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Agricultural post-harvest Innovative technologies and access to niche market: Experience from Gataraga IP, Rwanda

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Abstract

Limited capacity for post-harvest handling and processing often undermines the profitability of farming particularly during years of bumper harvest. Notably, the perishable nature of many agricultural products limits their access to profitable markets thus dwindling income of small farmers. Hence, enhancing post harvest technologies is the critical strategy to add value to the food crops so as to increase price and move millions of African small farmers from poverty. As part of its initiatives, FARA through its developmental approach namely Integrated Agricultural Research for Development (IAR4D) has been working with small farmers through the Sub Saharan Challenge Program (SSA CP) to link them with markets that offers a better price which will help them to reap from farming activities. The SSA CP has promoted Innovation Platforms (IP) within which all concerned stakeholders develop innovative technologies, processes, institutions for improving the efficiency of value chains. This is done among others by initiating innovative post-harvest technologies which are appropriate to the conditions of the area and crop grown. These technologies serve twin purposes: the increased shelf-life of the product and enhancing accessibility to niche markets which offers higher prices. The objective of this paper is to assess the effect of Irish potatoes post-harvest handling (cleaning, sorting, grading, and packaging) on the price basing on experience from Gataraga IP. The research is based on secondary data collected from several writings on the subject, data from Gataraga IP on sales, price and frequency

of potatoes delivery to various niche markets. The study results showed that since the inception of the innovative post-harvest technologies (cleaning, sorting, grading and packaging) and linking farmers to niche markets in Kigali the farm gate price of Irish potatoes has increased on average 30% compared to ordinary price. This also implies the increased income to 30% for farmers who sale their produce through group marketing organized at IP level in Gataraga.

Key words: Agricultural post harvest technologies, IP, IAR4D, niche market, price, rural income, Rwanda

Introduction

Agriculture dominates both the economy and livelihoods in Rwanda. It makes up just under half of GDP, employs most of the labor force, and is the main source of income for the majority of the poor. Poverty elimination thus depends heavily on raising agricultural productivity through new technology, improved access to markets, better prices and policies that promote agricultural growth. There has been increased production and improvement in productivity since 2000, mainly due to improvements in inputs use but also due increased hectarage. However, productivity improvement rate has slowed in recent years and has been volatile, mainly due to the weather. (loveridge et al, 2007)

Table1: Changes in Food Crop Production (‘000Mt)

Crop	2000	2001	2002	2003	2004	2005	2006	2007
Banana	2151	2103	2785	2411	2470	2528	2654	2698
Tubers and Roots*	2880	2915	3485	3111	3029	3118	2930	2544
Cereals**	235	293	305	294	315	409	362	356
Legumes***	252	330	290	288	244	252	334	405
Fruits	83	186	234	714	693	920	858	903

Source: EDPRS, 2007

*Tubers and roots include: sweet potatoes, Irish potatoes, Cassava, Taro.**Cereals include: Sorghum, maize, rice, wheat ***Legumes include: Beans, peas, ground nuts, soya

Typically, the main challenge has been to produce enough food to feed the growing population and making it accessible to people of all categories. This requires a well devised protocol to transform production policies to deliver proper market impact that would foster food accessibility as well as income of all players along all concerned value chains. It would however, make bigger impact if there are proper technologies appropriate to local conditions that enables small-scale farmers employed in agriculture to reap from farming activities. The question however, is the type of technology, the capacity of farmers to understand and implement the technology as well as appropriate time for dissemination.

Table2: Rwanda agricultural development indicators by categories (Household use in %)

Indicators	EICV 2001	EICV 2006	% point change
Ownership of livestock	59.9	71.3	11.4
Input use			
Chemical fertilizer	6	11.9	5.9
Organic fertilizer	2.6	7.1	4.5
Insecticides	11.8	26.2	11.4
Labour	26.5	46.7	20.2
Seeds	51.1	71.2	20.1
Post-harvest consumables			
Sacks and packaging	17.8	38.6	20.8
Services			
Access to rural credits	32.6	42.3	9.7
Access to veterinary services	50.6	53.7	3

Infrastructures			
Roads not accessible	1.26	0.87	-0.39

Source: from various tables of McKay Andy. 2007. *EICV poverty analysis for Rwanda's Economic development and poverty reduction strategy*. Kigali: MINECOFIN and Oxford policy Management.

Evidently, there is commendable progress on agricultural sector in Rwanda. It is however important to mentioning that there has been low pace on post-harvest technologies as the statistics displays, sacks and packaging material use increased from 17.8% in 2001 to 38.6% only in 2006 despite the growth in agricultural production and probable changes in consumption patterns by many Rwandans; and there is a growing concern that this would not only contribute to post harvest losses but also limit small farmers to get access on niche markets.

Despite the long-standing agricultural challenges, the government of Rwanda has made commendable strides through the Ministry of agriculture and several agricultural programs were put in place. The major aim is to reinforce the capacity of farmers as a priority for turning traditional agriculture into a market-oriented and revenue generating activity. Basically, the programs targets to increase the competitiveness of agricultural sector through commodity diversification and infrastructure development. However, the main challenge resides on development of innovative technologies which addresses all changes that occur in agricultural products.

According to (Republic, 2007), the major constraints that affect development of food crop growing can be grouped into 3 different categories:

1. Constraints linked to production systems are due to predominance in subsistence farming and poor market integration; extreme land fragmentation, over cultivation without restoration of mineral elements washed away by erosion; very low farm output compared with the potential resources used because of poor use of manure and fertilizers or other farm inputs; poor capacity in terms of plant protection;
2. Constraints linked to support services can be observed at the level of poor use of fertilizers because of ignorance about their effects by majority of peasant farmers and poor availability of these fertilizers (distribution circuits) as well as poor accessibility (purchasing power); the sales of improved seeds does not satisfy the demand; a disorganized system of selling fertilizers; inadequate relation between research and extension services leading to poor technology transfer to farmers and difficulties in accessing loans;
3. Constraints linked to markets arise because that there is no added value to agricultural production due to lack of resources, infrastructure and transformation technology, conservation and conditioning; farming techniques which do not guarantee

quality and security; poor marketing capacity amongst farmers' organizations; etc…

The concerted efforts from both political and technical considerations are highly needed to mitigate challenges which are affecting the progress of food crop sector. Notably, there is urgent need to improve the knowledge of farmers on the efficiency use of inputs and also enhance credit system which meets social and economic conditions of small farmers in order to increase their purchasing power to enable them to buy agricultural inputs. Such measures however, should be accompanied by policies and strategies for commercialization, value addition, and innovative techniques at farm levels to improve conditions of the products before entering into marketplace.

Commercialization, Value addition, and Post harvest technologies in Rwanda

Commercialization: The government together with development partners has made stride efforts to build infrastructures and institutions to strengthen agricultural trade in rural areas. The notable strategy is the creation of farmers' cooperatives to foster small farmers through group marketing and input supply. However, most of these organizations are characterized by poor managerial skills, low financial resources, low marketing skills and low innovative technological skills, which impede their capacity to commercialize products, collected from their members. According to **(**Loveridge et al, 2007), there are two underlying factors for the low commercialization of agricultural products: the inadequacy of business skills and entrepreneurial ethics and quality of products for farmers and farmers' organizations. Lack of business skills and entrepreneurship is also a problem in Rwanda. Key underlying factors include among others lack of detailed business plans, lack of understanding by banks, lack of information about opportunities, reluctance to use bank services for market agents and small processors. Low quality of products produce is an issue of concern, with most production intended for own-family consumption and little will be available for market; postharvest techniques, which are key determinants of competitiveness on both national and international markets, may be poorly understood by many farmers.

Value Addition: Almost all the Rwandan agricultural sub-sectors have high but unrealized potential value addition. Number of reasons can be used to expound this; like weaknesses in the organization, lack of competitiveness to imported products, lack of financing plans and lack of development initiatives backed by research to develop value addition mechanisms on each crop. According to (EDPRS, 2007) this is due to lack of access to credit facilities, poor rural infrastructure and weak land title. Agriculture has traditionally been seen as a risky investment by banks so only 2% of loans go to agriculture due to poor rural infrastructure is, due to unavailability of adequate energy and water resources, which in turn raises costs for processing and value addition. Hence as these are key important elements in value addition their inadequacy in rural areas impedes enhancement of value addition in agricultural products thus affecting profitability for farmers and other actors along the chain.

Post-harvest Technologies: (Loveridge et al, 2007) points out that, despite the high potential of the food crops sub-sector, the development of post-harvest value addition has been limited. Some of the reasons for this underdevelopment are ranked from the market oriented agri-

business coupled with low processing capacity to the limited financial incentives to support the development of the sub-sector. This is visible because 66% of the food crops is for own food consumption (34% of food crops production makes it to the market). Between 1999 and 2008, the proportion of food crops processed never exceeded 6.5%. The majority of strategies so far undertaken in the whole field of post-harvest technology have been concerned with grains, and other durable products which are stored dry. On the other hand efforts on perishable crops have been addressing the post-harvest and processing of fruits and vegetables and not staple foods like Irish potatoes.

Unlike strong research on crop production, the post-harvest innovative technologies have attracted low number of stakeholders despite the importance attached on it. However, the development of post-harvest technologies is seen by many as viable pro-poor development policy. The enhancement of such technologies require multiple partners with different caliber such as research institutions, government agencies, farmers' organizations, financial institutions, private sector, so as to improve the livelihood of smallholders.

The Rwandan agricultural constraints like other developing countries are eminent in market and are exacerbated by lack of innovative post-harvest technologies to improve quality of agricultural products. Imperatively, policies and initiatives that target to improve farming and collection systems of harvest are paramount to increase incomes of small farmers and motivate young farmers to engage in agriculture as business activity.

Why Post-Harvest Innovative Technologies?

Post-harvest technology constitutes an inter-disciplinary science applied to agricultural commodities after harvest for the purpose of preservation, conservation, quality control/enhancement, processing, packaging, storage, distribution and marketing to meet the food and nutritional requirements of consumers. Post harvest technology stimulates agricultural production, prevents post-harvest losses, and adds value to agricultural products thereby opening new marketing opportunities and generating new jobs while stimulating growth of other related economic sectors. The process of developing post-harvest technology requires an interdisciplinary and multidimensional research approach, which includes scientific creativity, technological innovation, and commercial entrepreneurship and stakeholder inputs. Post-harvest technology involves all treatments or processes that occur from time of harvesting until the foodstuff reaches the final consumer (Wikipedia, 2010). According to (Francis, 2010) post-harvest technology include all treatments that occur from time of harvesting until the food stuff reaches the consumer. These includes: harvesting methods/tools/equipment, handling (preparation-sorting, trimming, cooling), conveying/transportation (field processing unit), processing/preservation (tastes, smell, colour, texture) packaging, distribution and sale and storage (under which conditions).

Moreover, the most challenging issue to small farmers is appropriate technologies that add value to their produce. These in turn facilitates the access of their products on niche markets

like restaurants, hotels, supermarkets, etc which need cleaned and well packed goods so that farmers can sale directly to these markets through their agents or their organizations. However, the perishable nature of most agricultural food crops, the lack of capacity to enhance technologies caused by low income and poor knowledge on post-harvest technological use by small farmers are some of the impeding factors.

Post-harvest technologies are paramount to add value to agricultural products and increase its shelf life especially for the perishable crops and improve its accessibility to special markets. However, the process of agricultural technology and growth has remained outside the concern of most development economists (Allam Ahmed, 2004). While support has been provided to improve post-harvest technology, previous projects have had limited impact due to their staged approach focusing on drying, storage, or milling without tackling post-harvest loss, quality, and price in a comprehensive manner, (Njuki et al, 2008). The development and enhancement of consolidated package as post-harvest technologies to reduce post-harvest loss and improve quality is a cost-effective manner while considering market issues is vital to tackling rural market challenges.

Arguably, post-harvest technologies are seen as prime path to create more opportunities and diversification on food products. It is believed that preventing post-harvest losses is cheaper than to increase yield. And with proper post-harvest handling and post-harvest technologies, people can be sufficiently fed without bringing additional hectares under production or without changing present agricultural practices. According to, (Bautista 1990) if we could cut down post harvest losses by a mere 10%, we would have more food than by increasing yield by 10% without reducing post-harvest losses.

Post-Harvest Technologies and Linkage of Small-Scale Farmers To Markets

Agricultural research and development organizations are now increasingly under pressure to shift from enhancing productivity of food crops to improving profitability and competitiveness of small-scale farming, and linking smallholder farmers to more profitable markets. Over the years, agricultural research and development organizations have made significant progress on increasing agricultural productivity and promoting sustainable intensification of major food crops and livestock for small-scale farmers. Growing evidence and experience indicates that sustaining success in productivity-based agricultural growth critically depends on expansion of market opportunities (Diao and Hezel 2004; Gabre-Madhin and Haggblade, 2004; Haggblade, 2004) and requires thinking beyond productivity to incorporate profitability and competitiveness (Kaplinsky, 2000). According to (Kirsten et al 2008), to intensify agricultural production, smallholder households may require access to a range of support services, including improved seeds, inorganic fertilizers, credit, technical advice, market information and output market linkages.

It is now increasingly evident that smallholder farmers' key concern is not only agricultural productivity and household food consumption, but also increasingly better market access. Virtually all the African farmers depend on trading for some household needs, and hence seek income generating activities. Enhancing the ability of smallholder, resource-poor farmers to access market opportunities, and diversify their links with markets is one of the most pressing development challenges facing both governments and nongovernmental organizations (IFAD, 2001; IFPRI, 2002; Kindness and Gordon, 2002). Agricultural markets can therefore play significant roles in reducing poverty in poor economies, especially in countries which have not already achieved significant agricultural growth. (Dorward and Kydd, 2005) highlight three broad mechanisms through which agricultural growth can drive poverty reduction: (1) through the direct impacts of increased agricultural productivity and incomes; (2) through the benefits of cheaper food for both the urban and rural poor; (3) through agricultures' contribution to growth and the generation of economic opportunity in the non-farm sector.

According to (World Bank, 2008) among the policy agenda for agriculture-based countries are: Building markets and value chains**.** Agricultural growth will be secured and sustained only if markets work better. Continuing progress is needed to build on gains from the significant market reforms of the 1990s, particularly in facilitating private sector development and regional trade. In many countries, better functioning input markets are needed at least as much as expanding product markets to increase agricultural productivity. Strengthening markets requires "hard" investments in infrastructure, with particular attention to roads and communications to link farmers to towns, and "soft" (institutional) investments for regulation, risk management, market information, and organizing producers. Risk management instruments such as futures and options are being piloted for organized smallholders to reduce risks from price volatility in a few countries. And,

A smallholder-based productivity revolution in agriculture**.** Because the easy gains from price reforms have already been captured in many countries, future growth will have to rely more on increased productivity. Large gaps between current yields and what can be economically achieved with better support services, especially in high-potential areas, provide optimism that rapid productivity growth can be achieved. Accelerating adoption of new technologies requires improved incentives, investments in agricultural research and extension systems, access to financial services, "market-smart" subsidies to stimulate input markets, and better mechanisms for risk management. Decentralized approaches are required to address the wide heterogeneity of rain-fed production systems in Sub-Saharan Africa—an approach different from the one applied during the green revolution in South Asia. Special efforts are also needed to tailor technologies and support services to women farmers who produce and process most of the food.

The importance of post-harvest technology was also overemphasized by (Porter, 1990) who stressed that market and competitiveness are strongly related to technological and institutional options for linking producers with consumers through integrated supply chains and networks. Moreover, in a world of constantly changing and increasingly demanding consumer preferences, technological and managerial innovations are required to strengthen the firms' market, (UNCTAD, 2000; Gwynne, 1999; Kaplinsky, 2000).

In any case there is high need for concerted efforts to streamline the agricultural activities at smallholder levels and turn it to a profitable business that would lead to a dramatic life change. However, this is the task that requires strategy commonly agreed and adopted by policy makers and other stakeholders to tackle collectively the agricultural problem for the benefit of smallholders..

Integrated Agricultural Research for Development (IAR4D)

According to (Kirsten et al 2008), the CGIAR challenge program concept is a response to the need for innovative, high impact research involving a wider array of partners and attracting new funding sources. In early 2007 a new developmental approach namely Integrated Agricultural Research for Development (IAR4D) concept was adopted and coordinated by the Forum for Agricultural Research in Africa (FARA). IAR4D was developed through the Sub-Saharan challenge Program. The Lake Kivu Pilot Learning Site (LPLS), provides an example of how such an approach works. Fundamentally, IAR4D still relies on researchers "reaching out" to other stakeholders and inviting them to contribute to the research and adoption process. IAR4D carries out research in a demand-driven mode, with impact measured in terms of meeting that demand, rather than in the supply-driven mode that has characterized much agricultural research in the past. IAR4D asks fundamental questions about the type of research needed and the social organizations and attitudes and behaviors of the participants. The IAR4D promotes participatory research and contribution from stakeholders to research and the following key elements: addressed.

Integrating levels of analysis	Improving the adaptive capacity of stakeholders to manage the resilience to the agro-ecosystem
Merging disciplinary perspectives	Moving from training to social learning
Guiding research on component technologies while making use of a wide range of technological options	Advancing knowledge management
Generating policy, technological, and institutional options	Increasing awareness of the environmental costs of poor natural resource management

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The core operations of this approach requires that teams of scientists from different disciplines to work together as learning organizations with farmers and the full range of other stakeholders in highly adaptive ways. With this approach in responding to the market challenges; the approach has been the identification of the crop (commonly known as

enterprise), and introduction of post-harvest technologies to improve the accessibility to markets and particularly targeting initially niche markets which seem to offer higher prices. In any case the accessibility on these markets improves the income of smallholders and the post-harvest technologies are owned by farmers to ensure sustainability in production, markets and income of farmers. However, the extent to which post-harvest technologies increase opportunities for small farmers to get access on niche markets and whether income increases is not well documented.

Materials and Methods

This study used two sets of data sources namely secondary data and experimentation The secondary data which comprises the largest chunk of the information was obtained from the reports published by the Ministry of Agriculture, Ministry of Finance and Economic Planning, Rwanda National Institutes of Statistics, several research works on the subject and other related publications. Additionally, reports from Gataraga Innovation Platform which is the center of our discussion were used to indicate the variation in production, location and category of niche markets discovered, quantities of Irish potato sold, price and mode of income distribution to each farmer. This information was vital since it provided evidences on how the technology can alter price and income of smallholders.

Furthermore, the author has been actively involved in the preparation, designing, dissemination and evaluation of the post-harvest technologies availed to the Irish potato farmers in Gataraga. He was part of the team from partner institutions in task force three which comprises the leading institutions in marketing. Notably, prior to linking farmers to the niche markets, a quick survey was conducted in Kigali City seemingly harboring the largest number of consumers in the country due to its economic advantage, to assess the category of hotels, restaurants, supermarkets, and exporters and their needs. Initially, contacts were established during the survey and potential markets identified with their initial demands. The results from that survey and the author's field observations and experimentation were vital inputs to methodological design in preparation of this paper.

Results and Discussion

The following section tries to provide insight on post-harvest technologies used to upgrade the value of Irish potatoes and how they enhanced its accessibility to niche markets. At the start a brief description on potato farming strategies at both national policy and local levels is assessed. This is followed by brief description of the study area (where the IP is located) in order to understand the geographical, physical and socioeconomic characteristics of the area. The preceding subsections highlight current scenario on Irish Potato production, the introduction of the post-harvest technologies and use, strategies for searching niche markets, quantity delivered, price issues and income. In the last part, we attempt to indicate policy implications that come out after the study.

Irish Potato Farming in Rwanda

The growing of Irish potatoes in Rwanda is done mainly in areas where climatic shocks are not strongly felt (e.g. in Northern Province). As part of government policy to promote this crop, it takes the biggest proportion of improved seeds production. Several local and international organizations, specialized in Irish potato farming have been relentlessly working to foster the crop. The government in taking the lead or, it has strengthened research activities especially through Rwanda National Agricultural Research institute (ISAR), academic institutions; it has also strengthened other civil society organizations like Rwanda Farmers Federation (IMBARAGA), which are actively involved in potato production. Some studies show that Rwanda has a strong comparative advantage in potato production in the region due to its altitude and long term links with potato production. The country already has tissue culture screen house facilities for production of pre-basic and basic seeds and the extension service is planning to promote the use of improved seed, fertilizer and pesticide use through a national demonstration program.

As part of government policy to promote the crop, the Rwanda Agricultural Development Authority (RADA) was established under the Ministry of Agriculture and Animal Husbandry to promote seeds production and distribution. In its initial planning, five crops were identified for intensification among which the Irish potato is included. In order to promote the crop, the technical form that describes farming techniques was issued and circulated. Among others, were six varieties of potato promoted for farming: Sangema, Cruza, Mabondo, Victoria, Kirundo, Mizero, Gikungu (Republic, 2008).

The major challenge however, resides on market issue which is not well organized to capture various needs of consumers and also cushion farmers for overproduction. The potato value chain is not clear and farmers' are left to the whims of collectors, brokers, middlemen and women. According to Ruben (2006), potato marketing is traditionally handled by small traders buying directly from potato producers and selling to larger, urban-based traders. There are number of issues also that affect potato marketing. (Dardel, 2006) stresses that major constraints include low prices, limited value addition, storage and transportation losses, and packaging. Farmers tend to harvest potatoes prematurely in order to earn some early cash, but this practice negatively affects potato storage quality. The development of technologies that addresses post-harvest issues would definitely reduce harvest losses and increase farmers' income.

The Gataraga Sector

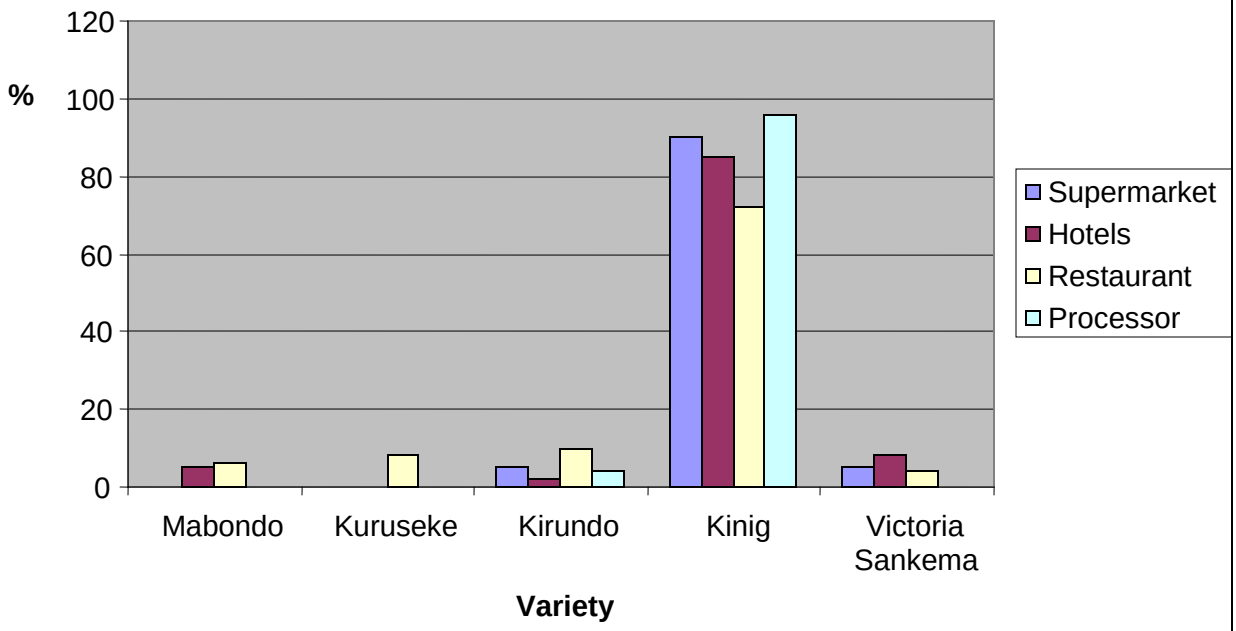
The Gataraga Sector is located in Musanze District in Northern Province of Rwanda; it has the population size of 21,183 in 2009. It is ranked fourth position among the poorest sectors that comprise the District of Musanze. Like other rural areas in Rwanda, the main stay of its population is agriculture which is dominated by Irish potato. It is the second largest producer of Irish potatoes behind the Kinigi sector also located in Northern Province, with an area equivalent to 400 hectares of land sown for this crop. The major challenge to small farmers was the price fluctuations that

range between 70 Frw and 90Frw per kilogram at farm levels (Report from the sector, 2010). Normally, transporters collect Irish potato from stores located alongside the road in the sector where farmers themselves carry their produce. This market channel does not require any kind of post-harvest technology apart from the normal packaging bags of 100kg or 50kgs. After the collection, Irish potatoes will be transported to other parts of the country, and sold to wholesalers and retailers especially in Kigali City where big number of consumers dwells. Normally, restaurants, hotels and other specialized processors would buy their potatoes from ordinary markets. However, with this supply channel the main question would be on the quality of potato sold and whether the price paid at farm gate is sufficient to sustain the purchase of inputs for another planting season and also improve living conditions of farmers. It was also observed that, this market channels, postulates limited chances to farmers in Gataraga to get access to potential niche markets like supermarkets located far from their area. This is because this product was sold unwashed, and packaging materials were not efficient to convince owners of supermarkets and other potential buyers about the quality of the produce.

Gataraga Innovation Platform: The Gataraga IP (commonly known as ISANGANO) is located in Gataraga Sector and is among four Innovation Platforms initially established in 2008 to prove the IAR4D concept in Rwanda. It is comprised by farmers' organizations, traders, transporters, input dealers, research institutions and bankers, in collaboration with the Sub-Saharan African Challenge Program local partner institutions. The Gataraga Sector was selected as an action site due to its market potentials particularly related to the easy access to potential market areas like Kigali and being at short distance to Musanze town. Farmers in Gataraga likewise produce large quantities of Irish potatoes but with limited post-harvest technologies. As part of initiatives under IAR4D strategy to ensure that farmers get income after their harvest through linkage to viable markets; three major steps were undertaken: survey to determine market needs, Potato handling and packaging, and supply to niche markets. All these market strategies were preceded by introduction of innovative technology related to Irish potatoes handling before, during and after harvest in order to meet niche markets' quality requirements.

A survey was conducted in Kigali city to have large population of consumers in all categories of life. The list of potential hotels, restaurants, supermarkets and other processors was made, and later the visit was organized. The team moved along with samples of potato varieties in order to assess varietal needs in each area. This survey provided data about the quantity needed; preference, frequency of delivery and price were established. These were basics in determining the size of the niche markets, and preferred variety which would be strengthened in the proceeding seasons to satisfy those niche markets. In this regard, ISAR and Imbaraga were urged to increase the Kinigi seed variety which was preferred by almost all customers visited.

Figure 1: Variety of Irish potatoes grown in Gataraga IP and Preference from Niche market



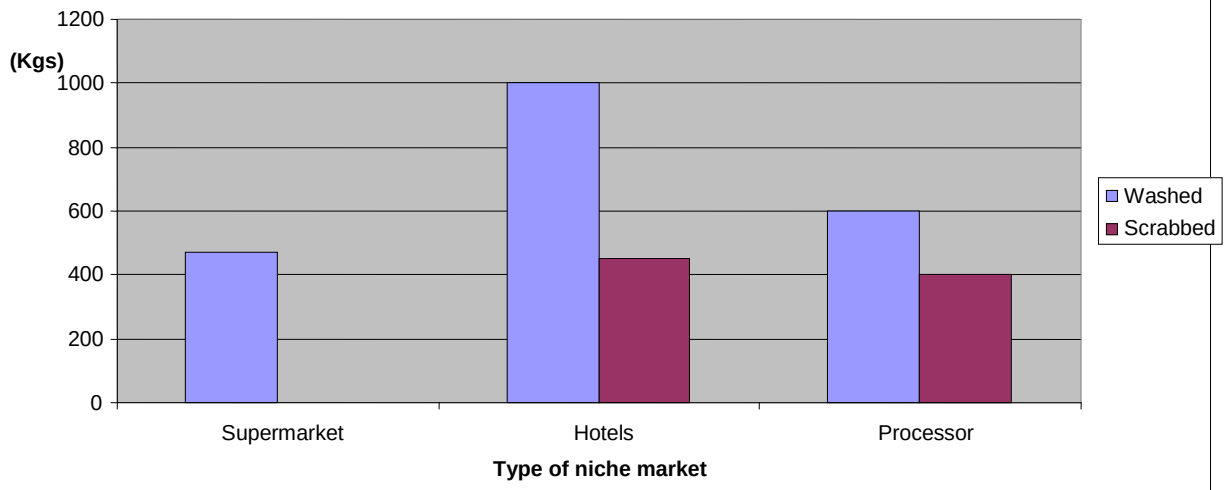
Source: Field Survey, 2009

The Gataraga IP normally grows six major varieties of Irish Pototoes: Mabondo, Kuruseke, Kirundo, Kinigi and Victoria Sankema. Previously, this area used to grow mainly Kinigi which is the most preferred variety. However, it was discovered that this variety attracted diseases and it was decided to stop producing it. Thus, the government as the policy to reduce the spread of diseases it promoted and distributed Mabondo and Kirundo as the major two varieties. However, the major reason for farmers to grow Kinigi was that it produces large quantities of Irish potatoes as compared to other varieties and can be stored for the longtime. Consequently, farmers used to grow it every season without replacement of seeds, which has led to vulnerability against diseases.

After the investigation during the survey conducted to determine the variety needs at the niche markets, it was discovered that Kinigi variety was the most preferred. Many of the reasons said by buyers (niche market visited) were that the variety has the large size of tubers and thus can be used to prepare various dishes, it can be stored for the longtime, and even others stressed that they like it due to its attractive color especially in supermarkets. All these arguments were industrious for stakeholders to understand the market needs and determine the important area of intervention. Therefore ISAR as partner

institution in this program entitled for breeding research was strongly advised to put more emphasis on Kinigi variety in order to capture market needs and to respond to farmers' expectations of farmers to grow the preferred variety. More was required for addressing the reduction of diseases impact on the Kinigi Variety.

Figure 2: Agreed Marketable deliveries for categories of Irish potatoes for selected niche markets



Source: field survey, 2009

During the short survey conducted to determine potential niche markets; four supermarkets, five big hotels, four major restaurants, and one food processor, were visited. The diagram 2 above depicts the initial quantity and variety that each potential buyer agreed to buy. However, many of them did not want to start purchasing immediately and periods of delivery were agreed. Basically, the response from potential buyers surveyed paved the way to forge and implement innovative idea that would add value to Irish potatoes in order to meet the requirements of the market. Notably, it helped to establish the diametric size and the preferred variety of the Irish potatoes which is the main concern of many restaurants, food processors, hotels, and supermarket for them to prepare different type of food needed by daily consumers. It also enabled stakeholders in the IP to understand the quality and packaging needs that suit the requirement for every concerned market segment.

Potato Handling and Packaging In Gataraga and Access to Niche Market: The challenges on the supply side exacerbated by lack of proper post harvesting technologies, prompted partner institutions such as CIAT, National University of Rwanda, Rwanda National Agricultural Research institute (ISAR), Rwanda Farmers Federation (IMBARAGA) to design strategies that would increase both output and quality that satisfies market needs. Notably, Irish potato enterprise was the entry point for the market task force in GATARAGA. The objective was to make this enterprise profitable and a robust business because farmers would

produce for markets providing higher prices than presently; thus improving incomes. This development would result from a package of innovative technologies such as cleaning, grading and packaging. This program of work was organized into the following main activities: sorting and grading, packaging and grading. :

Irish Potato sorting and grading system

***Sorting*:** sorting is used to eliminate potatoes that fail to meet with users/consumers defined standards for length, width or shape, color and the rotten ones; this method ensures the quality of marketed product, safety and responds to the demands of consumers (niche market).

Grading: This method is being used to put sorted potatoes according to categories of size before they are sold or used in different ways. Arguably, some of the conditions put by potential buyers (niche market) were the size of potatoes which enables them to prepare different type of food. Therefore, grading was important in order to select varieties and size that meet conditions at the niche market.

Farmers from Gataraga are using these practices to ensure that they deliver the needed potatoes to specific markets. For example at hotels and supermarket large potatoes are highly demanded whereas the restaurant, processor need medium size. All these activities are done by farmers themselves after series of trainings which were done to acquaint them with these strategies.

Potato Packaging and Handling technologies : As part of initiatives of the market task force, the introduction of post-harvest packaging and handling technologies were important to meet the conditions of the niche markets. The quality of potatoes should be improved through proper cultivation practices to begin with so that post-harvest technology would apply to improved production quality. It was thus important to train farmers on good practices in order to upgrade the quality of harvested tubers. These included sound production practices, proper handling during harvest, and appropriate post-harvest handling techniques. More specifically, farmers in Gataraga were trained on haulm cutting and pulling which are done three weeks before the harvest period. These were done in order to increase shelf life of potatoes and to avoid unnecessary mechanical injuries of potatoes. The three main post-harvest handling technologies are: washing, scrubbing and packaging.

Washing: This involves cleaning of tubers of Irish potatoes to remove the soil. During the washing time the rotten tubers are removed. Farmers of ISANGANO IP were trained on this technique in order to supply their potatoes at niche markets (especially supermarkets) which have put it as condition. This has created 15 jobs to women working at the site to wash potatoes before being transported to niche markets.

Source: Field visit; example of (Kinigi variety) washed potatoes from Gataraga IP, 2010

Scrubbing: This is the use of hands to remove the soil on the tubers of Irish potatoes without washing them. Scrubbed potatoes can be stored for longer time (Approximately 3 months), this production thus prepared is supplied to restaurants, hotels and food processors.

Packaging: Washed potatoes and Scrubbed potatoes are well packed in sacks and or crates that allow air to flow freely. This technique prevents tubers of Irish potatoes to rot and promotes better hygienic condition which was mandatory to access the niche markets mentioned. Two types of packaging materials are used: (a) locally made sacks or crates which are prepared by local cooperatives near to Gataraga sector; (b) polyester sacks imported from Polysacks Industries in Uganda.

This method of packaging also attracts many consumers of potatoes who do their shopping in supermarket. Each sack has the capacity of 5kgs, and looks simple and smart to carry and it is sold at 1800 Frw (that is 300 Frw per Kilogram).

Source: Field visit; Example of Irish potatoes packed in locally made sacks ready to be transported to supermarkets; 2010

Irish Potato Delivery to Niche Market : The delivery of Irish potatoes was organized in a proper way in order to avoid damages and to satisfy the demand timely according to agreements between potential buyers (niche markets) and the IP. The collection and supply of cleaned potatoes was done by the contracted businesswomen chosen from the IP, as part of capacity building Rwanda farmers' federation (Imbaraga) was asked to facilitate on technical aspects and to oversee the process. Initially, washing and packaging was done using facilities at Imbaraga as the person contracted to collect potato from farmers did not have facilities but is preparing to put her own facilities.

Source: Field visit; Example of vehicle carrying cleaned potatoes to niche markets in Kigali City; 2010

The quantity supplied and price charged is different in each market (category) due to agreements made. The price varies depending on whether potatoes are washed or scrubbed.

The number of potential buyers has increased overtime due to continual persuasion strategies to entice many buyers. As the table 2 shows the number of new customers has been increasing overtime since the strategy started. Further, the table shows the type of each market segment and time it started to purchase Irish potatoes from Gataraga IP. The most important to note is the number of families who have registered to be supplied regularly after noticing the business through supermarkets. They normally meet with supplier at point agreed and they can buy quantities in bulk since this type of potatoes can be stored up to three months. Definitely, the increase in number of buyers who offers good price compared to price at ordinary market is an indication of appreciation which affects also price and income of small farmers.

Table 3: Evolution of niche markets & categories of Irish Potatoes purchased

Period (Month)	Type of Niche market	Quantity & Category of potato bought	
		Washed	Scrubbed
November (2009)	1Processor	2400	1200
	1 Restaurant	800	
December (2009)	2 Supermarkets	1880	
May(2010)	2 Hotels	3200	800
	Ordinary consumers	400	
June	1Hotel		800
	Ordinary consumers	1000	
July	1Wholesaler	1000	

Ordinary consumers	1200

Source: IP Gataraga, 2010

Table 4: Category of market (i.e. niche market), and implication on price

Niche market	Category of potato agreed for purchase per	Unit price (Frw)/Kg
Super market	Washed	180 & 200
	Scrubbed	
Hotels	Washed	180
	Scrubbed	160
Processor	Washed	180
	Scrubbed	160
Ordinary consumers	Washed	160
	Scrubbed	
Restaurant	Washed	170
	Scrubbed	
Whole seller	Washed	160
	Scrubbed	

Source: IP Gataraga, 2010

The category of niche market of potatoes supplied, category of Irish potatoes purchased and the price from each category are depicted on the table 3 above. Basically, preferences are different from each category of market depending on purpose for buying Irish potato, some prefer to buy washed potatoes and others scrubbed potatoes only. In any case, restaurants and hotels prefer to buy scrubbed potatoes because they can be stored for longtime without rotting. On the other hand, supermarkets prefer washed potatoes because they are clean and would attract buyers. It has been the task of IP members to work hard to satisfy the demand of each category of market. Additionally, the quantity supplied to hotels and restaurants depends on weekly needs. Especially when there are functions and other events which convene big number of people, the quantity purchased would increase above the normal demand.

Furthermore, the table above portrays the implications of post-harvest technologies on three important aspects that touch the life of smallholder farmers: Firstly, access to niche markets; arguably, before action by the IP had been impossible for products like Irish potatoes collected from farmers to enter directly into supermarkets and other special places without the role of middlemen. But the introduction of post-harvest technologies like de-haulming, scrubbing, grading and washing potatoes had unveiled the potentials of potatoes to be sold in specialized places like other processed products.

Secondly, this technology had enabled the price of potatoes to increase from 70 Frw at ordinary markets to 200 Frw in niche markets (like the table above shows).

Thirdly, there is high implication of the tested technologies and corresponding actions for accessing niche markets to the income of smallholder farmers. In this regards, according to the agreement between farmers and businesswomen who collects potatoes from farmers and to supply them to niche markets, farmers are paid 30Frw extra on price prevailing at ordinary markets. Also, since collection is done by the businesswomen from farmyards it has reduced hurdles that farmers used to face before by transporting themselves their own produce to warehouses located some kilometers away from their farms the process which could result into the loss of harvest, value or weight.

Additionally, as part of efforts of IP members to enhance the sustainability of the market, they have initiated a strategy to monitor farmers and help them to follow good practices of farming and harvesting in order to minimize post-harvest losses. Accordingly, farmers will register their names, telephone numbers, planting dates and quantity of seeds planted and harvesting techniques used. This helps the IP to monitor daily farm activities performed by farmers, and eventually enables them to forecast their production for planning purposes in order to meet the demand of the niche markets. Additionally, using this technique they are in position to know if there would be surplus or deficit and the means to overcome them. This is used to monitor the delivery and limit risks of shortage of Irish potatoes during the season to satisfy the demand of the niche markets.

Conclusion and Policy Implications

For over decades, the governments and research organizations have largely focused on increasing productivity of food crops as strategy to achieve rural sustainable development. However, there were little efforts to enhance technologies and innovations to be used after harvesting that would link farmers to potential markets in order to diversify their products and increase their incomes, as well as reducing post harvest losses. In this regard, number of related issues need to be addressed to improve the capacity of small-scale farmers to get access to niche markets which offers good prices.

Improved understanding of postharvest technologies which are appropriate to the concerned crop and community are important to the development of rural area and ensuring sustainable rural incomes. In this regard there is growing evidences that post-harvest technologies increased the shelf-life of food crops, paved the way for access into niche markets and possibility for price increase, and income to rise. Despite the mounting benefits accrued, more emphasis should be put on increasing participation of small-scale farmers to own these technologies in order to ensure sustainability.

The evidence from this case study clearly shows that there is combination of many skills and strategies to enable small-scale farmers to sustain links to niche markets. Important to mention is the concerted efforts between Research Institutions, service providers, development organizations, farmers' organizations, etc to build capacities at small-

scale levels in order to keep farmers competitive in the market. Arguably, though this strategy looks effective in facilitating and improving income of small-scale farmers in Gataraga, there are challenges on how to scale it out to reach many small-scale farmers. It was noted that the lack of post-harvest technologies in many parts of rural areas to improve shelf-life of food crops to avoid unnecessary post-harvest losses is the main problem constraining goods produced at small-scale levels to get access to the markets that offers higher prices. Therefore, the possibility to scale-out this strategy would improve lives of many farmers and accelerate development.

A number of lessons can be learnt from this study: first, building capacity at local levels on agricultural technologies as strategy to link small farmers to markets is a long process and requires number of incentives to be in place. Among others is the knowledge of farmers to understand the technology in a reasonable time, proper infrastructures, financial institutions needed to provide starting capital for facilities to be enhanced, constant trainings and follow-ups since farmers are prone to technologies which are not familiar to their settings, etc. It was also noted that, these technologies are milestones to improve incomes of small-scale farmers and would contribute highly to sustainable development of rural areas in the long-run. It would therefore cause big impact if it is scaled-out to other farming communities, and encourage the demand-driven farming systems which embed farming with market knowledge. Secondly, the success of the technology is highly dependent on effective partnerships of various stakeholders including research institutions, NGOs, private sector, financial institutions, farmers organizations, government institutions, etc which work relentlessly to foster appropriate technology. Along this network, stakeholders share their experiences and mechanisms to monitor the implementation of the technology and the responsibilities designed to ensure sustainability. However, considerable strategies are still needed to build effective partnerships that encourage strong participation of private sector and financial institutions to ensure sustainability of the technology and scale it to other farming communities.

In any case the evidence from the study area shows that there is increasing emphasis on transforming subsistence agriculture to make farming a business, and entrepreneurial culture is promoted in rural communities, and farmers are trained to produce for market. Further, due to access to niche markets, income has been increasing and there are prospects that income will increase further as number of niche markets increases.

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