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Is Doubling Rice Production in Kenya by 2018 Achievable?

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With a population of 40 million, an annual population growth rate of 2.7% and recent rainfall deficits threatening its food security, Kenya needs to engage in crop diversification at the national level, with a focus on targeting production of staples such as rice in suitable agro-ecological systems. Such enhanced production could play a key role in ensuring that food production gaps are sealed and improving overall national food security. Rice consumption in Kenya is increasing at a rate of 12% annually, as compared with 4% for wheat and 1% for maize. The annual consumption stands at about 300,000 t against a production of 80,000 t. Despite the increased consumption, there has been little growth in rice production despite the huge potential that exists in the country. The Ministry of Agriculture developed a comprehensive National Rice Development Strategy for the period 2008–2018, with the aim of doubling current production. The Rice Promotion Unit, in collaboration with the Japan International Cooperation Agency (JICA), conducted a questionnaire survey in the Mwea Irrigation Scheme, Kirinyaga District, to determine whether this target was achievable by identifying some key challenges that must be solved to meet the goal. Inefficient water management methods and water-rationing programs, crop damage caused by *Quelea quelea* and weaver birds, and expensive inputs were identified as key bottlenecks. Almost all production activities are done manually, resulting in health hazards and higher costs of production. The rice seed industry is informal, often with poor quality seeds that result in poor crop establishment and yield. Lack of a structured market and access to milling facilities has resulted to very low farm-gate prices. These challenges will affect all the other irrigation schemes currently in operation, as well as new ones. Producers of rain-fed rice will share some of these same challenges. Collaborative initiatives by all the stakeholders involved in every stage of the rice value chain must be emphasized. With accelerated support from local and international development partners such as JICA, rice production in Kenya could be doubled before 2018.

Key words: Rice production, improved production, irrigation water, rice seed

Introduction

Food security the condition of having enough food to provide adequate nutrition for a healthy life is a critical global issue. With a population growth rate that exceeds the growth rate in regional food production, and with only limited foreign resources to sustain increased imports, the future for Africa's poor appears grim (WARDA, 2008).

Globally, rice is one of the most important food crops in the fight against hunger. About 3 billion people nearly half the world's population depends on rice for their survival. The total annual world production of milled rice stands at 400 million t, which is comparable with the production of maize and wheat. The area under rice cultivation is forecast to rise by 1.5% (from 153 million ha to 158.6 million ha), and yields are expected to increase by close to 1%. In addition, unlike maize and wheat, which are consumed by humans and livestock, rice is primarily grown for human consumption (National Rice Development Strategy, 2008).

Development of rice production techniques therefore presents an opportunity to halve the number of gravely food insecure people in the world (currently numbering 816 million) by 2015 in accordance with

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the goals established at the 1996 World Food Summit and in the Millennium Development Goals (MDG). Many African countries are expected to reduce imports and focus on local production of rice (National Rice Development Strategy, 2008).

Kenya covers 583,000 km^2, of which 17% is arable and 83% is arid or semi-arid. Agriculture contributes 45% of total government revenues and provides 75% of industrial raw materials. More importantly, it contributes to national food security, because 80% of Kenyans live in rural areas and derive their livelihoods from crop and livestock production, forestry, and the exploitation of other natural resources. Recent rainfall deficits have resulted in devastating crop failures and livestock losses that have left the majority of Kenyans food insecure.

Kenya's population was about 40 million in 2009 and it is increasing at an annual rate of 2.7%. Maize has been the predominant staple food, but the country in not self-sufficient in maize production. The current per capita consumption is about 100 kg, and the government spent more than 9 billion Kenyan shillings (Ksh) to import maize for distribution as relief food (National Rice Development Strategy, 2008). The overwhelming dependence on maize, which sometimes is grown in inappropriate agro-ecological zones, as the key staple crop has further exacerbated food insecurity in Kenya. Crop diversification at the national level, with a focus on targeting production of other staples such as rice in suitable agro-ecological zones, could play a key role in ensuring that food production gaps are sealed and that overall national food security is improved. Pressure on arable land is already high, however, and future increases in agricultural production will depend on the possibility of increasing yield per unit area as well as bringing unused (often marginal) lands under cultivation (Niemeijer *et al*., 1985).

Rice has been an important staple food for urban dwellers for a long time but is increasingly being consumed by the rural population (NRDS, 2008; Balasubramanian *et al*., 2007). Currently, rice consumption outstrips production in Kenya (Fig. 1): annual consumption is about 400,000 t and production is 80,000 t. The difference is met through imports, mainly from Pakistan, India, and Egypt, at an annual cost of about Ksh 8 billion. This level of spending eats into the foreign exchange earnings of the country, which could otherwise be invested in other development projects. The annual consumption rate of rice is increasing by 12% a year, as compared with 4% for wheat and

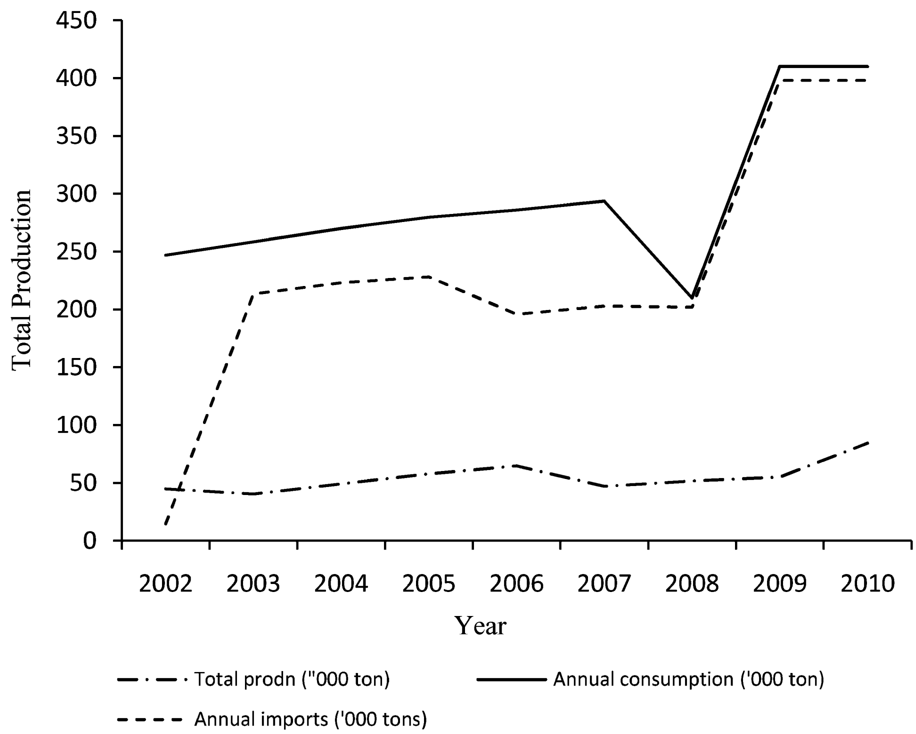

Fig. 1. Trends in rice production, consumption, and imports in Kenya.

1% for maize (Ministry of Agriculture, 2010). Most people desire rice of a specific grain type, or at least rice having certain cooking and processing characteristics (Action Peace Corps, 1976), and demand for aromatic rice cultivars is high.

Despite the enormous potential of the rice subsector in enhancing food security and livelihoods, it has not received adequate attention with regard to policy and institutional support. In response to the growing need for support, the Ministry of Agriculture developed a comprehensive and practical National Rice Development Strategy (NRDS) for the period 2008–2018, with the objective of promoting rice production in Kenya. The Yokohama Action Plan put forth at the Fourth Tokyo International Conference on African Development advocated improving Africa's capacity to increase its food production and improve its agricultural productivity. On the basis of that call to action, the Japan International Cooperation Agency (JICA) is promoting the Coalition for African Rice Development, an initiative to double rice production in Africa within 10 years. Within the coalition's initiative, the Kenyan government has set a goal of boosting domestic rice production from 50,000 t in 2008 to 178,000 t within 10 years.

Most rice in Kenya is grown under irrigation, mainly in four irrigation schemes managed by the National Irrigation Board (NIB): Mwea in Central Kenya, Ahero and West Kano in Nyanza, and Bunyala in Western Kenya. The rice grown in these schemes accounts for about 95% of total domestic production. The remaining 5% is grown under rain-fed conditions in coastal districts such as Kwale, Kilifi, and Tana River, and in some parts of Western Kenya. The Mwea scheme is the largest, with over 86% of the total irrigated rice produced in Kenya, and it produces 95% of basmati rice in Kenya (locally referred to as *pishori*). The total area under rice production has ranged between between 14,000 and 20,000 ha in the past two decades (Fig. 2), with increases in production generally mirroring increases in the area under cultivation. Productivity has remained stable or declined slightly over the same period. There is a high potential for expansion of irrigable area in Kenya and about 400,000 ha are suitable for rice production. Expansion of rain-fed rice production along the coast and in Western Kenya also presents great potential that has yet to be exploited.

Given these trends in rice production, the question is: Will it be possible to double rice production by the year 2018? I conducted a questionnaire survey in the Mwea Irrigation Scheme in the Kirinyaga District in collaboration with JICA to identify the key challenges and opportunities facing Kenya in meeting the goal of doubling rice production.

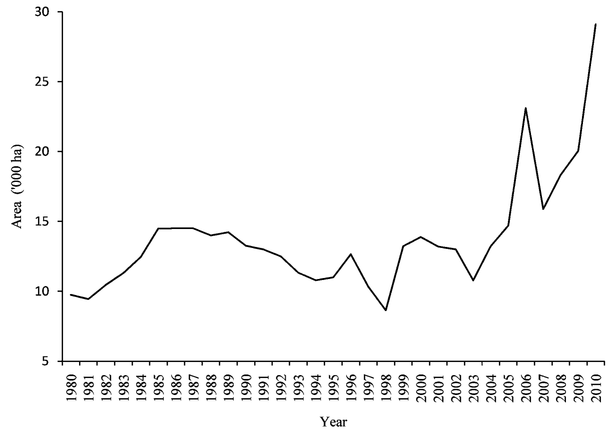

Fig. 2. Changes in area under rice cultivation in Kenya.

Materials and Methods

Study Area

The Mwea Irrigation Scheme was selected as the study area because 86% of all rice grown in Kenya is produced there, and it is an important entry point for studying the potential for doubling rice production. The key challenges and opportunities identified in Mwea can be used as a benchmark for enhanced production in other existing or potential rice production areas.

The scheme is situated in Kirinyaga District, Central Province, about 100 km northeast of Nairobi. Farming in the scheme started in 1956, with rice as the predominant crop. The scheme has a total area of 12,140 ha, 6,400 ha of which has been developed for paddy production. The rest is used for settlements, public utilities, and subsistence and horticultural crops. The scheme is served by two main rivers, Viz Nyamindi and Thiba. Irrigation water is withdrawn from the rivers by gravity with the help of fixed-intake weirs and conveyed and distributed via unlined open channels. Land tenure is on a tenancy basis. The scheme was run by the NIB from the time of its inception until it was taken over by the Mwea Rice Farmer's Cooperative Society in 1998. However, this group realized it could not manage the scheme on its own, and in 2003, it approached the government for assistance. The NIB, the Cooperative, and the Water User's Association (WUA) therefore formed a management committee to manage the scheme.

Data Collection and Analysis

A survey research design was used and a questionnaire developed and pre-tested by officers from the Rice Promotion Unit. Two officers from the Mwea Integrated Agricultural Development Centre (MIAD) and two other officers from Mwea Irrigation Scheme Water User's Association interviewed the farmers. The scheme comprises 7 Sections and 70 blocks, and a list of members from each block was supplied by the scheme manager. The sections were randomly numbered from 1 to 7. The first member listed in each block in each odd-numbered section was interviewed; subsequently, the 21st, 41st, etc. mbers were selected. In the even-numbered sections, the second member on the list was chosen, as were the 22nd, 42nd, etc. members. In all, 325 out of 5576 members were interviewed from March to May 2011. The farmers' responses were categorized and tabulated. Data analysis was conducted using MS Excel 2007.

Results and Discussion

Irrigation Water

The shortage of water was identified as the biggest challenge, with 85% of those interviewed mentioning it. The supply of irrigation water is sometimes inadequate, and this often critically affects productivity. The inadequate supply of irrigation water is a result of scheme expansion and below average rainfall. As a result, water rationing has been necessary, and distribution schedules have been developed to supply water to specific blocks in the growing season. Rice paddy blocks that are not within the schedule are left idle. Illegal diversion of water upstream by non-scheme-members has also become a large challenge and has resulted in a reduction in the amount of water for farmers on the distribution schedule. This issue is difficult to resolve, because upstream water management is not directly under the WUA but is handled by the Mwea Water Resource Management Association, which has no specific interest in rice production. Furthermore, the existing National Water Act has no clear guidelines as to specific punishments for illegal water extraction.

The respondents observed that inefficiency, both in on-farm water use and in the distribution network, has resulted in water waste and loss. Distribution canals are not lined; this results in seepage and vegetative growth, which in turn result in high maintenance costs that are eventually transmitted to the farmer. The paddy fields are not uniform and also suffer from leakage.

Farmers were also not sufficiently aware of the water distribution schedule: 69% of the farmers were not aware of the water distribution schedule in the main canal and 62% were not aware of the schedule on the secondary canal. This lack of awareness has negatively affected the farmers' ability to undertake appropriate planning in their cropping patterns. Even with this lack of awareness, 92% of the farmers reported participation in communal irrigation maintenance work, and all farmers reported paying their water fee.

Farmers pay a fee to defray operation and maintenance costs to sustain water distribution structures originally constructed by the NIB, including canals, transfer bridges, field gates, and boards. Increased demand for water has exerted pressure on the water distribution infrastructure, and the costs for operation and maintenance have risen, so that the fee paid by farmers (Ksh 2,000 per ha) no longer covers the costs. The government has therefore had to subsidize operation and maintenance costs. An NIB proposal to increase the levy to Ksh 5,000 was met with a great deal of hostility by the farmers. The high cost of maintenance is passed on to the growers in the form of a Service Levy as an additional cost.

All of the farmers expressed concerns about a lack of clean drinking water. There are no domestic water distribution systems in the scheme, and farmers must use the canal water for domestic purposes. This has resulted in outbreaks of diseases such as typhoid and dysentery and has had negative effects on health and productivity.

Seed

There are several sources of seed in Mwea: 61% of the farmers buy their rice seeds from MIAD, which operates under the NIB, 23% use their own saved seed, 8% exchange seed with neighbors, 1% buy seed from the local market, and 7% obtain their seed from other sources.

Five factors are taken into consideration when determining the rice cultivar to grow in a particular region: agro-climatic conditions, major pests and diseases, farmers' needs and circumstances, processor and consumer preference, and type of rice culture (rain-fed or irrigated). Formal research on rice started in Kenya in 1969 with the establishment of the Ahero Irrigation

Research Station and its sub-station, the Mwea Irrigation Research Station, both of which operate under the NIB. To date, these stations have developed and released 8 irrigated rice varieties to farmers, and in 2009, 5 rain-fed rice varieties were released. However, there is no formal rice seed system in place. Most seed is handled informally, and there is no certified seed for sale to farmers. Rice seed was not categorized under the Seed Act for mandatory certification, because rice is open pollinated and none of the commercial seed companies has shown any interest in commercial production of seed.

In terms of variety, 99% of the farmers in the area grow basmati, and farmers are shifting from varieties with higher yields and lower water requirements (e.g., sindano) to basmati because of the high demand and good marketability. Brokers often blend non-basmati varieties with basmati and sell the product as basmati at a higher price.

Rice Yields

Harvesting of rice in this area is best done in November, when there is adequate sunshine, which promotes high yields. However, the water levels in the rivers are very low during this period and inadequate to sustain rice growth. Conversely, during May and June, there is adequate rainfall, but the temperatures are normally very low, resulting in low yields. Outbreaks of blast disease, one of the most destructive fungal diseases, are also heaviest during this period (Zeigler *et al*., 1994). The water distribution schedule in the scheme also influences the farmers' choice of planting time, as does the limited choice of appropriate varieties.

The optimal per unit production under irrigation is 5.5 t/ha for aromatic varieties and 7 t/ha for non-aromatic varieties. Actual yields in Mwea, however, have been very much lower (Fig. 3). Although the farmers occupy their lands under a tenancy system, informal land subdivisions to family members is common. The production units are therefore small, and this also has had a negative effect on productivity.

Farmers also do not plant other, short-season crops (e.g. cotton and soybean) that can be grown with low water requirements, particularly during the "idle season" when the farmer is not within the distribution schedule. This results in a low-yielding monoculture with a buildup of diseases and pests. Attacks by the *Quelea quelea* and weaver birds have been a notable challenge to farmers. The birds move in large flocks and are able to migrate from one part of the country to another, especially to areas where large farms of cereal crops (wheat, millet, sorghum, and rice) are found. The different crops mature at different times of the season, and millions of the birds migrate from one section of the country to another as the crops mature. When they invade a place such as Mwea, the destruction can be devastating.

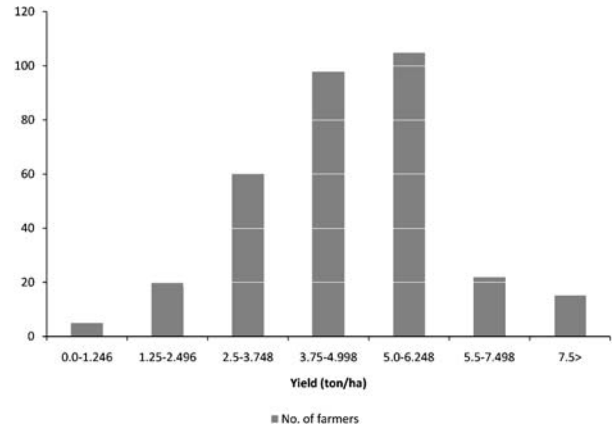

Fig. 3. Rice yields in the Mwea Irrigation Scheme

Fertilizer Application

Use of fertilizers is common in Mwea, with all farmers using at least one type of chemical fertilizer: 86% of the farmers use Diammonium Phosphate (DAP) for the basal application and 93% use ammonium sulfate (SA) for top dressing (Table 1). Only 2% of the farmers use muriate of potash (MOP; potassium chloride) as the basal fertilizer, although this is the recommended fertilizer for use in Mwea. Although DAP fertilizer is more expensive than MOP, it is more commonly used because farmers are able to buy it under a government subsidy program. However, rice is not an approved subsidized crop for DAP, so farmers purchase the fertilizer under the pretense that they will use it for a different approved crop (e.g., maize) and then apply it to their rice. Farmers also adhere to a top-dressing schedule, with 93% applying SA (Table 1), but the rate of application varies from one farmer to another.

The cost of fertilizer has increased, for example, a 50-kg bag of Ammonium Sulphate Nitrate ASN that cost about Ksh 1760 two years ago now costs about Ksh 2500. Subsidized DAP costs about Ksh 2600 per bag but costs about Ksh 4,000 on the open market. The Mwea Cooperative group purchases fertilizers on behalf of farmers, but some farmers source individually and thereby lose the benefit of reduced prices

Table 1. Fertilizer application by farmers in the Mwea Irrigation Scheme

Application	No.	Fertilizer type	No. of farmers	Average amount per ha	
				Bags	Kg
Planting	1	MOP	7	3.7	185
	2	DAP	279	2.7	135
	3	SA	0	—	—
	4	CAN	2	3	150
	5	TSP	27	3	150
	6	Urea	0	—	—
	7	None	10	—	—
Top dressing	1	MOP	3	3.7	183
	2	DAP	1	8	400
	3	SA	301	4.9	245
	4	CAN	13	2.9	145
	5	TSP	4	3.8	188
	6	Urea	1	1	50
	7	None	2	—	—

DAP: diammonium phosphate; MOP: muriate of potash; TSP: triple superphosphate; CAN: calcium ammonium nitrate; SA: ammonium sulfate

from group sourcing.

Another important finding is that none of the farmers uses organic fertilizer or "green" manure. A grain legume or green manure crop could be grown in the gaps in the current crop sequences. To consider opportunities for expanded use of green manure, rice-based farming systems can be divided into 3 types: irrigated lowland, rain-fed lowland, and rain-fed upland. Each type requires specific crop sequences. In areas where crop rotation includes one or more fallow seasons, multipurpose uses of legumes can help restore soil fertility, provide high quality forage, and reduce labor costs for initiating land preparations (IRRI, 1987).

Rice crop residues previously used to be burned in one part of the farm and the ash spread all across on the paddy. However, this has changed because of increased demand for the straw as animal feed. After the harvest, the rice straw is collected in a central location and then baled for sale. Most of the buyers are not from within the scheme, and hence the organic material is exported to other areas. The loss of this organic material is serious, because silicon is needed for rice growth and it occurs in large amounts in the exported biomass. Rice husks are not being returned to the farms, and this, combined with the lack of appropriate crop rotation programs, is depleting organic matter and other minerals in the soil and having a long-term effect on productivity.

Mechanization and Cropping Systems

Proper land preparation is essential for good germination, seedling emergence, early stand establishment, growth, and uniform maturity, all of which lead to high grain quality. Several primary tillage methods are used in Mwea: 73% of the farmers hire tractor services from privately owned tractors, 2% get tractor services from the NIB, 6% use their own tractors, 1% uses their own oxen, and 18% hire oxen services. Use of oxen in the rice fields is highly discouraged because of the risk of destruction of feeder canals and water barriers; hence, farmers are not allowed to keep them. However, many farmers keep the animals in the villages and use them in the evenings and hence difficult for the NIB to enforce the ban. Several methods of secondary tillage, puddling, and leveling are also used: 3% of the farmers use tractor-drawn rotavators, 90% use oxen-drawn implements 4% use family manual labor, and 3% use hired manual labor.

Rice nursery beds are established at one corner of the paddy field for ease in management, and transplanting is done manually. About 98% of the farmers' plant seeds in random, and only 0.5% plant in rows and 0.5% practice direct seeding. A lack of affordable and simple mechanized equipment has resulted in the farmers not appreciating the importance of row planting; this reduces the efficiency of farm operations. All of the other operations, including weeding, harvesting, threshing, and winnowing, are done manually. Most of the NERICA (New Rice for Africa) rice varieties are difficult to thresh manually, resulting to a great deal of waste.

The demand for human labor in land preparation is high at critical points in the plant's life cycle (primarily based on water scheduling), and farmers who lack adequate family labor plant later, because most of them wait for their children to go on school holidays. Therefore, farmers generally do not plant at the same time, or they plant off-season, and pests and diseases are therefore not as easy to control. One percent of the farmers use herbicides for weed control. This is not encouraged by the Public Health officers because the contaminated water drains back to the canals and rivers and is used downstream, thus representing an environmental and human health hazard.

Marketing and Value Added

The 1990s liberalization of the agricultural sector threw rice production into disarray. Before then, the NIB played a major role in rice marketing, but after liberalization it ceased to play any role in marketing. Many players, including privately owned mills, the National Cereals and Produce Board, and rice brokers, have since entered into rice marketing, without a marketing role; the NIB was left only with maintaining infrastructure and conducting research.

Almost all (96%) farmers sell their rice as un-milled paddy. Most (98%) of the harvested rice is sold, with the remaining 2% kept either for seed or domestic consumption. Several marketing channels exist, with 24% sold to brokers at the farm gate, 39% sold to brokers in marketplace, 1% sold to the National Cereals and Produce Board, 35% sold to the Cooperative Society, and the rest collected by money lenders. The price for un-milled rice varies from Ksh 30–70 per kilogram, but milled rice sells for about Ksh 120 per kilogram.

As a result of inefficiencies and high production costs, locally grown rice is not competitive in the market with imports. This problem is compounded by the fact that some of the harvesting is done in April and May during the rainy season. Poor grain drying systems lead to losses through sprouting, and the drying is often done in unhygienic conditions (e.g. on the ground or on a road).

Gender Dimensions in Rice Production

The evolution of farming systems is affected by the social norms and practices that determine the way in which production and consumption are organized at a household or village level.

Men, women, and children are involved in rice production at various levels. Men are mainly involved in land preparation (ploughing, rotavation and leveling) and transportation, whereas women and children do planting, weeding, bird scaring, harvesting, threshing, and drying.

The low level of adoption of agricultural technologies has been associated with gender-related issues. Women rarely attend seminars or training workshops, yet they are central players in rice production. This lack of access to training is likely to have adverse effects on the adoption and use of newer agricultural technologies.

The marketing of farm produce and acquisition of inputs (e.g., fertilizers and other chemicals) has traditionally been done by men, but women are the key implementers of the inputs, even though they have not been trained in this role. Rice marketing is done by both men and women, although women dominate the local retail rice businesses.

Conclusion

To double production of rice in Kenya by 2018, the Rice Promotion Unit (RIPU) under the Ministry of Agriculture, in collaboration with all rice stakeholders, must come up with strategic interventions that will address the challenges affecting the Mwea Irrigation Scheme and apply the same strategic interventions to existing rice irrigation schemes, as well as to new production areas.

According to the survey results, the country has enormous opportunities in regard to enhanced rice production. With improved water resource utilization, as well as innovative management technologies, an additional 800,000 ha could be irrigated and about 400,000 ha could be used for rice production. This compares with about 20,000 ha currently being used for irrigated rice production. In addition, another 1.0 million ha could be used for rain-fed rice production, as compared with the current 5000 ha. It is important, however to improve the utilization of the existing potential for rain-fed rice production through the development of NERICA varieties that are adaptable to the country's ecological zones.

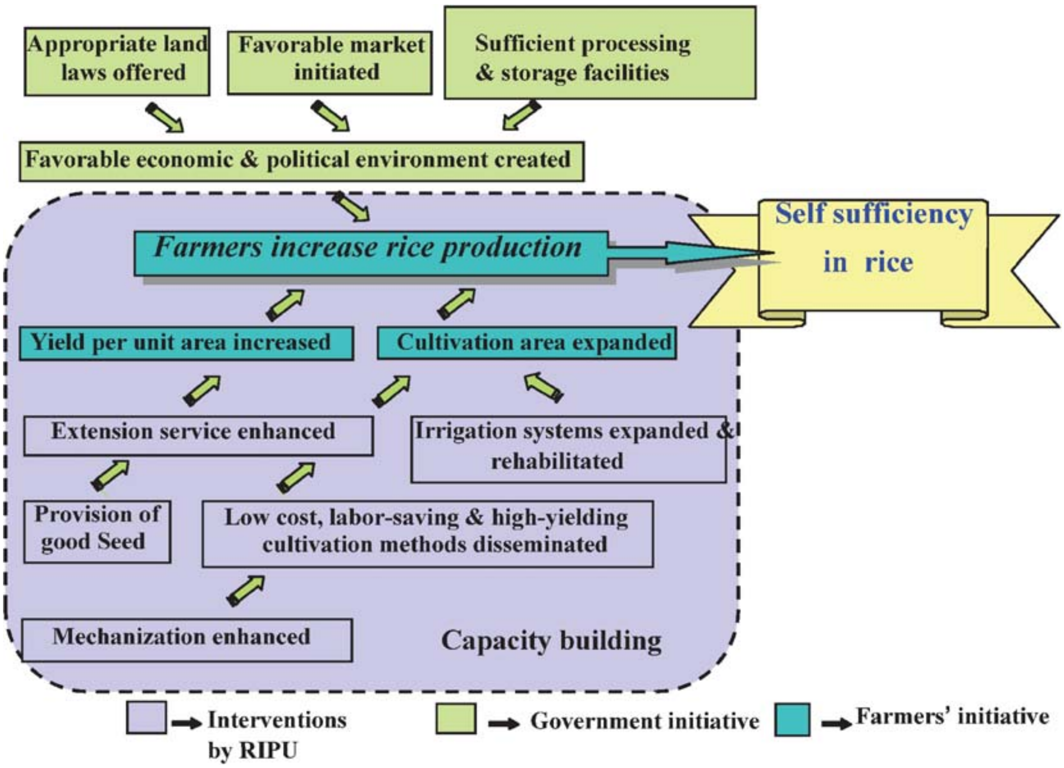

Fig. 4. Proposed interventions by the Rice Promotion Unit to meet the goal of doubling rice production in Kenya by 2018.

Locally produced rice is of high quality compared with imported rice and is preferred by consumers. Officials from Mwea Rice Farmer's Cooperative Society reported that there have been incidences of fraudulent repackaging of poor quality, cheap imported rice; this presents unfair competition to locally produced rice. They therefore recommended that the Kenya's Bureau of Standards (KEBS), being the national body mandated to oversee standardization, should enforce compliance of standards for imported and local rice.

Production should begin with market orientation, and everybody along the value chain should have a specific role; the farmer should be involved in all stages along the chain. Capacity-building is necessary so that farmers see farming as a business, and training of agricultural extension staff is essential.

If collaborative initiatives by all stakeholders involved in every stage of the rice value chain are emphasized, and with accelerated support from local and international development partners (e.g., JICA), rice production in Kenya could be doubled by 2018. Several technical committees established under RIPU have been created to drive the NRDS, and a number of intervention points have been identified (Fig. 4).

Rice research in Kenya was formerly solely under the NIB, but is now also handled by Kenya Agricultural Research Institute (KARI). MIAD, in collaboration with the Japanese Government (JICA), has embarked on research to create technologies that will boost yields; improve quality, disease resistance, and pest tolerance; and improve highland rice varieties. Working with other stakeholders, RIPU has developed a road map to seed certification and multiplication as a key starting point (Table 2).

To solve the problem of land subdivision, some family members are making agreements on land use that limits subdivision, with one family member doing the farming each season and then sharing the products and proceeds in a rotational manner.

Pesticides continue to be a significant and growing component of modern farming technology. The relative importance of pesticides has increased, despite the availability of alternatives to chemical pest control (i.e., varietal resistance and integrated pest management; Pingali and Roger, 1995). To reduce the contamination of water with chemicals, water delivery canals will need to be redesigned to separate unused and used water for treatment and recycling. This will

Table 2. Rice Promotion Unit (RIPU) — Roadmap to Rice Seed Multiplication

Year	Season	Nucleus Seed	Breeder's Seed		Pre-Basic Seed		Basic Seed*1		Certified Seed		Target Areas (Requirement)
		(No. of grains)*1	(No. of hills)*2	Production (kg)	Required Area(m^2)	Prod. (kg)	Required Area(ha)	Prod. (ton)	Required Area(ha)	Prod. (ton)	(ha)
										100*2	
2011	LR		40	1.0	128.0	30.0					2,058
	SR		40	1.0			1.0	3.0		140	
2012	LR				200.0	50.0			60	175	2,762
	SR		60	1.5			1.5	4.5			
2013	LR				250.0	65.0			90	230	3,508
	SR		80	2.0			1.7	5.0			
2014	LR				400.0	100.0			100	280	4,444
	SR		120	3.0			2.0	6.0			
2015	LR				450.0	120.0			120	360	5,568
	SR		120	3.0			2.2	7.0			
2016	LR				500.0	150.0			140	425	7,156
	SR		150	3.5			3.0	8.5			
2017	LR				600.0	180.0			170	500	8,470
	SR						3.5	10.0			
2018	LR								200	550	10,160
	SR										

(Note) *1 Preferably cultivated under irrigated paddy condition
*2 Standard Seed

also aid in water-use efficiency and reduced environmental contamination. Designated water treatment and delivery systems for domestic water should be established to supply water to all households.

Increased production of rice will ensure food security and save much-needed foreign exchange. Local rice production, processing, and marketing will improve the livelihoods of rural and urban populations by creating employment, opportunities for private investment, and income for small-scale farmers.

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