# Chapter 28
# Agricultural Innovations That Increase Productivity and Generates Incomes: Lessons on Identification and Testing Processes in Rwandan Agricultural Innovation Platforms

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**Abstract** The central question in increasing productivity and generating incomes in African agriculture is how to move from technology generation to innovations that respond to constraints of agricultural production along the value chains. This question was considered in the context of subsistence agriculture, smallholder production systems, inefficient marketing and investments by the private sector, a preponderance of public interventions, and inadequate policies. The Integrated Agricultural Research for Development (IAR4D) presents an opportunity to address the question as it involves innovative principles, demand-driven research, and utilizing organizational

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B. Vanlauwe et al. (eds.), *Challenges and Opportunities for Agricultural Intensification of the Humid Highland Systems of Sub-Saharan Africa*,
DOI 10.1007/978-3-319-07662-1_28, 

capacities of multi-stakeholders and relevant agricultural policies. The key element in identification and testing of agricultural innovations in the concept of IAR4D was the establishment of agricultural Innovation Platforms (IPs). IP stakeholders were used to identify and rank constraints to agriculture production along the value chains in their respective sites and contexts. Two to three main constraints were identified and translated into research questions that were envisaged to generate practical solutions for productivity and better marketing strategies while conserving natural resources. The research proposed a package of innovations and each stakeholder was assigned a role in testing, disseminating, and adopting each of them. A research agenda based on beneficiaries' demand, targeting value addition, and income generation was elaborated and implemented. Achievements so far indicate a high efficiency of agricultural innovations collectively identified and participatory methods tested by IP stakeholders, such as potato harvest and postharvest technologies in Gataraga IP and hence validating the efficiency of IAR4D over traditional participatory methods of agricultural research and dissemination.

**Keywords** Agricultural innovations • IAR4D • Innovation Platform • Innovative technologies • Partners • Productivity • Stakeholders

## Introduction

Sub-Saharan African (SSA) agriculture largely remains traditional and is concentrated in the hands of smallholders. Given the dominance of rain-fed agriculture, yields are low. Nevertheless, it remains an important economic sector in Africa. African agriculture contributed 29 % of Gross Domestic Product (GDP) in 1979–1981 and 25 % in 2002–2004 compared with the world averages of 7 % and 3 % respectively (Economic Commission for Africa 2009). The key challenges to agricultural production and farmers' livelihoods improvements include the linear top-down delivery of agricultural research results; the failure for agricultural Research and Development (R&D) to go beyond production and include markets, policy and natural resources management; the poor communication and collaboration between all actors within a commodity value chain from inputs through production, value addition/processing, and marketing to consumption (Stroud 2004). There is also massive undercapitalization of agriculture and research, inadequate use of mechanization and agrochemicals, inadequate investments in irrigation, and low land and labor productivity as well as climate variability (Mekonnen et al. 2009). Small-scale farmers predominate in a situation of increasing population pressure, food insecurity, very low and declining levels of agricultural productivity and rapid natural resource degradation (Beintema and Stads 2004). The poor performance of African agriculture can be attributed not only to inadequate and inappropriate policies but also to institutional bottlenecks. The lack of dynamism of many agricultural markets is an important cause of poor performance of the agriculture sector (de Laiglesia 2006).

Agricultural R&D systems such as Participatory Research and Development (PRD) have been the main channels of building agricultural productivity and food security (Gonsalves et al. 2005). Public research organizations conduct 94 % of

agricultural R&D works in most countries in SSA. Many agricultural research organizations have a supply-driven orientation. Their role is technology development prior to "handing over" to dissemination channels with little strategic planning of their research and its potential impacts (Ashley et al. 2009). Although there have been some islands of success, past Agricultural Research and Development (ARD) efforts have failed to fully respond to agriculture challenges due to their linear approach and ignoring the basic needs of the farmers and other interested stakeholders such as input dealers, traders, processors and consumers in ARD process (Scoones 2005). Such an approach to agricultural research is often described as sectoral, linear, and fragmented with little or no involvement of relevant stakeholders (Tenywa et al. 2011a).

The concept of Integrated Agricultural Research for Development (IAR4D) was proposed to bring solutions to the failures of R&D systems (Daane and Booth 2004). The concept proposed operating principles and guidelines for stakeholders with diverse interests to come together to analyze agricultural problems, to develop solutions and to work together towards the fulfillment of common goals (Hawkins et al. 2009). Therefore, the Sub Saharan Challenge Program (SSA-CP) initiated proof of concept research in three widely differing agroecologies in Western, Eastern, and Southern Africa to assess and validate the usefulness of the IAR4D concept in generating deliverable public goods for the end users, its superiority over conventional approaches, and its applicability as a research approach to generate more end-user acceptable technologies (FARA 2004).

The key element that makes the IAR4D principles work is the agricultural Innovation Platform (IP). Tenywa et al. (2011a) defined an IP as a tool for bringing together multiple stakeholders for visioning, planning and implementing or applying of new ideas, practices, and services, which arise through interaction, creativity, insight, and empowerment of the stakeholders to improving the existing situation/conditions around a common interest/challenge and thereby bringing about desired change with a particular interest in farmers' needs, problems and opportunities. In other words, it is a forum for sharing and creating new knowledge and identifying knowledge gaps relevant for planning explicit systemic innovations in agricultural development strategies. This paper presents the process of identification, testing, dissemination and utilization of agricultural innovations and innovative technologies using the IAR4D concept in the Rwandan IPs of the Lake Kivu Pilot Learning Site (LKPLS). Further, the paper presents lessons learnt during the identification and the implementation of activities.

## Major Stakeholders and Interfaces in Agricultural Innovation Platforms

The establishment and functioning of an IP are prerequisite environments that are used to identify, test, and utilize innovative technologies while implementing IAR4D. Stakeholders are the backbone of an IP, without them the platform cannot exist nor operate. The choice of stakeholders is driven by their willingness to participate and their potential contribution to move the process towards the achievement of the

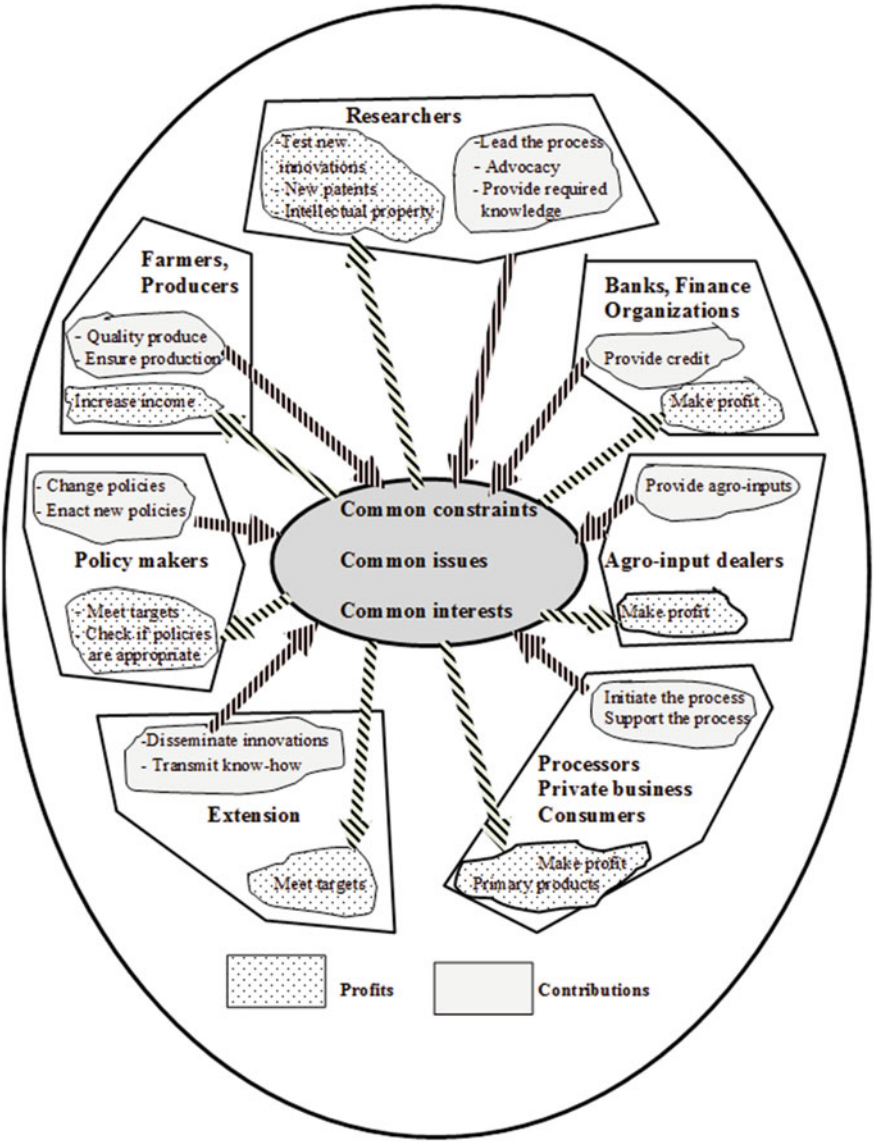


**Fig. 28.1** Interfaces in agricultural Innovation Platforms

common interests on the one hand and the foreseen potential benefits they are likely to obtain from the IP on the other hand. Contributions and benefits must be balanced in a win–win scenario to make the IP always attractive and profitable. This is very different from the conventional agricultural R&D approach, which has no strategy nor institutional arrangement that encourages stakeholders to work together.

The potential stakeholders in an IP include farmers and producers, researchers, banks and other financial institutions, agro-input dealers, processors, private business

owners and consumers, extension services, and policy makers (Fig. 28.1). Following the principle of contributions versus benefits, researchers may initiate the IP, but more importantly, they provide the necessary innovative technologies and technical knowledge needed to improve the productivity and to make the IP profitable and attractive. The researchers may act as advocates in several instances. The IP constitutes an environment for researchers to test new ideas, and new technologies, and hence have international recognition, intellectual property rights, and patents. Farmers or producers contribute by ensuring the availability of products in the value chains. Farmers gain enormously first and foremost being accepted as equals in the IP with researchers, government officers, traders, bankers, and processors. In the end, they get premium prices on primary products which increase their incomes, food security, and social development and they easily access new technologies.

The IP provides an opportunity to the banks and financial institutions to invest in agricultural value chains where profits are competitive. The banks and financial institutions provide access to credit and finance that are needed to enhance the production for increased profit. The agro-dealers provide agricultural inputs that are in high demand and increase their markets and hence make profits. The processors, private business owners, and consumers are on the top of the value chain and contribute by utilizing IP products and hence act as the driving force of the IP. At the same time they make profits and have reliable supplies of primary products. Extension services help in disseminating innovations and ensuring that new innovations are utilized and in return get recognition. The policy makers enact new, favorable policies, reinforce existing and beneficial policies, and change those that are inefficient, while they have a ground to test the efficacy of enacted policies and hence meet national targets.

Each of the stakeholders is capable of creating an IP based on common issues or while satisfying his/her needs. The processor, private business owners, and consumers can create IPs that supply primary products while banks and financial institutions can form IPs that allow them to invest in the agricultural value chain where they foresee high profits. Policy makers may form IPs to help in validating new policies while researchers create IPs to have testing environments of new technologies and new innovations.

The interactions between IP partners are not linear but are conducted in all directions. The communication and establishment of relationships among partners help move the whole IP system to the common goal. The identification, testing, dissemination and utilization of innovations are done through systems of interfaces where stakeholders contribute, get profits, and interact continually.

## Steps in Identification, Evaluation, and Utilization of Agricultural Innovations in Rwandan IPs

The identification, evaluation, and utilization of agricultural innovations were conducted through multi-phased, participatory, action learning approaches. Four important phases were considered: establishment of IPs, planning, implementation,

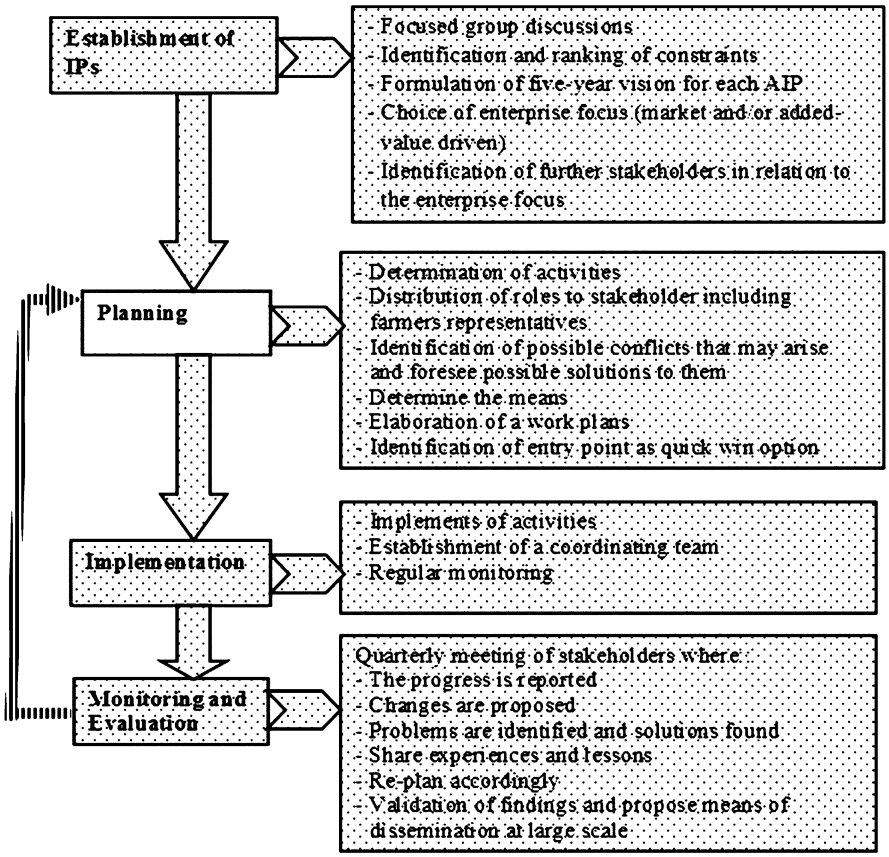


**Fig. 28.2** Steps in identification, evaluation and utilization of agricultural innovations in Rwandan IPs

and monitoring and evaluation (Fig. 28.2). The identification was initiated at the establishment of IPs during focused group discussions organized following the procedures of Wong (2008), Powell and Single (1996) and Byers (1991) where potential stakeholders, constraints, and major value chains were identified, and medium-term visions were formulated, thereafter approved during IP establishment meetings.

The defining principles of IAR4D include "perspectives, knowledge and actions of different stakeholders around a common theme and the learning that stakeholders achieve through working together" (Hawkins et al. 2009) so that the process of identification of agricultural innovative technologies started by defining a 5-year vision which was shared by all stakeholders. In all IPs, the vision was about the achievement of food security and income generation (Table 28.1). The agricultural constraints in each IP were ranked using pair-wise comparison methodology (Poursaeed et al. 2010; Saaty 2008; Alphonce 1997) with the participation of all

**Table 28.1** Major constraints, enterprise focus, and quick win–win options in Rwandan agricultural Innovation Platforms

| Items | Mudende | Rwerere | Gataraga | Remera |
|---|---|---|---|---|
| Constraints | 1. Lack of markets for farm produce especially for milk and potato<br>2. Insufficient improved varieties of crops and fodder species | 1. Insufficient options of sources of income<br>2. Poor market access, lack of markets | 1. Limited markets for farm produces especially for potato and maize<br>2. Low quality of marketable farm produce<br>3. Insufficient of improved and marketable varieties | 1. Lack and inaccessibility to markets<br>2. Low quality value of marketable produce<br>3. Insufficient improved and marketable varieties |
| Vision | Food security, increased productivity and profits | Food security and enough money to acquire all basic needs | Increased productivity leading to increased incomes and food security | Food security and income to satisfy basic needs |
| Enterprise focus | Milk/Irish potato | Chili pepper, passion fruit, milk | Irish potato/maize | Bean, maize |
| Quick-win options | Organize milk market to target Inyange dairy | Introduction of chili and passion fruit cropping to target Urwibutso | Establishing market outlets for potato production, adding value to potato produce | Organize bean and maize markets |
| Implementing partners | ISAR (presently RAB), CIAT, Imbaraga, NUR, ISAE, MAK, SAC-R | Urwibutso, ISAR (presently RAB), CIAT, Imbaraga, NUR, ISAE, MAK, ANS-R, SAC-R | ISAR (presently RAB), CIAT Urugaga Imbaraga NUR, ISAE, MAK | Urwibutso, ISAR (presently RAB), CIAT, Urugaga Imbaraga, NUR, ISAE, ANS-R, SAC-R |
| Other partners | Core IP members, BRD, Sector Executive Secretary, Milk collectors | Core IP members, Banque Populaire, Sector Executive Secretary | Core IP members, Input traders, Supermarkets and restaurants, Sector Executive Secretary | Core IP members, Sector Executive Secretary |

*ANS-R* Action Nord Sud-Rwanda, *BRD* Banque Rwandaise de Développement, *CIAT* International Center for Tropical Agriculture, *ISAE* Institut Supérieur de l'Agriculture et de l'Elevage, *ISAR* Institut des Sceiences Agronomiques du Rwanda, *MAK* Makerere University, *NUR* National University of Rwanda, *RAB* Rwanda Agriculture Board, *SAC-R* Send-a-Cow-Rwanda

stakeholders. The first three constraints were used to select the enterprises' focus to be used in proofing the effectiveness of IAR4D. The enterprise focus was chosen based on its likelihood to create impact, its socioeconomic importance, its likelihood to involve and bring benefits to all stakeholders and its likelihood of making all stakeholders moving towards the IP vision. It was validated by all stakeholders (Table 28.1).

The planning phase consisted of identification of specific activities and sub-activities to be conducted and allocating them specific partners, including farmers' group representatives, according to their ability and capacity (Tables 28.2 and 28.3). The targets were set, indicators elaborated, and milestones and completion periods agreed. At this stage, other activities not necessarily related to the enterprise focus were identified based on their relevance and included in the plan. The critical stage in planning was the identification of possible conflicts that would likely arise during the implementation and other subsequent phases. It was very important to foresee such conflicts before undertaking activities.

Issues and constraints common to all stakeholders in the IP were clearly articulated enabling each partner to know its exact role and to conduct activities as planned (Tables 28.2 and 28.3). The means for conducting activities were discussed during the planning phase. Each stakeholder brought the means at his/her disposal such as staff and an efficient planning of their utilization was performed by promoting synergy and complementarity. Furthermore, more partners were identified and engaged (Table 28.1). Their choice was on competence in conducting a given activity and on disposal of more means and facilitations highly needed in the value chain. The potential contribution of the new stakeholders was balanced with the potential benefit from IPs.

The last step in the planning phase was the selection of a quick-win option that would allow entering the IP, hence demonstrating the importance of the IAR4D (Table 28.1). The quick-win option was an action that has short-term impact. It was a market of an existing product, an improvement in agronomic practices, and/or an improvement of a step in the value chain. The quick-win options made all partners confidently undertake activities, to reduce fears of risk and be assured of success.

The implementation phase was very crucial because this is where each partner demonstrated their ability to work towards the common goal and showed how synergy and complementary among stakeholders with different origins, disciplines, interests, and capabilities were working. In fact, synergy and complementary of partners with different disciplines and interests but working towards the same goal and interactions among stakeholders in all directions, instead of linear approaches, were the major outputs from the IAR4D approach. Special relationships established among stakeholders were an important advantage and output of IAR4D approaches over the R&D systems. It was observed that stakeholders from various horizons were enthusiastic to work together, to know each other, and to establish particular relationships.

The monitoring and evaluation were conducted at all steps of implementation, but more importantly during the quarterly meetings where each partner submitted a detailed quarterly report of their activities emphasizing success, constraints and

**Table 28.2** Progress and achievements in Mudende and Gataraga IPs

| IP | Issue | Activity | Progress |
|---|---|---|---|
| Mudende | Linkage of famers to milk markets | Organize milk market to target milk collectors and dairies | The capacity of milk production: 6,000 L/day |
| | | | Milk handling procedures are very poor |
| | | | Training of 50 milk producers on milk handling |
| | | | Linkage of producers to milk collectors at Rubavu, Musanze, and Kigali |
| | | | Approximately 3,000 L/day are sold with 50 Frw/L higher than the market price |
| | | | Construction and equipment of a collection center financed by BRD (Rwandan Bank of Development) |
| | Improve cattle feeding | Participatory introduction and evaluation of fodder species | Six fodder species were introduced and participatory evaluated: *Brachiaria molato, B. marando, Chloris gayana, Medicago Sativa, Desmodium incinatum and D. Intoritum* |
| Gataraga | Organize potato market to target restaurants, hotels and supermarkets in Kigali | Apply harvest and post harvest innovations | All potato growers are using haulm destruction (haulm pulling or haulm cutting), |
| | | Link producers to Kigali market | Washing potato system for supermarkets and scribing for restaurants |
| | | | 8 t of potato per week are delivered to Kigali supermarkets, hotels and restaurants |
| | | | 14 supermarkets, hotels and restaurants in Kigali have been linked to Gataraga IP |
| | | Organize maize markets | 100 t of maize grain sold to Maizerie de Mukamira at 30 Frw/kg higher than the market price |
| | | | 10 t of maize grain sold to traders |
| | | | 18 t of maize seed sold to RADA at a price double than the market price |
| | Clean potato seed | Clean potato seed and marketable varieties | Three varieties: Kinigi, Mabondo, and Sangema participatory evaluated. Kinigi variety was selected to be used for Kigali market |
| | | | The right seed size and spacing have been determined and are used to produce potato for Kigali market |
| | | | 1,500 t of seed produced using positive and negative selections |

**Table 28.3** Progress and achievements in Remera and Rwerere IPs

| IP | Issue | Activity | Progress |
|---|---|---|---|
| Remera | No organized market for maize and bean produces | Organize bean and maize markets | 50 t of maize grain sold to Maizerie de Mukamira |
| | | | 10 t of maize seed sold to RADA |
| | | | 8 t of beans rich in ion and zinc sold to Harvest Plus as seed |
| | | | Collective marketing has been adopted |
| | | | Land consolidation has been strengthened |
| | | | Two varieties of beans (Cansilida and Rucagu) have been highly adopted (almost 100 % adoption) |
| | Insufficient adapted varieties | Promotion of improved varieties | Four bean varieties were promoted, but only two (Cansilda and Nyiranigisenyi) have been adopted in very short period |
| | | | One variety of maize has been introduced |
| | Alternative source of income | Alternative source of income | 5,000 seedlings of passion fruits have been distributed to 100 farmers, introduction of passion fruit cropping systems |
| Rwerere | Low farmer income | Chilli production to supply Urwibutso market | Around 2.5 ha cultivated under organic conditions were harvested and sold to Urwibutso |
| | | | Introduction of chili cropping |
| | | | Introduction of organic farming |
| | Alternative source of income | Participatory introduction of passion fruit crop | 3,000 seedlings of passion fruit were distributed to 60 farmers |
| | | | Introduction of passion fruit cropping |

possible solutions to them, what worked well and what did not work well, and how to make the process better. It was an occasion to resolve conflicts. Completed activities with practical conclusions were presented. Specifically, practical conclusions and possible utilizations of agricultural innovations that had showed possible impact were proposed. At the same time means of dissemination and dissemination plans were elaborated and implemented. A team in charge of daily coordinating, monitoring, and evaluation of activities was established. This team was required to submit a report to the quarterly meetings.

The quarterly meetings were opportunities to re-plan based on the past experience. New activities, new agricultural innovations, and new actions were added while existing ones were modified or redirected and new partners proposed and engaged in IPs. Furthermore, it was an avenue to find out how partners felt and discuss issues of balancing the contribution and the gain from the IAR4D process. Finally, it was on opportunity to see how to make the approach more profitable to every stakeholder in a sustainable manner.

## Progress and Achievements in IPs under IAR4D Systems

Mudende sector had the capacity of producing 6,000 L/day (Table 28.2) of milk before implementation of IAR4D principles through IP systems. However this milk was sold at a very low price to several middle-men and was of bad quality due to inappropriate handling procedures. The quantity sold per day did not exceed 1,000 L/day so much of it was lost. After the IP system was established and the IAR4D concept applied for 2 years, farmers (milk producers) were linked to markets and could sell 3,000 L/day at a higher price (Table 28.2). They were also linked to banks (BRD) and were able to construct a modern milk collector so that the remaining 3,000 L/day were stored and sold later to markets situated as far as Kigali city. Furthermore innovative milk handling techniques and fodder species were introduced and so improved greatly the quality of milk produced while the training on milk handling enabled producers to reach the standards of Inyange Dairy, the major dairy company in Rwanda.

Irish potato in Gataraga sector was the major staple crop and was planted in rotation and/or in intercropping with maize. However, potatoes of several varieties were harvested in bulk, were of poor quality, and were a mixture of all sizes. Both potato and maize were sold to rural assemblers at very low price. There was little interaction between producers and the markets. Stakeholders were moved by the fact of ensuring accessibility to Kigali-City markets composed by supermarkets, hotels, and restaurants. Potato producers were able to access markets in Kigali and hence fetched high prices. Research and extension agencies disseminated new packages of innovative technologies whereas hotels, restaurants, and supermarkets in Kigali obtained high quality potato produce (Nyamulinda et al. 2011). The IAR4D systems introduced changes in cropping systems where potato planting was thoroughly planned to ensure continuous supply of potato produce.

Beans and maize were the staple crops of Remera sector and were planted in rotation. However both bean and maize were used for self-consumption so that most of the harvest was used at home with very little quantity sold in the local markets. With the implementation of an IP system and IAR4D principles, two improved bean varieties were introduced tested, multiplied, and disseminated; collective marketing was promoted, and the land consolidation system was adopted so that producers accessed markets and had enough produce for marketing (Table 28.3). The land consolidation system consists of putting together small household plots to have large areas of at least 5 ha. The consolidated land is planted with one crop and one variety with the utilization of inputs and modern agronomic practices (Kathiresan 2012). Rwerere Sector is situated in a remote area with non-accessibility to Kigali and other markets. However, Urwibutso-Nyirangarama, the major fruit agroprocessor in Rwanda, is easily accessible from Mudende Sector. Therefore, chili pepper and passion fruit were introduced and disseminated while Rwerere IP was linked to Urwibutso-Nyirangarama.

## Lessons, Experiences, and Conclusions

Van Asten et al. (2009) distinguished three major constraints associated with R&D such as Farmers Participatory Research (FPR). The first constraint concerned the insufficient insight into systems complexity where farmers and scientists could have insufficient insights into systems complexity like different dimensions and interactions within a system (e.g., farming system, soil–plant–pest interactions). The second constraint was the difference in reference frameworks. Farmers tended to use their farm and immediate surroundings as the reference framework for observations, whereas scientists mostly used universally accepted reference frameworks, measurement units, and classifications. The third constraint was the methodological error where methods used to involve farmers in research could lead to the collection of inaccurate and/or misleading information. Under IAR4D, these constraints are minimized because stakeholders work together around a common theme with interactions in all dimensions, there is integration of analysis, actions, and change across different environmental, social and economic dimensions (Hawkins et al. 2009).

The identification, testing, and utilization of agricultural innovations undertaken following the IAR4D principles resulted in agricultural options that were quickly adopted, applied in a very short period, and profitable to all stakeholders along the value chain (Tables 28.2 and 28.3). The conventional R&D systems have not been able to achieve such results in a very short period because of linear actions where stakeholders on the top of the chain wait for those at the bottom to finish the work and provide the product (Arvidsson and Mannervik 2009). Markets and agroprocessing were the driving forces of the value chain making innovative technologies demand driven whereas in the R&D systems research and extension are the main driving forces and push technologies forward (Stroud 2004).

One very important advantage of IAR4D over traditional systems, demonstrated in this work was the fact that all the partners along the value chain shared a common goal, had a common target, and knew the actions of each other. This is not the case in traditional approaches where research or extension provides ready-made research outputs to the next stakeholder without knowing its goal and objectives (Daane and Booth 2004). The utilization of quick-win options was an important tool to make IP interesting as impact was achieved in a short period, thus allowing activities to be undertaken with confidence.

The partnership, synergy, and complementarity of research with other stakeholders in the IP along the value chains were unique for the IAR4D approach. This was enhanced by the fact that each stakeholder was involved not only for the contribution they were capable of making but also the profit they expected to obtain. The system of balancing profits and contributions made the IP more attractive and more sustainable. Furthermore working together towards a common interest enhanced national policies and built new and strong relationships among stakeholders. The communication was not linear; rather it was done in all directions allowing partners to interact at will during the process (Tenywa et al. 2011b). The

work demonstrated that with the IAR4D approach, the partners focused on reducing transaction costs within the value chain, not only in joint activities, but also in core mandates. Success depends on the quality of facilitation and strong market-led and knowledge-based interactions (Tenywa et al. 2011b). The complexity of managing several stakeholders with different backgrounds and interests, and the complexity of interactions between partners and conflicts that may arise between particular stakeholders are seen as major challenges that may lead to failure. Furthermore, the IP involving many partners with different and sometimes opposing backgrounds may be difficult to manage and may involve high costs in terms of financial and human resources. However, the benefits of IAR4D approaches are too important so that the IP seems to be the tool to utilize and hence to move from R&D static approaches to active IAR4D systems. In the considered IPs, new innovative technologies and agricultural innovations that responded to end-user needs were developed and used and this resulted in socioeconomic benefits. Small-scale farmers increased their income and were able to improve their livelihoods by building new houses, paying school fees for their children, and more importantly articulating their agriculture, research, and development demands with research institutions.

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