

# RWANDA GOAT PRODUCTION: A KEY ELEMENT FOR ECONOMIC GROWTH AND SUSTAINABLE DEVELOPMENT

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**Abstract:** This project analyses the possibility of goat production for sustainable development and improvement of livelihoods of Bugesera district farmers. The specificity of this study relied on the mixed mechanism of crops and livestock production for tiring small land where other sustainable agricultural mechanisms are inexistence or almost impossible to implement. This study applied quantitative and qualitative methodologies to analyze the real consequences of intensive use of inorganic fertilizers and proposed a coping mechanism of goat manures as a sustainable solution for small landholders. It combines data that captured the field's yields, and applied quantity of organic and inorganic manures in experimental fields to grow different crops, the experiment fields replicated using organic and inorganic fertilizers data were collected for comparability aspect. The study associated those findings with the structured interview questionnaire to examine further the importance of goat production on livelihood improvement as ultimate objective to alleviate poverty sustainably. Also, this study concluded by showing the potential role that the goat production intervention should have for sustainable development in Bugesera district. This requires a dramatic change in both policy and technological need to foster the economic development especially to alleviate the poverty by ensuring a sustainable living mode for farmers and increase their wellbeing using affordable investment to increase the small lands productivity and provide alternative sources of income for farmers who are heavily dependent on agricultural production.

**Keywords:** Goat production, Economic growth, Sustainable development, Organic and inorganic fertilizers, Rwanda.

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## 1. INTRODUCTION

Rwanda embarked on the growth agenda for reaching a middle-income country status by 2020 and efforts to increase the country production, which encompasses the adoption of land consolidation strategy and the use of inorganic fertilizers to increase agricultural production. The head of state summit on the use of fertilizer held in Abuja in 2006 validated the intensification use of the fertilizer from 8kg /ha-1 to about 50 kg/ ha-1 in 2015 (Marenja et al., 2012) and Rwanda has followed those recommendations through a modernization and crop intensification program to increase field yields by intensive use of inorganic fertilizers and terracing (MINAGRI, 2013). The problem is that this substantial capital investment in fertilizers and crop intensification has occurred at the expense of the capacity of the soil to sustainably cope with intensive use of fertilizers. The current farming practices in Rwanda if not changed will be unable to contribute significantly to food security and poverty reduction within the context of soil acidity and inherently poor soils such as those found in many parts of Rwanda.

There is evidence that the current farming process not only depletes soil fertility but also reduces the coping mechanism for soils by reducing the crumb structure and soil permeability (REMA, 2013). Agricultural sector sustainability requires a radical change in the way the current farming system is done. 'The current agricultural policies aims to transform farming practice national wide and involve a rapid shift away from traditional modes of production towards specialization in a small number of government approved marketable staple cash crops' (Neil, Adrian and Thomas, 2015, p 206) The two major components of this strategy are the Rwandan Land Policy (ROR, 2004) and the Crop Intensification Program (MINAGRI, 2008). The Rwandan Land Policy, introduced in 2004, states that current trends lead toward 'a completely degraded land as a result of such archaic agricultural practices, unable to meet the food demand of an ever increasing

population,' (ROR, 2004). Cash crop production requires intensive use of inorganic fertilizer, however little attention has been paid to the consequences of using inorganic fertilizers for soil depletion, land degradation and water downstream pollution (REMA, 2011). One sustainable solution to be undertaken is the use of organic manures produced by goats (Anglo Nubian). The preference for goat manure is supported by their affordability for both tiny landholder and big landholder and the economic, social and cultural potential role played by goats in Rwanda households. Peacock (2005) has provided evidence on the potential role played by goat production to alleviate poverty in Africa. The characteristics of goat manures in trace nutrient and quantity produced by goats have been studied by Wuta and (2012), 'they found that goat manure is rich in nitrogen (N), phosphorus (P) and potassium (K) and organic carbon and decreased soil acidity once applied'.

#### **Statement of the problem:**

Rwanda is called a country of a thousand hills and the steep slopes and acidic soils of highland areas make the growing of crops unsuitable and the application of inorganic fertilizers on acidic soils become problematic. Although fertilizer input can increase production in the short term, it is not sustainable as soils become more acid and depleted. The intensive use of inorganic fertilizers being used to increase agriculture production represents a danger in the near future and is not sustainable in whatever forms, not only with limited land but also with no option to use crop rotation and fallow practices because of limited land availability that forcing sedentary intensification. . In this regard, there are limited researches undertaken in Rwanda on the relationship between goat production, inorganic fertilizers' usage and the crop and livestock production in economic growth and sustainable development.

#### **General objective of the study:**

The main goal of this research is to analyze Rwanda goat production as a key element for economic growth and sustainable development.

#### **Specific objectives:**

The study wants to address the following specific objectives:

- Establish the impact of application of inorganic fertilizers on soil depletion and pollution of water sources in Rwanda;
- Examine the contribution of organic manure to support crop production and reduce soil depletion in Rwanda;
- Describe the importance of goat production for the economy especially for poverty reduction in Rwanda.
- Describe the benefits of improved income and livelihoods for goats' producers and the relationship with the agro-processing industries.

## **2. RESEARCH METHODOLOGY**

#### **Research design:**

This study applied both quantitative and qualitative methodologies to analyze the real consequences of intensive use of inorganic fertilizers and proposed a coping mechanism of goat manures as a sustainable solution for small landholders.

#### **Target population of the study:**

The target population was 100 farmers living in Mayange and Ngeruka sectors located in Bugesera district. Due to logistical challenges, questionnaires were only distributed to 50 farmers.

#### **Sampling technique:**

This study used Simple Random Sampling. A simple *random sample* is meant to be an unbiased representation of a group. This technique has the property that every possible combination of objects in the population studied has an equal chance of being selected. In that case, the researcher included everyone in the study considering that all respondents have common observable characteristics. On the other hand, the purposive technique enabled the researcher to choose respondents basing on the fact that they have desirable characteristics and variables related to the issue being studied.

#### **Data collection and Instruments:**

Both primary and secondary sources were used for data collection. Primary qualitative and quantitative data were collected by the use of semi-structured interview administered to the target population. For secondary data, reviewing and consulting the literature in place on the subject helped to answer the questions of the study.

**Data analysis:**

Given that this research combined different data, it was imperative to use different analysis methods using the statistics package for social and economic sciences (SPSS) to plot tables and figures and excel chart and figures were used. Multidimensional quantitative analysis was used to filter field evidence collected during the experimental period and to forecast the quantity of goat manure produced and the field yields per crop type.

Economic impacts have been assessed through input-output models (IMPLAN) that separate the district economy into numerous sub- sectors like agriculture, agro-processing, households trade, and exports. The input-output model was used to analyze how a variation in one sub-sector changes productivity, revenue, and service in other sub-sectors.

**3. RESEARCH FINDINGS AND DISCUSSION**

**The soils and climate characteristics of Bugesera district:**

The reconciliation of administrative map and agro-ecological zones shows that Bugesera district lies between two agro-ecological zones. A climate zone is defined as being a geographical unit that is homogeneous in terms of climate (rainfall and temperature) (MINITERE, 2007). According to a pedological map of Rwanda, this was divided into 10 units called climate zones, this study have concentrated on the two climate zones that cover Bugesera district. Based on soil characteristics and landscape, these 10 units were subdivided into 38 sub-units called agro-ecological zones. An agro-ecoclimatic area becomes a unit homogeneous geographical in terms of climate and pedology (MINITERE, 2007). The reconciliation of the administrative map and the map of climate areas agro-ecosystem done by Blueprint planning of marshes and catchment areas in Rwanda (MINAGRI,2002) shows that from the point of view climate agro-ecosystem of Bugesera district ranges two agro-climatic zones.

**Sample characteristics:**

For the purpose of this study, the interview questionnaire was applied to farmers who were involved in this study. The table below shows the characteristics of people asked and the number of goats owned. Because most farmers owned relatively small land, 42 percent have between 1 and 3 goats, 28 percent 4 to 6 goats, 14 percent 7 to 10 goats and 8 percent for both 11-15 and 16-20 goats.

**The number of goats owned by breeders in Bugesera:**

	Frequency	Percent	Valid percent	Cumulative percent
A- Represent the owner who have between 1-3 goats	21	42	42	42
B- Represent the owner who have between 4-6 goats	14	28	28	70
C- Represent the owner who have between 7-10 goats	7	14	14	84
D- Represent the owner who have between 11-15 goats	4	8	8	92
E- Represent the owner who have between 16-20 goats	4	8	8	100
A- Represent the owner who have more than 20 goats	0	0	0	100
Total	50	100	100	

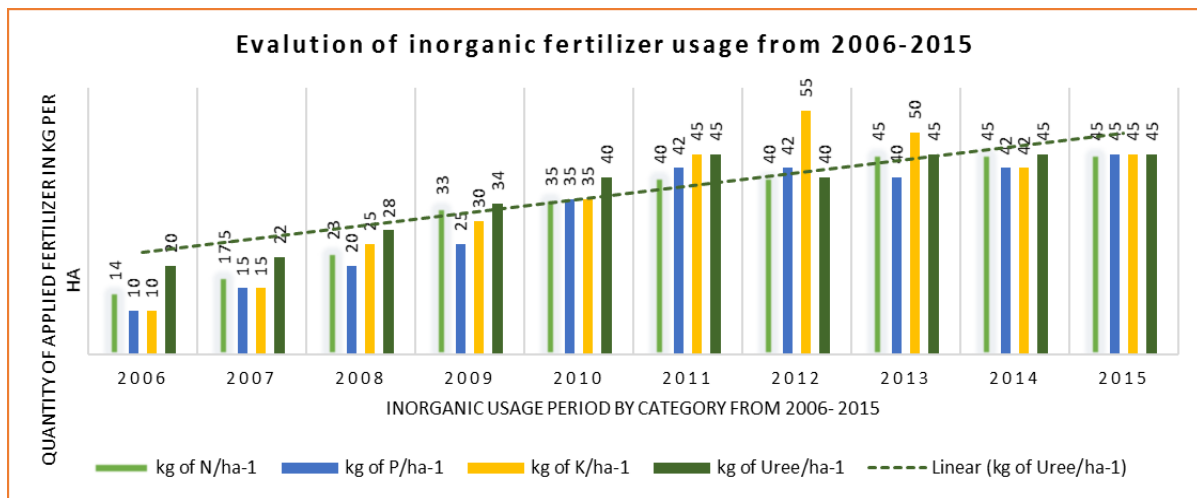
*Source: Author*

**Inorganic fertilizer trends usage from 2006- 2015:**

Every three years the Ministry of Agriculture and Animal Resources (MINAGRI) publishes the standardized inputs usage and quantity of inputs to be applied during the farming season for each selected crop. The Rwanda national fertilizer policy of 2014 was targeted to have supplied enough inorganic fertilizer of all categories and to have applied 45kg/ha by 2017. However, as the trends show in figure below, this target was reached by 2015 as the land consolidation policy increased the awareness and citizen participation through different local programs being implemented. This is notably the Ubudehe program and VUP program that increased farmers' usage of fertilizers.

Figure 1 shows the trend of usage of inorganic fertilizer and this has increased generally over time and specifically for inorganic N from 14 kg/ha in 2006 to 45kg/ha in 2013-2015.

**Inorganic usage trends analysis:**



Source: Plotted by author using the data collected from RAB, 2018

**Quantity of manure produced by goat:**

Table 2 shows how much one well fed goat can produce as organic manure on a daily, weekly and monthly basis. The information was computed using the information provided by goat farmers that were interviewed during field visits in two sectors (Mayange and Ngeruka) in Bugesera district. This shows that people who keep goats have also a secure way of producing organic manures in a constant manner because families that have between 1 and 3 goats can produce between 450 kg and 624 kg of organic manure per month. Those having between 7 and 10 can goats produce between 1680 kg and 2560 kg per month. As the cultivation season is for three months this means that before the new season has begun a farmer will be having enough organic manure for the next cultivation season.

**Table 1: Goat manure production quantities**

Goat numbers	Entre 1- 3	Entre 4- 6	Entre 7-10	Above 10
1 day (Kg)	13- 26	38-51	61-66	>70
1 week (Kg)	105-185	254-350	410-455	>500
1 month (Kg)	450-624	856-1260	1680- 2560	>3210

Source: Data collected from RAB, 2018

**Soils characteristics and chemical composition:**

For the purpose for this study, it was not possible to manage the analyses of soil characteristics and soil chemical composition but there are existing data on soil characteristics done by Pietrowiez (1985) on behalf of the agro pastoral project. A comprehensive soil map (CPR) was also generated between 1981-1990 (Birasa et al., 1990). These different studies describe the soil characteristics of Rwanda divided into nine sub-types of soils. In Bugesera district, the soil types are described in Table 1. They have a silty clay texture, are deep and highly acidic (humults) associated on the steepest slopes carrying moderate soil and shallow tropes derived from granite and gneissic formations that is almost 20 percent of total soil.

Another element highlighted by this research especially the UNDP report (2007, p 9) describes soils that comprise the Congo- Nile zone as soils that are characterized by the hilly central plateau and are particularly susceptible to erosion and are generally older, acidic and less fertile that the rest of the country.

**Experimental field compilation:**

In Bugesera district, every sector has an agronomist that focuses on improving agricultural practices and helping in experimentation of approved crops to be cultivated at each sector, cell and village level . This agricultural structure allows the country to implement the land consolidation policy and improve farming practices for small farm holders by teaching

them on the ground the best way of pursuing agriculture without major danger to the environmental degradation. Data were collected on the experimental fields (exemplary field) managed by the Rwanda Agricultural Board. The following Figure 2 show field yields using either organic manure produced purely by goats and using the inorganic fertilizers especially, urea, NPK, DAP and without any fertilizers. Data were collected for different crops from 2006 to 2014. This shows that field yields using organic fertilizers increased from 1.39 t of beans in 2006 up to 2.41 t of beans in 2015 over 10 years.

Additionally the yields from inorganic fertilizers combined with organic manures increased the yield from 2.12 t of beans in 2006 to 2.36 t of beans in 2015, the usage of inorganic fertilizers only yielded 1.6 t in 2006 and reduced to 1.52 t of beans in 2015. Without application of any fertilizers, the quantity yields have been increased from 0.59 t in 2006 to 0.79 t respectively. This trend shows how using organic fertilizers represents a sustainable production mechanism in the long term.

**Quantitative data presentation:**

The qualitative data collected using a semi-structured interview helped to respond to the first four questions asked in the research survey and the answers provided by respondents are detailed below in different tables retrieved from SPSS.

**The goat production situation in Bugesera district:**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	a- Goat	25	50.0	50.0	50.0
	b- Other	5	10.0	10.0	60.0
	c- Goat and others	10	20.0	20.0	80.0
	d- No one	10	20.0	20.0	100.0
	Total	50	100.0	100.0	

Source: Author

The results for the four questions initially asked were answered using the qualitative results, subsequent questions posed were also responded using quantitative results, and secondary data collected using methods mentioned above. For 50 farmers asked, 50 percent keep goats 10 percent have other ruminant livestock, 20 percent keep goats and other ruminant livestock and only 20 percent do not have any livestock.

**The repartition of number of goat maintained by a respondent farmer in Bugesera district:**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	12.0	12.0	12.0
	2	11	22.0	22.0	34.0
	3	18	36.0	36.0	70.0
	4	6	12.0	12.0	82.0
	5	3	6.0	6.0	88.0
	6	3	6.0	6.0	94.0
	9	3	6.0	6.0	100.0
	Total	50	100.0	100.0	

Source: Author

Considering the number of goats maintained by the farmer asked during the research and it is clear that 36 percent of respondent have at least 3 goats, because given than most of them have a small farm that varied between 0.1 ha and 1 ha they can maintain a certain number of goats for manure production but also for market when bad days come.

When asked, if they know the consequences of excessive use of inorganic fertilizers on their small farm and what could be the consequences, Table 6 shows that 24 percent responded that excessive use of inorganic fertilizers increased the nitrate leaching and soil acidification, and 28 percent knew that excessive use of inorganic fertilizer had environmental consequences that are related to soil depletion and erosion that come from N2O omissions. Others thought that excessive usage of inorganic manure had economic repercussions on their finances because it reduced their affordability as the productivity was reduced.

**The consequences of excessive use of inorganic fertilizers:**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Increase Nitrate leaching and soil acidification	12	24.0	24.0	24.0
	Environmental consequences related to soil depletion and erosion( N <sub>2</sub> O emissions)	14	28.0	28.0	52.0
	Economic consequences related to affordability	16	32.0	32.0	84.0
	Others	8	16.0	16.0	100.0
	Total	50	100.0	100.0	

Source: Author

Apart from manure, production respondents were asked for other reasons that may permit farmers to keep ruminant livestock and the possible circumstances that they can sell ruminant produce. From the answer provided, 28 percent confirmed that they normally sell the ruminants (goats) once the family needed money to purchase other food items during bad days especially before their crops harvest. 8 percent confirmed that they sell goat when the number became important and there is no enough feeder.

**The reasons for farmers to sell their goats:**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A- When need money to family supply of other commodities	14	28.0	28.0	28.0
	B- When need the number became important and there is no enough feeder	4	8.0	8.0	36.0
	During the bad days when family need money	15	30.0	30.0	66.0
	D- Other reasons	17	34.0	34.0	100.0
	Total	50	100.0	100.0	

Source: Author

For the question to know if farmers are having another alternative income rather than farming practices 20 percent affirmed that they do have temporary jobs or are doing business between the harvesting and planting period of new crops. 38 percent had a job in the public sector as a teacher, monitor, driver, technician, plumber and others.

**Other alternative sources of income for Bugesera farmers:**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Civil servant salaries	19	38.0	38.0	38.0
	Business/commerce	10	20.0	20.0	58.0
	Private employer	13	26.0	26.0	84.0
	Other precise	8	16.0	16.0	100.0
	Total	50	100.0	100.0	

Source: Author

The Bugesera farmers recognized the importance of organic manures usage on their farm productivity, during the discussions had with them. 34 percent recognized that organic manures helped in sustaining their farm fields and 30 acknowledged that organic manures helped them to enrich soil carbon. 12 percent affirmed that usage of organic manures increased their social-economic position, as intensive use of organic manures consolidated they soil fertility and reduced inorganic dependence and increased savings. 12 percent also recognized this importance and highlighted the role of organic manures as vital for their small farms soil sustainability.

**Importance of goat manure to increase small farm productivity:**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes Enriching soil carbon	15	30.0	30.0	30.0
	By Sustaining yield	17	34.0	34.0	64.0
	Enhance sustainability of soil fertility	6	12.0	12.0	76.0
	Increase the socio-economy of smallholder farmers	6	12.0	12.0	88.0
	I don't know	6	12.0	12.0	100.0
	Total	50	100.0	100.0	

Source: Author

The qualitative data collected also helps to evaluate whether growing goat and other ruminants livestock help Bugesera farmers to have a sustainable way of living by consolidating income from different sources and increase opportunities to escape from poverty. The findings from discussion with the respondents showed that 22 percent who growing goat increased their food security by having an alternative source of income. 22 percent recognized that goat production had improved the local production and consumption, whilst 18 percent affirmed that once the goat production is well managed it could help in industry expansion by providing raw materials. 18 percent believed that the expansion of goat production would create job opportunity for farmers.

**The socio-economic impact of improved goat production on small farmers' livelihood:**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Improved Food Security	11	22.0	22.0	22.0
	Improved Local production and consumption	11	22.0	22.0	44.0
	Agro-processing industry expansion	9	18.0	18.0	62.0
	Improved income and wellbeing	10	20.0	20.0	82.0
	Job creation and increase farmer opportunities	9	18.0	18.0	100.0
	Total	50	100.0	100.0	

Source: Author

For the purpose of this research, there was also a need to understand the goat manure handling before usage in farm and for both questions of the consequences of inorganic fertilizers for human life and the proposed remedy of different results and excessive usage of inorganic fertilizers on smallholder farms has also been discussed. The two remaining questions of the importance of goat production for economic and especially poverty reduction and that of benefits of improved income and livelihood for goat breeders were also discussed. The last question of relationships with other economic sub-sector was also investigated using the IMPLAN model to evaluate the impact that may rise from increased goat production.

**4. INTERPRETATION AND DISCUSSION**

The data collected were useful to answer the fundamental question asked during this research. For the qualitative data that are mainly constituted by the answers collected from interviewees in Bugesera district, results were interpreted using SPSS software to compute different tables and charts for quantitative data using excel. Both quantitative and qualitative data focused on four research questions: (i) determining the consequences of successive use of inorganic fertilizers on soil depletion and pollution of water sources and on the smallholder farm; (ii) the proposed remedy to alter the consequences of inorganic fertilizers for human health and if the usage of organic fertilizer as farming practices itself is enough to reduce soil depletion and deficiencies in nutrients and support the crops production; (iii) the role of goat production in the economy, especially in poverty reduction initiatives; and finally (iv) the benefits that may come from improved income for livelihoods and its relationship with other sectors. Although the information collected may primarily help to analyze the problem, finding data on soil acidity and depletion was a main challenge. The following interpretation and discussion was done with that spirit in mind to explore in depth the issues surrounding the extensive use of inorganic fertilizers for smallholder where other farming methods are quasi- in-existent.

## 5. INTERPRETATION OF RESULTS

The first fundamental question asked was related to consequences of inorganic fertilizers usage on soil depletion and the pollution of water sources. Using the findings from Table 5, 28 percent among the respondents confirmed that usage of inorganic fertilizers has consequences on soil fertility by reducing aggregated crumb structure and soil permeability, which aids in cultivation. 24 percent of respondents affirmed that intensive use of inorganic fertilizers increase nitrate leaching and soil acidification. This converse with usage of organic manure where 30 percent of respondents affirmed that marginal micronutrient deficiencies that occurred mainly after repeated fertilizing with chemicals can be avoided with additional application of manures.

The farmers are aware of chemical fertilizers dangers to natural resources and particularly on their small land that is tilled by hand. In the report published by REMA (2013) the soils depletion is a danger that may be contains as it is even associated with high deficiencies of zinc, copper, manganese, iron and molybdenum in different area. By comparing the farm yield either using organic and inorganic fertilizer it shows that the application of inorganic fertilizer generally increases crops yield in short term but the yield start decline in long-term for example maize yield increased from 0.9 tons per ha in 2006 to 1.79 tons of maize in 2010 and start declining up to 0.89 tons produce per ha in 2015.

In terms of consequences of intensive use of inorganic fertilizers although the answer got from interviewees confirmed that, inorganic fertilizers have adverse negative impact on soil depletion and spoil the water source, different studies have also confirmed this hypothesis like Solomon,W.et al.(2012), Mohd, H. I.et al. (2013), Mofuranya, A.A.J. et al. (2014), Abul, K.Md. et al.2015 and Bhaskarrao,C. et al.(2015).

### Goat breeds and manure production:

As shown in Table 2, the numbers of goats bred by farmers are small ranging between 1 and 10 goats per farmers, which represents 84 percent. Goats in Rwanda context are kept on a small-scale land by farmers for several reasons, as goat rearing does not require many resources. The population of goats in Rwanda is estimated at 4,971,000 (MINAGRI, 2015) and are used for different reasons ranging from slaughtering them for home consumption, using as alternative incomes to handle emergencies (Table 6). The most important role is that the droppings of goat are used in farming as organic manures. The economic growth of goat production is seen as a potentially direct benefit especially in rural areas; using the IMPLAN model simulation in the below describes the best-case scenario on how the interrelationships with sub-sector will benefit from goat production increase.

Illustrative transaction Table						
Production sectors (sellers)	AGRICULTURE	MANUFACTURING	SERVICES	HOUSEHOLDS	EXPORTS	OUTPUT
	PURCHASING SECTORS DEMANDS(IN BILLION FRW)			FINAL DEMANDS IN BILLION FRW		
AGRICULTURE	220	132	44	440	264	1100
MANUFACTURING	88	88	66	528	308	1078
SERVICES	132	44	22	748	220	1166
HOUSEHOLDS	352	550	836	22	1144	2904
EXPORTS	308	264	198	1166	22	1958
INPUT	1100	1078	1166	2904	1958	8206

Source: Consolidated from District Development plan assessment report 2014/15

The table above shows that once the agriculture production increases by 5 percent as a result of goat production this will increase the agro-processing by the same percent to reach equilibrium point. This 5% increase the agricultural output from 2.2 to 2.3 to meet this new high demand level for meats as the breeders' increases production. Increasing production requires the increase of 3.5 to 3.7 of feed from household's trade by purchasing new capital equipment for agro-processors that also requires to hire additional qualified services such as veterinarians, butchers and more labor.

These other services may also increase their production and their corresponding inputs to meet the new level of demand created by the increase in meat demand. In general, the volume of transaction will pass from 82.1 in 2014 to 86.2 in 2015 due to change only of increase in the agriculture sector. The new hired breeders for example increase the level of income and spending in the district economy, thus creating even higher levels of demand for meats. The increased demand for meat creates a moving effect through the whole economy. This rippling effect may be measured and applied to assess how a change in one part of the economy affects the whole economy. Different multiplier effects from income, output and employment may be investigated further in a future studies.



### **Goat production vs small land farming:**

Figure below shows the goat breed that grows in Bugesera district on terraced land. As explained in Chapter 4 the climate zone in Bugesera occupies the upper slopes the Bugesera watersheds. It is a conducive environment for goat development. In Rwanda culture goats plays a vibrant role in ensuring the food security of households, and on a daily basis are the primary asset possessed by family. During bad period resulted from poor harvest or family illness, goats become an alternative source of income if sold (Table 7). This role was also confirmed by (Peacock, 2005, p4) and breeding types (Anglo Nubian) as shown below:

The social and economic importance of goat production in Bugesera district was assessed using the structured interview questionnaires to farmers. Tables 9 and 10 confirm that farmers' responses highlighted the roles such as food supply for almost all households, sources of alternative income and saved as stock of assets. Their role goes beyond agricultural sustainability by increasing the soil fertility and consolidating soil structure.

### **Challenges and limitations of this study:**

The study was conducted in only one district and it is difficult to escalate the findings at national level given the existing differences across districts in terms of soil characterizes and goat-breeding behavior related to traditional culture. The sample size was also limited due to resource constraints and time available to investigate further the other dimension of sustainability such as an opportunity to expand goat production for improved species. The data available are scattered and not up-to-date so that we can draw conclusions effectively, some were even unavailable like the soils composition, and saturation in CO<sub>2</sub>, nitrate and other nutrients that need to be considered in further studies.

## **6. CONCLUSION**

Despite the challenges faced by farmers in terms of goat production, the economic role played by goats in Rwandan society is very important to alleviate the poverty and increase sustainably the soil fertility. The dramatic consequences for intensive use of inorganic fertilizers especially for small landholders in studied zones were identified and responded to our assumption in context where other farming practices like crops rotation and fallow are practically impossible. The mixed mechanism (crop production and livestock production) was seen as the best durable solution to produce sustainable development for farmers.

Firstly, this study has shown that the intensive use of inorganic fertilizers constitutes the primary danger for soil depletion and pollution of water sources in general which at the end led to serious soil erosion as evidenced by State of environment and outlook report (REMA, 2015, p 106). The affordability of successive use of inorganic fertilizers for farmers remains an obstacle compare to regional prices. This also has an adverse effect on farmers as far as affordability is concerned, and reduces their ability to cope with environment degradation and climate change.

Secondly, this study reveals that the usage of organic manure constitutes the best alternative given that goats' manures are affordable, easy to manage and represent the potential to increase the structure of soils and reduce the vulnerability to soil erosion, and increase the soil fertility in long run. Goat rearing also constitutes the coping mechanism (as an alternative source of income) by farmers in case of bad harvest due to poor climate. Given that Bugesera district has all the necessary conditions for rearing goats there is a full potential to produce enough manures to support crop production and goat manures are rich in nutrients to support crop production as confirmed (Loh, T.C. et al, 2005, p 112).

Thirdly, the importance of goat production for the economy and for society in general have been evaluated and confirmed. Goat production has become a profitable business, as it only requires a very low investment given its multi- functionality utilities. In Bugesera district goat rearing contributes to district production and is one of the primary sources of nutrition, income, and manures for the local population. Although for traditional beliefs district goat milk are at lower production, goat milk has the potential to provide other products likes goat cream, butter etc. Goat meat is the best and has a good taste, is nutritious and healthy and is considered as the poor man's cow because it is the main source of regular income for most middle class families.

Lastly, this research has shown the potential impact of goat production involvement for sustainable development in Bugesera district. To reach country's ambitious target it is imperative to change both policies and technologies that are required to foster the economic development. It is beneficial for both farmers and the environment to adopting lesser investment that allow graduation from extreme poverty by ensuring easiest mode of food production and increase the wellbeing of farmers with small size lands who are heavily dependent on agriculture.

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