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Innovation opportunities for milk production in Rwanda with lessons from the Mudende innovation platform

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ABSTRACT

While milk in Rwanda is recognized to have potential for enormous contribution to the food security, nutrition and employment situation in the country, national milk production has remained well below to levels that can sufficiently enhance this contribution. The overall objective of the study was to conduct a value chain analysis that would enable the identification of innovative opportunities that exist to boost milk production in Rwanda. This paper specifically analyses the environment within which the milk value chain operates, and the functionality of the value chain at the Innovation Platform. Innovation opportunities to improve milk production are found to lie in the interaction of a diversity of stakeholders and partners to provide critical services for production, to dairy farmers. These would include extension, veterinary provision, and financial service provision, interacting together with farmers at the production stage to ease the acquisition of critical inputs and knowledge. Further opportunity exists to engage milk processors, health workers and nutritionists as new stakeholders at the production stage. This would not only inspire milk utilization by the population, but would subsequently enhance milk production in the country.

Key words: Gross margins, Innovation Platform, milk, Rwanda

RÉSUMÉ

Bien que le lait au Rwanda contribue énormément à la sécurité alimentaire, à la nutrition et à la situation d'emploi dans le pays, la production nationale en termes de lait est inférieure aux niveaux susceptibles d'améliorer suffisamment cette contribution. L'objectif général de la présente étude était de mener une analyse de chaîne de valeur capable d'identifier les possibilités novatrices pour stimuler la production laitière au Rwanda. Ce document analyse spécifiquement l'environnement et la fonctionnalité de la chaîne de valeur au sein de la plateforme d'innovation. Les possibilités d'innovation pour améliorer la production laitière se trouvent dans les interactions entre acteurs et partenaires pour fournir des services essentiels pour la production aux producteurs laitiers. Celles-ci incluent la vulgarisation, les services vétérinaires et financiers, les interactions avec les agriculteurs au stade de production pour faciliter l'acquisition des connaissances. Il y a aussi d'autres opportunités

de collaboration avec les transformateurs de lait, les agents de santé et les nutritionnistes en tant que nouveaux acteurs. Cela non seulement inspirerait l'utilisation du lait par la population, mais aussi améliorerait par la suite la production laitière dans le pays.

Mots clés: marges brutes, plateforme d'innovation, lait, Rwanda

INTRODUCTION

Rwanda is a small, land locked country (26, 338 sq.km), with a population of 9 million people (2007), estimated to be rising at 2.9% per annum. The population is projected to be at 15 million in 2020, and 20 million in 2030 (World Bank, 2007). At such a high rate of population increase, the problem of land scarcity is expected to worsen. Yet the majority of the country's working population is employed in agriculture; 90% of households have at least one person working in agriculture (Technoserve, 2008). At the same time poverty is a serious issue in Rwanda and 57% of the population live below the poverty line (MinFEP, 2007). The challenge to support the agriculture sector so as to improve the economic situation is enormous. However, in Rwanda, 68% of all households countrywide raise some type of livestock, cattle being the most commonly raised (MINAGRI, 2013). It is believed that the cow is a stable source of milk, providing a crucial input for children and the family, and that when there is surplus milk, the family has a reliable source for additional cash. Milk is therefore a strategic commodity for the Government of Rwanda to target in order to address the economic situation in the country.

Milk, the term usually applied to cow's milk, means the fresh and clean lacteal secretion obtained by the complete milking of a healthy cow (MINAGRI, 2009). It is a very important component of a human diet because it is easily digestible, an exceptionally good source of protein, and a good source of calcium for sound bone and tooth development. It also contains a useful variety of vitamins including vitamin A, E, D and vitamins of the B group. As a rich and

complete food, milk plays a significant role in the fight against malnutrition and underfeeding. In addition, it can be transformed into various products in order to increase its shelf-life including fresh pasteurized milk, yoghurt, butter, ice cream, among others (MINAGRI, 2009). In Rwanda therefore, realizing the enormous contribution that milk could make to the food security and nutrition situation, as well as employment and revenue generation, the milk value chain is considered an ideal value chain to stir economic development and poverty reduction in the country. However, milk production has remained well below levels that can sufficiently support such developments. The overall objective of this study was to conduct a value chain analysis that would enable the identification of innovative opportunities that exist to boost milk production in Rwanda. This paper specifically analyses the environment within which the milk value chain operates, namely the socio-economic context, input and output markets, and governance of the value chain at the national level. A functional analysis of the chain is also conducted at the level of Mudende Innovation Platform (IP).

Mudende IP and the Sub Saharan Africa Challenge Program (SSA CP). The Sub Saharan Africa Challenge Program (SSA CP) that was led by the Forum for Agricultural Research in Africa (FARA) established 36 Innovation Platforms (IPs) in three sites in Africa, between 2008-2014. During this period, the Program was expected to test the proof of the Integrated Agricultural Research for Development (IAR4D) concept, which was implemented using the IPs. In the context of the

IAR4D concept, an IP is defined as a physical or virtual forum established to facilitate interaction and learning among stakeholders of a commodity value chain, and others that are outside the chain but are influencing the chain's activities (Adekunle *et al.*, 2014). The stakeholders of a given value chain would include both the direct value chain actors such as producers, processors, transporters, and traders, while the indirect actors include extension service providers, researchers, policy makers, among others. This multi-stakeholder interaction is expected to lead to participatory diagnosis of problems, joint exploration of opportunities, and investigation of solutions, leading to the generation of agricultural innovation along the targeted value chain or system of production (Adekunle *et al.*, 2014).

In the East African region, the Lake Kivu Pilot Learning Site (LKPLS) of the SSA CP was comprised of 12 IPs including Mudende IP. Located in Mudende Sector of Rubavu District, western Rwanda, the IP was established for the development of the milk value chain. Mudende IP was formed in November, 2008 to improve milk quality and production, and to link farmers to a secure market. The IP that started with 30 members (17 men and 13 women) had reached a total membership of 750 members as of December, 2015 (363 men and 387 women) drawn from five villages of Mudende sector. The weather in Mudende sector is favorable for good high quality pastures, making the area one of the high milk producing areas in the western province (Adekunle *et al.*, 2014). The farmers who grew crops and reared livestock were expected to have the opportunity of improving their livelihoods by integrating both systems. The multi-stakeholder approach to the development of the milk value chain realized a number of achievements in Mudende IP: the members were trained on hygienic milk production, milk handling and transportation, improved potato production techniques using

organic and mineral fertilization, introduction of new fodder species and establishment of demonstration gardens.

The IP also established its own milk collection centre through a 6 million Rwandese francs (RwF) loan from the Rwanda Development Bank (RDB) and other partners (approximately US\$6900). The center currently collects 5,000 litres a day, during the rainy season, and between 2,500-3,000 litres a day during the hot season. The milk is being sold to Inyange Industries in Kigali, and other towns such as Gisenyi in Western Rwanda, and as far as Goma in the DRC. These achievements were the efforts of many stakeholders including Rwanda Development Bank (RDB), Mudende SACCO, Inyange Industries and local government authorities from the Sector.

There were research partners involved in the IP including International Centre for Tropical Agriculture (CIAT), Rwanda Agriculture Board (RAB), and Makerere University (MUK). The SSA CP in general ended with various successes including improved household incomes and livelihoods, among others (Adekunle, 2013; Nkonya *et al.*, 2013), all credited to the multi-stakeholder approach.

METHODOLOGY

Study area and population. The study was conducted in Rubavu district which is located in the Western province of Rwanda (Figure 1). The estimated total population of Rubavu district is 423,000, representing 16% of the total population of Western Province and 4% of the total population of Rwanda (National Institute of Statistics Rwanda, 2012). Rubavu district has the biggest population among Western Province districts. The district is composed of 12 sectors including Mudende, Bugeshi, Busasamana, Cyanzarwe, Gisenyi, Kanama, Kanzenze, Nyakiriba, Nyamyumba, Nyundo, Rubavu and Rugerero. Mudende IP is located in Mudende

sector, and the main economic activities in the sector include livestock farming, mainly cattle keeping.

Data sources. Both primary and secondary data were used in this study. Primary data were obtained from households at IP level. Secondary data/information were obtained by doing a national-level desk literature review with a view of analyzing the environment within which the milk value chain in Rwanda operates. This environment is believed to comprise of several domains that can be analysed using a value chain analysis (FAO, 2013). This study analysed the following domains; the socio-economic context of the value chain, input and output markets, and the governance and institutional set-up of the value chain in the economy. The literature used included reports of development agencies working in the selected areas, and secondary data collected from the country's national statistics, and FAOSTAT. From this analysis, the constraints, opportunities, strengths and weaknesses that needed to be addressed at the national level were identified.

Sample selection and primary data collection. Mudende sector was purposively selected because of the IP concept operating in the area. Subsequently, members participating in the IP (henceforth members) and those not participating (non-members) were selected from the same location, for a household survey. To obtain a sample of members, a list of IP member households with a record of daily milk sales was obtained and only those who sold at least half a litre of milk were purposively selected. Lists of non-IP member households (consisting of dairy cattle keepers) were obtained for every village in the district with the assistance of local leaders. Similarly, households who sold at least a litre of milk were purposively selected. Thus, a sample of 106 members and 93 non-members was obtained. The rationale for using milk sales was that the multi-stakeholder IP concept was introduced to boost the value chain, particularly focusing on helping dairy cattle farmers to increase productivity and hence sales. A similar household questionnaire was used to interview both member and non-member household heads



Figure 1. Map of Rwanda showing the location of Mudende IP in Western Rwanda

about their socio-economic characteristics, such as level of education, number of animals, mode of production, land hectareage owned and/or hired, and production of milk. Interviews with key informants were held. Key informants included the IP chairman and individual members of the IP management committee. Group interviews were held, one each, with IP and non-IP members who were able to turn up. The household survey, interviews with key informants, and structured group interviews were conducted at the IP in December, 2015.

Data analysis. Information collected at national level through literature was analysed qualitatively, and subsequently a SWOT analysis of the value chain at that level. Data from national statistics and FAOSTAT were used to find trends of milk production in Rwanda over the years, for comparison with neighboring countries in the region. This was to enable determination of the prospects for competitiveness of the milk value chain in the region. A functional value chain analysis at the IP level was done using value chain analysis tools (M4P, 2008). These included a map of the actors, processes and services of the chain. The tools enabled the identification of intervention points along the chain. In this study, innovation opportunities existed at the identified intervention points, and this is where they were drawn from.

In order to complement the value chain analysis tools, annual gross margins from milk production of the respondent households were estimated and compared for the period between August 2014 and August 2015. Annual gross margins per household in Rwanda Francs (RwF) were obtained by subtracting the household's total variable cost of milk production (RwF) from the annual total value (RwF) of milk produced, thus;

$$AGM = ATV - AVC \dots\dots\dots (1)$$

Where *AGM* is Annual Gross Margins per

household in RwF,
ATV is Annual Total Value of milk per household in RwF,
AVC is Annual Variable Cost of milk production per household in RwF

Further, *ATV* was obtained by multiplying the average price of milk per day by an estimated number of milking days during the study period. *AVC* is obtained as a summation of the various costs incurred for milk production;

$$AVC = \sum_j^n C \dots\dots\dots(2)$$

Where *C* _{1-n} are costs of feed, vet services, deworming, tick control, and Artificial Insemination (AI).

RESULTS AND DISCUSSION

The socio-economic context of the milk value chain in Rwanda. The dairy subsector is important to the economic development of Rwanda. Dairy is expected to offer a pathway out of poverty for large numbers of households keeping livestock and for those who provide services and value addition throughout the supply chain (MINAGRI, 2013). In Rwanda, 68.2% of all households raise some type of livestock, and cattle are among the most commonly raised by 47% of households (NISR, 2012). There are three types of dairy farmers, as defined by the way in which cows are fed; open grazing, semi-grazing, and zero-grazing. Semi-grazing farmers are those that are transitioning between open and zero grazing and do not intend to remain in this stage for long. The reliance on naturally growing or cultivated grass as the sole source of nutrition (i.e., open grazing and some semi-grazing farmers) creates a production system dependent on weather (Technoserve, 2008).

The country produces about 188 million litres of milk annually according to FAOSTAT data for 2013. This translates into on average of about

3.2 litres per day per cow. This yield is thus still very low, due to the fact that improved breeds constitute only 10% of the 157,000 milking cows in the country (TechnoServe, 2008). Rwanda's milk production between 2000-2013 when compared to other countries in the EAC is also very low as illustrated in Figure 2 which shows the trend of milk production by the EAC countries during the same period.

In spite of the apparent low milk production performance regionally, the vision of the Rwanda dairy subsector remains to contribute effectively to the growth of the national economy and improve the standard of living for the largest number of Rwandan households in a sustainable and environmentally sound manner. The goal of the sub-sector is to achieve a competitive dairy sector providing quality dairy products which are affordable, available and accessible to all Rwandans and other consumers in the region (MINAGRI, 2013). The Goal of Rwanda (GoR) through the Ministry of Agriculture and Animal Resources has set the mission of the dairy subsector to create conditions for the provision of wholesome, affordable milk products to benefit

the largest numbers of consumers for both the local and regional markets on a sustainable basis (MINAGRI, 2013). As a result, a number of government programmes have been put in place to enhance the growth of the sub-sector. These include the introduction of new cattle breeds, a robust insemination programme, an effective disease control programme, and the 'one cow per poor family' programme. The latter, also known as Girinka, is GoR's cornerstone for the development of the dairy sector (MINAGRI, 2013).

The efforts of the Government programmes in the dairy sub-sector have resulted in a dramatic transformation of the sector with an annual growth rate of milk production of about 8% in the recent years. This is mainly attributed to the Girinka programme. In 2008, the programme distributed more than 10,000 heads of cattle increasing the total number of cattle, to 157,000 as well as milk production, and the growth rate is further projected to increase to 13% by 2020. Figure 3 shows Rwanda's milk production between 2005-2013.

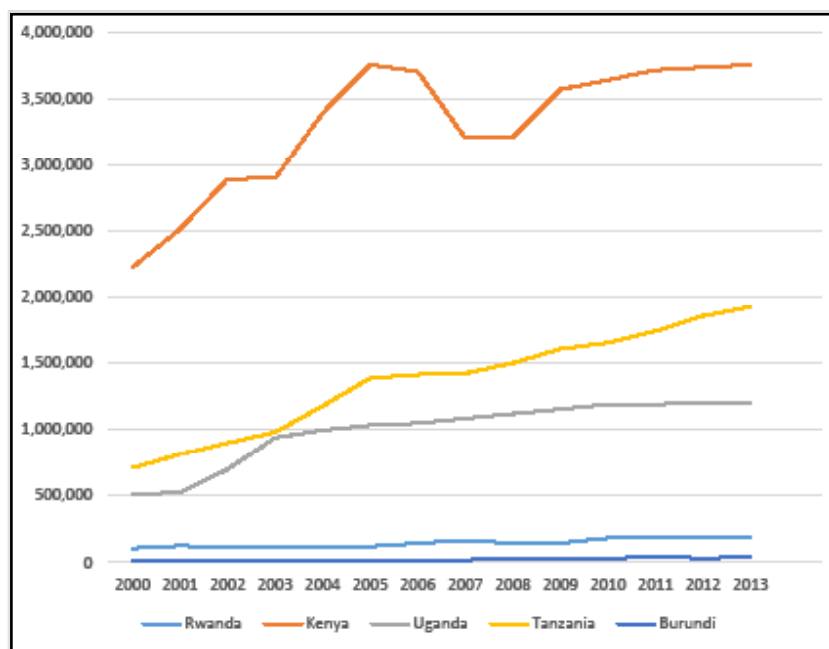


Figure 2. Trends of milk production (tonnes) in the East African Community countries between 2000-2013
Source: FAOstat data, 2016

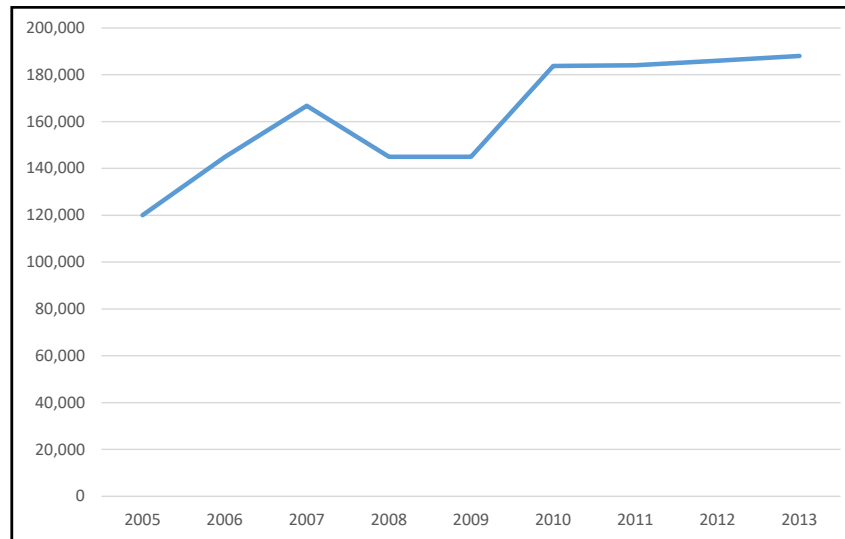


Figure 3. Rwanda's milk production (tonnes) per year between 2005-2013
Source: FAOstat data, 2016

Milk is mostly consumed at household level and in the market it is mainly sold in fresh form. Annual milk consumption per capita however, has been reported at only 12 litres which is very low compared to 100 litres in Kenya and 22 litres per capita in Uganda (Technoserve, 2008). Government effort to improve milk production in the country is commendable. However, the Rwandan population needs to be sensitised on the use of milk and dairy products for better household nutrition as production increases. Further, while there are a number of processors that are beginning to produce processed products from the raw milk, only about 10% of the milk produced in the country is being processed, due to capacity under-utilisation of existing plants (Technoserve, 2008).

Input market. The inputs that dairy farmers most frequently purchase are various types of bran for feed (e.g., maize), salt blocks and treatment for ticks and worms. These inputs are largely sourced from Kigali, with few feed products reaching other regions as transport is difficult and branches of these stores are few (TechnoServe, 2008). Smallholder farmers'

use of these inputs is low for the following reasons: limited knowledge about feeds and their benefits, inability to pay, and the challenge of physically procuring materials. Further, most farmers only have one or two cows and for the majority of them, milk prices for most of the year do not justify the use of feed concentrate that costs Rwf 160-190 per kg (MINAGRI, 2013). Feed prices are reportedly higher in Rwanda than in neighbouring countries such as Kenya due to low levels of grain production. In addition, Rwanda lacks a thriving milling industry which would provide, through its by-products, some of the key feed ingredients. Rwanda also suffers from low productivity of such crops such as sunflower or cotton, whose by-products are converted to animal feed (cake) (TechnoServe, 2008). Hence, the cost of milk production is higher in Rwanda than the neighboring countries, i.e., Kenya and Uganda. None the less, based on the cost of production, opportunity exists for Rwanda to export milk to DRC and Burundi where the milk sector is underdeveloped and cost of production is relatively higher.

In this regard, also, good quality forage is another important input for milk production. The CIP program in most of the country, with the exception of the North-west, has used up most of the productive areas for crop production leaving marginal lands which constrains the production of quality forage (MINAGRI, 2013). In the market, however, there are private suppliers of forage seed and hay. Another important input in the milk value chain is Artificial Insemination (AI). The demand for AI is still low, although as farmers turn their attention to the increased revenue that improved breeds can bring, demand is increasing. Prices for AI services depend on the quality of the semen and the AI provider. There are three general categories of semen. The cheapest, referred to as “ordinary,” is semen from local breeds and is unproven. Higher quality semen is referred to as “super” or “extra-super” and is genetically tested and proven (TechnoServe, 2008). The Government is the main supplier of bull semen in Rwanda, but ABS Global, a worldwide provider of bovine reproduction services, also has its presence in the country.

Financial services in the country are provided by micro finance institutions (MFIs) and SACCOs. The challenge they have is to develop appropriate products especially for the milk producers given that production is still low. Although opportunity exists, since milk production has a steady source of cash flow from daily sales of milk, financial lenders need skills to identify worthy producers, train loan specialists, and conduct appraisals. Many MFIs and SACCOs do not have the capacity in terms of physical infrastructure and trained personnel, to offer the required services. Opportunity also exists for special lending programmes that adopt structured trade financing strategies so that repayment of the loan is recovered through deductions from milk sales (MINAGRI, 2013), but this is yet to be exploited.

Output market. A large volume of milk produced is sold in the informal market and therefore not tracked, and it is estimated that about 96% of the milk marketed is in this market (TechnoServe, 2008). It is also mostly sold fresh. Farmers normally milk the animals in the morning and deliver the milk to Milk Collection Centres (MCC). Some sell milk in the evenings and boil the milk to be able to sell it the following day. The Goal of Rwanda has so far established over 96 MCCs to work as chilling and bulking centres (MINAGRI, 2013). Some MCCs have shops where the milk is sold while others sell to transporters who find buyers elsewhere. A few milk processors exist in and around Kigali who make various products such as yoghurt, cheese and butter, although they are reported to operate at less than 20% of their installed capacity (TechnoServe, 2008; MINAGRI, 2013). They also seem to produce other products that the population demands, such as mineral water and fruit juices, instead of developing the dairy product lines. Four of the main processors include Nyanza, Inyange, Rubirizi and Masaka. The market for fresh milk and processed products within the country is small mainly because of lack of awareness by the population, on the consumption of these products. The GoR, through MINAGRI is making every effort using a multi-sectoral approach, together with Ministry of Education (MINEDUC) and Ministry of Health (MINISANTE) to promote milk consumption in schools, community health clinics, and at household level. A further market for the processed milk and products is anticipated in Uganda as quality requirements for export are met.

Governance/Institutions. The responsibility for the development of the milk value chain in the dairy sector lies directly with MINAGRI, and it is here that the National Dairy Strategy has been developed together with Ministry of Trade and Industry (MINICOM). Other line ministries include MINEDUC, MINISANTE

and MINECOFIN. Stakeholders in the sector include Rwanda Bureau of Standards (RBS), Rwanda Agricultural Board (RAB), Rwanda Development Board (RDB), Banque Rwandaise de Developpement (BRD), Rwanda Milk Sellers Association (RMSA), among others. Since the Goal of Rwanda has identified the dairy sector as priority, it has supported multiple programmes, which has also resulted in numerous international agencies and NGOs joining the sector to provide relevant services. The most active of these are 'Send a Cow' and Heifer International. Farmers on their part are organized in farmer groups and cooperatives to access extension and marketing services. It is also the Government policy that all fresh milk from the producers is collected at the MCC for chilling and marketing. The Goal of Rwanda also has plans to develop the MCCs into business centres using the Business Hub model. This will enable them to provide a number of required

services to the community including veterinary services, information and business development (RDB, 2016). A summary of the strengths and weaknesses of the value chain as obtained from this environment is shown in Table 1 below.

Functional analysis of the milk value chain at the Mudende IP. In Mudende Sector where the IP is situated, a household survey was conducted with a sample consisting of both IP and non-IP member households. Selected socio-economic characteristics of the respondents are shown in Tables 2 and 3. On average the respondents own 0.84 ha, which was not significantly different between IP and non-IP members, and between male and female headed households. On average the households own at least 2 improved cows, and there were no significant differences between IP and non-IP members, nor between male and female headed households.

Table 1. SWOT Analysis of the milk value chain in Rwanda

Strengths	Weaknesses
<ul style="list-style-type: none"> • Different new national programmes have been established to support the dairy sector e.g the 'one cow per family programme', disease control programme, Insemination Programme, • Improved breeds have been introduced in the country, • Excellent climate for dairy production, • There are over 96 milk collection centres countrywide, • Good road network 	<ul style="list-style-type: none"> • Limited land; Rwanda is a land-locked country with an area of 26, 338 sq.km. With a population growth rate estimated at 2.9% per annum, land scarcity will worsen (TechnoServe, 2008) • Local breeds are still the majority, • Limited use of veterinary services by the livestock keepers (services are rarely sought), • No grazing policies, • Low milk production (3.2 litres per day per cow) • Poor milk consumption in the country (12 litres per capita)
<p>Opportunities</p> <ul style="list-style-type: none"> • Rwanda is developing fast, and the country side is also urbanizing fast; demand for new processed dairy products is likely to increase, • So far only 10% of the milk is being processed, • 96% of the milk sold in informal markets • A variety of dairy products can be made requiring a packaging 	<p>Threats</p> <ul style="list-style-type: none"> • Volatility of milk prices, • Draught; It reduces water for the animals and hence low milk production, It reduces water cleaning and other production processes, and reduces the productivity of rain-fed pastures

Gross Margins. While IP and non-IP households were not significantly different in many ways, there were significant differences between the two households in the parcels of grazing land accessed, daily quantity of milk per cow, and annual total value of milk produced. The IP households accessed significantly more parcels of grazing land (at 1% level), obtained more milk per cow and achieved a higher annual total value of milk both at the 5% level. These results lend credit to the IP intervention in this location, and a reason for sharing lessons of milk value chain development at the IP. The gross margins between the IP and non-IP member households however did not vary significantly (Table 3). This is because much as their total value of milk is high, they also incur a relatively higher cost of production, as required for the improved management of the animals that they are exposed to by the IP intervention.

Mapping the value chain processes, actors and services at the Mudende IP. The milk value chain at the Mudende IP begins with

input provision (Figure 4). The major inputs include salt, and feeds which are provided by local agro-input shops. Feeds constitute the largest proportion, about 90% of the total cost of production. Artificial Insemination is provided by government services and a few farmers who can afford it, access private service providers. However there is no AI services in Rubavu district and so the majority do not use AI but pay to have their cows served naturally. Production is done by the farmers who feed the cattle either on purchased feed, open grazing, or a combination of open range and zero grazing. Overall, 70% of the respondents were engaged in zero grazing, 21% were engaged in semi-grazing while 9% were engaged in open range grazing. Farmers were able to access parcels of land for grazing but mainly for preparing fodder for zero grazing as emphasized by the extension at the IP (Figure 5). This is most likely to be the reason why IP members accessed more grazing parcels than non-IP counterparts.

The next stage after input provision is milk

Table 2. Selected socio-economic characteristics of the respondents

	N	Mean	Std.dev	Min	Max
Age of Household head (years)	198	41.89	12.92	18	84
Education level of Household head (years)	199	3.85	7.63	0	17
Household size (number)	199	5.79	2.45	1	13

Source: Survey Data, December, 2015; N= number

Table 3. Selected socio-economic characteristics of the respondents (segregated by IP membership and by sex)

	N	IP	non-IP	t-value	Male	Female	t-value
Land owned (Ha)	198	0.79	0.89	-0.266	0.88	0.61	0.498
No.of improved cows owned	128	2	2	1.02	2	1	1.02
Parcels of grazing land accessed	195	4.12	3.07	3.07***	3.78	2.78	1.91**
Daily quantity of milk per cow (ltrs)	120	2.23	1.47	2.19**	1.87	1.87	-0.016
Annual total value of milk produced (RwF)	120	277,170	198,320	2.132**	255,640	175,520	1.903*
Annual total Variable cost of production (RwF)	120	188,000	153,000	1.209	176,000	173,000	0.084
Annual Gross Margins per household	90	109,540	60,752	1.085	95,491	64,064	0.472

Source: Survey Data, December, 2015; N= number of respondents

production (Fig.4). This is also the stage that was most significantly impacted by the multi-stakeholder approach. Research, extension and veterinary service providers interacted with each other and with the farmers to improve dairy management and milk handling. Consequently, the difference between the quantity of milk produced per animal was found significantly more for IP than non-IP households. As such the IP members in focus group discussions, appreciated the trainings they obtained from the partners on dairy management, preparing fodder, and practicing good hygiene. The IP members who sold their milk at the Milk Collection Centre (MCC) were able to get a better price than selling to middlemen. In particular, the IP members credited RAB for providing good pasture material and offering training on good farming methods. Non-the less, although this level of milk production lay between the estimated range of milk production in Rwanda of 0.7-3.2 ltrs per cow (TechnoServe, 2008), milk production by the respondents was low. This should be the first intervention point

to raise the yield of milk per animal. Low milk yield is believed to be due to by local breeds and poor animal feeding. Intervention at this point ought to focus on improving animal breeds, and stepping up efforts to provide extension services to dairy farmers both in the IP and outside, for better dairy management and fodder preparation. Financial service providers should be engaged as stakeholders of the IP to improve feed acquisition and other input purchases.

Dairy farmers were found to transport milk from their residences on bicycles to the Milk Collection Centre (MCC), also located in Mudende sector. However, not all farmers were able to do this because of the long distances involved. Those that did not sell at the MCC opted to sell to middlemen who collected the milk at farm gate. The MCC was established through the concerted effort of partners and stakeholders of the IP to support milk marketing within the IP area and the IP farmers were urged to sell their milk at the MCC. While IP members mostly used the MCC, a number of

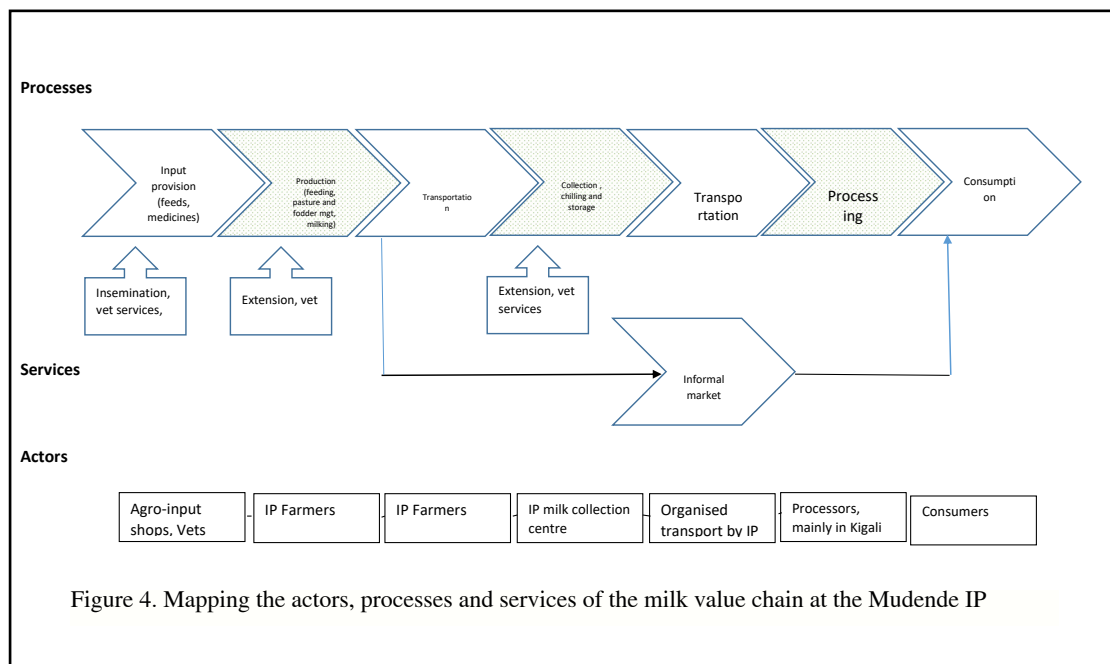


Figure 4. Mapping the actors, processes and services of the milk value chain at the Mudende IP



Figure 5. Mr. Bwitinge Innocent, one of the model farmers with a demonstration of a fodder garden

other farmers sold their products in the informal market where prices were highly volatile. On average farmers sold at 140 RwF per litre at the MCC during the study period, while in the informal market, they were offered as low as 80 RwF per litre. The value of the milk produced was found to vary significantly between IP and non-IP members, and between male and female headed households. The IP households had a value significantly higher than the non-IP households, most likely as a result of selling at the MCC. Male headed households had a value of milk produced significantly higher than their female headed counterparts. This implies that more female headed households most likely sold their milk in the informal markets. Although the arrangement to sell milk at the MCC would mitigate against price volatility giving more returns to the farmers, women farmers would need special consideration to enable them market more at the MCC than in the informal markets.

From the MCC, the milk is loaded on to trucks for transportation mainly to Kigali where it is processed, packed and sold to consumers by

supermarkets. Kigali city, located about 4 hours from Mudende is currently the main market of the processed milk and products. The second intervention point could consist of support to small and medium scale processors to establish businesses in the milk producing areas near the IP. This would help to increase the players in the milk market and make it relatively more competitive. More competition would also help stabilize the price. Although the consumption of milk and processed products was still low in the rural areas, these areas were urbanizing fast, and they were likely to demand the products in the near future. Domestic consumption of milk and products is generally low in the country (MINAGRI, 2013). A third intervention point would therefore consist of involving other stakeholders such as nutritionists, health centres and schools in this multi-stakeholder approach to value chain development. These would step-up awareness campaigns for the consumption of milk and processed products as well as the introduction of school feeding programmes that would increase the demand for milk in the formal market to further stabilize price. Lastly, the MCC was used for collection and chilling the

milk. As a collection center the MCC could be supported to provide a number of other business services including business development, extension, as well as collection and chilling of the milk.

CONCLUSION

The results of the study show that the multi-stakeholder approach of the IP has potential to improve milk production at household level through training in dairy management, fodder preparation, and other services that were offered to the IP members. Stakeholders and partners supported the establishment of the MCC which provided a relatively higher price compared to other buyers, and increased the total value of milk produced, hence more income to the household. The interaction of a diversity of stakeholders to provide critical services is found to benefit milk production at the Mudende IP. While the increase in cost of production is unavoidable, innovations will be required to create more partnerships and appropriate arrangements that will enable households meet the costs of purchasing feed, establishing fodder gardens and other required services. Opportunity further exist to engage with dairy farmers at the production stage, milk processors, health workers and nutritionists as new stakeholders that would not only inspire milk utilization by the population, but would subsequently enhance milk production in the country.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

REFERENCES

Adekunle, A. A., Fatunbi, A. O., Buruchara, R.

and Nyamwaro, S. 2013. Integrated Agricultural Research for Development: from Concept to Practice. Forum for Agricultural Research in Africa (FARA), Accra, Ghana

Adekunle, A.A., Fatunbi, A.O., Bafana, B.O., Babaleye, T. and Akinbamijo, O.O. 2014. Transforming Africa's Agriculture: Successes of the Integrated Agricultural Research for Development (IAR4D) concept. Forum for Agricultural Research in Africa (FARA), Accra, Ghana.

FAOSTAT. 2016. www.fao.org/faostat/en downloaded 9th April, 2016

Food and Agriculture Organisation of the United Nations (FAO). 2013. Milk and dairy products in human nutrition. Muehlhoff, E, Bennet, A. and McMahon, D. (Eds.). FAO, Rome

M4P. 2008. Making value chains work better for the poor: A tool book for practitioners of value chain analysis, version 3. Making Markets Work Better for the Poor (M4P) project, UK, DFID. Agricultural Development International: Phnom Penh, Cambodia.

Ministry of Agriculture and Animal Resources (MINAGRI) 2009. Updating the Master Plan of the Milk Value chain in Rwanda: Final Report 2009. Development and Management Solutions (DMS).

Ministry of Agriculture and Animal Resources (MINAGRI). 2013. Annual Report for the Financial Year 2011/2012. MINAGRI, Kigali.

Ministry of Agriculture and Animal Resources (MINAGRI). 2011. Rwanda National Post-Harvest Staple Crop Strategy. MINAGRI, Kigali.

Ministry of Agriculture and Animal Resources (MINAGRI). 2012. Annual Report for the Financial Year 2010/2011. MINAGRI, Kigali.

Ministry of Finance and Economic Planning (MINECOFIN). 2016. www.minecofin.go.rw

- Ministry of Finance and Economic Planning (MinFEP). 2007. Economic Development and Poverty Reduction Strategy 2008-2012. MinFEP, Kigali.
- National Institute of Statistics of Rwanda (NISR). 2012. EICV3 Thematic Report – Agriculture. NISR, Kigali.
- Nkonya, E., Kato, E., Oduol, J., Pali, P. and Farrow, A. 2013. Initial impact of integrated agricultural research for development in East and Central Africa. *African Journal of Agriculture and Resource Economics* 8 (3): 172-184.
- Rwanda Development Board (RDB). 2016. www.rdb.rw
- TechnoServe. 2008. The Dairy Value Chain in Rwanda. TechnoServe, Kigali.
- World Bank. 2007. Cultivating Knowledge and Skills to Grow African Agriculture. World Bank, Washington, DC.