number introduced are being used extensively by farmers in commercial production; and only limited improvement in breeding and seed production of hybrid rice and potato crop has been achieved thus far. Further improvements in existing seed sector are highly needed for better growth in crop production with increased efficiency, innovation, diversification, and added value.

In order to improve breeding of crop varieties for farmers, research institutions should broaden genetic material background by fully exploiting the available national plant genetic resources and via international cooperation in order to incorporate desirable crop traits into developed varieties. Breeding cycle need to be shortened as much as feasible by employing advanced accelerated breeding methods in combination with conventional ones. Greater attention should be paid in selecting promising lines/ clones of better quality-focused traits such as high grain quality for export and high resistance to rice blast and brown plant hopper in inbred rice; improved grain quality and disease and pest resistance in hybrid rice breeding and high starch content and processing quality in potato.

For seed production and supply, though Vietnam has been able to satisfy its demand of inbred rice seed, further improvement is still needed in seed quality management such as variety trueness and higher cleanliness of seed-borne diseases. Better agronomical practices in seed use such as sowing, seedling raising and transplanting, field land leveling and using water to control weed should be encouraged/ introduced for farmers adoption, so as to reduce seed rate, especially in the MRD where farmers use up to 150 - 160 kg/ha for broad-casting as compared to only 35 kg/ha for seedling transplanting in the RRD. Vietnam's seed sector may also explore the possibility of exporting high quality inbred rice seed in the near future. Greater efforts are similarity needed to introduce and employ more capable seed technologies to sharply reduce production cost of hybrid rice seed and potato tuber seed and increase seed volume affordable to farmers and to reduce imported seed.

It appears that the regulations of Vietnam seed sector are still very complicated and may not be completely in line with the international regulations. It is therefore necessary to revise the existing legislation and make recommendations for improvement/ revision/ simplification at the earliest, so that the seed sector can better support agriculture and crop production.

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Annex 1

QUESTIONAIRE

for Focus Group Discussion

Target Interviewees: Farmers as seed users at the village or commune level.

I. Background Information

Date	
Venue	Commune: District Province

Participants					
No	Full Name	Age	Gender	Occupation	Telephone No
1					
2					
…					
n					

II. Questionnaire

Q1. Name the major food crops produced in your place (in order of importance)

1. ……. 2. ……. 3. ……. 4. …….

Q2. Seasons and cropping time

N	Crop	Season and Timing (planting - harvesting, from month to month)			
		Spring Crop	Summer Crop	Autumn Crop	Winter Crop
1	Rice				
2	Potato	Not applicable (n.a)	n.a.	n.a	-
3					

Q3. Major varieties used in each cropping season and strengths/ weaknesses of such varieties

No	Crop Season	Common variety	Varietal Agronomical Traits	
			Strengths	Weaknesses
1	Spring rice	1.		
		2.		

		3.		
		4		
2	Summer rice	1.		
		2.		
		3.		
		4		
3	Autumn Rice	1.		
		2.		
		3.		
		4		
		4		
4	Winter Potato	1.		
		2.		
		3.		
		4		

Q4. Change of varieties and farmers opinion

4.1. Facts about the crop varieties farmers are using

No	Variety Name	No of years in use	Reasons for keeping use of a given variety*
I	**Rice**		
1.1			
1.2			
1.3			
1.4			
II	**Potato**		
2.1			
2.2			
…			

* Possible reasons: High yield, high adaptability to local climatic/ soil conditions, high disease and pest resistance, farmers familiarity, high selling price and/or stable market, easy to afford seed/ reuse saved seed…

4.2. Reasons for farmers to change a variety

- Degeneration of the used varieties (low yield, reduced adaptability),
- Change of consumer preferences for produce quality/ unstable market
- Export promotion program…

- …

Q5. Seed rate, purchase price and estimated yield increase

No	Crop Season	Seed rate (kg/ha)	Seed Price (000 đ/kg)	Quality Class*	Yield Incr (%)**	No of seasons re-used***
1	Spring Rice					
2	Summer Rice					
3	Autumn Rice					
4	Winter Potato					

* Prebasic, basic, Certified…

** As compared to the use of farmers saved seed of the same varieties

*** Number of cropping seasons farmers reuse the purchased seed stock.

Q6. Reasons for farmers to buy a new seed source

- Degradation in plant uniformity?
- Decrease in crop adaptability?
- Decrease in yield/ produce quality/ selling price…
- Other considerations/ interests/ motivations

Q7. Yield and Income from crop production

No	Crop Season	Fresh Yield (kg/ha)	Finished Produce Yield	Selling Price (000 đ/kg)	Income (1000 đ/ha)	Estimated Net profit (%)
1	Spring rice					
2	Summer rice					
3	Autumn rice					
4	Winter potato					

Q8. Farmers' practices in investing crop seed and other production materials for their production.

No	Farmers' practices	No of FGD participants employed	Reasons
1	Purchase seed and pay at once to the seed supplier		
2	Receive seed in advance and		
	- Pay later *by cash* with or without interest after harvesting the crop		

	- Pay later *by harvested product* with or without interest (%)		
3	Purchase other production materials and pay at once to the supplier		
4	Receive production material in advance and pay later by cash/ harvest product		
5	Other practices (elaborated)		

Q9. Farmers' use of farm saved seed and their opinions (Question to be addressed separately for rice and for potato crop)

9.1. Of your total planted area per year, how many percent (5) are planted with your own/ neighbors' farm saved seed?

9.2. Why do you use your own/ neighbors' seed? (easy access, low cost, no credit = lack of money to purchase improved seed, no information/ lack of confidence about the benefits of purchased seed…?

9.3. What problems had you experienced with using your own/ neighbors' farm saved seed and how did you solve/ overcome/ draw lessons from such experiences?

9.4. In your opinion, what are the best ways/ practices to improve quality of farm saved seed?

Q10. Farmers' knowledge, experiences and practices in identifying and checking the quality of a seed source when purchasing. Based on:

- Experiences gained from a long-term partnership with seed suppliers of high trustiness and creditability.
- Recommended by the official extension workers/ production managers.
- Introduced by relatives/ neighbors/ close friends
- Others
-

Q11. Farmers challenges/ constraints in benefiting crop seed value chain for improving their productions

- No easy access to a good quality seed source?
- High cost/ high price for renewing the old seed stock?
- Seed is not available on time and in place?
- Lack of technical information/ training on the newly improved crop varieties which prevent farmers from trying to afford the seed of such new varieties for production?
- Changes in climatic/ weather conditions or the prevalence of disease/ pest attack which make farmers difficult to look for a right crop variety to cope with?
- Fast changes in the customers' preference and/or the market demand for their harvest produce sold out easily and profitably?

- Lack of guidance from the local extension network or production management.
- Other?

Q12. Others

- Who do you interact with for seed purchase, crop production and marketing? More details for rice and potato?
- Are there any government subsidy? Was there a time for a government subsidy on seeds?
- How does the subsidized seed system work, if there is any?
- What do you think would happen if such government program/policy/project is removed?
- If there is no existing government program/policy/project in the seed industry or the commodity/output market, what should be implemented?

Annex 2

QUESTIONAIRE

for Key Informant Interviews

Quest No	Detail
Q1	About the interviewee (name, position, organization, address)
Q2	Mandates & Resources of the organization
2.1	Main mandates
2.2	What are the crop-seed related activities (breeding new varieties, seed production, seed quality control, seed marketing, varietal extension and seed dissemination)
2.3	Resources
	- Land (ha), of which land is used for seed production
	- Staff (#): Total and Number working on seed related activities
	- Facility for seed quality assurance and quality control (sun-drying yard & in-house drying facilities, seed storage, field inspection and laboratory testing for seed quality control…)
	- Other …
2.4**	Total annual budget, revenue and share from all the seed related activities (% of the total revenue)
Q3	Genetic resource management & Varietal development
3.1	Do you have program/ activities related to genetic resource management and varietal development for rice and for potato?
3.2	If yes, how do you develop a new variety?
	- Do you make crosses of your own and do selection from segregating population?
	- Do you just evaluate a set of introduced varieties and select the most desirable one for introducing to farmers and for your seed business (multiplication and marketing to farmers..)?
	- Others
3.3.	Do you have contacts/ collaboration with research institutions for varietal breeding activities? If yes, what are they?
3.4	What are the major achievements of your breeding activities in the past 5-10 years?
	- Name the 5 top varieties you have bred and released into production? Where are these variety grown commercially and what are the annual planted area (ha) and proportion (%) share in the total planted rice area in the region?:

Quest No	Detail
	- What are the strengths and weaknesses of these varieties in terms of production (by our farmers), and consumption (by consumption either industrial or home)?
	- How long does it usually take for each stage in the varietal improvement process? What about their respective cost? Where do you usually get your funds?
3.5	Management of breeding activities
	- How do you conduct field trials and tests? Who are your collaborators?
	- After successful field trial, and registration and approval, do you still consider seed dissemination?
	- How do seed companies/ farmers get a hold of your new varieties? What are the government program and policies related to this?
Q4	Seed production (focus on rice and potato only)
4.1	What crops are you producing seed: For example rice, maize, soybean, potato…
4.2	What are the 5 main varieties (in order of importance) of rice/ potato you are producing seed?
4.3	What seed classes (breeder, prebasic, basic, Certified 1, Certified 2) you are producing and the total respective volume produced or aprox share (% of the total seed business revenue) in 2018?
4.4	What seasons (spring, summer, winter…) are you producing different quality classes and the respective volumes in 2018?
4.5	Where do you produce seed?
	- On your own farm land (ha?, volume ton/year & share% of the total seed volume)
	- Through contact farmers (ton/year?) and how
	- Imported from other companies/ abroad, then processed and packed with your own label for marketing?
	- Other?
4.6	What are the basic considerations for you to plan seed production with regards to:
	- Choice of varieties for seed production?
	- Volume planning for different seed classes?
	- Advanced contract with farmers/ seed dealers
	- Seed marketing forecast and experiences…
4.7	How do you obtain core seed source to produce a given seed class (for example breeder seed for producing prebasic seed)?
	- For your own source? and what are the classes of seed source (breeder's, prebasic, basic…)

Quest No	Detail
	- Purchased from other institutions (name if possible) and price for each seed quality class (VND/kg)
	- Other?
Q5	Seed Quality Control
5.1	- What measures do you often employ to ensure quality of the seed produced by your own?
	- How much do you have to pay for field inspection and quality testing of the breeder seed produced by your own?
	- Do you have an accredited/ certified seed quality testing laboratory for ensuring quality of your own seed of prebasic, basic and certified classes.
	- If not, from where do you hire this service and how much do you have to pay for 100/ 1000 kg of seed certified?
	- Do you employ the post-control practice for the seed produced and marketed by your institution (to solve the complains/ problems related to your seed after selling if any).
Q6	Seed marketing
6.1	How do you market your seed? Through and respective proportion (%) of the total volume
	- Directly to farmers or farmers organization?
	- Wholesalers and retailers?
	- Forward contracts?
	- What variety have the most demand and why?
	- What volumes are you selling each year by variety?
	- Do you provide credit or financial products related to your products? What kind of sales arrangement do you have? (cash, credit, discounted for bulk, discounted for preferred customer, etc.?
	- Other?
6.2**	What are the cost and profitability, profit margin?
	- What are the selling prices of seed by variety and/or by seed quality class?
	- How do you establish your selling price (other vendors, buyers' demand, costs, location, time of the year)?
Q7	What specific challenges/ constraints are you facing in running your seed business and why?
	- How many years have you experienced with seed business?
	- Are you aware of any specific farmer's behavior related to the production on rice/potato?
	- Are you aware of the challenges faced by farmer's related to the production on rice/potato?

Quest No	Detail
	- What do you think to improve your seed business in future?
Q8	Opinion on the existing government seed regulations
	- What aspects do you satisfy with the available government regulations on seed production and business?
	- What policy/ regulatory constraints have you experienced/ been facing in promoting seed value chains?
	- What aspects do you propose for revising/ improvement to improve crop seed value chain?
	- Are there any government subsidy? Was there a time for a government subsidy on seeds?
	- How does the subsidized seed system work, if there is any?
	- What do you think would happen if such government program/policy/project is removed?
	- If there is no existing government program/policy/project in the seed industry or the commodity/output market, what should be implemented

* RI = Research Institution, SC = Seed Company, Ext = Extension worker, PM = Production Manager

** There are some sensitive questions such as this question 6.2, because *it is related to business secret of a seed actor who is not always willing to answer. So please highly anticipate that almost no reliable/ detail answers will be given to such kinds of question. It also means that quantitative assessment such as cost-and-benefit/ profit margin of seed value chain is not easily made clear and reliable in this study.*

Annex 3

LIST OF PEOPLE PARTICIPATED
in Focus Croup Discussions and Key Informant Interviews

A. People met in FGDs

TT	Name in full	Gender	Age
I. Xa Loan Village, Bong Lai Commune, Que Vo District, Bac Ninh Province			
1	Nguyen Thi Dang	F	52
2	Nguyen Thi Quyen	F	66
3	Nguyen thi Tuoi	F	61
4	Nghiem Thi Manh	F	52
5	Nguyen Thi Dam	F	49
6	Nguyen Thi Chac	F	62
7	Nguyen Thi Tuyen	F	60
8	Nguyen Thi Hoe	F	46
9	Nguyen Thi Quy	F	50
II. Bong Lai Village, Bong Lai Commune, Que Vo District, Bac Ninh Province			
10	Nguyen Van Dong	M	52
11	Nguyen Thi Huong	F	48
12	Vu Vanw Khuong`	M	43
13	Nguyen Thi Hien	F	43
14	Nguyen Thi Quyen	F	59
15	Nguyen Thi Van	F	50
16	Nguyen Thi Hue	F	61
17	Nguyen Thi Tinh	F	55
18	Nguyen Nhu Thinh	M	52
III. Phuong Qua Nam Village, Quynh Nguyen Commune, Quynh Phu, Thai Binh			
27	Hoang Dinh Khang	M	64
28	Khong Thi Mien	F	53
29	Tran Thi Nguyen	F	54
30	Hoang Thi He	F	48
31	Nguyen Thi Phan	F	51
32	Khong Van Thieu	M	54
33	Nguyen Thi Hue	F	47
34	Hoang Thi Oanh	F	45
35	Hoang Thi Van	F	49
36	Vuong Thi Mao	F	45
37	Doan Thi Luong	F	55
V. Dai Trach Commune, Bo Trach District, Quang Binh Province			
38	Phan Duy Trinh	M	61
39	Nguyen Thi Quyen	F	35
40	Duong Thi Thien	F	36
41	Nguyen Thi Thuy	F	52
42	Hoang Van Quy	M	59
43	Nguyen Anh Soai	M	60
44	Hoang Van Loi	M	49
45	Phan Minh Luan	M	63
46	Nguyen Van Hue	M	65
47	Phan Van Thanh	M	55

Nguyen Commune, Quynh Phu, Thai Binh			
19	Nguyen van Tuyen	M	45
20	Doan Thi Dung	F	53
21	Nguyen Ngo Hac	M	63
22	Hoang Dinh Hai	F	50
23	Nguyen van Lich	M	58
24	Khong Minh Luyen	M	67
25	Hoang Van Tu	M	65
26	Dinh Cao Tu	M	59

48	Hoang Van Loi	M	52
49	Hoang Van Luong	M	49
50	Nguyen Thi Thuy	F	54
51	Ngo Thi Le	F	46
52	Nguyen Thi Thao	F	56
53	Pham Van Dung	M	60
54	Phan Thi Thom	M	44
55	Phan Thi Khuyen	F	47
56	Nguyen Thi Phuong	F	52

TT	Name in full	Gender	Age
VI. Thoi Thanh A Village, Truong Xuan B Commune, Thoi Lai District, Can Tho			
57	Tran Minh Thien	M	48
58	Nguyen Van Nam	M	58
59	Nguyen Van Ha	M	50
60	Nguyen Van Chau	M	45
61	Nguyen Van Thu	M	62
62	Nguyen Thanh Tu	M	40
63	Le Tan Binh	M	56
64	Le Van To	M	67
65	Tran Van Phung	M	56
66	Nguyen Thi Ut	F	56

TT	Name in full	Gender	Age
VII. Thoi Hoa A Village, Thoi Hoa Commune, Thai Lai District, Can Tho			
67	Le Thanh Nhan	M	47
68	Pham Quang Kiet	M	57
69	Le Van May	M	67
70	Tran Ngoc Doan Trang	F	32
71	Huynh Thanh Mung	M	64
72	Nguyen Thi Xay	F	33
73	Phan Tan Phat	M	33
Average			52.7
By age (%)		61-67	20.5
		51-60	39.7
		41-50	31.5
		33-40	8.2

B. Key Informants Consulted

I	**MARD and National Research Institutions & Centers**	
1	Dr. Tran Xuan Dinh	Deputy Director, Crop Production Department, MARD. Ngoc Ha, Ba Dinh, Hanoi
2	Dr Nguyen Trong Khanh	Rice breeder, Director, Field Crops Research Institute (FCRI). Address: Lien Hong, Gia Loc, Hai Duong
3	Dr Trinh Van My	Director, Root & Tuber Crops Research Center (RTCRC) of FCRI. Address: Thanh Tri, Ha Noi.
4	Dr Le Hung Phong	Director, Hybrid Rice Research Center (HRRC) of FCRI. Address: Thanh Tri, Ha Noi.
5	Dr. Tran Ngoc Thach	Director, Cuu Long Rice Research Institute (CLRRI). Address: O Mon District, Can Tho Prov.
6	Dr. Duong Hoang Son	Head, Research Planning & Int'l Cooperation Department, CLRRI, O Mon - Can Tho

II	**In Thai Binh Province**	
7	Mr Tran Minh Hung	Director, Thai Binh Provincial Agricultural Extension Center
8	Mr Nguyen Duc Chi	Head, Quynh Phu District Agricultural Extension Station
9	Mr Nguyen Van Soai	Chairman, Agricultural Service Cooperative, Quynh Nguyen Commune, Quynh Phu District.
10	Mrs Hoa	Seed Shop Owner, Quynh Phu Town, Quynh Phu District

III	**In Bac Ninh Province**	
11	Mr Duong Duc Tuan	Deputy Head, Crop Production Office, Bac Ninh Provincial Department of Agriculture and Rural Development
12	Mr Phuong Huu Nep	Deputy Director, Bac Ninh Provincial Seed Company
13	Mr Nguyen Van Manh	Deputy Head, Que Vo District Extension Station
14	Mr Nguyen Nhu Thinh	Chairman, Agricultural Service Cooperative, Bong Lai Commune, Que Vo District.
IV	**In Quang Binh Province**	
15	Mr. Hieu	Deputy Director, Quang Binh Provincial Seed Company (QBSC)
16	Mr. Le Van Lam -	Head, Seed Production Planning & Quality Management, QBSC
17	Mr.Tu Duc Hoa	Head, Rice Variety Research and Development Center located in Dai Trach Commune, Bo Trach District, QBSC

18	Mr. Van	Rice Breeder, Rice Variety Research and Development Center, QBSC
19	Mr. Hoang	Rice Seed Production Specialist, QBSC

V	**In Can Tho Province**	
20	Mr. Nguyen Van Den	Head, District's Agricultural Extension Station, Thoi Lai District, Can Tho Province
21	Mr. Nguyen Quoc Tuan	Deputy Head, District's Agricultural Extension Station, Thoi Lai District, Can Tho Province
22	Mr. Tran Thai Nghiem	Director, Can Tho Provincial Crop Seed Center
23	Mr. Nguyen Tan Dam	Head, Seed Production Planning Department Can Tho Provincial Crop Seed Center


CIP
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CGIAR
RESEARCH PROGRAM ON
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Food Security
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