

Republic of Rwanda



Roadmap for Rice Seed Development in Rwanda

Draft_0_13/11/15

Ministry of Agriculture and Animal Resources
Kigali

EXECUTIVE SUMMARY

Rice is acknowledged as a priority crop for food security and economic development in Rwanda. Rice is generally produced in marshland ecosystem with supplementary irrigation. Total paddy production has increased from 46,191 tons to 93,746 tons between 2004 and 2013. While most of the increase in grain production shall be attributed to a rapid increase in physical area under cultivation, the average rice crop productivity has also increased from 3.3 t/ Ha to 5.34 t/ Ha during the same period. Owing to a surge in demand for rice consumption and the quality differences over the locally produced rice however, the market has been importing about 62% of the rice from other rice producing countries over the past 5 years.

National Rice Development Strategy (NRDS) of Rwanda aims to achieve self sufficiency in rice production by 2018 improving the volume and quality of the locally produced rice. Good quality rice seed is one of the major factors that can improve the market competitiveness of the locally produced rice and enhance the on-farm productivity. Rwanda recently joined the Coalition for African Rice Development (CARD) initiative on developing rice seed sub sector. This document presents analyses of the current situation, the various challenges and opportunities for rice seed sub-sector and outlines a roadmap (2016-2020) for advancing the rice seed value chain in Rwanda.

Rwanda's seed laws and national policies require synchronization with regional and international accords governing seed classes, property rights, quality assurance and seed trade regulations. Even though rice is largely grown as a cash crop in Rwanda, both formal and informal rice seed systems are adopted by rice growers. Under the formal system, about 10 registered seed producing cooperatives source basic seeds from Rwanda Agriculture Board (RAB), produce certified seeds by engaging a few rice growers in their marshlands, and subject their fields and production to inspection and certification processes. The certified rice seeds are then distributed to farmers in their own marshlands and to farmers in other marshlands. The informal system of rice seed production generally takes place under cooperatives that are not registered as seed producers. Here, the farmers use a portion of the grains saved from their own previous harvests as seed or source from fellow farmers.

Among the two types of rice grain (short and long) varieties grown in Rwanda, the genetic identities of the short grain varieties (referred as Kigoli) remain unknown. Authentic seeds of these highly adapted cultivars are not yet made available through pure line research. Most of the recently released (2003 and 2010) long grain varieties are international accessions sourced from Africa Rice or IRRI and have similar phenotypes (appearances). The source seeds (breeder and pre-basic) of these varieties are not periodically refreshed from the original nucleus seeds and instead are being recycled in the country through repeated multiplication. Significant levels of admixtures have accumulated in several of these source seeds over the years.

Reeling under the transition of recent institutional reorganization, the coordination between seed research, production and inspection arms of RAB remains wobbly. This affects the much needed quality assurance process for the upstream classes of rice seeds that could ascertain confidence along the supply chain. Lack of a comprehensive information management system for all rice seed classes of the different varieties that can be accessed by the stakeholders has also cramped the effectiveness of planning, budgeting and seed inspection services. Seed producing cooperatives do not have clear business/entrepreneurial models through which certified seeds can be produced professionally and marketed. Due to inefficient inspection and monitoring mechanisms, several informalities have crept into the formal systems along the entire production and supply chains.

To overcome the several inherent issues in the rice seed system, this roadmap proposes that certified seeds in Rwanda are produced and distributed through centralized cooperatives or miller based approaches. Under the centralized approach, two or few apt marshlands/cooperatives shall be licensed to exclusively produce seeds of the different rice varieties for the entire country and directly supply to rice cooperatives and farmers. This approach may efficiently channel the limited technical and inspection resources; help trace and address issues more quickly. Under the miller based approaches, few potential rice grain processors shall be exclusively licensed to produce seeds of market driven rice varieties by engaging farmers and distribute through existing agro dealer networks in the country. With a grain quality conscience, the millers shall also improve the market competitiveness of locally produced rice under this approach.

The roadmap also proposes amendment in seed laws, policies and institutional planning for improving the environment for all the stakeholders of the rice seed value chain. Demand for quality rice seeds will be increased by facilitating awareness, improving the quality assurance processes and matching the needs of the rice growers. Capacity building of researchers, technicians and seed producing farmers on seed production, handling, processing and storage are emphasized. Inspection services will be reinforced with additional human capacities and technical- and administrative amenities for serving the seed producers and users adequately and timely. Supply of rice seeds in the markets will be strengthened by creating sustainable demand, facilitating access to smaller packages of seed, market information, stakeholder linkages and promoting cost saving measures in production and packaging.

It is envisaged that implementation of these approaches will substantially improve the seed sub-sector and thereby directly contribute to achieving the NRDS goal of attaining self sufficiency in rice production. It is expected that the government, development partners and other public- and private stakeholders of the rice seed value chain will sponsor the proposed roadmap. The NRDS taskforce will oversee the implementation of this roadmap by executing the activities through relevant institutions.

ADMINISTRATIVE MAP OF RWANDA



ACRONYMS AND ABBREVIATIONS

- AFSAR: Appui a la Filiere Semenciere du Rwanda
- ARIPO: African Regional Intellectual Property Office
- BTC: Belgian Technical Cooperation
- CARD: Coalition for African Rice Development
- EDPRS: Economic Development and Poverty Reduction Strategy
- GIZ; German Agency for International Cooperation
- ICM: Inter City Mills (Rwanda)
- IFAD: International Fund for Agricultural Development
- ISAR: Institut des Sciences Agronomiques du Rwanda
- ISTA: International Seed Testing Association
- JICA: Japan International Cooperation Agency
- KWAMP: Kirehe Community-based Watershed Management Project
- MINAGRI: Ministry of Agriculture and Animal Resources
- MINICOM: Ministry of Commerce
- NRDS: National Rice Development Strategy
- OECD: Organization for Economic Cooperation and Development
- PAIRB: Projet D'Appui Aux Infrastructures Rurales De La Region Naturelle Du Bugesera

RAB: Rwanda Agriculture Board
RADA: Rwanda Agriculture Development Authority
RALICS: Rwanda Agriculture and Livestock Inspection and Certification Services
RBS: Rwanda Bureau of Standards
RSSP: Rural Sector Support Project
SNS: Service National Semencier
SPAT/PSTA: Strategic Plan for the Transformation of Agriculture in Rwanda
STAR: Seed Traders Association of Rwanda
STRASA: Stress Tolerant Rice for Africa and South Asia
UPOV: International Union for the Protection of New Varieties of Plants

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1. INTRODUCTION

Rice has become one of the essential food commodities in Rwanda. National household surveys reveal that the growth rate for rice consumption in rural areas has surpassed that in urban areas.¹ Anticipating further momentum in the trend, the National Rice Development Strategy (NRDS) of Rwanda aims to achieve self-sufficiency in rice production by 2018 by more than doubling its domestic production from 73,000 tons of milled rice in 2012 to 204,000 tons of milled rice by 2018.² Rising total productivity levels and expanding area under cultivation represent the two major strategic avenues along which the NRDS outlines various approaches to achieve the set goal.

Rice is almost exclusively cultivated in the marshlands with supplementary irrigation from water harvesting and storage structures. With an average on-farm rice yield level of 5.36 tons/ Ha; Rwanda ranks as one of the most productive rice growing countries in Sub-Saharan Africa. The total paddy (rough rice) production in Rwanda has increased substantially from 67,253 tons in 2010 93,746 tons in 2013.³ Although the NRDS estimates show that Rwanda would need to grow rice over about 55,100 Ha to achieve self sufficiency at current productivity level; owing to demographic pressure on land and infrastructure limitations, rice is presently cultivated over 17,568 Ha.⁴ On the other hand, the rate of growth in consumption of rice in Rwanda has consistently surpassed that of local production in the recent years (Fig. 1).

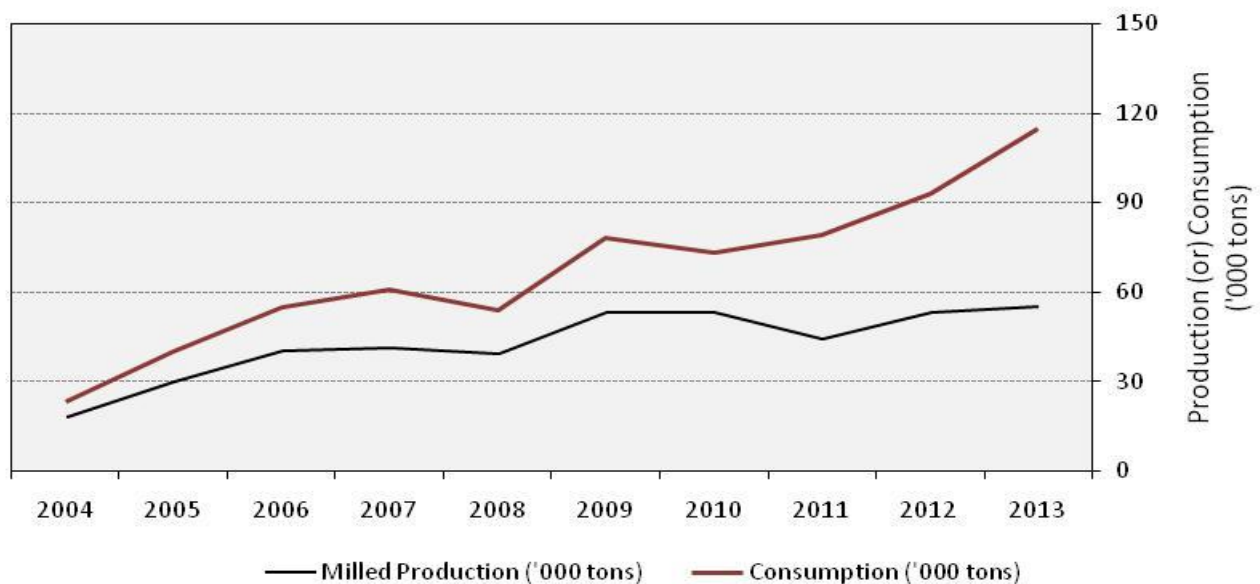


Fig. 1: Recent trends in local milled rice production and consumption in Rwanda⁵

¹ National Institute of Statistics of Rwanda (2011) The third integrated household living conditions survey (EICV3): Thematic Report; Patterns of Consumption

² Ministry of Agriculture and Animal Resources (2012) National Rice Development Strategy – revised edition

³ faostat3.fao.org

⁴ Ministry of Agriculture and Animal Resources (2013) Crop Assessment Surveys

⁵ USDA Grain data; apps.fas.usda.gov

The widening gap between domestic consumption and production of rice has prompted the mainstream markets to fill the deficit (Fig. 2) by importing rice from other rice growing countries. Besides exerting macroeconomic pressure through trade imbalance and foreign exchange, the surge in importation is increasingly challenging the market competitiveness of locally produced rice and hence the viability of rice sub-sector. Furthermore, the low self sufficiency rate in rice production increases the vulnerability of national food security to global fluctuations in market price for rice.

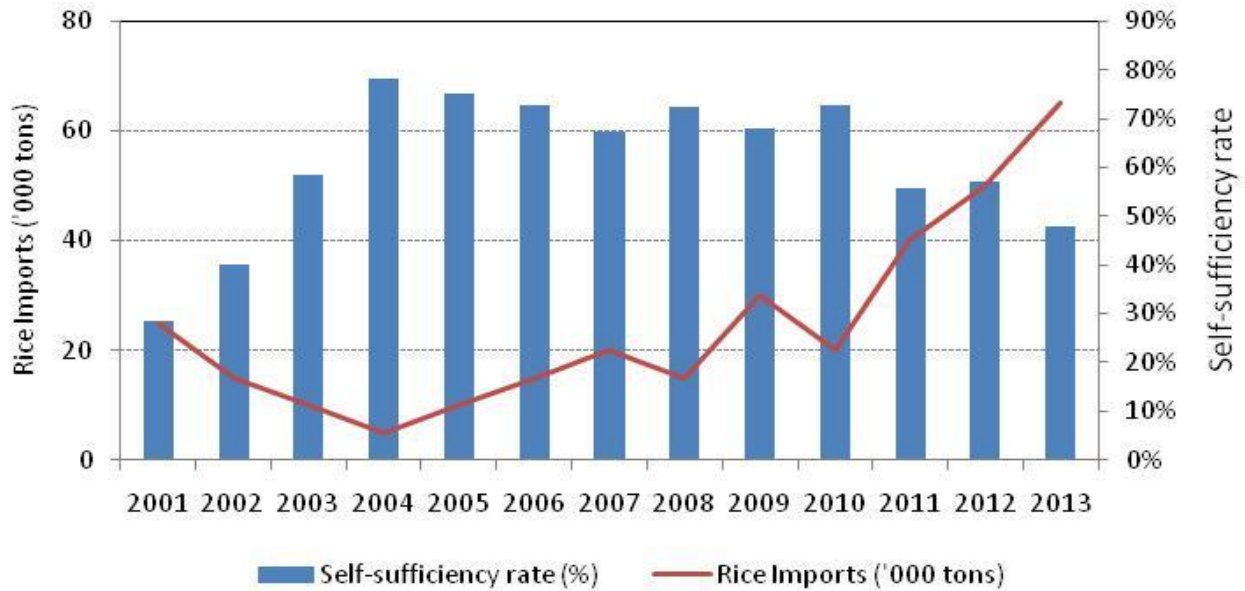


Fig.2: Volumes and dependency of imported rice in Rwanda⁶

Besides propping up the food security, the expansion of rice cultivation in the marshlands has opened new vistas for the poverty alleviation and economic development strategy of the government. Agriculture in the associated hills is often less sustainable than in the marshlands owing to fragile agro climatic features and extensive soil erosion in the slopes. Being a water loving crop, rice fortuitously thrives better in the valley swamps than most other food crops, especially during the rainy seasons and flash floods.⁷

Several rural development initiatives in Rwanda revolve around marshland reclamation and/or rehabilitation for rice cultivation. Owing to a relatively higher productivity of rice, the revenue generation opportunities amongst the farming communities living around marshlands have improved. Impact assessments of marshland interventions show that the mean annual consumption expenditure per adult in the rural populations living around reclaimed marshlands is higher than their peers in Rwanda and that poverty reduction amongst the marshland beneficiaries is more significant than in other rural areas.⁸ Furthermore, the rice production in marshlands has also

⁶ Compiled from FAO (local production) and USDA (importation) data

⁷ Jones and Beye (1997) Report on rice as a viable food crop in Rwanda; West African Rice Development Authority (Africa Rice)

⁸ World Bank (2013) Implementation Completion and Results Report (IDA – H4080); Rwanda Second Rural Sector Support Project

generated several on-farm and off-farm employment opportunities for the rural neighborhoods, especially the women and the youth.

Developmental activities in marshland play a central role in implementing NRDS in Rwanda by expanding the area under rice cultivation and developing rice value chain around the reclaimed/rehabilitated marshlands. Recent government initiatives such as crop intensification, proximity extension services and privatization of fertilizer importation and distribution and capacity building of value chain actors and supporters have invigorated the adoption of productivity enhancing technologies.⁹ In order to improve the quality of locally produced rice, the government has introduced several regulations in paddy procurement and processing and privatized the erstwhile public rice mills.

Technical on-farm technical demonstrations in Rwanda reveal that on-farm yield potential of most of the popular long grain varieties are in the range of 7.5 – 8.0 tons/ Ha.¹⁰ One of the major facets of on-farm productivity enhancement involves usage of good quality rice seed. However, the rice seed sub-sector in Rwanda remains largely under developed. Rwanda recently joined the Coalition for African Rice Development (CARD)'s initiative to support the development of rice seed value chain in its member countries. Under this initiative, a rice seed taskforce was formed to draw strategic approaches for improving the rice seed sub-sector in Rwanda. The purpose of this document is to analyze the current situation, recognize the challenges and opportunities, and draw a strategic roadmap for developing the rice seed value chain in Rwanda.

2. REVIEW OF NATIONAL RICE SEED SUB-SECTOR

2.1. Legislations and Policy

Currently the seed sub-sector in Rwanda is governed by its Law N° 14/2003 of 23/05/2003 on production, quality control and commercialization of plant quality seeds.¹¹ Although this law is presently being reviewed, it specifies that all seeds produced and marketed in Rwanda have to undergo quality control and certification. Seeds marketed without adhering to the Law will be punished by imprisonment from 8 days to 3 months and fined between 10,000 to 300,000 RWF. The Law states that it does not concern (or apply to) the farm saved seeds that are distributed between farmers with or without commercial interest (informal seed system). Nonetheless, the Law empowers the Minister of Agriculture to lay down decrees (Ministerial orders) according to which the control of seed production and marketing shall be regulated; without contradicting the Law n° 03/2002 governing Rwanda Bureau of Standards (RBS).

Under this law, the smallest unit from which all other classes of seed shall be produced is referred to as 'parental material'. The Law refers to the seeds derived from parental material as foundation (or pre-basic) seed.¹¹ Basic seed shall be multiplied from foundation (or pre-basic) seed. Both

⁹ Kalibata, A., Roy, A (2015) The fertile roots of Rwanda's green revolution; In: The Guardian

¹⁰ Nkima G et al. (2007) New High Yielding Rice Varieties for Sustainable Increase in Rice Production in Rwanda; In: Sustainable Agriculture Productivity for Improved Food Security and Livelihoods. Kigali Press, pp. 62-72

¹¹ Republic of Rwanda (2003) Official Gazette J.O.no special du 11/07/2003

foundation and basic seed destined for multiplication but has not yet attained commercial status shall also be referred as 'initial seeds'. The Law recognizes two classes of 'commercial seed' namely 'certified seed' and 'declared quality seed'. While the certified seed refers to commercial seed with accepted quality as the result of a systematic official control, the declared quality seed refers to seed declared by the producer that conform to the standards. However in recent communications and Ministerial decrees, the terminologies of these seed classes are replaced with nucleus seed, breeder seed, pre-basic seed, basic seed, certified seed and quality declared seed respectively.

Although the current laws in Rwanda does not explicitly set rules for protecting plant varieties, intellectual property rights are broadly governed by the Law of the protection of intellectual property N° 31/2009 of 26/10/2009. However since Rwanda is a member state of African Regional Intellectual Property Office (ARIPO), the recent adoption of 1991 protocol of International Union for the Protection of New Varieties of Plants (UPOV) by ARIPO to grant and protect breeders' rights, and new varieties of plants shall apply to Rwanda.¹²

The current national seed policy (2007) seeks for an organized and high performing seed commodity chain in Rwanda. It intends to improve the seed sector through a coordinated and complementary action of its public and private stakeholders. The policy outlines various approaches to promote collaboration of public services with private sector in order to ensure adequate production and supply of quality seeds and a strong awareness of farmers about the crucial importance of quality seeds in agricultural production. It emphasizes on capacity building in relation to variety development and regional cooperation and proposes a central role of private sector in the production and supply of quality seeds to agricultural farmers. The policy is presently being revised and a new policy draft is being discussed with the stakeholders.

2.2. Institutions and Planning on rice seed

Until recently, the former Institut des Sciences Agronomiques du Rwanda (ISAR) had long owned the responsibilities of production and distribution of all seed classes in the country. In 2005, Service des Semences Selectionnees was established within Ministry of Agriculture and Animal Resources (MINAGRI) which provided institutional support in partnership with Belgian Technical Cooperation (BTC) under a 5-year AFSAR (Appui a la Filiere Semenciere du Rwanda/ Rwanda seed commodity chain) project. After the creation of Rwanda Agriculture Development Authority (RADA) in 2006-07; the AFSAR project and multiplication of foundation (pre-basic) and basic seed moved to Service National Semencier (SNS) under RADA, while the responsibility of breeder seed production remained with ISAR. The SNS itself was later reformed into Seed Production Unit under RADA. Following the merger of RADA and ISAR in 2010-11, the institutional responsibility on production of breeder, pre-basic and basic seed has come under Rwanda Agriculture Board (RAB). At RAB, the production of breeder and pre-basic seeds is carried out by researchers under the 'Rice Sub-program', while the multiplication of basic seeds is done by 'Seed Unit' of RAB.

Directorate of Inspection under the RAB is responsible for inspection of seed production plots and quality control of all the seeds produced within Rwanda. RAB is also responsible for certifying the

¹² International Union for the Protection of New varieties of Plants (2015) Status in relations to UPOV

quality of seeds produced in Rwanda. For imported and exported seeds across the border, the Rwanda Bureau of Standards (RBS) is in charge of certification. RBS in collaboration with RAB and Rwanda Agriculture and Livestock Inspection and Certification Services (RALICS) is responsible for the enforcement of national and international plant health regulations and other phytosanitary measures necessary for trade.

Table 1: Institutions responsible for rice seed production, inspection and supply in Rwanda

		Name of institutions	Roles/Responsibility	Legislations/Policies determining responsibility
Overall	Production	Rice Sub program, RAB	RAB is in charge of rice seed production, inspection and supply at the level of breeder, pre-basic and basic seeds.	Prime minister's order n° 143/03 of 05/10/2011 determining the organizational structure and summary of job positions of Rwanda Agriculture Board ¹³
	Inspection	Directorate of Inspection, RAB		
	Supply/distribution	Seed Production Unit, RAB		
Breeder Seed	Production	Rice Sub program, RAB		
	Inspection	Directorate of Inspection, RAB		
	Supply/distribution	Rice Sub program		
Pre-basic Seed	Production	Rice Sub program		
	Inspection	Directorate of Inspection, RAB		
	Supply/distribution	Rice Sub program, RAB		
Basic Seed	Production	Seed Unit, RAB		
	Inspection	Directorate of Inspection, RAB		
	Supply/distribution	Seed Unit, RAB		
Certified Seed	Production	Registered Seed multipliers	Multiplication of certified rice seeds.	
	Inspection	RAB/Inspection unit	Inspection of certified seeds	
	Supply/distribution	Multipliers (farmers cooperatives)	Distribution of certified seeds to farmers	

Rwanda has developed a national seed master plan (2014-17) for all food and fodder crops. Besides this medium term (2014-2017), the rice unit under RAB prepares annual plans for rice seed multiplication in the country. A seed commodity chain consultative framework comprising of all stakeholders provide a platform for exchange of information and consultations on planning seed production and distribution in the country. This framework is responsible for overseeing the national seed policy and providing critical feedback on seed laws and regulations. Seed Traders Association of Rwanda (STAR) provides another platform for seed importers, merchants and seed producing cooperatives. A National Varietal Release Committee comprised of researchers, farmer associations and private sector is responsible for recommending the multiplication of seeds after the evaluation of varietal adaptability.

¹³ Republic of Rwanda (2011) Official Gazette N°04 of 24/01/2011

Through marshland development projects, development partners provide assistance in rice seed production. World Bank's Rural Sector Support Project (RSSP), Agro Action Allemande (GIZ; German Agency for International Cooperation), African Development Bank's Projet D'Appui Aux Infrastructures Rurales De La Region Naturelle Du Bugesera (PAIRB), International Fund for Agricultural Development (IFAD)'s Kirehe Community-based Watershed Management Project (KWAMP) directly assist seed producers under farmer cooperatives by facilitating the supply of basic seeds and training on seed production techniques. Although will be closed soon, the AFSAR project by BTC also presently provides technical and administrative assistance on rice seed value chain in Rwanda. Japan International Cooperation Agency (JICA) through its Smallholder Market-oriented Agriculture Project (SMAP) provides technical assistance on seed production and accessibility in rice growing provinces. Africa Rice through its regional projects such as Stress Tolerant Rice for Africa and South Asia (STRASA) - Phase II and Rice Germplasm project facilitate nucleus and breeder seeds.

2.3. Seed production

In Rwanda, two types of rice varieties viz., (i) short and bold grain and long and (ii) relatively slender grain are cultivated. The short grain type varieties (such as Yun Yine, Yun Keng, Zong geng, Yunertian) are collectively referred as Kigoli varieties. These varieties were once introduced through missions from China and Korea in Rwanda in 1960s. Pure/original seeds of these highly adapted varieties are presently not available in Rwanda. However, homogenous pools of the grains from the field grown plants are constantly renewed as source seeds by farmers and research stations alike. In 2003 and in 2010, ISAR (RAB) released several long grain varieties through participatory varietal selection (Table 2). These varieties were originally imported from international germplasm banks of Africa Rice and IRRI and introduced in Rwanda for their adaptability features. The breeder and pre-basic seeds are produced by the researchers in rice sub program at RAB. Basic seeds are then multiplied from the pre-basic seeds by the seed unit of RAB.

At the next level of seed class, both formal and informal means of seed production are followed. Under formal system of seed production, the registered seed producers (farmer cooperatives) produce certified seed. Other than the cooperatives, typical private seed enterprises or companies are presently not engaged in rice seed production. The registered cooperatives generally source the basic seed of varieties preferred by their farmers from RAB through an official request. Farmer cooperatives then generally engage select farmers or farmer groups in one of their marshlands for seed multiplication through informal contracting wherein the cooperatives facilitate the necessary inputs (basic seed, fertilizer, water and technical support) and collect seed from the seed producing farmers for a pre-fixed price. The registered seed producing cooperative formally arrange for field inspection and certification through the Directorate of Inspection of RAB. The certificate is usually issued in the form of an endorsement letter based on which the cooperative then distributes the seeds to individual rice growers within their own marshland(s) and other marshlands.

However since not all the cooperatives from all the rice growing marshlands are registered as seed producers, informal system of seed production has also crept in some of the marshlands. The farmer cooperative or individual farmers or farmer groups organize seed multiplication without formal contexts of seed sourcing and inspection. Unable to source the basic seeds from RAB and subject

the seed production fields to inspection, the seed producers use either grains or the certified seeds purchased from other registered seed producing cooperatives as source seeds and multiply without subjecting their fields to inspection. The seeds produced are then informally distributed to rice growers in their marshlands on a mutual trust basis.

The data on quantities of rice seeds produced in Rwanda of the past years are not traceable due to the recent restructuring of institutional responsibilities. Available remnant data on cumulative volumes of certified rice seed production reveal that about 94 tons in Southern zone, 145.6 tons in Eastern zone and 18 tons in Western zone were multiplied in 2014. Since rice is cultivated almost exclusively in marshlands, varieties released in Rwanda are adaptable to irrigated lowland (Table 2). Given a relatively higher yield performance of these varieties in marshlands, rice production in Rwanda is largely market oriented. Current regulations imply that rice growers generally sell most of their harvest to medium/large mills (>150 Kg/hr) personally and/or through cooperatives. Hand pounding of paddy and processing in rural small scale mills are uncommon amongst rice growers. Thus although rice is an important crop for the food security in Rwanda, it is generally grown as a cash crop.

Table 2: Names of varietal options available to rice growers in Rwanda

Agro-Ecological Zones	Name of Varieties (Market oriented)		
Irrigated Lowland	Released before 2003	Released in 2003	Released in 2010
	1)Yun Yin 2)Yun keng 3)Zongh geng 4)Yunertian	1) WAT 54 2) Instindagirabigega 3) Gakire 4) Inzinzi 5) Nerica 9 6) IRRI 64 7) Basmati370 8) BR153 9) Fashingabo	1) IR 78908-193-b-3-B (Kigega) 2) IR81431-B-B-162 (Nzahaha) 3) WAS161-B-6-4-FKR1 (Terimbere) 4) WAB 880-1-38-20-17-P1-HB (Rumbuka) 5) WAB 880-1-38-20-28-P1-HB (Nemeyubutaka) 6) WAB 569-35-1-1-1-HB (Kimaranzara) 7) WAB-569-35-1-1-1-HB (Ndamirabahinzi) 8) WAB 450-11-1-P31-1-HB (Muhinzi) 9) IR47686-13-2-2 (Kanyabukungu) 10) WAB 788-19-1-1-2-HB (Imberabyombi) 11) IR28 (Ndengera) 12) IR5 (Nsizebashonje) 13) IR68 (Garukuhinge) 14) IR6 (Mbakungahaze) 15) IR37 (Ndamirabana) 16) WAB1025-1-8-1-1-4-2-1 (Kungahara) 17) WITA 4 (Jyambere) 18) WAB923-B-6-AL1 (Mpembuke) 19) IR05N499 (Mbangukira) 20) WAB450-11-1-1-P24-HB (Cyicaró)
Rain-fed Lowland	N/A		

Rain-fed Upland	
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2.4. Quality Control

2.4.1. METHODS

RAB's Directorate of Inspection is responsible for the overall supervision of seed production and seed quality testing in Rwanda. RBS plays a complementary role in regulating the quality along the supply chain, including imported and exported seed lots. Wherever necessary, RBS engages both RAB and RALICS for implementing quarantine regulations of traded seeds.

For inspection of seed production fields, inspectors follow the protocols and procedures described by Organization for Economic Cooperation and Development (OECD). For laboratory based seed testing and sampling of seed lots along the supply chain, methods outlined by International Seed Testing Association (ISTA) are followed. Although not yet internationally accredited, the seed testing laboratory facilities for seed testing are located at RAB's Rubirizi station (in Kigali). The purity standard adopted by the Inspectorate is shown in table 3.

Table 3: Purity standard imposed on various seed classes

Features	Pre-Basic	Pre-Basic	Basic	Certified
Purity (Minimum; %)	99.9	99.0	98.0	98.0
Other seed (Maximum)	0.1	0.1	0.1	0.1
Inert matter (Maximum)	1.9	1.9	1.9	1.9
Moisture content (Maximum)	13.0	13.0	13.0	13.0
Germination (Minimum)	80	80	80	80
Blast <i>Pyricularia oryzae</i> (Maximum)	0.2	0.2	0.5	1.0
Objectionable weed seed (Maximum)	0.0	0.0	0.0	0.0
Restricted noxious weed seed (Maximum)	1 per kg	2 per kg	3 per kg	4 per kg

During field inspection, the Inspectorate insists on adoption of the following factors by seed producers;

- Selection of seed production sites*:- The rice variety to be grown for seed production in the chosen must be adapted to the microclimatic conditions prevailing in the given marshland.
- Selection of seed plot*:- The chosen production plots in the marshland must have adequate water resources, must be free from volunteer plants, weed plants and have good soil texture and fertility. The soil of the seed plot should be comparatively free from soil borne diseases and insects pests.
- Isolation distance*:- The rice crop must be isolated from other nearby fields of the same variety and the other contaminating crops by at least 5 m.
- Time of planting*:- Rice crop should invariably be sown at their normal planting time. Depending upon the incidence of diseases and pests, some adjustments, could be made, if necessary.
- Roguing*:- Roguing must be done at (i) vegetative / pre-flowering stage, (ii) flowering stage; and (iii) maturity stage
- Weed control*:- The seed plot in which rice is grown should be free of weeds at all stages.

- (g) *Pest and disease control*:- The occurrence of pests and diseases and the overall health of plant population is scored by the inspectors. The field in which seed is produced should be totally free of pest- and disease incidences.

The agronomic methods and managerial procedures for rice seed production and maintenance of rice seed purity are as described under OECD and ISTA protocols. The protocols for field inspection and assessment of harvested seed lots are summarized in tables 4 and 5 respectively. On arrival on the farm, the grower and a member of the registered seed producing cooperative should always accompany the seed inspector during the field inspection. This is particularly important in the case of a crop rejection or withdrawal of the crop from the certification. During the inspection, a general view of the crop is first done, followed by a detailed inspection of the crop. A quadrant walking pattern for every square meter for 10 random quadrants is followed to maximize field coverage. Within each quadrant a careful search is made for off-types and their numbers are counted.

Table 4: Procedure and methods for field inspection of seed production plots

Seed class	Frequency and timing of inspections	Items for inspection	Inspection methods
Breeder Seed	(1) First field inspection during flowering to check isolation, rogues, and other relevant factors (2) Second field inspection is made prior to harvest and after the seed has matured	An inspector must obtain a field number of that particular field from the researcher/breeder, field numbers are issued to every registered plot. Measuring tape for verification of isolation distance, Rice field seed standards, a pen, notebook, field inspection report form, if it is available GPS instrument to verify location and acreage of the field and cultivar description to help an inspector when conducting cultivar assessment.	Described under the Annex of the Working Tool
Pre-basic Seed	(1) First field inspection during flowering to check isolation, rogues, and other relevant factors (2) Second field inspection is made prior to harvest and after the seed has matured	An inspector must obtain a field number of that particular field from the certifying institute, field numbers are issued to every registered farmer. Measuring tape for verification of isolation distance, Rice field seed standards, a pen, notebook, field inspection report form, if it is available GPS instrument to verify location and acreage of the field and cultivar description to help an inspector when conducting cultivar assessment.	Described under the Annex of the Working Tool
Basic Seed	As for pre-basic seed	As for pre-basic seed	As for pre-basic seed
Certified Seed	As for pre-basic seed	As for pre-basic seed	As for pre-basic seed

After harvest, seeds are stored in warehouse where inspection must be carried to make sure the seed lots are identified. The effective identification of lot is done by proper labeling which should give such information as the name of the variety, the seed number of the crop and the number of the crop is the same as the number of the field. During the handling of seeds after the harvest, seeds harvested from different fields are not allowed to mix. Seed sampling is performed to assess the quality of seeds from the seed lots. The sampled seeds are generally tested for quality attributes such as analytic purity, moisture content, germination and seed health.

Table 5: Procedure and methods of harvested seed inspection

Seed class	Items for inspection	Inspection protocol
Breeder Seed	Sampler, pen, notebook, sampling bags	The post-harvest inspection of a seed crop covers the operations carried out at the threshing floor, transport of the raw seed produce to the processing plant, pre-cleaning, grading, seed treatment, bagging and post processing storage of the seed lot.
Pre-basic Seed	Sampler, pen, notebook, sampling bags	The post-harvest inspection of a seed crop covers the operations carried out at the threshing floor, transport of the raw seed produce to the processing plant, pre-cleaning, grading, seed treatment, bagging and post processing storage of the seed lot.
Basic Seed	As for pre-basic seed	As for pre-basic seed
Certified Seed	As for pre-basic seed	As for pre-basic seed

2.4.2. HUMAN RESOURCES FOR INSPECTION

Presently about 14 field inspectors and 5 laboratory staff work under the Directorate of Inspection. While the 5 laboratory staffs are stationed in the seed testing facility at Rubirizi, the field inspectors are posted in the five administrative zones/provinces (Eastern (5), Western (3), Southern (2) and Northern (3) and Kigali (1)). Of the 14 field inspectors, about 7 staffs are permanent and the remaining 7 are hired on a contractual basis. Four of the permanent field inspectors had worked for more than 3 years and had also received technical training through short term courses on inspection of seed quality and fields producing seed. The remaining field inspectors were recently recruited and possess less than 2 years of experience.

Projects such as World Bank's RSSP, BTC's AFSAR, IFAD's PAIRB and KWAMP and Agro Action Allemande provide training to the seed producers in their respective marshland sites. RAB provides technical support in these training programs. The trainings cover land preparation, transplanting techniques, roguing, harvesting, post harvest handling and storage of rice seeds. During the training, researchers and Inspectors from RAB provide technical advice on maintaining purity and preventing admixtures in the seed lots.

2.5. Seed Supply

RAB serves as the major source for breeder, pre-basic and basic seed supply in the country. Recently Inter City Mills (ICM) Rwanda Ltd., a private rice mill, has successfully tested the performance of some introduced varieties from Australia. Although the high yielding varieties from this test are not yet officially released, presently the seeds are directly controlled by ICM under a closed system. While the researchers supply the pre-basic seeds to RAB's seed unit which upon multiplication unit

supplies the basic seeds to the registered farmer seed producing cooperatives. The registered cooperatives supply certified seeds to members (rice growers) of marshland(s) that are under their management and also to those cooperatives which are not registered as seed producers. Under informal systems, a few individual farmers also access pre-basic seeds directly from the researcher through the varietal testing platform and/or access certified seeds from registered seed producing cooperatives multiply and engage in supplying certified seeds to fellow farmers. In the new marshlands, projects such as RSSP, KWAMP and PAIRB also represent key stakeholders in the supply routes for basic and certified seeds to farmers and seed producers (Table 6).

Table 6: Stakeholders engaged in rice seed supply in Rwanda

	Market varieties	Roles played	Subsistence varieties	Roles played
Breeder seed development/ Production/ supply	Rice Sub program (RAB)	Adaptability tests Multiplication of seeds of promising varieties	N/A	N/A
Pre-Basic seed production/ Supply	Rice Sub program (RAB)	Multiplication and distribution of basic seeds to Seed Production Unit and Cooperatives	N/A	N/A
Basic seed production/ Supply	Seed Unit (RAB), RSSP, Registered rice seed producing cooperatives	Multiplication and distribution of basic seeds to Cooperatives	N/A	N/A
Certified seed production	Registered rice seed producing cooperatives	Multiplication of certified seed and distribution to farmers	N/A	N/A
Distribution of seeds	RAB, Registered rice seed producing cooperatives, Rice mills	Ensure availability of quality rice seeds	N/A	N/A
Financing	BRD, Microfinance institutions, Rice Mills	Providing capital and/or inputs for cooperatives involved in seed multiplication	N/A	N/A
Others	Africa Rice	Supply of nucleus seeds, rice germplasm	N/A	N/A

Although the government does not provide subsidy for the uptake of certified seeds, MINAGRI plays an important role in facilitating and guiding the sources of supply of seeds in the country. A typical survey data on adoption of certified seed usage and seed renewal are not available. In general, farmers in registered rice seed producing cooperatives are supplied with fresh certified seeds every season. However, since only a few of the 10 registered cooperatives engage in regular certified seed production and there are several rice cooperatives which have not registered as seed producers; it is assumed that only about 40% of the rice farmers in the country use certified seeds (Table 7).

Table 7: Rice seed prices in Rwanda (in Rwandan Franc (RWF) where 1 USD = 750 RWF)

	Name of Varieties	Price information from the year 2014
Irrigated Lowland	All Long grain varieties	350 RWF = 0.50 USD/Kg
	All Short grain varieties	300 RWF = 0.41 USD/Kg
Rain-fed Lowland	N/A	
Rain-fed Upland	N/A	

Although a seed specific forum/platform is presently not available in Rwanda for engaging dialogues between the public and private stakeholders of seed sector, the government guides the stakeholders in determining the price for certified seeds. Seasonal price setting forum for grains and seeds engage RAB, MINAGRI, Ministry of Commerce (MINICOM), rice millers and representatives from rice cooperatives each season and agree on price. Issues affecting seed production and supply are often discussed at this forum.

3. CHALLENGES FACING RWANDA’S RICE SEED SUB-SECTOR

Rice seed sub sector is presently facing several serious challenges that threaten the sustainability of country’s rice production. The core of these challenges revolves around the quality of the rice seed available in the system which in turn stems from a number of limitations and shortcomings along the seed value chain.

3.1. Legislation, Policy, Institutions and Planning

The fragility of the rice seed value chain is partly due to a lack of clarity on several regulatory, policy and institutional mechanisms governing rice seed value chain in Rwanda. The present seed law in Rwanda does not clearly reflect the types of seed classes that are internationally recognized under formal systems. The law also neither does explicitly state if semi- or informal seed systems are not recognized nor the crop systems and conditions under which formal systems are difficult to apply. The varietal release committee is not empowered with sufficient funds and secretariat using which it can routinely. Hence, the performance of a large number of rice varieties available for cultivation in Rwanda is not yet officially verified for their claims by the researchers. Release of most of these varieties for cultivation had been largely informal.

Given the self pollinating nature of rice flowers, it is generally difficult for farmers to discern the genetic segregation or phenotypic changes from the plant populations of early generations of fresh seed lots, unlike in other often cross pollinating crops such as maize. Consequently the need for quality seed is often inadequately felt and hence the demand for fresh and authentic rice seeds is often ill conceived. For these reasons, rice seed industry is often overlooked by private sector. Yet rice is grown in Rwanda as a cash crop. It is therefore necessary for the national seed policy regulations to outline approaches that will ensure quality of the seeds of such self pollinating crops which bear commercial importance. The lack of clarity on policy and legal regulations however has led to multiplicity in rice seed systems (Table 8).

Table 8: Plurality of rice seed systems in Rwanda

Seed System	Description	Example
Mixed public/private	Breeding and production of some classes of seed production and distribution are undertaken by RAB (public); certified seed production, multiplication and distribution by cooperatives (private)	Registered seed producing cooperatives
Community based seeds	Seeds produced in other registered seed producing cooperatives are multiplied by progressive or trained farmers, and either sold or shared with farmers	Unregistered seed producing cooperatives
Farmer-based	Farmer saved seeds (or often grains), exchanged and/or sold as seeds between individual farmers	All marshlands
Closed value chains	Breeding (introduction), seed production, seed multiplication and seed distribution all undertaken by private sector only	ICM

Due to frequent institutional reforms in the recent past, the delicate network of responsibilities of seed maintenance, production and distribution was subject to several ambiguities. This has affected the institutional coordination between breeders, erstwhile basic seed production/distribution unit and the rest of the stakeholders along the rice seed value chain. This quandary was further exacerbated by the rising demand (in volume) for rice seed due to the rapid expansion of marshland areas under rice cultivation in the past decade. Although presently the production of breeder, pre-basic and basic seeds, and the inspection of quality of seeds are under the responsibility of RAB, the functional coordination between the two units is feeble and often withering.

Planning and budget allocation processes for production of breeder, pre-basic and basic seeds of rice varieties are sporadic and inconsistent. They are often informally prompted on the basis of instant and/or felt demands from the cooperatives. Since presently the basic seed production is also managed by RAB, the weak coordination between the planning and budgeting for production of breeder and pre-basic seeds and that for basic seeds compounds the entanglements amongst the available seed stocks for certified seed production. A comprehensive information database on production and stocks of seeds of the different classes of the rice varieties that can aid the planning and budgeting processes is presently not available in Rwanda.

Existing policies do not clearly demarcate the roles of public and private institutions on the production and supply of various seed classes of rice varieties. For instance, the roles of RAB and other public agencies in production of basic and certified seed production are not clearly defined. While breeder and pre-basic seeds are produced directly by the researchers under its rice sub program, other seed classes are also produced by a separate generic seed unit under RAB. Moreover, in the absence of an organized private seed industry in Rwanda, the current human resources under RAB are not adequate enough to meet the needs of the production and inspection of seeds for the different rice cultivars.

Seed prices are determined by a committee which also decides prices for grains based on the costs of production provided by RAB. However, since RAB is not a commercial entity, the cost estimation does not reflect the entrepreneurial costs on business management and marketing. Furthermore,

the meager profit margins along the production and supply chains leaves the seed production less attractive. For instance in 2015 Season B, although the seed price is set as 350 FRW/Kg for seeds of long grain varieties, the contracted seed producing farmer gets 300 FRW/Kg which is about 40 FRW higher than the farm gate price of paddy grains (260 FRW/Kg). Given the compensation that the seed producing farmer has to account for roguing and border row plants, the net revenue from a seed production plot is not significantly higher than that from a grain production plot especially in a smaller land holding. Thus from a business perspective, presently rice seed production is less alluring to progressive smallholder rice farmers and hence also to potential private entrepreneurs.

3.2. Production and Quality Control

The source materials of the popular short grain rice varieties in Rwanda remains a paradox. Because these varieties have long been in circulation amongst farmers and researchers since 1960s, it is highly likely that the original genetic composition has now been significantly eroded. Nevertheless, these varieties yet show good adoption to the local production environments. Hence it is also possible that over the past few decades; the plant population (and hence the seed lots) of these varieties have co-evolved with the environment and/or indirectly subject to benign selection by the users. However, until now no effort on either purification or improvement of these lines has been reported.

Ex situ and *in situ* preservation of the nucleus seeds of the released long grain rice varieties are not carried out by researchers in Rwanda. Instead, the researchers have long been subjecting the breeder seed to simple seed multiplications from the initial accessions through recycling. This could cause genetic erosion of the original accessions which once expressed the superior traits under marshland environment during the selection trials. In some instances, the original accessions of the released varieties couldn't be traced as the varieties were released without common names. In such instances, since the seed producing farmers and technicians have to use the long alphanumeric names for labeling during seed production, storage and distribution; the stakes for contamination and admixtures are high even under the formal rice seed system.

The feeble and often withering internal coordination between inspection and seed production arms of RAB leaves the quality assurance process with less relevance. Presently RAB's breeder, pre-basic and basic seed production plots are rarely reported to inspection and/or seldom scrutinized by the inspectors. Although the assumption that the researchers are competent enough to take proper precautions of their production plots slackens the inspection elements, the multiplication in reality is often done in open fields under the supervision of technicians who do not have the same depth of awareness on seed production and handling as the researchers.

Presence of genetic impurities and admixtures in upstream classes gets amplified during the subsequent multiplication of other seed classes (basic and certified). Registered seed producing cooperatives which produce most of the certified seeds often complain that the quality of basic seeds obtained from RAB is not satisfactory as they contain seeds of more than one variety. Technical knowledge of farmers engaged in multiplying seeds under cooperatives is very limited. Training programs offered to seed producing farmers are not routinely organized, inadequate and need stronger technical orientation. The fewer training opportunities organized by the development

partners focus rather more on one-time capacity building for the first-time seed producing farmers in newer marshlands than for the already established marshlands.

With an already lower farm gate price difference for seed over grain (about 40 FRW), the seed producing farmers are generally reluctant to identify and remove off type plants as such roguing could add production costs and yet minimize the volume of output. Often the seed producing farmers use the same threshing and drying yards that the other grain producing farmers in the neighborhood use. Such lack of exquisite post harvest handling and storage facilities could introduce admixtures into seed lots. The lack of incentives for producing good quality seed further afflicts the system by failing to encourage good production practices amongst seed producing farmers under the cooperatives. Such shortcomings in differentiating the produced seeds based on quality features directly set a treacherous predicament amongst seed users in the neighborhood who do not see the added value.

Given the limited human resources and inadequate monitoring mechanisms for the rice seed sector, enforcement of inspection and penalty for not adhering to the regulations remains a serious challenge for Rwanda's rice seed sector. Most of the inspectors are not experienced or trained in rice seed production and inspection protocols. The available inspectors are not proportionally distributed in rice growing zones. This makes inspection costly and untimely. Tagging of certified seeds does not follow the recommended procedures under OECD. Upon inspection of fields and seed lots, certification is issued by providing a letter of quality acceptance for the entire lot at once. However, when the produced seeds are distributed to farmers in smaller quantities, they are not tagged with a label of certification; allowing more space for informalities to creep in.

3.3. Seed Supply

Although the supply of the seeds of upstream classes (breeder and pre-basic) is not a major limitation in Rwanda, the quality of these seeds lacks the necessary mettle that can assert confidence in the rice seed supply chain. Most of the released long grain rice varieties in Rwanda were originally once sourced from international germplasm collection at AfricaRice and IRRI. These nucleus seeds however are not being constantly renewed to refresh the entire seed supply chain. The available breeder and pre-basic seed lots represent outcomes of repeated multiplication of the nucleus seed lots once supplied by international genbanks. Information management on the multiplication of the different seed classes along the supply chain is not in place. Hence in most instances, the existing stocks of seeds could not be traced to the source seeds rendering harsh challenges in storage and distribution.

The registered seed producing cooperatives access basic seeds for the production of certified seeds from RAB. However, due to inefficient institutional streamlining of processing of the requests from cooperatives between researchers, seed units and administration, the timeliness of seed supply is often poor. In most cases, the cooperatives circumvent the institutional issues by approaching the researchers directly for the supply of seeds. The basic seeds supplied to the registered rice seed producing cooperatives by RAB however are not always accompanied by a certificate of quality assurance. In some instances, a few individual farmers who are not registered as seed producers also access pre-basic and basic seeds directly from the researchers through their accessibility to varietal

testing platform. Such practices allow several informalities to creep into the system and thereby undermine the quality of rice seed distributed down the supply chain.

Most of the registered cooperatives lack adequate storage facilities to stockpile the basic seeds sourced from RAB and certified seeds produced by its contracted farmers. Limitations in such infrastructures and information management systems often inadvertently expose the seeds to impure and off type seeds (admixtures), shorter shelf life and quality degradation before and during the distribution. Rice cooperatives which are not registered as seed producers and represent other marshlands are supplied with certified seeds from the 10 rice cooperatives that are authorized to produce certified seeds. A few established cooperatives representing other marshlands however show hesitation to procure certified from the authorized seed producing cooperatives. Besides a conservative mindset, it is also because the cooperatives prefer to be self dependent and hesitate to place higher value for seeds coming from other cooperatives. The need for arranging the transportation logistics through rugged landscapes and the associated costs also adversely influence the supply of rice seeds between marshlands.

Although the farmers under the registered rice seed producing cooperatives readily access certified seeds as part of the input support services provided by the cooperatives, the accessibility and adoption of certified seeds in other non-registered seed cooperatives prevails low. Yet the quality of the certified seed remains an important factor in seasonal renewal of certified seeds by farmers within the registered seed cooperatives. The absence of any significant means of sharing of information on availability and accessibility of certified rice seeds also affects the efficiency of supply of certified seeds amongst marshlands. Moreover, since rice seed producing cooperatives are run on a social model rather than a private business model, marketing mechanisms of their certified seeds in other marshlands often do not exist or in cases where it is attempted, the efforts are generally subdued. Given the human capacity constraints and multi-tasking of existing public extension service personnel, promotion of adoption of certified seed usage by farmers is largely carried out at the cooperative level. Hence the promotion of certified seeds amongst farmers in marshlands served by non-registered cooperatives is not substantial enough to improve the adoption.

4. ROADMAP FOR RICE SEED DEVELOPMENT

4.1. Vision and Scope

This document outlines a roadmap for developing rice seed sub-sector in Rwanda in order to facilitate achieving the goal of tripling rice production as outlined in the National Rice Development Strategy (NRDS).

The vision of this roadmap is set to become a 'leading, market-responsive, quality rice seed system for Rwanda and the region'. The scope of the roadmap covers all elements within the framework of rice seed value chain. This includes policies, legislations and, institutional elements that provide the environment for production and distribution of rice seeds.

4.2. Position of the Roadmap

Development of the rice seed value chain proposed in this document shall form an intrinsic component of the implementation of the NRDS. The NRDS is already well integrated with the Strategic Plan for the Transformation of Agriculture in Rwanda - Phase III (SPAT/PSTA-III; 2013-17)¹⁴. Since PSTA represents the medium term sector wide implementation framework for agriculture under Rwanda's Economic Development and Poverty Reduction Strategy (EDPRS-II; 2013-2018)¹⁵, it is conceivable that this roadmap fits into the overall national developmental context envisaged under the country's Vision 2020¹⁶.

4.3. Goal and Objectives

The goal of this roadmap is to enhance the competitiveness of Rwanda's rice sector by galvanizing the seed value chain through integrated approaches. The roadmap aims to achieve this goal through a set of interventions timed for the period of 2016 to 2020. While the general objective is to improve the efficiency of the rice seed production and distribution systems; the specific objectives of the roadmap include the following:-

1. Build capacities of the stakeholders engaged in rice seed value chain (including technical staff, inspectors, producers, and users of seed)
2. Develop rice varieties that address the biotic and abiotic challenges in local production environment, and consumer demand
3. Facilitate the availability of and accessibility to 'quality' source seeds for all classes of seeds of all rice varieties
4. Strengthen the linkages between rice seed value chain stakeholders (actors and supporters)
 - a. In-house coordination between research, seed production, inspection and extension units of RAB
 - b. Stakeholder forums to facilitate market information sharing, market driven pricing, private sector engagement, feedbacks
5. Improve the penetration of seed related extension services including information, production, adoption and promotion of quality seeds, and organization
6. Provide enabling environment for sustainable rice seed value chain development through facilitation of infrastructure, human capacity, financing, pricing, marketing and regionally well integrated seed laws, policies and regulations

4.4. Implementation Structure

The roadmap for developing the rice seed value chain will be implemented through NRDS framework. While the rice seed taskforce members will provide the necessary technical inputs to the implementation process, the NRDS taskforce members will monitor and evaluate the implementation of this roadmap on an annual basis. The required funds for carrying out the proposed activities will be mobilized by the NRDS taskforce members by approaching the government, development partners and other public and private stakeholders of the rice seed sub-sector. The NRDS taskforce

¹⁴ Ministry of Agriculture and Animal Resources, Republic of Rwanda (July 2013) Strategic Plan for the transformation of agriculture in Rwanda

¹⁵ Ministry of Finance and Economic Planning, Republic of Rwanda (May 2013) EDPRS2 – Shaping Development

¹⁶ Ministry of Finance and Economic Planning, Republic of Rwanda (July 2000) Rwanda Vision 2020

will also be responsible for ensuring a cohesive coordination amongst stakeholders by organizing a national platform and providing feedback to the government and development partners on such contexts as policy, laws, human resources, production, supply and finance for the advancement of the rice seed sub-sector. The NRDS taskforce will also engage in further refinement of strategic approaches described in this document and evolve new and modified interventions according to dynamics of the rice seed value chain in the country and the region.

5. STRATEGIES

5.1. Strategic Principles and Approaches

Facilitating availability and accessibility of quality seeds to rice farmers through both the formal and informal rice seed systems forms the principle of the strategic interventions proposed under this roadmap. Since growing rice in Rwanda tends to foster cultures that are more symbiotic and interconnected amongst the rice growers, the cooperatives become pivotal to the strategic improvement of the seed value chain in Rwanda. Given the preciousness of the limited human resources in technical support and inspection, and participation of large private sector in rice seed business in Rwanda, the options for the strategic improvement of rice seed value chain shall involve (a) a slightly centralized seed production model in which two or a few marshlands produce quality rice seeds of all the varieties and distribute to the entire country in an exclusive fashion and/or (b) facilitation of major rice millers in the country to produce quality certified seed of the market oriented varieties and supply the certified seeds through fair entrepreneurial spirits.

5.1.1. Cooperative based oligopolistic seed production and distribution

Under this proposed model, a slightly centralized rice seed production mode is envisaged. A few large, viable rice cooperatives shall be allowed to produce quality seeds of the rice varieties that are demanded by the market. Given the limitations in human resources for inspection, such oligopolistic seed supply chain shall be efficiently monitored for quality assurance. Technical assistance on seed production and training of seed producers could also be more productive and cost effective as the producers will be concentrated in a fewer marshlands. The source seeds and distributed seeds shall be effectively traced and issues on varietal integrity shall be quickly resolved. Financial, logistical and other technical support for seed production and supply chains shall be efficiently channelized to the cooperatives. Moreover, since rice cooperatives in Rwanda are owned by the farmers they serve and are largely guided by social moralistic principles that reflect the best interests of the consumers (seed users); cooperative businesses can be felt as more judicious in promoting adoption of certified rice seeds.

5.1.2. Miller based seed production and distribution

Under this model, millers shall be facilitated to produce quality rice seeds of the market preferred varieties. Millers shall engage individual progressive farmers from their operational areas on a contract basis and distribute to cooperatives and individual farmers. However, since involvement of cooperatives in the seed production could introduce conflict of interest in such key business elements as side selling of seeds, price negotiation, contractual agreements with the seed producing farmers and grain sales (for processing), this model does not envisage any functional roles for cooperatives in rice seed production by the contracted individual farmers under the millers. Existing

agro dealer network through which other farm inputs such as fertilizers are distributed shall be considered for the supply of certified seeds. Since millers are expected to be more conscious of quality of the ultimate product (grain), it is highly likely that this approach shall substantially enhance the market competitiveness of locally produced rice. Furthermore, despite the low profit margin observed in rice seed business under the present situation, the miller is perhaps the only private sector segment who may become willing to absorb during the business development as they stand to tap additional benefits from the grain quality and capacity utilization of mills.

5.2. Target Setting

This roadmap aims to gradually increase the usage of certified seeds amongst rice farmers at a rate of 10% per year; from the current level of 40% (2015; base year) to 90% by 2020. Since the physical area under rice cultivation is planned to increase to 28,500 Ha (for both the seasons) under the NRDS by 2018, the total rice seed production targets for the various seed classes are estimated according to the NRDS period (up to 2018) and proportionally extrapolated for the period between 2018 and 2020 (Table 9). The estimated land area required for multiplying the above targets under the roadmap are shown in table 10.

Table 9: Amounts of rice seeds required for the next 5 years in Rwanda

	Targeted Seed production volumes (g or Kg or MT/year)					
	2015	2016	2017	2018	2019	2020
Breeder Seed (gram)	58.67	80.00	106.4	134.4	165.6	n/a
Pre-basic Seed (Kg)	7.33	10.00	13.3	16.8	20.7	n/a
Basic Seed (tons)	1.10	1.50	2.0	2.5	3.1	n/a
Certified Seed (tons)	n/a	220.0	300.0	399.0	504.0	621.0

Table 10: Physical Land (or greenhouse) area required for seed multiplication

	Target Area for Seed Production					
	2015	2016	2017	2018	2019	2020
Breeder Seed (Sq. m)	0.2347	0.3200	0.4256	0.5376	0.6624	n/a
Pre-basic Seed (Sq. m)	24.44	33.33	44.33	6.00	69.00	n/a
Basic Seed (Ha)	0.31	0.43	0.57	0.72	0.89	n/a
Certified Seed (Ha)	n/a	55.0	75.0	99.8	126.0	155.3

Despite the market advantages for the long grain rice varieties, rice growers in Rwanda prefer to cultivate short grain rice varieties which have shown adaptation to a wide range of stress environments in the marshlands.¹⁷ Hence recent government policies promote cultivation of long grain rice varieties in higher proportions (up to 70%) than the short grain varieties (about 30%) in order to meet the market demands. Accordingly, the targeted seed volumes and the corresponding area required for multiplication for the certified seed (tables 11 and 12), basic seed (tables 13 and 14), pre-basic (tables 15 and 16) and breeder seed (tables 17 and 18) of the presently popular varieties are shown below. It shall be noted however that, one shall expect a shift in farmers'

¹⁷ Rural Sector Support Project (2013) Rice Farm Surveys

demand for these varieties as newer rice cultivars will be introduced during the period of this roadmap. Nevertheless, it shall be assumed that this equilibrium in dynamically changing varietal preference shall be offset amongst each other within the estimated total volumes of seeds. To safeguard against any abrupt changes, a separate category (others) is also included in the tables below.

Table 11: Amounts of certified seeds of the popular rice varieties in Rwanda

Varieties	Target amount (MT/year)					
	2015	2016	2017	2018	2019	2020
Yun Yine	n/a	44.0	60.0	79.8	100.8	124.2
Yun Keng	n/a	33.0	45.0	59.9	75.6	93.2
Rumbuka	n/a	33.0	45.0	59.9	75.6	93.2
Ndamirabahinzi	n/a	11.0	15.0	20.0	25.2	31.1
Mpembuke	n/a	11.0	15.0	20.0	25.2	31.1
Gakire	n/a	11.0	15.0	20.0	25.2	31.1
Insinzi	n/a	11.0	15.0	20.0	25.2	31.1
Intsingirabigega	n/a	11.0	15.0	20.0	25.2	31.1
Fashingabo	n/a	22.0	30.0	39.9	50.4	62.1
Others (on-demand basis e.g. Basmati 370; includes future introduction)	n/a	33.0	45.0	59.9	75.6	93.2
Total	n/a	220.0	300.0	399.00	504.00	621.0

Table 12: Land area required for the production of targeted certified seeds of different rice varieties

Varieties	Target Area (Ha/year)					
	2015	2016	2017	2018	2019	2020
Yun Yine	n/a	11.00	15.00	19.95	25.20	31.05
Yun Keng	n/a	8.25	11.25	14.96	18.90	23.29
Rumbuka	n/a	8.25	11.25	14.96	18.90	23.29
Ndamirabahinzi	n/a	2.75	3.75	4.99	6.30	7.76
Mpembuke	n/a	2.75	3.75	4.99	6.30	7.76
Gakire	n/a	2.75	3.75	4.99	6.30	7.76
Insinzi	n/a	2.75	3.75	4.99	6.30	7.76
Intsingirabigega	n/a	2.75	3.75	4.99	6.30	7.76
Fashingabo	n/a	5.50	7.50	9.98	12.60	15.53
Others (on-demand basis e.g. Basmati 370; includes future introduction)	n/a	8.25	11.25	14.96	18.90	23.29
Total	n/a	55.00	75.00	99.75	126.00	155.25

Table 13: Amounts of basic seeds of the popular rice varieties in Rwanda

Varieties	Target amount (MT/year)					
	2015	2016	2017	2018	2019	2020

Varieties	Target amount (MT/year)					
	2015	2016	2017	2018	2019	2020
Yun Yine	0.22	0.30	0.40	0.50	0.62	n/a
Yun Keng	0.17	0.23	0.30	0.38	0.47	n/a
Rumbuka	0.17	0.23	0.30	0.38	0.47	n/a
Ndamirabahinzi	0.06	0.08	0.10	0.13	0.16	n/a
Mpembuke	0.06	0.08	0.10	0.13	0.16	n/a
Gakire	0.06	0.08	0.10	0.13	0.16	n/a
Insinzi	0.06	0.08	0.10	0.13	0.16	n/a
Intsindagirabigega	0.06	0.08	0.10	0.13	0.16	n/a
Fashingabo	0.11	0.15	0.20	0.25	0.31	n/a
Others (on-demand basis e.g. Basmati 370; includes future introduction)	0.17	0.23	0.30	0.38	0.47	n/a
Total	1.10	1.50	2.00	2.52	3.11	n/a

Table 14: Land area required for the production of targeted basic seeds of different rice varieties

Varieties	Target Area (Ha/year)					
	2015	2016	2017	2018	2019	2020
Yun Yine	0.06	0.09	0.11	0.14	0.18	n/a
Yun Keng	0.05	0.06	0.09	0.11	0.13	n/a
Rumbuka	0.05	0.06	0.09	0.11	0.13	n/a
Ndamirabahinzi	0.02	0.02	0.03	0.04	0.04	n/a
Mpembuke	0.02	0.02	0.03	0.04	0.04	n/a
Gakire	0.02	0.02	0.03	0.04	0.04	n/a
Insinzi	0.02	0.02	0.03	0.04	0.04	n/a
Intsindagirabigega	0.02	0.02	0.03	0.04	0.04	n/a
Fashingabo	0.03	0.04	0.06	0.07	0.09	n/a
Others (on-demand basis e.g. Basmati 370; includes future introduction)	0.05	0.06	0.09	0.11	0.13	n/a
Total	0.31	0.43	0.57	0.72	0.89	n/a

Table 15: Amounts of pre-basic seeds of the popular rice varieties in Rwanda

Varieties	Target amount (Kg/year)					
	2015	2016	2017	2018	2019	2020
Yun Yine	1.47	2.66	2.66	3.36	4.14	n/a
Yun Keng	1.10	2.00	2.00	2.52	3.11	n/a
Rumbuka	1.10	2.00	2.00	2.52	3.11	n/a
Ndamirabahinzi	0.37	0.67	0.67	0.84	1.04	n/a
Mpembuke	0.37	0.67	0.67	0.84	1.04	n/a
Gakire	0.37	0.67	0.67	0.84	1.04	n/a

Varieties	Target amount (Kg/year)					
	2015	2016	2017	2018	2019	2020
Insinzi	0.37	0.67	0.67	0.84	1.04	n/a
Intsingirabigega	0.37	0.67	0.67	0.84	1.04	n/a
Fashingabo	0.73	1.33	1.33	1.68	2.07	n/a
Others (on-demand basis e.g. Basmati 370; includes future introduction)	1.10	2.00	2.00	2.52	3.11	n/a
Total	7.33	13.30	13.30	16.80	20.70	n/a

Table 16: Land area required for the production of targeted pre-basic seeds of the different varieties

Varieties	Target Area (Sq. m/year)					
	2015	2016	2017	2018	2019	2020
Yun Yine	4.89	6.67	8.87	11.20	13.80	n/a
Yun Keng	3.67	5.00	6.65	8.40	10.35	n/a
Rumbuka	3.67	5.00	6.65	8.40	10.35	n/a
Ndamirabahinzi	1.22	1.67	2.22	2.80	3.45	n/a
Mpembuke	1.22	1.67	2.22	2.80	3.45	n/a
Gakire	1.22	1.67	2.22	2.80	3.45	n/a
Insinzi	1.22	1.67	2.22	2.80	3.45	n/a
Intsingirabigega	1.22	1.67	2.22	2.80	3.45	n/a
Fashingabo	2.44	3.33	4.43	5.60	6.90	n/a
Others (on-demand basis e.g. Basmati 370; includes future introduction)	3.67	5.00	6.65	8.40	10.35	n/a
Total	24.44	33.33	44.33	56.00	69.00	n/a

Table 17: Amounts of breeder seeds of the popular rice varieties in Rwanda

Varieties	Target amount (g/year)					
	2015	2016	2017	2018	2019	2020
Yun Yine	11.73	16.00	21.28	26.88	33.12	n/a
Yun Keng	8.80	12.00	15.96	20.16	24.84	n/a
Rumbuka	8.80	12.00	15.96	20.16	24.84	n/a
Ndamirabahinzi	2.93	4.00	5.32	6.72	8.28	n/a
Mpembuke	2.93	4.00	5.32	6.72	8.28	n/a
Gakire	2.93	4.00	5.32	6.72	8.28	n/a
Insinzi	2.93	4.00	5.32	6.72	8.28	n/a
Intsingirabigega	2.93	4.00	5.32	6.72	8.28	n/a
Fashingabo	5.87	8.00	10.64	13.44	16.56	n/a
Others (on-demand basis e.g. Basmati 370; includes future introduction)	8.80	12.00	15.96	20.16	24.84	n/a
Total	58.67	80.00	106.40	134.40	165.60	n/a

Table 18: Land or Greenhouse area required for the production of targeted breeder seeds

Varieties	Target Area (Sq. m/year)					
	2015	2016	2017	2018	2019	2020
Yun Yine	0.047	0.064	0.085	0.108	0.132	n/a
Yun Keng	0.035	0.048	0.064	0.081	0.099	n/a
Rumbuka	0.035	0.048	0.064	0.081	0.099	n/a
Ndamirabahinzi	0.012	0.016	0.021	0.027	0.033	n/a
Mpembuke	0.012	0.016	0.021	0.027	0.033	n/a
Gakire	0.012	0.016	0.021	0.027	0.033	n/a
Insinzi	0.012	0.016	0.021	0.027	0.033	n/a
Intsindagirabigega	0.012	0.016	0.021	0.027	0.033	n/a
Fashingabo	0.023	0.032	0.043	0.054	0.066	n/a
Others (on-demand basis e.g. Basmati 370; includes future introduction)	0.035	0.048	0.064	0.081	0.099	n/a
Total	0.235	0.320	0.426	0.538	0.662	n/a

5.3. Human Resources

Capacity of both the rice seed value chain actors and supporters require to be built under this roadmap. Technical and management capacities of the existing public and private personnel involved in production, maintenance, inspection services and marketing of seeds of all the classes (breeder, pre-basic, basic and certified) will be upgraded through in-country short-term training courses. Knowledge and hands-on training on refreshing the different seed classes, maintenance methods, labeling and tagging of seed materials during storage and distribution and seed grades will be enriched amongst technical staff (Table 19). For the seed producing farmers, field training workshops will be organized on a routine basis. Areas of training will include good agriculture practices; identification and roguing of off type plants and seeds; harvesting and post harvest handling of seeds. Besides seed producing farmers, awareness on the importance of usage of certified seed production will be disseminated amongst farmers in rice growing marshlands.

Table 19: Gaps in human resources for breeder, pre-basic and basic seed production

Seed Class	Name of Seed Producing Stations	Researcher		Gap	Technician		Gap
		Required	Available		Required	Available	
Breeder, Pre-basic seed	Rubona, Nyagatare, Ntendezi, Ngoma, Karama	7	7	0	3	3	0
Basic seed	Mututu + future possibilities at Bugarama/other places	0	0	0	2	1	1
	Total	7	7	0	5	4	1

Redistribution of existing inspectors into the different rice growing provinces is important for effective inspection of seed production. Technical expertise of inspectors and laboratory based seed testing staffs will be improved through overseas short-term training courses on quality features of

rice seed production, storage and supply chain. Table 20 illustrates the proposed geographical deployment of inspectors and their training needs.

Table 20: Gaps in human resources for seed inspection

Geographical area	Number of Inspectors			Required Capacity of Inspectors		Means and Budget required
	Required	Available	Gap	Knowledge	Experience	
Eastern Province	4	5	-1	Only 4 have good training	>0 years	3-weeks training (Field+Lab Staff): Overseas: =51,500 USD/year For both field & lab staff In-country: =20,000 USD/year
Western Province	2	3	-1			
Southern Province	4	2	+2			
Northern Province	2	3	-1			
Kigali	2 (+5)	1 (+5)	+1			
Total	14+5	14+5	0			71,500 USD/year

5.4. Seed Supply

Analytical surveys on seed usage, seed demand and varietal preferences of rice farmers will be conducted on a regular basis to match the demand and supply of rice seeds. Enhancing the quality and timeliness of supply of certified seeds in Rwanda requires significant improvement in the quality of source seeds (breeder, pre-basic and basic). Renewal of nucleus seeds from the germplasm centers and maintenance breeding of all the improved cultivars will be emphasized under the proposed roadmap. The necessary technical and financial capacities that are required for maintaining the supply of basic seeds of both the short- and long grain rice varieties will be facilitated. Record keeping of breeder, pre-basic, basic and certified seeds will be modernized to improve the traceability of seeds along the supply chain.

Capacity constraints on inspecting the production of seeds will be addressed so as to improve the timeliness of supply of certified seeds. Displaying the technical features of the rice seeds should be appropriately displayed on the packets/bags of rice seeds. Tagging and bagging protocols for certified rice seeds will be introduced and the implementation of the practices will be monitored. Infrastructures that could improve seed processing and seed storage will be established through public-private partnerships in strategically critical routes of rice seed distribution.

Presently government of Rwanda does not provide any subsidy towards the purchase of certified rice seed by the farmers. However, the prices set by the committee are underweighted and therefore kept low. Under this roadmap, policy recommendations for prices to be driven by market forces will be emphasized for the long term sustainability of stakeholders engaged in rice seed value chain. An easily accessible web based online market information system on current production activities, availability of seed stocks of different rice varieties, prices and complaints/feedbacks will be set up to facilitate exchange of information amongst all stakeholders. Private sector participation in logistics and supply of rice seeds will be enhanced through policy, institutional and financial assistance.

5.5. Intervention Options

Analyses of the current situation and the challenges and opportunities of the rice seed sub-sector reveal that several intervention options exist for improving the legal, policy and institutional regulations; and technical and inspectoral aspects of rice seed production and distribution in Rwanda. These options are listed below. However, it shall be noted that each of the proposed option needs to be further discussed thoroughly with the stakeholders before considering implementation:

5.5.1. Legislations, Policy, Institutions and Planning

- Refinement of the present seed laws in Rwanda so as to clearly reflect
 - the different seed classes in synchronization with regional and international systems and
 - clarity on recognition of formal and informal seed systems for rice
- Enforcement of seed systems through stricter repercussions or penalties for lack of adherence (to inspection, quality standards) through Ministerial Order for 'all seed classes'
- Establishment of a clear mechanism for guiding the seed price according to the market forces (including supply, demand, margins, all costs of production and inspection)
- National seed policy shall
 - distinguish the roles of RAB and other stakeholders in production and supply of the various seed classes
 - put in place mechanisms for internal coordination between research, inspection and seed production arms of RAB
 - improve the functionality of varietal release committee by setting up a Secretariat and routine funding for the operations
 - clarify the roles of Directorate of Inspectorate and Rwanda Bureau of Standards in assuring quality of the rice seeds along the supply chain
 - establish monitoring and evaluation systems for the seed sector
 - ascertain international accreditation of seed inspection and testing institution
- Reallocation of the existing and future inspection staff according to the expected work load in the different provinces
- Considerations on setting up a NRDS/Rice Secretariat for national coordination on rice value chain through discussions with JICA, FAO and other development partners
- Creation of a forum for stakeholders to facilitate public-private dialogues on various issues, challenges, recommendations and feedbacks on rice seed value chain
- Harmonization of national seed regulations with that of regional and international economic unions (EAC, COMESA) for smoothening of seed trade
- Encouraging youth and women rural entrepreneurs in rice seed production, marketing and promoting the use of quality seed

5.5.2. Production and Inspection

- Renewal of breeder seeds of all the released rice varieties by multiplying afresh from the original accessions or germplasm or parental materials as appropriate
- Making the descriptions of the prevalent short- and long grain rice cultivars available to the seed producers, inspectors and seed users
- Improved public-private partnerships in research and development of varieties, maintenance breeding of existing varieties, multi-location testing and seed production
- Surveys on rice seed demand, production (volumes, costs), supply (stocks, accessibility), preferred varieties and bottlenecks in marshlands
- Training of researchers and technicians on nucleus, breeder and pre-basic seed production, storage and seed purity management
- Training of inspectors and laboratory seed testing staffs on the various technological means of scrutiny of locally produced rice seeds
- Validate and introduce appropriate labor and cost saving machineries/tools (including transplanters, hand held/motorized row weeders, harvesters and threshers) in smallholder rice seed production systems
- Set and engage local planning and monitoring committees in different rice producing areas to provide forecasts on seed demands and quality related issues
- Training of seed producing farmers under the registered cooperatives on productivity enhancing technologies, inspection and quality features
- Routine Government funding through RAB to facilitate acquisition, storage and maintenance of nucleus, breeder and pre-basic seeds on an annual basis
- Self financing mechanisms for basic rice seed production through seed unit (Rubirizi) at RAB by refunding the sales money on seeds
- Intensified public extension services for seed users (awareness creation, information on availability and accessibility) engaged in rice seed value chain
- Improved logistics (transportation, hand-held equipments and sophisticated time saving kits) for field inspectors
- Capacity building of the registered seed producing cooperatives on rice seed business (production and marketing) and financial management practices

5.5.3. Seed Supply

- Ensuring that a critical reserve of fresh source seeds (breeder and pre-basic) of all the short- and long grain rice varieties is constantly available
- Streamlining of request routes for pre-basic and basic seeds from the stakeholders through seed units in order to avoid informalities in supply of these seeds
- Promotion of marketing linkages between registered seed producing cooperatives and other marshlands which do not belong to the registered seed producing cooperatives
- Improve demand for quality seeds by creating awareness on the importance amongst rice growers through demonstrations, mass media/communication and other extension methods
- Improvement of packaging and labeling practices by;
 - promoting small (<5 Kg) and medium (<20 Kg) packaging of rice seeds

- labeling with comprehensible tags carrying seed class; species and varieties of seed lot number; date of production/sealing; weight of the packet, and certificate number
- introducing low cost packaging technologies using locally available resources for seed distribution
- Engaging agro-dealer network in selling certified rice seeds
- Investments on infrastructures supporting quality seed production (e.g. threshing/drying yards), storage (cold warehouses, rural electricity) and seed supply (rural transportation and communication) through public-private partnerships
- Establishment of an accessible, comprehensive information management system for all the seed classes of the different rice varieties
- Promote linkages between seed users, seed producers, cooperatives, millers and agro-dealers so as to synergize their mutual interests and benefits along the rice value chain
- Improved vigilance and enforcement of standard practices during the distribution of rice seeds along the supply chain

6. ANNEXURE

6.1. Working tool (Questionnaire) on Rwanda's seed sub-sector

(Attached as a separate file)