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Technical Report
Livestock Farming and Management: The Case of Meat Production and Processing in Rwanda

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Abstract

Objective: This study was conducted with the aim of characterizing the existing meat value chain of Rwanda as well as examine its full potential. **Materials and Methods:** It was carried out in 192 households in six districts in Rwanda which engaged in all aspects of the cattle value chain. The districts were Nyagatare, Kirehe, Ngoma, Bugesera, Kayonza and Gatsibo. The occupants of the households were interviewed using structured questionnaires which aimed at eliciting a clear understanding of the production strategies, processing, marketing channels and attributes of the meat production and processing situation in the country. **Results:** The results showed that 90% of the respondents were producers, 1.2% butchers, 0.4% producers and fatteners, 0.8% fatteners while the rest (1.2%) wholly engaged in cattle production, fattening and trading. It was also realized that most of the youth engaged in grazing their cattle more than selling them. The results further highlighted that cattle production in Rwanda was a typically low input system with low initial capital investments. Average milk production was found to be 7-fold more than the live animal sales per household per year. However, the income realized from live sales were more than 100-fold the income generated from milk sales. It also came to light that four beef cattle value chains were operational in the cities and towns. Identified strategies to improve the existing value chains included the establishment of feedlots, buying of animals from smallholder farmers for fattening by commercial ranchers as well as exploiting domestic niches and regional markets. **Conclusion:** Since the size and weight of cattle were major determinants in pricing, cattle fattening based on crop residues could provide producers with more income. It was, therefore, envisaged that market-oriented beef value chain development would be an economically viable and socially acceptable investment option in Rwanda.

Key words: Livestock farming, meat production, processing, beef, cattle, Rwanda

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Agriculture is the most important sector in the economies of most low-income African countries and about 75% of them depend solely on incomes generated from agriculture and agribusinesses. In effect, agriculture contributes reportedly 40% of the Gross Domestic Product (GDP) of African countries[1]. Additionally, the livestock industry contributes 10% of the overall GDP[2]. Various estimates have been advanced for the consumption of milk and meat in Rwanda and the per capita meat consumption is reported to be 7.59 kg which is below the 50 kg mark recommended by FAO/WHO. The major livestock is cattle because it is the highest contributor to meat and the only source of milk in Rwanda. The cattle population is estimated to be 1.3 million herds according to NISR[3]. The dominant cattle genotypes in Rwanda are the Ankole Longhorn cattle and their crosses. The Sahiwal and dairy sire lines are also available. The dual purpose breed, Fleckvieh has also been introduced into the system. The Ankole cattle has not been bred specifically for meat production in Africa, although there is tacit indication that the potential exits. Nevertheless, it is the most viable option for investment at this stage of animal genetic improvement in Rwanda. The climate is tropical and at the same time temperate with an average temperature of 19°C and the rainfall annually ranges between 900 and 1600 mm. The country has a short rainy season from September to November and a longer one from February to May. The short dry season is usually between December and January while the longer dry season last from June to mid-September.

The Ministry of Agriculture and Animal Resources (MINAGRI) is, therefore, seeking to increase the productivity (milk, meat, butter, cheese, skin, hide, wool, eggs and organic manure) of animal resources of the country through efficient livestock development[4-7]. Feed scarcity reportedly was an endemic feature that triggered a systematic shift from cattle to small ruminants in the pre-colonial era[8]. However, Rwanda is known to have a number of feed production niches that have not been adequately explored and exploited to provide useful alternatives. Crop intensification programmes have provided opportunities for improving the effectiveness of using crop residues as feeds resources as well as promoting crop-livestock integration.

Steinfield *et al.*[9] reported that livestock production is the most important agricultural land use in the world with grasslands covering 25% of land surface and contributing to the livelihoods of more than 800 million people. Forage/grassland-based crop-livestock systems represent about 70% of agricultural land use in the tropics. Over the past 30 years, meat and milk consumption in developing countries have grown three times as fast as in developed countries with a market value of US$155 billion. Smallholder mixed crop-livestock systems reportedly provide over 50% of the world's meat and over 90% of its milk and these are the most important livestock systems in developing countries[10]. However, a major constraint to livestock production in many developing countries in the tropics is the inadequate quantity and quality of forage produced. Poor grazing, land mismanagement and lack of suitable forage options that are better adapted to biotic (pests and diseases) and abiotic (edaphic and climatic) stress factors contribute immensely to the low productivity situation[11]. Nutrient depletion and inadequate management of forage options as well as grazing lands lead to reduced livestock production particularly in the face of worsening climate change. About 70% of the world's rural poor depends on livestock (mainly sheep, goats, pigs and poultry) and this forms an important component of their livelihoods. Livestock makes a disproportionately higher contribution to income and welfare of the poorest smallholders particularly women and children[12,13].

While meat consumption per capita in developed countries has been found to be in the region of 80 kg per year, it is reported to hardly exceed 32 kg in Africa[14]. The meat per capita consumption for Rwandans is very low compared to the average figure for other African countries[7,15,16]. In reality, there is a low propensity to meat consumption by the general populace and the reasons could be ascribed to the low purchasing power, outdated eating habits and socio-cultural beliefs (taboos related to the consumptions of mutton and rabbit), inaccessibility to quality meat particularly among rural folks among others[7]. The advent of a vibrant and cost-effective meat industry would be an initial response to the fight against malnutrition, poverty and food insecurity in Africa.

The Government of Rwanda (GoR) has identified investment in two areas as the most viable option for sustainable progress namely intensification and development of sustainable production systems and changing the mindset of the primary and secondary producers along the commodity value chains meat and milk) through strategic public-private sector partnerships. Compared to meat, the dairy sector development has received considerable attention from GoR, development partners, civil society organizations and the private sector. The meat sector has lagged behind in this context and therefore, forms the basis for the proposed investment plan. The current study was undertaken to evaluate livestock farming and management systems in Rwanda with special emphasis on meat production, processing and marketing.

MATERIALS AND METHODS

Sampling: The survey was conducted in six districts in Rwanda and they were Rwamagana, Bugesera, Kirehe, Ngoma, Gatsibo and Nyagatare. The sampling method used was the systematic stratified random sampling technique in which four sectors were randomly selected from each district. From each sector, eight households were in turn randomly selected which resulted in a total of 192 households being used for the survey work.

The household survey involved farmers (producers), fatteners, traders and butchers. A well-structured questionnaire was administered in order to gather the needed information. Secondary data on the meat value chain in Rwanda were also collected from different sources such as official documents and policy briefs from the Ministry of Agriculture (MINAGRI), Rwanda Agricultural Board (RAB), National Institute Statistics of Rwanda (NISR) and others sources in the country.

Survey protocol: The survey team used structured questionnaire to collect information from the households and other relevant stakeholders. Some of the information sourced were cattle population, farming systems, herd composition, feed resources (feed resource calendar depicting types, amounts, level of use, sources, means of acquisition and costs), etc.

Data analysis: Data entry was done using MS Excel while Statistical American Software[17] was used for the analysis of data generated.

RESULTS

Stakeholder characteristics in the beef value chain

Stakeholder categories: Table 1 highlights gender, stakeholder categorization and years engaged in the beef value chain. The majority of stakeholders in the beef value chain were primary producers or cattle keepers. Majority of them were males although the proportion of females was appreciable. A small percentage of the stakeholders (2.8%) participated in more than one section of the value chain. The average period of exposure to the beef production, processing and marketing was determined to be 17 years old.

Human capital in the beef value chain: The characteristics of the respondents used in the study are presented in Fig. 1. The dominant source of human capital is the household which include spouses, biological children, extended family and others. Within this resource base, the household heads featured most prominently and they were followed by the spouses and biological children.

There were six basic activities that the family members usually undertook singly or in various combinations. Cattle sale was the most common activity followed by animal care particularly grazing, watering and supplementary feeding from fodder banks (Table 2). In effect, different family members rarely undertook these activities in isolation.

Grazing was the most frequent single activity implemented by spouses and children of the household. This was followed by the headship of the households and non-relatives. The other non-family members were mostly hired-labor. Cattle sales and health care were the most frequently combined activities which suggested that most of the cattle that the farmers handled were most probably in transit to the market centres and/or slaughter houses (Table 3). Women and children were found to be involved in more activities than heads of the households who predominantly got engaged particularly in sales and health care.

The stakeholder's age distribution profile across different activities in the value chain indicated that producers, fatteners and multiple enterprise practitioners dominated the cattle sale

Table 1: Gender, stakeholder categories and period engaged in the beef value chain

	Representation (%)			Years of experience		
Stakeholder category	Men	Women	Total	Men	Women	Total
Producers	73.2	17.5	90.7	18	16	18
Butchers	1.2		1.2	10		10
Producers and fatteners	0.4		0.4			
Fatteners	0.8		0.8	19		19
Others	2.3	0.8	3.1	15	11	13
Producers, fatteners and traders	1.2		1.2	16		16
Producers and butchers	0.8		0.8			
Fatteners and butchers		0.4	0.4		3	3
Producers, fatteners and butchers	0.4		0.4	19		19
Traders	0.8		0.8	8		8
Gender total	80.9	18.7	99.6	15	10	17

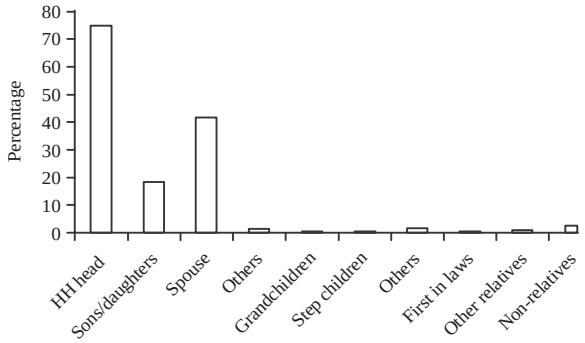

Fig. 1: Percentage of composition of respondents/households

Table 2: Common activities undertaken by household members in percentage

Activities	Percentage
Grazing	17
Feeding	3
Feed collection	1
Watering	4
Health	1
Cattle sales	74

venture. The producers who were in their youthful age usually engaged in grazing, feed collection and feeding the animals (Table 4).

The analysis of the labor deployment for various activities identified three major activities. Labor efficiency (man days/animal) was highest with respect to watering and veterinary care. The gap between the minimum and maximum labor deployment per animal indicated that there was considerable amount of idle labor (Table 5).

Table 5 highlights the efficient use of labour in beef cattle production in Rwanda. The intensity of labor involved in grazing was 2.94, watering 22.02 while veterinary care accounted for a mean efficiency of 22.02. The minimum labors required in grazing cattle was found to 0.10 while the maximum was 47.90. Watering cattle in Rwanda was found to be the most laborious of all the activities.

Extension services and input supply: The respondents who received extension services and inputs were subsistence grazers, beef cattle producers as well as producers who also practiced fattening. The study revealed that majority of the respondents did not put the pieces of advice received from the extension services into practice. These categories of stakeholders were equally divided in their position on the ease of accessing extension services (Table 6). The producers in the value chain were equally divided in their position on the availability and access to beef cattle production guidance.

In relation to input supplies, majority of those who engaged in grazing agreed that inputs for beef cattle production were readily available. Others disagreed and positioned that suppliers were not easily accessible although what could be obtained were usually at no cost. They had divided opinion on whether the inputs were always available or not. Regular beef cattle producers were equally divided on all issues of input availability except the need to incur travel cost to purchase them.

Table 7 presents the affordability of beef cattle inputs, provision of land, labor and accessibility to market. On the affordability, a highly significant ($p<0.0001$) majority agreed that the inputs were affordable because they were not too expensive especially for those who could afford at the present income levels. The position of producers in the beef value chain was equally divided on affordability with or without budgetary allocations of household expenditure. However, a significant ($p<0.05$) majority disagreed that it was impossible to afford beef cattle production inputs, especially when housing expenditure was compromised in favor of investments in the production. The fattening segment was very optimistic about the affordability of inputs and positioned that beef cattle production inputs were not impossible to access with or without household budget adjustments. It was further realized that it was still possible for investors to afford the inputs.

With respect to markets, a highly significant ($p<0.0001$) majority affirmed that there was ready market for cattle products. In the area of land as a factor of production, a highly significant ($p<0.0001$) majority agreed that they needed more land than they currently had either to have economically viable unit or improve on the economy of scale (Table 7). Albeit, the current state of land constraint was not necessarily prohibitive to beef cattle production. The beef cattle producers strongly agreed on the need for more land. However, others had different position to this.

The fatteners maintained that land was not a limiting factor to beef cattle production and it was not likely to be in the foreseeable future. On labor, the grazers maintained that

Table 3: Percentage of households involved in different activities in the beef value chain

Activity combinations	HH head	Spouse	Sons/ daughters	Other relatives	Grand children	Non-relatives	First in laws	Others	Activity total
	(%)								
1	0.71	3.55	3.19			0.35			7.80
2	0.35	0.35							0.71
3		1.06							1.06
4		0.35							0.35
5		0.35							0.35
6									
7			0.71						0.71
8		1.42	1.77						3.19
9	0.35	0.35							0.71
10	62.77	10.28	4.96	0.71	0.35	2.13	0.35	1.42	82.98
11			0.35						0.35
12									0.00
13			0.71						0.71
14	0.35								0.35
15									
16			0.35						0.35
17		0.35							0.35
H' hold total (%)	64.53	18.09	12.06	0.71	0.35	2.48	0.35	1.42	100.00

1: Grazing, 2: Feed collection, 3: Feeding, 4: Health care, 5: Cattle sale, 6: Grazing+feeding, 7: Grazing+watering, 8: Grazing+health care, 9: Grazing+cattle sales, 10: Cattle sale+health, 11: Grazing, feeding and health, 12: Grazing feeding and watering, 13: Grazing, health and watering, 14: Grazing, cattle sales and health, 15: Grazing, feed collection, feeding and health, 16: Grazing, feed collection, feeding and watering and 17: Nondescript activities

Table 4: Mean age of stakeholders engaged in different activities in the beef value chain

Category	Grazing	Feed collection	Feeding	Health	Cattle sales	Unspecified
Producers	30	39	29	65	50	30
Fatteners					50	
Traders	18				35	
Butchers					31	
Producers and fatteners						
Producers and butchers	23				35	
Producers, fatteners and traders					50	
Producers and fatteners, butchers					49	
Nondescript					41	

Table 5: Labour efficiency (man days/animal) in beef cattle production

Parameters	Grazing	Watering	Veterinary care
Mean	2.94	22.02	22.02
Median	1.43	13.71	13.71
Mode	1.14	5.71	5.71
Minimum	0.10	0.23	0.34
Maximum	47.90	574.86	192.00

Table 6: Percentage of availability of beef cattle extension services and inputs

Stakeholders	Grazer	Significance level	Producers	Significance level	Producers+fatteners
Beef cattle extension advice					
No problem	57.77	*	60.98	ns	100
Nightmare	34.48	****	12.2	****	0
No complaint	50.25	ns	43.9	ns	100
Put extension advice to good use	34.30	****	31.7	*	100
Given up	32.66	****	14.63	****	0
Too much effort	52.7	ns	56.1	ns	0
Beef cattle inputs					
Inputs readily available	63.32	***	50	ns	100
Suppliers readily available	54.23	ns	40	ns	100
Supplier nearby	38.89	**	45	ns	100
No travel cost to access suppliers	44.00	**	33.33	*	100
Input suppliers are rare	41.92	*	45	ns	0
Availability not always guaranteed	51.79	ns	48.72	ns	0

*Significant difference at p<0.05, **Significant difference at p<0.01, ***Significant difference at p<0.001, ****Significant difference at p<0.0001 and ns: Non-significant difference at p>0.05

Table 7: Stakeholder opinion on affordability of beef cattle production inputs, availability of land, labour and access to market

	Grazers			Producers			Producers and fatteners		
Parameters	Agree	Disagree	Significance level	Agree	Disagree	Significance level	Agree	Disagree	Significance level
Affordability of beef cattle inputs									
Impossible with present income	47.8	52.2	ns	46.3	53.7	ns	-	100	ns
Impossible to afford at all cost	30.5	69.5	****	34.2	65.9	*	-	100	ns
Beef cattle inputs too costly for me	40.9	59.1	**	41.5	58.5	ns	-	100	ns
Affordable with household budget adjustments	55.8	44.2	ns	65.9	34.2	*	100	-	ns
Can afford some beef cattle inputs	72.3	27.7	****	62.5	37.5	ns	100	-	ns
Can afford some beef cattle inputs with present income	67.0	33.0	****	65.9	34.2	ns	100	-	ns
Market availability of livestock products									
Buyers readily available	66.2	33.9	****	50.0	50.0	ns	-	100	ns
Prices are extremely low	44.3	55.7	ns	62.5	37.5	ns	-	100	ns
Prices are at throw-away level	29.6	70.4	****	35.0	65.0	ns	-	100	ns
Almost sold all my products due to very good price	32.4	67.6	****	15.0	85.0	****	-	100	ns
Prices are encouraging	46.0	54.0	ns	33.3	66.7	*	100	-	ns
Lack of buyers is a disincentive to increased production	36.8	63.2	***	57.5	42.5	ns	100	-	ns
Factors of production-land									
Land is not a constraint to me	46.3	53.7	ns	40.5	59.5	ns	100	-	ns
Land is not a constraint in a foreseeable future	40.5	59.5	**	50.0	50.0	ns	-	100	ns
I have never needed more land than I have	33.3	66.7	****	35.7	64.3	ns	-	100	ns
More land is needed for me to survive in beef production	67.2	32.8	****	85.7	14.3	****	-	100	ns
I desperately need more land for beef production	61.1	38.9	**	66.7	33.3	*	-	100	ns
Things would be better if I had more land	64.0	36.0	****	81.0	19.1	****	-	100	ns
Factors of production-labor									
There is inadequate family labor for all the livestock activities	66.5	33.5	***	67.5	32.5	*	-	100	ns
Family labor is just enough for all the livestock activities	39.51	60.49	****	33.3	66.7	*	100	-	ns
Too many family labor for all the livestock activities	26.6	73.4	*	21.4	78.6	**	100	-	ns
Current family labor is underutilized	41.79	58.21	ns	33.3	66.7	ns	100	-	ns
Current family labor is too few	51.23	48.77		52.4	47.6	ns	100	-	ns

*Significant difference at p<0.05, **Significant difference at p<0.01, ***Significant difference at p<0.001, ****Significant difference at p<0.0001 and ns: Non-significant difference at p>0.05

Table 8: Gross margin analysis of cattle production (Rwanda Francs)

Species	Fixed cost	Variable cost	Price	Quantity produced	Gross revenue	Gross margin
Live sales	565,944	238,848	176,491	1,140	104,471,786	104,346,063
Milk	184,200	354,375	155	7,514	1,148,683	1,120,889

labor accessed from the family was not sufficient to meet the requirement for activities on beef cattle farms. However, the communities were indecisive as to whether the available labor on the farms were properly utilized. The producers expressed similar position which differed from the opinion held by the fattening group.

Investment profiling of cattle production: The gross margin analysis of cattle production in Rwanda is presented in Table 8. The study revealed that there were no systematic means of farm records keeping. Therefore, farms were requested to recall their expenditures and sales. The costs included items such as fixed costs on infrastructure and equipment as well as variables namely labor, drugs, veterinary charges, other materials and supplies. Also captured were the quantities of items sold and their price components. These pieces of information were validated by staff on the farms. The results showed that cattle production in Rwanda was a typically low input system with low initial capital investments as well as low variable cost inputs. Average milk production was found to be 7-fold more than the live animal sales (per household per year). However, the income generated from live sales of cattle were more than 100-fold that made from milk.

Preferences of domestic livestock species and breeds: The survey revealed that the indigenous cattle breeds were the most predominant of all the food animals available. Their crosses with exotic cattle were the second most preferred (Table 9). It further showed that the basis for these preferences were for the provision of meat and milk. For the second ranking preference, the participating households tended to focus on milk and manure production while the third settled on meat and manure as the basis for the selection of breed of cattle for farming (Table 9).

The herd structure of the cattle producers is shown in Table 10. The dominant class was found to be the breeding females and it ranged between 1 and 50 cows. It was also

Table 9: Species and households ranking based on their products

	Rank 1 (%)			Rank 2 (%)			Rank 3 (%)		
Species/breed	Meat	Milk	Manure	Meat	Milk	Manure	Meat	Milk	Manure
Local cattle	19.0	27.7	5.9	4.3	19.1	17.6	10.6	4.4	39.8
Crossbred cattle	0.7	26.3	-	10.9	2.7	10.9	8.0	0.9	24.8
Exotic cattle	1.0	3.8	-	1.6	1.6	2.3	1.8	-	5.3
Goat	1.4	-	2.8	0.4	-	0.4	0.9	-	0.9
Sheep	1.7	0.3	4.5	2.0	-	-	-	-	-
Local chicken	2.1	-	-	-	-	-	-	-	-
Exotic chicken	2.4	-	-	-	-	-	-	-	-

Table 10: Herd structure of beef cattle producers

Cattle type	Mean	Median	Mode	Min	Max
Breeding females	10	7	10	1	50
Breeding males	2	1	1	0	6
Non-breeding males	4	3	2	1	10
Non-breeding females	3	2	1	1	11
Heifers	4	3	2	1	12
Young bulls	2	2	1	1	8
Female calves	3	3	3	1	10
Male calves	3	2	2	1	13

Table 11: Level of feed adequacy in the dry and wet seasons

	Adequate			Inadequate		
Level feed type	Wet	Dry	Total (%)	Wet	Dry	Total (%)
Banana peels	0	0	0	100	0	100
Crop residues	100	0	100	0	0	-
Napier grass	77.78	11.11	88.89	11.11	0	11.11
Natural grass	35.67	9.33	45.03	43.86	11.11	54.97

Table 12: Sources of replacement stock

Source	No. of respondents	Frequencies (%)	No. of cumulative	Cumulative frequency (%)
Own farm	4	3.08	4	3.08
Markets	100	76.92	104	80.00
Other farms	26	20.00	130	100.00

Table 13: Methods of in-breeding control

Methods	No. of respondents	Frequency (%)	No. of cumulative	Cumulative frequencies
AI	45	25.57	045	25.57
Others	5	2.84	50	28.41
Own bulls	6	3.41	51	28.98
Bulls from distant markets	118	67.05	169	96.02
Rented bulls	2	1.14	176	100.00

AI: Artificial insemination

Table 14: Calving interval (year) in beef cattle herds

Calving interval (year)	Percentage
Once	14.53
Biennially	55.30
Triennially	29.05
Once in 4 year	1.12

realized that majority of the farms had 10 cows. The range of all classes of cattle was wide.

Feed resource base: The respondents mentioned several feed resources they fed to their cattle. Majority of the households (>80%) had access to natural pasture. A small but significant proportion used fodder banks of Napier or Kikuyu grasses as well as an assortment of crop residues. The most common crop residues were cereal straws and bean haulm (Fig. 2).

It also came to light that the availability of feed resources varied across seasons. Despite the wide variety of feed types, the dominant feed resource were natural pastures, Napier, crop residues and banana peels. In all, the respondent households revealed that banana peels were inadequate across seasons (Table 11). Crop residues were adequate even during the dry season. Napier grass was adequate for most households (88.9%) and was more available in the dry season than in the wet season. Natural pasture was not sufficient across the season and this was represented by 54% of the participating households. It was observed that no farmer practiced supplementary feeding.

Sources of replacement stock: The sustainability of the beef cattle value chain was determined to depend on the capacity to provide replacement stock and avoid in-breeding which usually promotes the expression of deleterious genes. The majority of the respondents indicated that open market was the main source of replacement stock (Table 12).

Table 13 highlights the various methods of breed control. Majority of the respondents purchased bulls from distant markets in order to avoid the problem of in-breeding. This effort was complemented by the application of Artificial Insemination (AI) technique as well as bull renting (Table 13). A small proportion, however, used bulls from their own herds likewise other undisclosed sources.

Age at first calving and sale of cattle: Most of the respondents reported age at first calving at 2 years. Approximately, 30% of them reported unrealistic age of first calving of 1 year which indicated the need for training in record keeping. In extreme cases, the respondents reported calving intervals of 3-4 years (Table 14).

Table 15: Per capital consumption of animal products

Products	2006	2007	2008	2009	2010	2011	2012	2013	2014
Milk (L person^{-1} year^{-1})	20.70	23.00	25.70	33.50	37.30	44.20	50.10	58.10	59.00
Meat (kg person^{-1} year^{-1})	5.68	5.71	5.72	5.68	6.44	6.69	6.77	7.50	7.90
Eggs (kg person^{-1} year^{-1})	0.20	0.20	0.25	0.36	0.47	0.52	0.57	0.62	0.63
Fish (kg person^{-1} year^{-1})	1.02	1.04	1.32	1.42	1.36	1.41	1.59	2.51	2.59

Source: NISR[2]

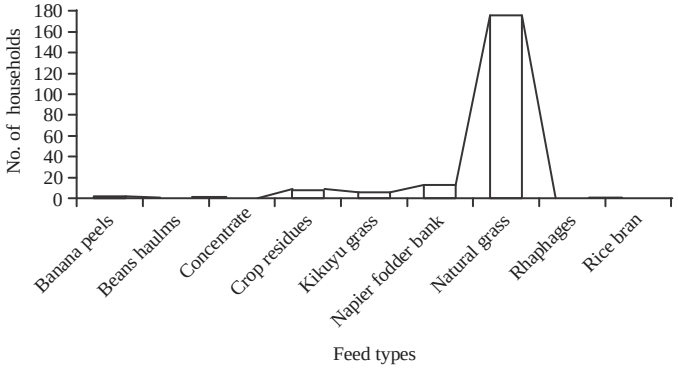

Fig. 2: Variety of feed resources used for beef cattle production

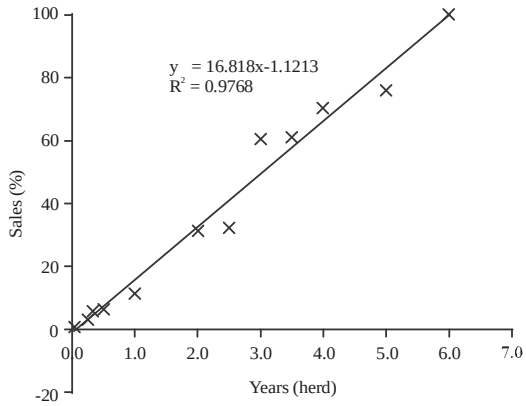

Fig. 3: Percent sale of cattle as against years spent in the herds

Majority of the households who took part in the survey sold their animals by the age of 4 years (Table 14). It was also observed that less than 20% of the households sold their cattle within 1 year after birth.

Access to veterinary services: Most of the respondents (77.2%) claimed to have had adequate access to veterinary services. However, those who had inadequate access to extension services constituted 22.8%. About 65.2% experienced limited access to veterinary services because either they were not available in the area or their places of abode were too far for easy accessibility. It was further noted that an appreciable proportion (22.7%) preferred treating their animals themselves (Fig. 3).

Status of livestock production in Rwanda: Farmers in Rwanda usually keep cattle, small ruminants, poultry (mainly chickens), pigs, rabbits as source of meat, milk and eggs. Table 15 presents the per capita consumption of animal products.

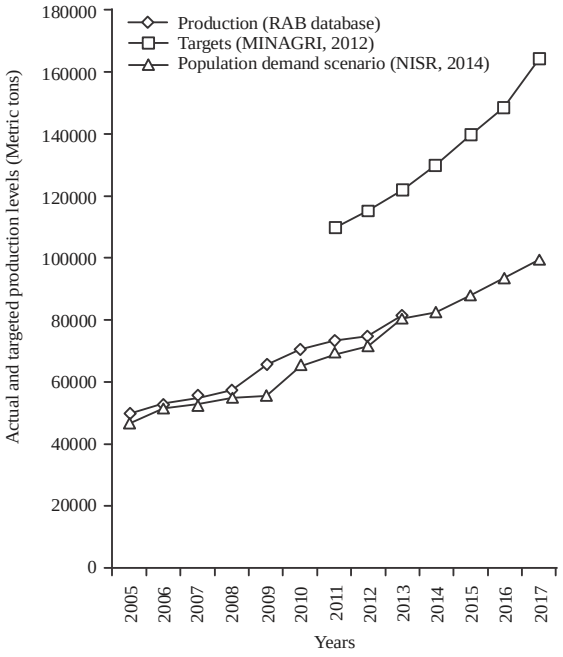

Fig. 4: Targeted and actual production levels over the years

Available records show that the actual production and estimates of consumption based on population growth and per capita consumption trends have been increasing. However, the production and consumption levels have remained lower than the targets set by the state for nutritional security (Fig. 4).

Table 16: Trade balances (1,000 US$) of Rwanda in the regional global beef markets

	Rwanda/region			Region/global			Rwanda/global		
Product label	2012	2013	2014	2012	2013	2014	2012	2013	2014
Live sales	4145	6321	6605	-9352	-7353	-2787	6605	6605	6605
Beef	1	0	-1	-1106	-2411	-6267	-1	-1	-1
Dairy products	-843	698	853	-42512	-50399	-76043	-7098	261	4417
Overall	5315	9032	9471	-50958	-58150	-83083	1518	8878	13035

Source: (http://www.trademap.org/bilateral_TS.aspx)

Table 17: Trends and projections of breed composition and annual milk offtake

	Genotype (%)			Contribution to annual milk offtake (%)		
Year	Ankole	Cross breeds	Pure breeds	Ankole	Cross breeds	Pure breeds
2014	67	24	8	42	37	21
2015	65	25	9	40	38	22
2016	63	26	9	38	39	23
2017	62	28	10	36	41	23
2018	60	29	10	34	42	24
2019	59	31	11	33	43	25
2020	58	33	12	31	44	25

Source: Butera and Rutagwenda[18]

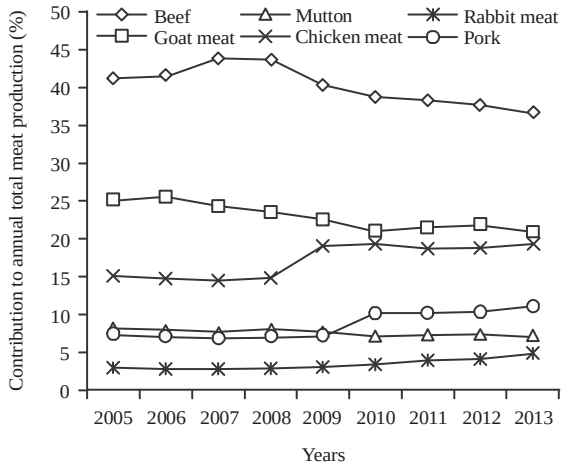

Fig. 5: Percentage contribution of meat type to annual meat production and consumption[4]

Most of the meats consumed in Rwanda were found to come from cattle. However, the contributions of beef, goat (caprine meat) and mutton (ovine meat) were determined to be decreasing with time due to declining grazing land (Fig. 5). Conversely, the proportions of the annual meat available from chicken and pork were found to be on the rise.

In an effort to broaden the export base of the economy, Rwanda seeks to become a net exporter of beef in the regional and global market. The balance of payment records indicate that on the whole, the country is competitive. However, it is not adequately competitive in beef production. The trade deficits in the region suggest that the country can penetrate the regional market if it develops the capacity to meet international standards for livestock and livestock products (Table 16).

Meat consumption in Rwanda: The per capita consumption of meat in Rwanda has been increasing by approximately 4% annum^{-1} over the last decade. It is projected to increase beyond 9 kg/year by the year 2020 (Fig. 6). However, this level of consumption was still found to be below the WHO/FAO standards[14].

Trend analysis shows that the capacity to produce meat has been increasing. Except for 2006 and 2013, the country has been able to produce more meat than the population could consume (Fig. 6). This scenario could probable be due to the predominantly informal nature of the export trade of livestock into neighboring countries particularly the Democratic Republic of Congo (DRC) (Fig. 7).

Cattle genetic resource in Rwanda: Meat produced for consumption in Rwanda comes from a diverse range of cattle genotype. The highest cattle genotype was found to be the indigenous landrace of Longhorn cattle (Inyambo) and their crosses with dairy (Friesian, Jersey and Brown Swiss) as well as beef (Sahiwal) sire lines. Recently, the Fleckveih cattle was introduced as a dual purpose breed. There are isolated cases of private initiatives in the introduction of other cattle genotypes for beef production. The relative proportion of Inyambo and its contribution to the annual milk offtake has rather been declining. It is expected or projected to keep declining exponentially as a conservation strategy (Table 17). In addition to milk, these animals also contribute to meat production.

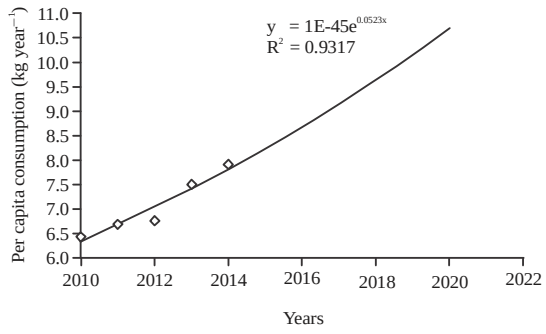

Fig. 6: Per capita meat consumption trends in Rwanda[2,3]

Fig. 7: Surplus meat production over the years[2,3]

DISCUSSION

Livestock production is one of the major agricultural activities in Rwanda because it plays a very important role in the socio-economic developmental agenda of the country. Livestock contributed 10% of the country's Gross Domestic Product (GDP) in 2015 and also serves as food security, source of manure, income, savings as well as other non-monetary but important social-cultural functions which include among others prestige and bride price[19]. The results of this study confirmed earlier research that pointed to male dominance in the beef value chain. It further revealed that most of the respondents had engaged in the business for more than 10 years. The findings further demonstrated that the herd structure was small (<60 herds) and was dominated by breeding females as well as replacement heifers which was suggestive of the fact that bulls were mainly for sales. The age for selling cattle ranged from weaning up to 6 years of age. However, most households sold their cattle when they were at the age of 4 years. The sources for the replacement stock were the markets and other farms. The three major production systems in Rwanda were found to be similar to what prevailed in most of the sub-Saharan countries[20,21].

Three production systems reportedly have been identified with the intensive zero-grazing system being the most prevalent which was followed by the semi-intensive and lastly, extensive[19]. Intensification in livestock production is seen as a deliberate policy response to constraints in production and it stands to generate meat and milk the extensive management systems. With respect to the extensive system, pure pastoralists were found mainly in Nyagatare. Cattle ownership under this system ranged from as low as 1-50 herds per household and this sector contained 40% of the country's cattle population. Most of the smallholder livestock farmers in this system kept local Ankole breeds of cattle or their crosses with exotic breeds. In terms of the semi-intensive system, stock breeders kept cross-bred cattle (Ankole × Sahiwal) which were managed under minimal housing, health and feeding conditions. Under the intensive management system, farmers kept mainly imported pure breeds or grade Jersey, Sahiwal, Holtein Friesian, Brown Swiss and crossbreed of these breeds with Ankole cattle. Farmers under this system kept 1-10 herds of cattle with an average herd size of 20 cows per farm.

The production systems have been observed to experience peculiar characteristics relative to climatic conditions, location and resource ownership which influence the marketing systems and profit margins obtained by the different value chain actors[22,23]. Climatic variability and fragile soil conditions have been reported to have prime characteristic features of Rwanda's cattle production systems[24]. In addition, meat production and productivity in Rwanda is however, constrained by tremendous pressures created by reduced availability of land. The availability of inputs such as adequate feed, genetically improved breed are contributory factors to low production levels. Meat production and productivity needs to be improved through the use of breeds of higher genetic potential, good breeding practices based on scientifically planned breeding strategies, good extension and training programme and organized marketing systems among others[7,25].

In other words, better utilization strategies of available land for livestock, introduction of well thought-out educative training programmes as well as the application of improved animal production technologies at all levels of the value chain would lead to the advancement of the livestock industry in Rwanda.

CONCLUSION AND RECOMMENDATION

The following are some of the key findings of the study:

- Some of the constraints of the livestock industry were dwindling land space for pasture development, lack of input supplies, veterinary services and poor genotypes of local cattle for meat and milk

- Production and consumption of meat was below the level expected for improved nutrition of citizenry
- Cattle was the prime meat source of the country
- There were both sub-regional, regional and global market avenues for the cattle industry (beef and milk) in the country if deliberate strategies are deployed to improve the livestock industry (use improved breeds of cattle for meat and milk, apply improved feed/feeding formulae, target-oriented training regimes, improvement in the various segments of the value-chain among others)

SIGNIFICANT STATEMENTS

Assessing the meat industry in Rwanda by way of unearthing the inherent challenges and opportunities and making them available for developmental purposes formed the bedrock of this work. The study revealed that beef cattle producers, fatteners and traders constituted the main value chain. The production and consumption of meat were found to be below the recommended level expected. Cattle was determined to be the prime source of meat though the contribution of small ruminants has been appreciating. The realized expectation was that improving on the productivity of the available cattle as well as elevate the capacity to comply with OIE quality standards (including traceability) would markedly be beneficial to the country. The development of market-oriented cattle production system was also found to potentially create more employment opportunities for the teeming youth and entire populace.

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