33 Realizing Africa's Rice Promise: Priorities for Action

Marco C.S. Wopereis,[1]* Aliou Diagne,[1] David E. Johnson[2] and Papa Abdoulaye Seck[1]
[1]*Africa Rice Center (AfricaRice), Cotonou, Benin;*
[2]*International Rice Research Institute (IRRI), Los Baños, Philippines*

Introduction

Rice is the most rapidly growing food source in Africa. In 2010–2011, the rice self-sufficiency ratio in sub-Saharan Africa was about 60% with imports close to 10 million tonnes (Mt) per year or about one-third of that available on the world market, and costing almost US$5 billion per year. As witnessed during the food crisis of 2007–2008, this is a risky, expensive and unsustainable situation that may lead to severe food insecurity and civil instability in some countries. Soaring and highly volatile rice prices and relatively low levels of global rice stocks are predicted to remain the norm until at least 2020, and predicted demand for rice remains strong. Total rice consumption in sub-Saharan Africa is projected to rise from 24.0 Mt in 2012 to 36.0 Mt by 2020 (Seck *et al.*, Chapter 2, this volume).

The critical challenge facing the African rice sector is to sustainably enhance production, processing and marketing, and to turn this major concern into an opportunity as rice becomes a preferred staple. Africa's rice sector has the potential to be a powerful engine of economic growth as the huge demand for rice is currently filled by imports. Rice production concerns millions of people and not just rice farmers. There are the producers and manufacturers of inputs (seeds, fertilizers, pesticides) and machinery, and the traders who sell these, while on the post-production side, there are processors, traders, wholesalers, retailers and consumers.

This book deals with a diverse range of topics that are all of relevance to realizing 'Africa's rice promise', defined in the Introduction: 'Africa has sufficient land and water resources to produce enough rice to feed its own population and, in the long term, generate export revenues'. This concluding chapter brings together the main ideas presented in this book and traces a way forward to develop Africa's rice sector in a sustainable and equitable manner. We will discuss a number of priorities that are grouped in four main action areas:

- sustainably increasing rice production and rice productivity;
- enhancing rice quality and marketing;
- promoting conducive policies for smallholder and agribusiness development; and
- strengthening impact-oriented rice research, extension and knowledge management.

Many priorities will need to be addressed simultaneously to ensure effective and sustainable connections among value-chain actors (often women, see Agboh-Noameshie *et al.*, Chapter 28,

* Corresponding author: m.wopereis@cgiar.org

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this volume) – from production to processing to marketing – to avoid fragmentation of efforts, and to promote equitable development.

Sustainably Increasing Rice Production and Rice Productivity

Enhancing rice production in Africa will necessitate concerted efforts to increase the productivity of rice per unit of land, water, labour and nutrients applied, and through the development of new land and water resources in a responsible and sustainable manner. Since the rice crisis of 2007–2008, good progress has been made in sub-Saharan Africa. According to USDA data (USDA, 2013), rice production in sub-Saharan Africa increased by a spectacular 8.4% per year over the period 2007–2012 (see Seck *et al.*, Chapter 2, this volume). Approximately 71% of this production increase can be attributed to yield increase, and 29% to harvested area expansion. Despite two relatively bad years, average rice yield in sub-Saharan Africa increased over that period by 108 kg/ha per year. In comparison, rice yield worldwide, driven by the Green Revolution in Asia, increased by 52 kg/ha per year over the period 1960–2010. Cereal growth rates after the Second World War amounted to 78 kg/ha per year in the UK and to 50 kg/ha per year in the USA. The rice yield growth rate in sub-Saharan Africa (as a response to renewed commitments to boosting Africa's rice sector after the rice crisis of 2007–2008) is, therefore, similar to growth rates witnessed on other continents after the introduction of technological innovation and institutional change. These trends are visible in all regions, except Central Africa (virtually no change in yield in the period 2007–2012) and North Africa (decline in average yield, driven by Egypt). In comparison, rice production in Asia over the period 2007–2011 grew by only 1.6% (Seck *et al.*, 2012). It is essential that this remarkable production growth rate of 8–9% per year is maintained to keep rice imports at about 10–12 Mt/year (Seck *et al.*, Chapter 2, this volume). In fact, this growth rate needs to be even greater (12% per year) to reach the ambitious goal of lifting the rice self-sufficiency ratio in sub-Saharan Africa to 87% by 2020 and reducing rice imports to about 5 Mt/year, as called for in the newly approved 2011–2020 strategic plan for rice research for development in Africa (AfricaRice, 2011b), which is discussed in more detail below.

It is, therefore, paramount that more rice is harvested on the African continent and this needs to be done in the most effective, efficient and sustainable manner. To achieve this, we distinguish five priorities for action:

1. Raising labour productivity through mechanization.
2. Establishing effective and efficient seed systems.
3. Closing yield and productivity gaps, and sustainably intensifying and diversifying rice-based farming systems.
4. Expanding rice harvested area.
5. Adapting to climate change.

Raising labour productivity through mechanization

As shown in this book (e.g. Rickman *et al.*, Chapter 27, this volume; Stryker, Chapter 26, this volume), lack of appropriate mechanization is one of the most important bottlenecks to the development of Africa's rice sector. Mechanization is particularly needed for land preparation, harvest and postharvest operations, which are still mostly manual and are extremely time consuming, causing severe delays which impact directly on rice yield and rice quality. Rice crops in Africa are often not planted on time because of late and poor land preparation as farmers wait for rain to soften the soil so that they can prepare the land using hand implements. This often results in poorly prepared and uneven seed beds and weed infestation. Small- to medium-scale equipment for land levelling, seeding, transplanting and weeding can make a huge difference in the time investment for crop establishment and free up time for farmers (often women) to pursue other activities.

Harvesting and threshing are also serious bottlenecks for farmers and these operations are also still mostly done manually. Paddy may sit in the field for weeks or even months waiting to be harvested or threshed, during which time its quality deteriorates. The introduction of locally adapted small combine-harvesters (as is being done in Senegal, Mali, Nigeria and several

other countries) should go a long way towards enabling timely harvesting and threshing. This could provide the incentive for farmers to sell their paddy quickly and focus on producing a second crop. The early removal of paddy from the farm would not only enable farmers to focus on their core farming business (i.e. crop production), but would also open up the prospect for greater aggregation of the marketable surplus of paddy (AfricaRice, 2011a).

Africa is, however, littered with abandoned machines that rust away because they were not adapted to the growing environment, there is a lack of spare parts and inadequate local knowledge. Research organizations must be involved in the testing of machines, and massive introduction of purchased machinery must be avoided. Instead, local manufacturing and maintenance of machinery needs to be stimulated and governments need to facilitate the import of machine parts and raw materials. Much can be learned from experiences with mechanization in Asia and Latin America, and active knowledge exchange in the field of mechanization for rice-systems needs to be promoted.

Establishing effective and efficient seed systems

Farmers' access to quality seeds and rice varieties that are adapted to their rice-growing environments, is the backbone of rice-sector development in Africa. However, many farmers in Africa do not have access to improved rice varieties that could make a huge difference to their lives. Bèye *et al.* (Chapter 14, this volume) show that the informal sector is the dominant source of seed for African rice farmers. Farmers retain seed from their previous harvest or buy, exchange or receive seed from other farmers within their own village or from neighbouring villages. There is no blueprint solution for seed-system development in Africa, and the best possible approaches are likely to be specific to rice agroecosystems and the degree of market access. Seed systems will also evolve – for example, with emerging formal systems catering to specific market niches. Governments need to strengthen both commercial and development-oriented rice seed systems. Quality breeder or foundation seed must form the basis for seed production–supply systems. Governments must also support farmer seed systems and strengthen farmer knowledge and capacity to select and conserve quality seed for the next season. The emergence of a commercial seed sector will occur where farmer seed systems are strong, where farmers are keenly aware of what varieties are available, are engaged in seed and information exchange, and are knowledgeable consumers (Louwaars and De Boef, 2012). The introduction of hybrid rice (see El-Namaky and Demont, Chapter 13, this volume) may further catalyse rice seed-sector development in Africa.

At the regional level, seed legislation needs to be harmonized or complemented by guidelines to facilitate efficient seed flows across borders. Adequate rice seed security stocks must also be maintained to respond to emergency situations. At both national and regional levels, there is a need to adopt an integrated rice seed-sector development approach, aiming to promote diversified seed systems, meeting the seed needs of all of Africa's rice farmers.

Closing yield and productivity gaps and sustainably intensifying and diversifying rice-based farming systems

As shown by (e.g.) Saito *et al.* (Chapter 15, this volume), yields in farmers' fields are often below what would be possible with improved management ('potential yield'). A good understanding of such 'yield gaps' enables us to identify progress in farmers' fields and also helps us identify the extent to which increased costs can be justified to raise yields or reduce losses. Identifying the yield gaps also enables the major yield-limiting factors (e.g. drought, excess water, nutrient deficiencies, extreme temperature) and yield-reducing factors (e.g. pests, diseases) to be identified. Interventions may solve more than one constraint – for example, improving water control through building bunds and land levelling in lowland fields may at the same time improve weed management (see Rodenburg and Johnson, Chapter 16, this volume). Characterization of the key constraints also raises questions, such as: what is the variability in management among farmers, what are farmers doing who obtain

relatively good yields, and what are others doing who obtain relatively poor yields?

Yield gaps occur in low-input systems with poor water control and relatively low-input management, but often also in high-input systems with good water control that allows for more precise management. The degree of crop management precision that is possible is of great importance to rice productivity. Lowlands in the inland valleys with scarce infrastructure to retain water or drain excess water do not allow precise management (e.g. timing of rice transplanting, weed control or nitrogen application). Rice growth and development can be severely disrupted by drought or floods. Absence or late availability of critical inputs may also undermine farmers' ability to manage precisely. With increasing control over water and other resources, improved crop management becomes possible. As a result, systems can be intensified (greater use of inputs, higher cropping intensity) or diversified (e.g. a legume crop after rice).

We propose here to identify two types of yield gap on the basis of what is presented in this book. The first yield gap (type I) is defined as the difference between actual farmers' yields and what would be possible through the introduction of technological innovations (e.g. a new variety) given the level of management precision under which farmers operate. The second yield gap (type II) is defined as the difference between actual farmers' yields and what would be possible if the system could be moved to a higher level of crop management precision with less production risk (e.g. by introducing bunding, supplementary irrigation or digging a drainage canal).

Defoer and Wopereis (Chapter 31, this volume) illustrate how type I yield gaps can be closed by working with farmers in an inland-valley setting in Madagascar, who all work under similar agroecological conditions and with similar crop-management precision and yet still obtain vastly different yields. The most important innovations identified for increasing and stabilizing yields were improved land preparation, transplanting of young seedlings, transplanting in lines, and weeding using a rotary weeder. Some rice technologies may work like an 'insurance policy' and help farmers to reduce risk. This is the case with varieties that have been 'upgraded' to include tolerance to certain biotic or abiotic stresses. Introduction of a variety with the *Sub1* gene in flood-prone areas (see Dramé *et al.*, Chapter 11, this volume) helps reduce risk for farmers with fields at risk of flooding. In years when flooding occurs, farmers with *Sub1* varieties would have much higher yields or be able to harvest much earlier than farmers without such varieties, effectively helping to close a type I yield gap.

Investing in bunding in drought-prone lowlands may radically change the production environment in which farmers operate, reducing risk and enabling greater farming precision, this would then open avenues for intensification and diversification and lift the yield ceiling to another, higher level – resulting in a greater (type II) yield gap between actual and potential yields that can be exploited. Investment in key production infrastructure (bunding, levelling, irrigation) and providing access to key resources (credit, fertilizer, etc.) will allow Africa's farmers to get out of high-risk, low-input, unsustainable agriculture and open up new production horizons.

As we have seen in this book, the degree of precision that can be applied to crop management is important for the type of technologies that can be used by the farmer (Wopereis and Defoer, 2007). Technologies suited to well-defined and precise conditions (e.g. good water control, high fertilizer input, and 'narrow windows' for field operations) will be of little use to a farmer in an inland valley without any water control. In low-precision or 'fuzzy' systems, farmers need flexible technologies that give reasonable results under a range of biophysical conditions. Especially in such low-precision systems, farmers can contribute to technology development at an early stage, which gives them the opportunity to evaluate a range of prototype options. Precision management systems will be better served with a smaller range of well-defined technological options. Technology development for these systems can be done under more controlled research conditions with less intensive farmer involvement, resulting perhaps in a few well-defined final products. In other words, the degree of flexibility of a technology required is related to the degree of crop management precision of a system. A lower degree of crop management precision increases the need for flexible technologies with large application

domains. To ensure adequate farmer involvement in the technology development, methodological approaches are needed to strengthen farmers' capacity in technology innovation, experimentation, evaluation and adaptation, making optimal use of the available resources and best choices of alternative ways of managing resources.

In the past, the introduction of new technologies has had limited impact, because attention was often focused on only one aspect of the cropping calendar (e.g. fertilizer management or varietal improvement). As shown in this book (e.g. Defoer and Wopereis, Chapter 31, this volume), much better results are obtained if a more holistic approach is used, where a new technological option is not so much introduced but rather integrated into the prevailing production system, taking into account interactions with other production factors and management practices. As shown in irrigated rice-systems in the Sahel (Tollens *et al.*, Chapter 1, this volume), a new soil-fertility management strategy may require new options for weed management. Gradually, other technological options may be integrated, eventually leading to a range of technological options that encompass the entire growth cycle, from the initial planning phase to harvest and postharvest stages. This process is called integrated crop management, indicating the step-wise integration of new technological options into production systems with full farmer participation, thereby raising production levels in a sustainable way. When applied to rice, this process ultimately results in 'baskets of integrated rice management options' or 'baskets of good agricultural practices' for different rice production systems. As these systems are dynamic, baskets of options will evolve over time (Wopereis and Defoer, 2007).

Expanding rice harvested area

Across the continent, the most fertile and productive lands for rice are found in the flood plains and inland valleys, and the potential to expand rice harvested area in sub-Saharan Africa is huge. There is large untapped irrigation potential in sub-Saharan Africa, estimated at about 21 million ha (Zwart, Chapter 21, this volume). There is scope to increase the area under irrigation in many countries through expansion or rehabilitation of irrigation structures. This is especially important in countries like Mali and Senegal, where farm size per household in irrigated systems has been declining since the 1970s because of population growth and lack of new land that has been developed for irrigation and is reaching critically low levels (SWAC/OECD, 2011).

With irrigation, farmers will reduce rice production risk and will be able to lift their rice farms to a higher production level through intensification. It will also open up possibilities to grow two or even three rice crops per year depending on the prevailing climate. With an estimated land area of 130 million ha, inland valleys are common landscapes in many parts of Africa that have traditionally not been used for agriculture. Only a fraction (3–4%) of these inland-valley lowlands is used for rice. This is partly because inland-valley lowlands are difficult to manage and are often associated with water-borne disease. Moreover, inland-valley exploitation is often complicated by unfavourable land-tenure arrangements. However, inland valleys are increasingly being used for rice cultivation in the wet season and for other crops, including vegetables, in the dry season near large urban centres because of high population density and proximity of markets (Rodenburg, Chapter 22, this volume). For upland rice, too, there are possibilities for area increase if accompanied with appropriate crop management practices, such as proper soil-fertility management, through balanced use of organic inputs and mineral fertilizers. For example, the growth of Uganda's rice sector in recent years has depended mostly on upland rice systems (Ministry of Agriculture, Animal Industry and Fisheries, 2009). One of the most striking examples is the rapid expansion of rice cultivated areas in Ethiopia, where upland NERICA varieties are grown with supplementary irrigation in hydromorphic zones (AfricaRice, 2012a). On the other hand, experience from Brazil has shown that the area under upland rice may eventually decrease upon intensification and increased yield per unit of harvested area (Pinheiro *et al.*, 2005).

While the rice harvest area expands, it is important to consider the value of environmental services of land and water resources, and how these will be affected by developments in rice-based

systems. Inland valleys in particular are important for local flood and erosion control, water storage, nutrient retention, stabilization of the micro-climate, as well as for recreation and tourism, and as sources of water, clay and sand for crafts and construction. While the main crop is often rice, inland valleys and their fringes are used to grow a variety of other crops (e.g. maize, vegetables, fruit trees), and are also often used for cattle grazing – particularly during the dry season when the water table recedes below the soil surface of the valley bottoms, but there is sufficient residual moisture to support crop growth. Furthermore, these environments provide important forest, wildlife and fisheries resources, and contribute to biological diversity as well as local cultural heritage. The water resources available in inland valleys are often used by rural communities to fulfil a variety of daily household needs. Besides the water resources, biological diversity of inland valleys is probably among the most important functions for the local communities – inland valleys are important locations for the collection of non-agricultural plant resources, and local communities have considerable knowledge of the useful plant species, their use, abundance and collection places (Rodenburg, Chapter 22, this volume).

Such environmental services are often neither well understood nor quantified. Such understanding of who would potentially benefit or lose from land and water developments is, however, extremely important, particularly in the light of a changing climate and the growing interest in Africa's natural resources. Policies are needed (e.g. on land tenure) to facilitate socially acceptable and environmentally sound expansion of rice-producing areas.

Adapting to climate change

Changes in the climate of Africa are expected to include major changes in rainfall distribution, increased frequency of extreme weather events, and generally rising temperatures and CO_2 levels. Farmers have great experience in dealing with climate risk, but the expected pace of change may mean that local knowledge and technologies may be insufficient to cope with new conditions. Anticipating likely climate changes will help in providing alternatives or measures to enable farmers to adapt (e.g. to lower and erratic rainfall, changing river discharges). New climate-resilient varieties, crop- and resource-management technologies, and institutional innovations such as insurance against crop failure may help farmers adapt to rapidly changing environments. Mitigation opportunities are also important. The impact of the predicted enhanced use of Africa's lowlands for rice, land clearance and burning in upland environments, and increased use of nitrogen fertilizer needs more study to develop ways to limit additional release of greenhouse gases into the atmosphere. A global effort is needed to develop targeted technological options to help African farmers to adapt to and mitigate the effects of climate change.

Enhancing Rice Quality and Marketing

Locally produced rice needs to find a market, and it must be of sufficient quality to compete with imports. Quality of locally produced rice is often poor because of sub-optimal harvest and postharvest practices, leading African rice consumers to prefer imported rice. Further, varieties grown may not be to the liking of urban consumers. Hence, to attract Africa's rice consumers and lift the demand for locally produced rice, marketing campaigns are required to make African consumers aware of quality rice produced in Africa. In short, locally produced rice must respond to the preferences of Africa's rice consumers and be promoted to find a market. We distinguish three priorities in this action area:

1. Promoting investment in improved processing technologies.
2. Enhancing access to appropriate financial products for the local rice value chain.
3. Improving market knowledge, branding and policy sequencing.

Promoting investment in improved processing technologies

Rice processing in Africa is dominated by small-scale rice millers, the majority of which produce

an end-product that fails to meet the quality requirements of urban consumers. Moreover, most operators only provide milling services – they do not buy paddy and sell on milled rice. This practice contributes to the fragmentation of the market for milled local rice and discourages private-sector investment. The promotion of private-sector investment in efficient rice processing technologies, such as 'mini-rice mills' with built-in capacity for de-stoning, polishing and sorting homogeneous high-quality rice, will go a long way towards stimulating the local rice value chain (see Stryker, Chapter 26, this volume). Government support of modern rice processing should include mechanisms to provide incentives for processors to upgrade their technologies, such as duty-free imports on processing equipment, tax concessions or access to finance. As paddy production expands, there is an urgent need to process good-quality milled rice that matches the quality benchmark of imported rice (see Futakuchi *et al.*, Chapter 25, this volume). The objective, however, should not be to repeat past misguided policies of government-run large-scale industrial rice mills, but rather to promote modern processing technologies capable of producing high-quality rice. Such mills should include medium-scale operations to deliver large quantities for urban centres and 'mini-rice mills' for rural locations (see Stryker, Chapter 26, this volume).

Enhancing access to appropriate financial products for the local rice value chain

Access to agricultural finance is critical for all rice value-chain actors and to stimulate development in the supply and competitiveness of local rice. For instance, limited access to production credit to purchase productivity-enhancing inputs can counter otherwise profitable production decisions. Without access to adequate financial products, rice farmers often end up selling paddy on credit to traders who may then delay payment to farmers because of their own lack of access to adequate finance.

Failures in credit provision constitute major bottlenecks in the development of a well-integrated value chain for locally produced rice, which adversely affects the overall competitiveness of the chain. Fixed investments in improved processing technologies, warehouses and farm machinery require long-term financing rather than the short-term financing needs of paddy-production credit.

In many African countries, little locally produced rice is available in urban areas, and the development of storage capacity (warehouses) requires appropriate financial products to guarantee rice supply. As paddy production expands, it will be necessary to promote year-round availability and marketing of local rice. Greater investments are therefore needed for the development of effective warehouse systems. Successful experiences – for example, with warehouse-receipt systems – could be promoted. Incentives should be given to rice millers to facilitate access to finance for investment and working capital necessary to procure and hold paddy and milled rice in storage. Adequate financing mechanisms and facilities for the marketing of rice could be extended to local rice wholesalers.

Improving market knowledge, branding and policy sequencing

Africa Rice Center (AfricaRice) research using experimental auctions (Demont and Neven, Chapter 24, this volume) has shown that women consumers are willing to pay a premium for locally produced quality rice compared to imported rice of the same quality. Some consumers, however, prefer the lower price of local mediocre-quality rice. The implication is that different market segments exist for different rice consumers, and development of the rice sector should take such differences into account. Looking at the effect of branding, Costello *et al.* (2013) found that the majority of rice consumers in Dakar, for instance, preferred 'local' sounding brands over 'foreign' sounding brands. Rice value-chain development should, therefore, ensure that rice of different quality remains available to cater for consumer preferences and differences in purchasing power.

The key lessons from the value-chain work conducted in Senegal by AfricaRice and partners are that the availability of quality local rice needs to be promoted among the population,

and that production of quality rice requires investment and conducive policies. Several steps may be required starting with increasing the quality of local rice to the level of imported rice, thus adding value to the local product, then scaling up local rice production while running promotional programmes to market the surplus, with the goal of eventually replacing imported rice in urban markets. A branding exercise in Saint-Louis in 2006 failed to impact the market because of lack of promotion (M. Demont, Saint-Louis, Senegal, 2012, personal communication). Fragmentation of the local paddy contributed to this as producers act alone in processing and selling their surplus paddy, which is a major disincentive to private-sector investment in the domestic rice value chain.

Promoting Conducive Policies for Smallholder and Agri-business Development

Development of Africa's rice sector will require coherent, evidence-based policy making at both national and regional levels. There is greatly increased awareness of rice as a strategic commodity capable of fuelling economic growth and contributing to hunger and poverty reduction across the continent. Many African countries have embarked on ambitious programmes to boost their rice production capacity as a response to the 2007–2008 rice crisis. With the upward spikes in food prices, many policy tools have been implemented that were out of vogue following the implementation of market-oriented reforms in the 1990s. These include price controls, export bans, subsidies on retail prices, the release of food security stock, subsidies on inputs such as seed and fertilizer, farm machinery and postharvest equipment, and the establishment of a minimum producer price. Some of the policy measures taken by African governments to alleviate the impact of soaring staple prices on consumer welfare are well founded given the strategic importance of rice. Many untargeted subsidies and outlays, however, will make it more difficult to balance the public budget. Governments should avoid undermining incentives for domestic rice production by misjudged policy measures such as price controls and reduced import taxes introduced in an unpredictable manner – which increases market uncertainty – or maintaining these for unnecessarily long periods. In short, policy intervention needs to be rules-based and predictable so as not to discourage investment or undercut the emergence of a dynamic private rice sector (see Seck *et al.*, Chapter 2, this volume).

As a result of the global food crisis in 2008, Africa has also become a target for direct foreign investment in agriculture. Major companies are acquiring large tracts of land for food production and biofuel plantations. It is clear that African countries need to move cautiously with respect to this new situation because of the complexity, political sensitivity and context specificity of the land issue within and across countries. They need to ensure that these investments lead to win–win situations for all involved, not least the resource-poor local farmers (AfricaRice, 2011a).

Regional economic communities should be strengthened to contribute in such areas as harmonizing seed legislation, import tariffs and regulating rice imports, in line with the Comprehensive Africa Agriculture Development Programme Framework for African Agricultural Productivity (FARA, 2006). National governments need to take the lead in promoting public–private partnerships across the rice value chain for production, storage, processing and distribution infrastructure for quality rice in the African market. To boost Africa's rice sector, policies conducive to developing investment in domestic production capacities are required. Further, investments to rehabilitate and expand areas under irrigation should continue, along with support provided to raise the productivity of smallholder rice producers through access to improved varieties, good-quality seed and fertilizer. We have learned, however, that targeting investment efforts uniquely on production can create gluts at harvest time because of insufficient processing and marketing capacity in the value chain. Therefore, it is vital to simultaneously invest in the harvesting, processing and marketing nodes of the local rice value chain by a combination of public support to farmers and privileging private-sector investment. Also, as proposed by the Economic Community of West African States (ECOWAS; CEDEAO, 2012), it is important to establish local (regional) rice stocks

that are well managed (not necessarily by the public sector), to protect local markets from short-term price shocks on the global market.

Strengthening Impact-oriented Rice Research, Extension and Knowledge Management

Rice research and development efforts need to be strengthened in Africa and become more interlinked and impact-oriented. The following priorities will need to be addressed in this action area:

1. Capacity strengthening among research and extension communities and rice value-chain actors.
2. Improving rice knowledge management.
3. Implementing a new Africa-wide rice research agenda.

Capacity strengthening among research and extension communities and rice value-chain actors

Lack of investment in agriculture in the 1990s led to a desperate lack of capacity at all levels in the rice value chain and gross neglect of Africa's agricultural research and extension capacity, which jeopardizes progress in developing Africa's rice sector. A survey conducted among AfricaRice's then 22 member states in 2008 showed that approximately 250–275 researchers (including about 15 women) were involved to some extent in rice research. Most of these worked on many other crops and spent only a fraction of their time on rice, and the average age of researchers was 47. Egypt alone took the lion's share of this research pool, with 50 highly qualified researchers working full time on rice, including 12 breeders. In comparison, a country the size of Nigeria had only two rice breeders (AfricaRice, 2011b).

Extension services in Africa are largely understaffed and starved of access to consistent and relevant rice information and improved extension tools. Public and private extension services often focus on high-value export commodities and less on staple food crops such as rice. This is seriously hampering rice-sector development, which will depend to a large extent on the development of rice technologies adapted to local settings and their dissemination to actors in the rice value chain. There is a clear need for improved accessibility to rice-related information and functional infrastructure for research and development, and the development of a critical mass of trained scientists and public, NGO and private-sector extension agents. There is also a clear lack of appropriate technology-delivery and information-exchange mechanisms. There is, therefore, an urgent need to rebuild Africa's research and extension capacity for rice. The Second Africa Rice Congress held in Mali in 2010 called for a 'Marshall plan' by African governments and their development partners to substantially strengthen the training and retention of new staff, while updating agricultural curricula in vocational training schools and universities, ensuring efficient spillover to actors in the rice value chain and strengthened information exchange. Conducive working environments and appropriate budgetary provisions are needed to strengthen and retain an effective capacity in agricultural research and extension.

Improving rice knowledge management

Knowledge management and creating rural learning opportunities at the regional, national and local levels presents challenges. Public- and private-sector agents continually renegotiate their roles and build new sets of skills and expertise, either in-house or by partnering with others. New actors in the rice sector, however, often work with 'top-down mindsets', lacking awareness of gender, poverty and sustainability issues. Strategic partnerships, and learning alliances and methods may help to increase awareness and increase rice-sector performance in a sustainable and equitable manner. Promising opportunities to strengthen learning and innovation systems include: the establishment of partnerships with NGOs and producer organizations; the emergence of brokers between the supply and demand sides of innovation; the use of information and communications technology (ICT) to enhance rural learning and 'self-diagnosis' of problems and testable solutions; the development of 'new professionals' through institutional

change in higher education; and new funding sources and mechanisms to better address resource-poor and women farmers' needs.

Rapid development of ICT in sub-Saharan Africa (mobile phones, rural radio, internet, etc.) offers exciting new opportunities for AfricaRice and partners to facilitate exchange of information and learning modalities that are demand-driven and tailored to specific needs. Given the high illiteracy rates in sub-Saharan Africa, there is a need for quality audio- and video-based learning content, and local capacities for content creation and adaptation. This will be of particular importance to rural women.

Implementing a new Africa-wide rice research agenda

After a series of workshops and meetings that started in 2008, the AfricaRice Council of Ministers approved, in September 2011, a new Strategic Plan to boost Africa's rice sector for the period 2011–2020 (AfricaRice, 2011b) – seven Priority Areas are considered:

1. Conserving rice genetic resources and providing smallholder farmers with climate-resilient rice varieties that are better adapted to production environments and consumer preferences.
2. Improving rural livelihoods by closing yield gaps and through sustainable intensification and diversification of rice-based systems.
3. Achieving socially acceptable expansion of rice-producing areas, while addressing environmental concerns.
4. Creating market opportunities for smallholder farmers and processors by improving the quality and the competitiveness of locally produced rice and rice products.
5. Facilitating the development of the rice value chain through improved technology targeting and evidence-based policy-making.
6. Mobilizing co-investments and linking with development partners and the private sector to stimulate uptake of rice knowledge and technologies.
7. Strengthening the capacities of national rice research and extension agents and rice value-chain actors.

Priority Areas 1–5 will result in new rice technologies that will make a positive, sustainable and lasting difference in the livelihoods of farmers and other rice value-chain actors. Through Priority Area 6, links will be established with large rice-sector development initiatives and the private sector to obtain co-investments to stimulate uptake of appropriate rice knowledge and technologies and to obtain feedback on technology performance. Priority Area 7 addresses the desperate lack of trained capacity across the rice value chain and in rice research and development in Africa (discussed above). Across Priority Areas, there is a need for working closely with women farmers, researchers, extension agents and agribusiness women in order to maximize efficiency, effectiveness and impact (AfricaRice, 2011b).

As an Association of currently 24 African member states (January 2013), and recognized by the African Union as the Center of Excellence for Rice Research in Africa, AfricaRice is well placed to coordinate these rice research-for-development efforts across the continent over the next decade. AfricaRice will act as both a developer and broker of rice knowledge, and will tap sources from within and outside the African continent, with each partner contributing to the rice research-for-development agenda according to its comparative advantage.

Links between research and development investments from both public and private sector are often very weak in Africa. As a result, opportunities for large-scale exposure of farming and agribusiness communities to new rice technologies and crop and natural-resource management principles are often lacking. Rice-sector development will require better linkages (feed-forward and feedback loops) between research networks and development initiatives in the public sector, civil society and private sector. This rice research-for-development agenda will, therefore, be implemented through a range of partnerships from strategic upstream research to linking with development partners to achieve impact on the ground, with the national agricultural research systems (NARS) as the key entry point in each country.

To achieve impact and boost Africa's rice sector, it is essential to: (i) focus efforts; (ii) build critical mass; (iii) connect actors in the research and development communities; and (iv) communicate results. To follow these four principles, AfricaRice will implement its Strategic Plan through three mechanisms.

The **first mechanism** is through AfricaRice's participation in CGIAR Research Programmes (CRPs), in particular the Global Rice Science Partnership (GRiSP), led globally by the International Rice Research Institute (IRRI) (see www.cgiar.org/our-research/cgiar-research-programs/rice-grisp/). AfricaRice is leading the implementation of GRiSP in Africa; it will play a broker role to mobilize rice knowledge from outside Africa and will also ensure that knowledge from Africa will benefit other continents.

The **second mechanism** consists of the Rice Task Force mechanism: an Africa-wide systematic collaborative research effort on critical thematic areas in the rice sector (e.g. rice breeding, rice agronomy), based on the principles of sustainability, build-up of critical mass, and ownership by the NARS. The Task Force mechanism will contribute to the development of a new generation of rice scientists across the continent.

The **third mechanism** consists of 'Rice Sector Development Hubs' – zones where rice research products from the CRPs and the Task Forces will be integrated across the rice value chain to achieve development outcomes and impact. These Hubs represent key rice-growing environments and different market opportunities across African countries, and are linked to major national and regional rice-development efforts to facilitate broader uptake of rice knowledge and technologies. The geographic positioning of each Hub is determined in national workshops, convened by the NARS (AfricaRice, 2011b, 2012b).

Activities in the Hubs focus on producing sufficient quantities of the right quality of rice and rice-based products of interest to the national or regional markets in a sustainable manner. Hubs are regions strategic for rice development, where local innovations and research products and services are tested, adapted and integrated in 'baskets of good agricultural practices' (integrated rice management options) with feedback provided to researchers on technology performance. Hubs are built around large groups of farmers and involve other value-chain actors, such as rice millers, input dealers and rice marketers. Change agents from research, NGOs and extension agencies work with these actors to evaluate technological and institutional innovations, facilitate diffusion of knowledge and establish linkages along the rice value chain. This type of interaction is stimulated through the establishment of multi-stakeholder platforms (Tollens *et al.*, Chapter 1, this volume). Care is taken that women and youth are not marginalized, but rather strengthened in the process of rice value-chain development. By January 2013, there were already 59 Hubs identified in 20 sub-Saharan African countries; and in support of these, Task Force activities focus on the Hubs to avoid dispersion of activities.

Diagne *et al.* (Chapter 32, this volume) assessed the potential impact of this Africa-wide rice research agenda for 2011–2020. They show that the total cumulative discounted income benefit expected for all the research-based technologies and all sub-Saharan African countries will be $0.9 billion in 2014 and $10.6 billion in 2020, corresponding to an annual income gain of $1.8 billion. As a consequence of these income gains, 2.3 million people will be lifted above the $1.25 purchasing power parity (PPP) poverty line in 2014 and 11.0 million in 2020. In terms of research, rice breeding is expected to yield the greatest benefits, closely followed by agronomic research. Postharvest research, even though coming in last position, provides a significant share of the total benefit. In terms of geographical area, research efforts need to continue to be focused on West Africa, with a special focus on Nigeria, Guinea, Sierra Leone and Côte d'Ivoire. East Africa will be the second major beneficiary region and Central Africa third. Rainfed rice-growing environments predominate on the continent. Priority-setting results show that the rainfed lowlands will receive the greatest benefit from research, closely followed by the uplands. Irrigated systems, whose importance is increasing, will be the third major environment. These figures hide important differences across research options, rice environments, research types and regions.

Conclusions

Rice is critical for food security and political stability throughout Africa, and it has great potential to fuel economic growth. For many decades, rice has had the fastest-growing consumption rate among the staple crops, in large part driven

by huge growth in urban demand; however, about 40% of the rice consumed on the continent is imported. Despite being a global crop, only 7% of world production is traded internationally. Africa's reliance on the international market is therefore a very risky strategy – any rupture in the global market supply would likely have major political implications due to the numbers of (especially urban) people who rely on rice for their daily food, as seen during the 2007–2008 rice crisis in Africa.

Research has shown that the potential for rice production on the African continent exceeds anticipated consumption levels in the distant future by far and that domestic rice can be competitive. Even though aggregate yields are lower for Africa than for Asia, closer examination of yield by growing environment and season suggests that rice yields in Africa are often on a par with those in Asia, especially for irrigated systems (AfricaRice, 2011a). Moreover, Africa has huge untapped natural resources in the form of land and water – resources that are now scarce in other parts of the world, such as Europe, Asia and North America. Although local rice has for a long time suffered the stigma of poor quality, its taste is preferred by many consumers over imported varieties, and when quality concerns are met consumers are prepared to pay a premium for local varieties.

The critical challenge facing the African rice sector is to enhance production, processing and marketing to enable a major concern to be turned into an opportunity – the growing demand for rice as a preferred staple. To respond to this challenge, Africa will have to become a global powerhouse of rice production, avoiding the trap of fragmentation of production, processing and marketing factors, to produce sufficient quantities of the right quality of rice to compete against imports on the African markets.

In terms of enhancing production, we need to understand factors limiting and reducing rice productivity per unit of land, water and labour, and work together with farmers to develop 'baskets of good agricultural practices' that can gradually close the current large yield gaps in farmers' fields. There is also a need to mobilize investments to raise the yield ceiling in farmers' fields, reduce risk and enable greater farming precision. One way of achieving the latter is to enable greater control over water resources in a collective and sustainable manner. For inland valleys in Africa, this will often entail the construction of main and secondary drainage channels and the identification, bunding and levelling of individual fields with minimal soil disturbance. There is also a need to rehabilitate and expand irrigation structures, because rice in Africa is still mainly grown under rainfed conditions. Improved access to credit, quality seed of improved varieties (tailored to specific growth environments and market demands) and mineral fertilizer will continue to play a key role in boosting rice productivity.

With the prospect of increased production, there is a need for investment in the harvesting, processing and marketing described above, so that the whole value chain works together to ensure more and good-quality local rice reaches consumers' tables. Financial products (e.g. credit) need to be adapted to the target borrower – there is no 'one size fits all' credit mechanism for everyone involved in the value chain. Moreover, access to good storage facilities along the rice value chain (including warehouses) should be expanded to improve the storage and marketing of quality rice (AfricaRice, 2011a).

Past experiences have shown that encouraging farmers to do their own processing is not helping in the drive to improve and maintain quality. For this reason, we need to move towards systems where farmers focus on production, using appropriate machinery to maximize their output in terms of both quantity and quality. Processing may then be carried out with medium- and large-scale machinery owned by producer associations or private entrepreneurs. These could contract farmers to grow specific varieties with quality seed and specified inputs and other management practices – some form of outgrowers' scheme. In this way, the processors will collect and aggregate rice of a single variety of a similar quality, which will enable them to produce grain of uniform quality ready for the market (AfricaRice, 2011a).

Marketing is another important aspect. There is strong evidence that Africans prefer local rice varieties and will pay a premium for them if the quality is right. Contractual arrangements for delivery of quality grain between processors and wholesalers, and appropriate branding are logical steps to improve the value and consumption of local rice on the continent.

Thus, the 'final' step in the value chain is that wholesalers will buy and brand (package and label) quality local rice for onward sale to retailers and thence consumers (AfricaRice, 2011a).

In our vision, Africa's rice farmers will operate modernized family farms, most of which will be mechanized and in many cases farmers will grow a second crop (either rice or some other crop). Farmers, many of them women, will be well informed, using quality rice seed and good agricultural practices that are environmentally sustainable from land preparation to harvest. Farmers' prices will be differentiated to reflect quality grain and farmers' associations or millers will aggregate quality paddy; rice will be mainly milled by dedicated quality millers using good storage and processing practices; credit will be available to all stakeholders in the rice value chain; contractual arrangements will be the norm, between farmers or farmers' associations and processors, and between processors and wholesalers or importers; wholesalers will bulk-buy quality rice for branding and onward sale to retailers; and the commercial rice product will carry a label indicating not only its origin, but also its quality.

Working together towards that vision will allow Africa as whole, and the various subregions, to realize 'Africa's rice promise'.

Acknowledgements

Some of the Conclusions in this chapter are reproduced from AfricaRice (2011a) with permission from Africa Rice Center.

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