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**GOAT PRODUCTION IN RWANDA: ASSESSING THE POTENTIAL
FOR FUTURE DEVELOPMENT**

by

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ABSTRACT

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This study is uniquely structured to assess the potential for future development of the Rwandan goat industry based on a thorough empirical analysis of how farm households of many different types participate in, and depend on, this pervasive industry. Data from the 1984 National Agricultural Survey in Rwanda and the 1989 follow-on survey permit us to highlight recent trends in goat (and other livestock) production in Rwanda, and to assess the degree to which variations in goat production are linked to other household and farm characteristics. Findings show that farmers are adapting to population pressure by shifting away from the production of cattle in favor of small ruminant production. Declining farm size, low start-up costs and relatively low mortality rates have all contributed to the growth of goat production, particularly among young farmers and those with small holdings.

The major factors influencing livestock production in Rwanda are farm size and the availability of household labor. Rwandan farmers are currently overstocked with livestock, marketing only one-third of the goats potentially available for sale each year. This is partly because meat consumption in Rwanda is very low due to its high cost relative to other sources of protein, but also because farmers use livestock as a

mechanism for savings and the accumulation of wealth, to be "cashed in" only for special occasions or in times of need.

Possibilities for local processing of hides and skins and for manufacturing leather products are reviewed.

DEDICATION

This research publication is dedicated to my dear Odette, Patrick, Yvette, Sergine, Pacifique, J. Luc, Celse, and to my sister Jackie, all of whom endured a great deal during my twenty-three months so far away from home. Their daily sacrifices will one day be compensated by the Holy God.

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CHAPTER ONE INTRODUCTION

Livestock production has been an integral part of farming systems in Rwanda and other East and Central African countries for centuries. Though Rwandan farmers seldom use their livestock as beasts of burden, they nonetheless attach great importance to livestock ownership as a mechanism for capital accumulation, as a source of nutrition, and, concomitantly, as a symbol of wealth and status in the local community. Traditional animal husbandry in Rwanda has emphasized a combination of cattle and goat production, a reflection of the country's mixed ethnic heritage.

Results from a number of smaller, specialized studies as well as the observations of local researchers, extension agents and government officials, consistently point to the following long-term trends relative to livestock production in Rwanda: 1) meat and milk consumption (primarily from cattle and goats) among both rural and urban populations has increased, and this has benefitted the livestock industry as a whole, 2) the per capita production of cattle has declined over the past three decades, and 3) goat production has increased greatly, particularly over the past 10-15 years. It is this third observation, on the recent growth of the goat industry, that clamors for attention and arouses interest among all sectors of the development community.

While reliable figures on the history of livestock production at the national level are hard to come by, the country's first National Agricultural Survey, fielded during the 1983-84 agricultural years provides a bench mark estimate of the current overall

magnitude of the industry. Animal husbandry in Rwanda is now practiced by 76% of the country's farm households and goats are found on over half of Rwanda's farms (56%). The total goat population has reached 1.9 million, an average of 3.1 head among households raising goats. This total production figure represents nearly a 100% increase over previous estimates published by the Ministry of Agriculture based on a conservative extrapolation of results from earlier studies. In other words, growth in Rwanda's goat industry over the last 10-15 years has far exceeded the Ministry's often optimistic expectations. While at the same time, cattle production has declined in relative importance.

A guiding hypothesis of this research is that the recent increase in goat production has occurred in large part as a function of fundamental change in the structure of Rwanda's small farm agriculture, which itself is a response to rapid population growth and the pressure this growth places on the country's limited land resources.

Rwanda's population is growing at an annual rate of 3.7% (one of the highest in Africa) and as a consequence landholdings are becoming increasingly small and fragmented. Farm families have learned to adapt to this pressure on the land in many ways--perhaps most notably through a restructuring of land and labor use. Two aspects of this restructuring are that marginal lands once set aside for pasture are now being brought into production, and the need for more intensive use of scarce land resources is placing greater demands on the household labor pool. In turn, lost pasture and the need to devote available adult labor to a more intensive system of agriculture and off-farm employment may help explain why goat production has outstripped cattle production in recent decades.

Specifically this research addresses the following set of fundamental, interrelated questions:

1. What are the underlying market, demographic and household characteristics and changes associated with, and responsible for, the recent increase in goat production?
2. How is goat production (and the consumption of goat meat) integrated into other aspects of Rwandan agriculture at the household level?
3. Based on analyses of the structural causes and of the importance of goat production to Rwandan farm households (questions 1 and 2 above), what are the implications of technological innovations (breeds, feeds, practices, etc.) and/or potential policy changes on the future development of the country's burgeoning goat industry? More specifically, which among the range of such innovations or policy changes will be both economically feasible and structurally compatible with Rwanda's system of subsistence agriculture?
4. What is the structure of goat marketing in both rural and urban sectors of Rwanda's domestic economy?
5. What is the importance of livestock production as a source of foreign exchange? What kinds of modifications in agricultural policy will help create a favorable environment for the growth of this export market (licensing, pricing, tax assessments, etc.).

This study stands apart from others in two respects. First, rather than attempting to stimulate a weak or faltering industry, this research aims to provide information that will help the Rwandan Ministry of Agriculture capitalize, at this critical juncture, on the recent development of its small yet robust, and potentially expansive goat industry. Second, while the literature is replete with recommendations for technological innovation and policy change, the present study is uniquely structured to assess the potential for future development of the Rwandan goat industry based on a thorough empirical analysis of how farm households of many different types participate in, and depend on, this growing industry.

As such, this study is especially timely given current national resource limitations and the associated constraints to economic growth forced by Rwanda's ever-increasing population. The need for a concerted policy orientation to the development of small agriculture-related industries has never been stronger. This study works to meet this need in considering the policy implications and potential for developing the small ruminant subsector of the economy.

Understanding the importance of, and potential for, livestock production in Rwanda requires a multifaceted approach to the subject. This study emphasizes three important dimensions. The first is an historical and sociocultural perspective which reviews the context through which the livestock industry in general has evolved over time.

Second, an analysis is conducted using existing data on goat production in Rwanda gathered by the Agricultural Statistics Division (DSA) of the Ministry of Agriculture as part of an ongoing agricultural statistics and analysis program. Benchmark data on livestock production were initially collected as part of the 1983-84 nationwide survey of farm households. Livestock inventories and sales were again measured in 1989. Analyses of these data permit us to highlight recent trends in goat (and other livestock) production in Rwanda, and to assess the degree to which variations in goat production are linked to other household and farm characteristics. The focus of this analysis is on variables such as farm size, land use (e.g., crops versus pasture), household labor availability, and variations in agro-ecology, all of which will help us define the underlying structure of goat husbandry in Rwanda. These important structural variables contribute in a very tangible way to our understanding of the important role goat production plays in the day-to-day subsistence of Rwanda's

farm population. Moreover, it is only through this kind of "grass roots" analysis that alternative technologies and policy changes affecting goat production can be adequately evaluated.

Third, this study will focus on goat marketing in Rwanda. As little empirical evidence currently exists on the structure of goat marketing at the local level (e.g., the role of wholesalers and slaughter houses, seasonal variations in sales, use of hides and skins, etc.), original fieldwork has been carried out in a small sample of the country's more important regional goat marketing sites. A variety of field research techniques were employed in these sites, including semi-structured interviews and first hand observation of marketing transactions, to collect information essential to the analysis of these markets. As it is generally acknowledged (yet not empirically substantiated) that a great number of goats are trucked across Rwanda's borders into neighboring countries, notably Zaire and Burundi, special attention has also been given to trying to better understand these informal export markets.

CHAPTER TWO SOCIAL AND ECONOMIC DIMENSIONS OF LIVESTOCK PRODUCTION IN RWANDA

2.1 Introduction

Livestock production in Rwanda is influenced by both sociocultural and economic factors. Sociocultural influences are rooted in differences among Rwanda's three ethnic groups and their traditional sustenance activities. From an economic standpoint, livestock production is important as a medium for storing and accumulating capital and for its value in exchange for goods, services and land. This chapter identifies three periods of time in the history of livestock production in Rwanda over which changes have occurred in the social and economic importance of livestock. The first covers the period of time up until 1919 when German colonial rule came to an end. There was no treaty established during this period, only an oral agreement in which the King of Rwanda accepted the dominion of Germany's Imperial Government Protection (d'Hertefeldt 1961).

The second period covers the decades from 1919 to 1962, and can be divided into two parts. In the first part, under international public law, Rwanda was under the protectoral authority of Belgium (1919-1946) (Orts-Milner 1919). In the second part, from 1946 to 1962, Rwanda was under the "tutelle" of Belgium, meaning that the Belgian government was given a mandate to guarantee peace, security, and good management of the resources of the territory, and to promote the population's welfare, both materially and spiritually.

The last identifiable period can be referred to as the post-independence period, which began in 1962 and continues today under the leadership of the National Revolutionary Movement for Development (MRND).

2.2 Precolonial Period (before 1919)

2.2.1 The role of livestock

The role of livestock in Rwandan society has been described from various perspectives by historians, anthropologists, and ethnologists. Some have argued that livestock was an instrument of domination (Maquet 1961) which had to disappear completely before social equality could be achieved. Others considered livestock to be a resource that had to be promoted in order to generate income.

During the precolonial period, the sustenance of the population was achieved through three major activities: agriculture, animal husbandry, and hunting. Historians report that the Batwa were the first population to live in Rwanda. They were hunter-gatherers, potters, and dancers. The second group to arrive was the Hutu and their principal activity was agriculture. The last group was the Tutsi, a pastoralist population that emigrated from territories to the north (Kagame 1954). According to Roger-Louis, the Tutsi came to occupy parts of the territory now known as Rwanda during the 15th century. Rather than becoming a profitable resource for the country as a whole, livestock, cattle in particular, emerged as a source of conflict. In 1959, because of a lack of equality in terms of access to resources, including land and livestock, ethnic strife escalated into full-scale social revolution. Cattle belonged to the class with power, and because cattle ownership was so closely associated with power, skills

necessary for the production of small ruminants such as goats and sheep were neglected for centuries.

While in western society money was used as a means of exchange for goods and services, in Rwanda livestock played the same role. Wealth in traditional Rwandan culture was defined largely by the number of cattle an individual possessed. The fewer cattle one owned, the more protection he needed. Effectively, cattle ownership defined the relationship between client and patron. Cattle were used to rent land, pay labor, and buy commodities. A good illustration of this form of exchange is given by Czekanowski (1917) who in his description of the market system in Rwanda-Urundi noted that: two to four hoes could be exchanged for one goat, two to five hoes for a calf, eight to eleven hoes for a young bull, and so on.

It was traditionally recognized that any cattle owner had usufruct rights to the land. There were two levels of responsibility, one for land used for livestock and another for land used for agriculture. As a means of payment when land was received for pasture or for agricultural production, goods and services had to be offered in return by the client. For many households this repayment could take an entire lifetime. It has been argued that this exploitative system was not characterized by economic efficiency (Maquet 1957).

Cattle were raised, then, for social and economic reasons, rather than for nutritional purposes (Marchi 1938). By owning more cattle, a client could become upwardly mobile, possibly even of regal status (Maquet 1957). This had a negative impact on the quality of livestock and on resource use because it was only the number of cows that mattered. It is reported that some cattle owners never ate beef, surviving exclusively on milk and honey wine or banana beer (Pages 1933). The principal

agricultural product derived from raising cattle was milk. Beef was rarely consumed. As cattle were socially more valuable as capital than as food, beef was consumed only when an animal had been injured or was killed for sacrificial reasons (Meyer 1916). Only the chief indulged in the luxury of killing an animal for food from time to time. In these circumstances, only steers, old heifers, or sterile cows were slaughtered.

By contrast, goats were more often raised for meat consumption and for sacrifice, and goat sales were important for income generation among small households. Goats were used to buy salt, cloth, and hoes imported from the Tanganyika territory by Asian merchant traders. Goats were also exchanged for ivory and rubber smuggled out of the Congo. They were exported from Ruhengeri, the Mulera region, Kibungo, and Gisaka. Even though the importance of cattle in the northern provinces was relatively limited, because of the dominant role of cattle production in general in precolonial society, goat production was given secondary status in Rwanda, and little initiative was taken to alter this situation.

The consumption of lamb was restricted to the Twa. Because there was a taboo which prohibited other ethnic groups from consuming lamb, neither food nor drink of any kind was ever shared with the Twa. The sheep skins were used by mothers to carry babies on their backs. Hunting constituted the major sustenance activity of the Twa, whereas it was viewed more as a training exercise for warriors or simply as physical entertainment by the two other ethnic groups. For the Twa, the purpose of hunting was to supply meat. Skins and ivory from hunting were exported or gifted to the King. Those from the Gisaka region were well known as good hunters, particularly of elephants.

Bees were also important as they provided honey for the brewing of beer. The Mulera region was known for its production of honey. Neither chickens nor eggs were eaten. Rather, they were used for divine sacrifice (Meyer 1916).

2.2.2 Land use and livestock

Land was allocated to agriculture, forest, and pasture. In early times, much of the country was said to have been covered by extensive forests which, over time, were destroyed for the purposes of growing crops and raising livestock. Historical reports unanimously confirm that by 1929 the country was undergoing radical changes in land use, and that deforestation was proceeding at a rapid pace (Czekanowski 1917).

Historians reported that ecological destruction was the consequence of the principal sustenance activities of the country's three ethnic groups. Hunters killed animals and collected fruit, seeds, and roots. Farmers cleared forest land and grew beans, peas, sorghum, millet, sweet potatoes, cassava, maize, bananas, pumpkins, groundnuts, yams, tomatoes, and red peppers (Maquet 1961). Pastoralists brought their cattle for grazing. They did not practice nomadism, but transhumance was practiced from the hill sides in the rainy season to the valleys and wetlands in the dry season. A lack of forage and fodder plants, combined with an irregular rainfall, resulted in serious ecological disequilibrium (Troquereau 1965).

The bush fire was the most damaging practice of pastoral management. Herders put fire to pastures in order to promote the growth of fresh grass, a practice which had the negative effect of destroying the micro-organisms responsible for the decomposition of organic matter. Some scientists defended the practice, arguing that it also helped to destroy parasites that were noxious to the animals (Troquereau 1965).

This agricultural practice contributed to the degradation of forest land, one of the country's most important natural resources. The replacement of primary forest with bush and savannah has in the last five decades contributed to recurrent famine and irregularity in the agricultural and livestock production environment. The progressive disappearance of peas has been identified as still another casualty of forest destruction (Scaëtta 1929).

Land use rights during the precolonial period stipulated that there was no full ownership of land. An individual could garner the right to cultivate a plot and collect its harvest, or to use it for grazing purposes during another time of the year (Vanhove 1941), but in neither case was he considered the owner. The King had jurisdiction over the land and managed to achieve a balance of power in this respect with local authorities. He had the right to allocate land to those under him and, if necessary, to withhold land from some as a form of punishment or for political reasons (Kagame 1954).

The head of the family had usufruct rights to land which he "inherited" from his father. He could in turn pass on this land to his own sons. With the agreement of the local authorities, farmers could expand their operational holdings as well. The pasture-chief could allocate a parcel of land to a herder, or a farmer could obtain a plot of land from the land-chief. There was an exception to this general system in the country's northern provinces. In this region, the lineage head was the land-chief of the family and a parcel of land left without heirs was returned to the family instead of to the local authorities. A person entitled to the use of a plot could rent it out, but not sell it. The new user could not build a hut or plant banana trees. The hunters considered forest

lands as their own property, which seemed not to concern those engaged in agriculture and livestock production.

The complexities of the client-patron system were such that one researcher has identified seventeen ways of obtaining cattle, each with its own unique name (Vanhove 1941). Rights were defined by how cattle were given and under what circumstances. Relationships between receivers and donors often defined their rights, but, as a rule, cattle received as a gift or inherited were considered fully owned; there were no obligations on the part of the donor to reciprocate in any manner. Even so, homage limited the right of this "full" ownership, and disobedience or nonconformity could result in the patron's repossession of the gift. Every pastoralist had the right to graze his herd on the hill where he lived, under the condition that he respect locally defined rules. A new herder in an area had to ask the permission of the chief of pasture and to pay tribute according to the number of cattle he owned. By contrast, goats and sheep were fully owned and were not subject to a head tax.

2.2.3 Institutional structure

Prior to 1924, Rwanda was divided into provinces and districts, though some of the provinces did not fall under the jurisdiction of the authority (d'Hertefeldt 1961). The King was recognized as the head of state and political organization was characterized by three important features: a central administration, an army, and the patron-client system of rights and responsibilities. Each district was governed by two chiefs: one was responsible for the allocation and taxation of land, while the other oversaw the keeping of livestock. Of the cattle, goods, and services collected from the district population, one portion was given to the king and another was kept by the district

chiefs. There were independent organizations established in different districts: one district, for example, was governed by the chief of the military, another was designated as the provincial capital, still others specialized in agriculture and/or livestock production (Vansina 1964). Because of the importance of cattle in traditional society, there was a strong incentive for local authorities to accumulate cattle and, in turn, to garner payment of more and more goods and services. There was an absence of integrated government policy, and kinship and local community obligations overshadowed commitment to national goals for most.

Agricultural and livestock management skills were transmitted from one generation to the next through kinship lines. A father's breeding techniques, for example, were passed on to his sons, and the same was true for all that involved the production and marketing of crops. Centrally issued interventions and improvements in agriculture and animal husbandry were essentially nonexistent.

2.3 Colonial Period (1923 to 1962)

2.3.1 The role of livestock

In 1923, Belgium was mandated by the League of Nations to guarantee the administration of the country and ipso facto to promote efficient use of resources to ensure the well-being of the population. On October 24th of the following year, Belgium officially accepted the responsibilities of this mandate (Orts-Milner 1919). Under Belgian colonial rule the meaning and importance of livestock to individual farmers, and to the country as a whole, was gradually redefined.

As mentioned in the previous section, the role of livestock in traditional Rwandan society was to increase the number of cattle, primarily for social and political reasons.

Economic considerations were of secondary importance. Though traditional livestock production was not economically driven, Dr. Marchi (1938) points out that cattle production under the traditional management system was, in fact, profitable for those so engaged. The extra demand for labor was marginal and, similarly, little was required in terms of capital investment. Breeding was a service provided by livestock owners among family and friends at no charge. Sick animals were likewise provided with traditional remedial treatment at little or no cost. Gradually, the economic motivation in livestock production became more and more important. Livestock was seen as a part of agricultural production, most notably as a source of cash, or as a source of meat and milk for consumption and sale, and as a source of manure for improved crop production. Agriculture and livestock production became increasingly integrated.

Growing tensions between the different ethnic groups in Rwanda were, in turn, eased by the convergence of agriculture and animal husbandry. Because increased herd size was the basis for upward social mobility and access to land during the precolonial period, livestock owners often raised more animals than they could realistically care for. Agriculturalists and pastoralists were pitted against one another in competition for the country's most fertile and productive land. To resolve this problem, the mentality of cattle owners had to change; this was not easy, given that large-scale herders also held considerable political power.

A more balanced and complementary agricultural system that integrated livestock and agricultural production had to develop. Policy encouraging the transformation of pastoralism into farming was eventually implemented. Livestock production was allowed to support agriculture. But, because the lives and livelihood of

the large-scale pastoralists were so uniquely dependent upon livestock, these changes were difficult. Even in the livestock owner's diet, agricultural products were largely excluded: only milk, blood, and sometimes meat were consumed. They saw no need to devote their time to agricultural activities. After four centuries of dedication and dependence on animal husbandry, it is no surprise that the Tutsi population resisted this change. This situation was similar to that of the Massai tribe in Kenya which has until recently maintained a pastoral way of life, despite rapid social change and the pervasiveness of modern life.

2.3.2 Land use and livestock

Land use during the colonial epoch was shaped by a number of factors including the practice of transhumance, an irregular climate, periodic bush fires, and population pressure. Goats seemed to be biologically better adapted to these conditions than were cattle. First of all, cattle were found in large number relative to available land resources, and second, though not nomadic, the pastoralist group practiced transhumance between rainy seasons (Troquereau 1965). This had very negative consequences for animal health. In fact, Marchi (1938) argued that most of the cattle parasites, which contributed to decreased height-age and weight-age ratios, came from the wetlands and humid shallows during the dry season. Climatic irregularities combined with periodic bush fires and the conversion of pasture to crop land to meet the food needs of a growing population all contributed to a decline in livestock production and to the integration of agriculture and animal husbandry in Rwanda (Scaëtta 1929).

Table 2.1. Livestock trend inventory

	Year	
	1938	1958
Human Population	1,886,890	2,551,000
Cattle	610,000	604,831
Goats	600,000	1,075,535
Sheep	210,000	324,000
Pigs	5,000	---

In 1938 the Rwandan population was estimated at 1,886,890 people, while livestock estimates were on the order of 610,000 head of cattle, 600,000 goats, 210,000 sheep, and 5,000 pigs (see Table 2.1.). In 1958, twenty years later, enumeration of the human population was estimated to be 2,551,000 with an increase of 1.8% per year. Population density shifted upward from 73 persons per square kilometer in 1938 to 132 persons in 1958. By contrast, there were 604,831 head of cattle in 1958, indicating a decrease of 0.05% per year during the 20 year period. The number of goats increased by 4.0% per year and sheep increased by an annual rate of 2.7%.

Thus, while the human population grew, cattle declined slightly over these twenty years. Statistics show a marked decline in 1959, probably due to the government's decision to place a head tax on livestock in the late 1950s. The 4% yearly increase in the goat population can be partially explained by their low rate of mortality, high birth rate, and their feed which is easily obtained, even for poor households. The same set of circumstances also apply to the production of sheep.

In 1929 Scaëtta described the sequence of changes in land use that accompanied population growth in Rwanda. Axes and hoes were brought into forest areas, followed by cattle and other livestock. Traditional legumes were replaced by grains, which, combined with irregular rainfall and wind, brought soil erosion. Population pressure and the decline of the level of Lake Victoria led to drought conditions in the eastern provinces of the country. Agriculturalists and pastoralists alike were forced to migrate to the west and invade the natural forests.

2.3.3 Institutional changes

Land ownership was permitted by law in 1926. Before 1926, the country's provinces were under the jurisdiction of the military chief and each district was headed by a chief of land and chief of pasture. Under this system, full ownership of land was not recognized (d'Hertefeldt 1961). As described above, the patron-client relationship was the defining characteristic of the system.

The first change after 1926 was to abolish the roles of the provincial and district chiefs. Replacing provinces and districts were "kingdoms and subkingdoms." There was a redistribution of cattle, and individual ownership was permitted; gradually the economic significance of cattle became as important as its social meaning. Agriculturalists and small pastoralists began to claim individual rights of ownership over land previously operated under usufruct. Land given could never be taken back by the patron.

The Belgian administration implemented agricultural policies to increase the production of meat, milk, skins and hides. Research on livestock was begun and new technologies allowed the supply of animal products to increase. Despite these

favorable institutional developments, there were no major changes in the population's diet. Goat and lamb/mutton consumption did not rise, as changes in popular attitudes lagged behind the wishes of the government.

Table 2.2 shows how in twenty years animal products increased in Rwanda. In general, this was a high growth period for animal products with the exception of meat. One interpretation of these findings might be that those living in urban settings, those with purchasing power,

Table 2.2 Animal Products

Product	Year	
	1938	1958
Meat (tons of beef)	7,920	8,605
Skins & Hides (tons)	443	983
Milk (processed) (liters)	400,000	1,013,836

had access to the higher quality beef produced by European land holders. The export of hides and skins more than doubled during the period, becoming the country's most important export next to coffee. The production of processed milk grew by a factor of 2.5, reflecting an increase in its demand during the period. Milk and skin production during the colonial period reached its peak in 1956 at 2,949,987 liters of milk per year and 1,253 tons of skins and hides exported.

In 1920, a veterinary laboratory specializing in bacteriological disease was established in Gisenyi. In 1923, the first experimental agricultural research station was

opened at Ntendezi in Cyangugu with the objective of selecting and breeding cattle on the basis of conformation, from the existing population of cattle (Marchi 1938).

In 1925, marino sheep, the angora goat, large black pigs, and poultry were introduced through the research center. Castration and the systematic slaughter of old female livestock were introduced to improve selectivity and productivity.

In 1936, the first livestock research center was established in Nyamiyaga in Butare with the objective of selecting superior animals for meat and milk production. However, the new breeds introduced at Ntendezi in Cyangugu were not resistant to pests infesting the wetlands during the dry season and suffered high rates of mortality.

In 1944, four dairy cooperatives were processing milk at Nyanza in Butare, Kigali, and two in Gisenyi.

In spite of these new institutions, policies and technologies, Rwandans neither ate more meat nor drank more milk, and continued to suffer from a lack of proteins and fat in their diet. Attitudes remained unchanged and seemed to prevent the population from converting these institutional interventions into improved nutrition. Indeed, in 1950, a survey conducted on 799 households reported that 29% of the respondents did not eat meat at all, 46% ate meat once a week, and 19% ate meat twice a week.

Instead, these improvements had the effect of increasing the production of meat, milk, and hides and skins either for export ~~for~~ for consumption by high-income households. Another survey conducted on 810 people in the area surrounding Nyanza in Butare showed that 11% did not consume fat at all, 49% consumed 10 grams a day, 7% had 15 to 20 grams, and 31% consumed 30 grams or more each day. In 1952, in a survey on tuberculosis, 89,277 individuals were tested for daily minimums of 80 grams of proteins, 65 grams of fat, and 398 grams of carbohydrates. The study found

that all regions suffered from a lack of fat in the diet, as 8% consumed only 10% to 19% of the required minimum, and even the 22% of the population who had the highest fat intake only consumed 40% to 49% of the minimum required (Bervoets and Lassance 1957). The situation was exacerbated by taboos that prevented children from eating any organ meats. Similarly, girls did not eat animal hearts, men neither fished nor ate eggs, and women did not eat goat meat. In a survey conducted in 1955-1957, researchers Bervoets and Lassance reported that, in Rwanda and Burundi, the diet was extremely low in fat, and that a large proportion of the population did not eat meat at all.

Sweet potatoes and beans are the staples of the diet in Rwanda's southern provinces, while bananas and beans are most important in the east. In the northern provinces, the diet consists primarily of corn, beans, and potatoes. Even though beans are high in protein, animal protein is also required for human cells. As table 2.3 shows, nearly all of Rwandan staple crops are rich in glucide and very poor in fat.

In 1933, a regulation was promulgated to protect forest sites in the western provinces of the country in response to the encroachment of the population for agricultural and livestock grazing purposes. Polemans (1951), before the implementation of the five year plan, asserted that Rwanda had to reduce its livestock population in order to free up land for crop production. At the same time, he called for an enhancement of productivity in the livestock industry, though he recognized that attitudes surrounding the production and consumption of livestock would be an obstacle. He also saw the need to plant more trees in an effort to control soil erosion, and to practice irrigation in lowland areas by digging wells. The authors of the five-year plan beginning in 1951 were unanimous in their recommendation to reduce

Table 2.3 Major Components of the Rwandan Diet

Commodity	% of proteins	% of fat	% of glucide
Cassava	1	--	20
Corn	9	5	70
Wheat	14	1.9	71.9
Dry beans	24	2	57
Peas	24	3	57
Sweet potatoes	2	--	23
Sorghum	10	5	69
Millet	10	5	69
Peanuts	27	40	20
Soybeans	27	40	20
Bananas	1	--	22

Source: Bervoerts and Lassance (1957)

livestock by 45% over the 5-year period, suggesting that even then Rwanda may have been overpopulated with livestock.

We can say in conclusion that in spite of the policy and institutional changes, and technological improvements, the livestock industry contributed relatively little to the social and economic welfare of the Rwandan population. People were still suffering during the colonial epoch from poor nutrition, notably a lack of protein and fat in their diet. Goat production did not benefit from new technologies, in fact, no research at all was done on goats. Lamb and mutton were still not eaten, as attitudes and taboos persisted from the preceding era. Even with improvements in the milk industry, in vaccine processes, and in cross-breeding, cattle were still not recognized as a viable and contributing component of farm income and/or welfare. Goats were seen strictly as a source of foreign exchange through exports, but no investment was made in

terms of research or marketing. Nor was any effort made to introduce new breeds of goats to enhance milk production, despite the lack of animal proteins and fat in the diet. The need to define a more appropriate role for livestock in Rwanda, particularly for the poorest households, was as great as ever. Perhaps it is unreasonable to suggest that cultural patterns developed over four centuries could be wholly restructured in less than four decades.

2.4 Post-Independence Period (1962 to present)

2.4.1 The role of livestock

The post-independence period has brought full land and livestock ownership to the farm population of Rwanda. Moreover, the continual interpretation of farming systems has allowed pastoralists to become agriculturalists and agriculturalists to engage in pastoralism. This change has affected livestock management practices as well as the distribution of livestock. Ownership has become less concentrated so that more households are now involved, but herds are far smaller than they once were. Today, nearly all who raise cattle are owners of only one or two animals. Dispersion of ownership, fragmentation of the land, and a lack of experience among new livestock owners has contributed to an initial decline in milk production in Rwanda.

After independence, the government invested in infrastructural improvements of various types. Public services were developed, and farmers began to improve their incomes. Continuing high rates of urbanization and growing non-farm employment have boosted the demand for both milk and meat, and have contributed to a revitalization of the industry. This has happened in spite of the production constraints highlighted above. In short, attitudes affecting livestock production and consumption

have begun to change. Livestock are no longer valued exclusively for the prestige they bestow on their owners, but for their value in the market place, and for the value of their products (meat, milk, and hides) in the market place.

2.4.2 Land use and livestock

While more and more farms gained access to livestock during this period, landholdings were diminishing in size due to population growth. Consequently, the ratio of livestock to land increased significantly. One beneficial effect of these changes was that agriculture and animal husbandry became even more integrated than they previously had been. A lack of pasture land led to permanent stabling of animals on certain farms. The distribution of livestock has gradually come to depend more on the size of farm holdings and on the availability of animal feed than on ethnicity. The conversion of pasture into cropland has become a serious constraint to the livestock industry and has increased the demand for fodder. But even permanent stabling and fodder production have not been a realistic option for the increasing numbers of very small farm operators, particularly for those with holdings of less than a half a hectare. Land in pasture has also been lost to the expansion of private and public woodlots. Recent government campaigns to control soil loss has resulted in the planting of trees on land reserved for livestock. Even a National Tree Day is now celebrated and a five-year national program to protect the soil has become one of the country's biggest public investments ever.

2.4.3 Policy and Institutional changes

Agriculture and animal husbandry became more integrated during this most recent period, as competition for land forced some farmers to consider permanent stabling of their livestock. Though this system enabled farmers to increase their production and make better use of animal manures, there was a concomitant demand for forage. To promote milk production, exotic breeds of goats, cattle, and sheep were imported by the research centers. Institutional changes included the creation of a ministry responsible for the implementation of livestock and agricultural programs and policies. It was envisioned that livestock production would ultimately play an important role in meeting the food needs of the Rwandan population, though it was recognized that animal feed would be a major constraint due to the fact that certain types of livestock, cattle in particular, would have to compete for land needed for crop production. Local research efforts determined that .30 hectares was the minimum amount necessary to maintain one head of cattle under permanent stabling conditions. However, little research was done on the cost of wood needed to build a stable, or on the labor required to build the stable, to cut grass to feed the animal, to compost the manure, or to supply the animal with water on a daily basis. The government has continued to promote the use of forage through the introduction of legumes for forage, but land scarcity is still a constraint on that policy.

Research policy emphasized the importation of exotic breeds to improve milk and meat production, but because these breeds did not adapt well to local conditions, such research efforts have had very limited success. The initial investment is high for the majority of farmers, as is the mortality rate. However, a small number of breeds of goats and sheep did show some promise, even for the small farmers. Milk supplies

increased thanks in part to milk imports, but also due to improved marketing and performance in the dairy industry. Though adaptable, the productivity of local breeds was low. Capacity production from the dairy processing plants was estimated at 22,000 liters a day, but actual production came to only 9,970 liters a day, or around 45% of capacity. Milk imports have increased by 45% over the 1980-1985 period, or approximately 11% per year.

The government has promoted the use of manure through the extension service in an effort to increase food production. Yet the growing scarcity of land brings some uncertainty to this endeavor since a decline in livestock means a decline in the availability of manure. The Ministry of Agriculture has also advanced the notion of subsidizing the use of chemical fertilizers, but has come to realize that questions of appropriate application techniques, ensuring regular supplies, and training extension agents will also have to be reckoned with. And all this assumes that there will be a pay-back to these subsidies through increased production over the long term.

Slaughter houses and the meat wholesale industry have also received governmental attention. Effective meat refrigeration and conservation is expected to have a positive impact on the supply of fresh and processed meats. The meat industry appears to have gone the same way as the milk industry, as slaughter houses are operating at only a fraction of their designed capacity. The private sector, too, has organized to promote meat production by importing new breeds of poultry for production and sale in the cities. The major constraint to this endeavor has been the cost and availability of grain. It must be recognized that any type of animal that feeds on grain will be in direct competition with the food needs of the Rwandan population.

The government has continued to promote the export of skins and hides, and from 1980 to 1987 the industry saw an annual increase of 24.6%.

2.5 The Evolution of Livestock Production Over Time

This chapter has taken an historical perspective on the evolution of livestock production in Rwanda, discussing some of the fundamental differences and changes that have taken place from one period to the next. The precolonial period was characterized by the use of livestock for barter, often in trade for land, cloth, hoes, axes and so on. Cattle also formed the basis upon which relationships among members of traditional society were defined. Cattle ownership implied the receipt of goods and services from others in society who needed the protection of wealthy patrons. Poor agricultural and livestock management during this period took its toll on the country's fragile lands and forests.

The second, or colonial period was characterized by change in the role of livestock. Though still important as a criterion for social differentiation, farmers began to think of livestock in terms of economic value and, with the encouragement of the government, began to integrate them into local farming systems. Motivation for this change emerged from a redefinition of individual rights. Most important were ownership rights over land and livestock which were placed in the hands of individual farmers, the government, or the community. The patron-client system was abolished (Maquet 1961). Consumption of milk and meat increased among wealthy households, while skins and hides were exported. New institutions were established, including livestock research centers, dairy processing enterprises, and slaughter houses. Unfortunately, little improvement was seen at the micro-level in terms of health and

nutrition, despite the increase in milk and meat production. Small ruminants were largely neglected during this period, as public investment was funneled into projects to improve cattle production. Goats and sheep were seen only as a source of hides and skins for export.

The third, or post-independence period, has witnessed even closer integration of crop and livestock production. Sustainable agriculture has been emphasized by the government and there is now widespread recognition that the future of livestock production in Rwanda will need to be "land-efficient," particularly for the growing numbers of farmers operating exceptionally small holdings. This has entailed the construction of permanent stables and the cultivation of forage crops. To increase livestock production, the government has begun to invest in dairy processing and slaughter houses. To date, both of these enterprises have operated at a fraction of their full capacity. Research on exotic breeds aimed at increasing milk and meat production has been undertaken, but results show that the new breeds are successful only when managed by more educated, larger-scale farmers.

Also characteristic of this post-independence period is the involvement of the private sector, which has invested in meat and milk production, particularly in the cities, in response to a growing urban demand. The government has overcome shortages in the supply of milk only through increasing imports. Skins and hides continued to be one of the major sources of foreign exchange earnings.

Other official efforts to improve crop and livestock production have focused the conservation and development of natural resources through the institutionalization of an annual Tree Day to increase the area in forest, and a strong national campaign to combat soil erosion.

To supplement declining manure production, the government has experimented with importing chemical fertilizers.

CHAPTER THREE RESEARCH ON GOATS AND OTHER SMALL RUMINANTS IN AFRICAN CONTEXTS

3.1 Introduction

The present chapter reviews some of the more important research findings in recent decades relative to goat production in Africa. Results from research supported by the International Livestock Center for Africa (ILCA), Winrock International Institute for Agricultural Development, and the International Development Research Center form the core of this discussion. Findings on breeds, nutrition, animal health, and the management and economics of goat productives are examined from the perspectives of smallholder agriculture.

Other topics discussed include the role of the goats in African traditional society and the state of research in the 1970s and 1980s vis-a-vis the transformation of farming systems from a subsistence orientation to more of a market orientation. The strengths and the weaknesses of these different systems are evaluated and possibilities for improvement are suggested.

Findings from the survey conducted in Kenya by Kitavo and Connell (1973) showed that goats were raised largely by low-income households while high-income farmers raised cattle. Large animals were highly valued relative to small ruminants; goats were raised primarily for consumption on special occasions or for sale when cash was needed for tea, sugar, maize meal, or clothes. Goats were exchanged for the economic necessities, while the large animals brought higher social status to their

owners. Sheep and goats were kept by some farmers as a dietary supplement, being a more convenient form of meat supply than beef. During the dry season when cattle did not get enough fodder to produce sufficient milk, goats could also be milked. Skins were either sold or worn by the women or children, traded in exchange for steers, or given away as part of a dowry or at a ceremonial event (Lenemiria 1981). In short, goats played a secondary role in the society, most of the attention going to the larger animals.

In the humid tropics where cassava and other tubers are the staple crops, goats played a role in providing the necessary protein to the diet. For this reason, there is still much potential for increasing meat production throughout the humid tropics. One option for increasing the meat supply is through investing in goat production (ILCA 1979). Goat meat is accepted by consumers, and the initial investment and financial loss through animal mortality is low. Goats can be fed crop residues and by-products which are not utilized effectively by other livestock species. Little research on the possibilities for increasing goat production was conducted before the 1970s.

The improvement of goat production in Togo (Diovin 1975) was motivated not so much by dietary concerns but by stagnating agricultural production and the fluctuation of import prices. However, in a comparative sense, public funds allocated to small ruminants was very low. The country's research agenda focused more on cattle in order to satisfy urban demand. Because small ruminants were scattered, means for improving production were further constrained. Cattle, on the other hand, tended to be concentrated in large numbers thus facilitating economies of scale in meat processing.

3.2 Research on the Adaptability of Goats

Goats adapt more easily to the environment than do large animals. They can eat a wide variety of plants, such as shrubs and tall grasses, and due to their small size, goats have higher metabolic rates than do large animals. Feed consumption per unit of body weight is generally higher among dairy goats than cattle, and this is compatible with the goat's higher yield per unit of body weight, though this can vary with the environment, genotype and physiological state of animal. The proportion of dry matter in a goat's carcass is in general higher in temperate zones than in the tropics. Galal (1986) reports that goats tend to digest fibers more efficiently than other domesticated ruminants especially when the diet is poor. Goats are more prolific than other domesticated ruminants in part because the female starts breeding at a relatively young age. Goats are also more efficient in water utilization.

McFarlane (1982) reveals that the rate of thyroxine secretion is mainly function of body size (thyroxine assists in the digestion of plant matter). It ranges between 1.2 and 2.1 mg/kg liveweight/day in large animals and it is twice that in goats and sheep. McDowell and Woodward (1982) find that goats have a relatively high metabolic rate, so the feed ration must meet both quality and quantity requirements. Goats have the ability to select out the higher quality part of herbage. The small size and high metabolic rates of goats are also reflected in this relatively large intake and high milk production per unit of body weight (Devendra 1980).

Sherman (1987) reports that the percentage of retained nitrogen ingested was 30.1, 49.8 and 58.7 in cattle, sheep, and goats, respectively. This reflects the higher efficiency of goats in extracting proteins from feed. In marginal areas, goats will thrive

better than sheep because they can consume more of the vegetation under such conditions, and not so much because they are a better converter (Harrington 1982).

Goats browse more, eat a wider variety of plants and are more selective than other ruminants. They also travel longer distances in search of food (Houston 1978) which makes goats very flexible in diet composition (Louca et al 1982). However, goats can be wasteful of pasture, as they have been found to leave up to 50% of the herbage ungrazed (Morand-Fehr 1981).

Wilson (1982) estimated kg of meat per kg of liveweight per animal/year, finding that goats yielded less (.21 kg per kg of liveweight) than did camels (.40) and cattle(.60), but more than sheep (.12). By contrast, milk production of goats per kg of liveweight was far higher (1.50) compared to camels (.06), cattle (.43), and sheep (.59). Devendra (1981), Morand-Fehr (1981), Devendra (1982), Louca et al (1982), Sharma et al (1982), Elbadawi (1986), and Brown and Johnston (1984) conclude that on low-quality high-fiber diets, sheep tend to digest more completely than goats, but their voluntary intake levels tend to be lower.

Goats have the ability to withstand hot dry climates, even temperatures in the 35°C-40°C range. Researchers attribute the heat tolerance of goats to their ability to maintain feed consumption even when their body temperature increases and metabolic rate decreases (Maltz and Shkolnik 1981). In addition, Maloiy and Taylor (1971) found that feed intake in goats was reduced by 74% to 92% when they were deprived of water for five to eight days but their pulse rate and respiration were little affected. Maltz and Shkolnik (1981) reported that the Black Bedouin goats in Sinai did not lose weight at all when deprived of water for two weeks and fed only dry matter.

3.3 Constraints to Goat Production In Africa

Goat production in Africa suffers from a lack of key inputs. Most studies agree that there is a lack of knowledge about the potential productivity of goats. Similarly, marketing and extension services are poorly developed, there is a shortage of water facilities, and, above all, a lack of improved technical know-how by the producers. Constraints on the availability of labor and capital also have consequences for the goat industry. The relationship between gross revenues, total costs, and profits are not well understood. Most smallholders have little access to such important services as capable extension agents, animal health centers, and banking and marketing facilities.

Lebbie and Mastapha (1985) report that in Swaziland, the average flock size is too limited for a commercially oriented, market approach to production. Commercial production can require substantial cash inputs in order to purchase more animals, better housing, improved pasture and other necessary infrastructure. Currently the cash income per homestead from livestock production is too low to meet these costs. Goat farmers do not seem to have any problem selling their goats, but home consumption is constrained by the perishability of the meat. However, a market-oriented approach would also require organized marketing channels, services and facilities.

In the tropics, goats have relatively high abortion rates as compared to cattle and sheep (Sand and McDowell 1978). This was confirmed by Gelah and Akalu (1982) on Ethiopian goats. In commercial production systems, the mortality of the young is higher among goats than among sheep or cattle. Wilson (1976, 1982, and 1984) reports mortality rates in Africa of higher than 20% and sometimes higher than 30%.

The uncontrolled breeding does lead to some females being bred too early, resulting in low conception rates, low birth weight, and high mortality.

3.3.1 Breeding

In West Africa, information on local breeds of sheep and goats is largely limited to descriptive accounts of size and conformation. Little information is available on production parameters. A major characteristic of these local breeds is their small size and body weight, which has been attributed to their feed supply, metabolic adaptation, and reduction of heat loss. In western Europe, the average body weight has increased 200% over two centuries primarily as a result of improved feeding and selection. High milk production leads to a larger animal with a bigger appetite. Improving feeding, selection and management lead to larger and therefore faster growing animals. These factors have been absent in Africa until recently.

More needs to be known about the genetic characteristics of existing goat populations. Early findings by Sada and Vohrdsky (1973) show that in Ghana the average birth rates of West African Dwarfs to be 1.40 kg. Experiments were conducted in Ghana in which crossed West African Dwarf and Blackhead Persian herds produced birth weights of 2.25 kgs compared to 1.13 kgs for the local breed.

Table 3.1 Comparisons between Local Breeds and Exotic Suffolk

	West African Dwarf	Blackhead Persian	Suffolk
Birth weight	1.66	2.55	5.26
Marure weight	21.00	22.00	76.00
Birth as % of mature weight	8%	8%	7%

Table 3.1 reports selected differences between the West African Dwarf, its cross with the Blackhead Persian, and the Suffolk; birth weights range by a factor of 3.2, and the mature weight by a factor of 3.6. Sada and Vohradsky 1973 reported that the local type of African Dwarf was still growing after three years, in terms of body weight and size. The considerable variation in birth weights and growth rates recorded in the humid zone, particularly for goats, may mean that there is still room for improvement in selection.

Attempts to improve the productivity of goats have concentrated on the importation of exotic breeds and crossing them with indigenous types. According to Wilson (1982), this approach has been unsatisfactory except in the highland areas of Kenya. The presence of tse-tse flies in the lowland areas has resulted in high rates of mortality. At the present, the small ruminant industry is not sufficiently structured for such an enterprise and there appears to be little possibility of exploiting hybrid vigor. The small size of adult animals seems to be attributed not to breeding, but to their adaptation to a harsh environment and poor nutrition. Wilson (1982) reports that even the local type (called "angora") was originally imported from the Middle East. Blackhead Persians, Dorpers, Boer goats, and Borams were introduced to Kenya by the migration of the Massai themselves. In general, under present conditions, there appears to be adequate genetic material in the indigenous breeds for production to be raised much higher than current levels. S.M. Das (1987) reported that, in Tanzania, exotic dairy goats were introduced with the objective of supplying milk in hilly and semi-arid areas where cattle were not well adapted. Goats crossed three ways with 55% Kamorai, 33% Boer and 15% indigenous blood yield .4 kg of milk per day over 266 days compared to .87 kg/day for Barbain goats in India (Mittaland Pandey 1972)

and 1.01 to 1.25 kg/day for Jammnapori goats in the Sudan (Sand and McDowel 1978).

For the local breeds in Rwanda, Murayi, Sayers and Wilson (1987) report that the average weight for an adult male at the research station is 35 kgs. Karangwa (1981) reports that in rural areas, the average adult weight is 25 kgs to 30 kgs, the range being 11.5 to 47 kilograms.

The first parturition on station according to Murayi, Sayers and Wilson (1987) was estimated to be 663 days in low altitudes and 954 days in high altitudes. The litter size was 1.58 and the sex ratio was 50% male and 50% female. Cross breeding was done to test the effect of exotic blood on the local breeds. The first mating weight for the Alpine-local cross in a low altitude environment was 31 kgs, compared to 19.7 kgs for the local. The weight was 24.9 kgs for anglo-nubienne local cross. Birth weight is similarly affected. Murayi, et al. (1982) obtained an average of 2.03 kgs when the local breed was crossed with alpine, 2.20 kgs when anglo-nubiennes were crossed with local breeds, and only 1.44 kgs for the local breed alone. The authors added that environmental factors such as year of birth, season of birth, genotype, feeds and so on also affected birth weights. In high altitude areas, the alpine-local cross had an average birth weight of 2.20 kgs, compared to 2.44 kgs for the anglo-nubienne-local cross and 1.44 kgs for the local breed.

The mortality rate was 17.8% for the alpine-local cross, 11.2% for the anglo-nubienne-local cross and 16% for the local breed. In high altitude test sites, the alpine-local breed exhibited a 19.7% mortality rate, while the anglo-nubienne-local and the local breed showed rates of 1.48% and 26.7%, respectively.

3.3.2 Feeding

In the traditional livestock system, goats are allowed to wander to find feed. Grass is the most common feed for goats, although the nutritional value of grass declines after a certain point in the plant growth cycle. Rice, maize, and tubers (cassava and sweet potatoes) constitute the main supplements to grass. Cassava is consumed, but contains cyanide which disappears when cassava is sun-dried. Peanut hulls are very rich in proteins and constitute another feed supplement. By-products from agro-industries are used to supply animal feeds in the dry season or as another supplement to grass. Water constitutes 70 to 80% of the total ration (Medessou Tondji 1981).

Three trials on goat productivity in western Kenya were conducted on a cross between the Small Eastern African and Toggenburg breeds. They were fed in the first trial unchopped sweet potato vines, in the second trial chopped sweet potatoes and fresh water, and in the last trial chopped sweet potato vines, fresh water, ground maize, and mineralized salt with Ca and P. The results suggested that feeds of lower nutrient concentration such maize or sorghum stover could be substituted for part of the sweet potato vines in the diets of these three groups. But there was no investigation or analysis of refusal. Dry matter intake as percentage of body weight was lowest (2.5 - 2.8%) for dry does, highest (6.1-6.5%) for lactating does and intermediate (3.9-4.8%) for young does.

Table 3.2 reports the effects of fertilizer use on selected fodder crops (ILCA 1979). Yet, given the current price of fertilizer (35 Frw/kg) and the market value of adult goats (around 2000 Frw) in Rwanda, fertilization of fodder crops is generally not profitable for traditional goat production.

Table 3.2. Fertilizer response for fodder plants.

Forage species	Fertilizer application (kg/nitrogen/ha)	Yield (tons dry matter/ha)
Andropogon gayanus	0	4
Brachiaria ruziziensis	0	5
	300	15
	600	49
Brachiaria mutica	400	27
	700	33
Panicum maximum	0	7
	120	12
	300	25
	400	33
	600	38
	700	41
Tripsacum laxum	150	20

Source: ILCA (1979)

Agro-industrial byproducts in the humid tropics are abundant and varied. They constitute an important resource for increasing animal production. Their use is economically justified in cases where the cost of supplementation is less than the value of increased animal production. A consideration in the use of supplements for livestock are other alternative uses for human consumption, particularly in the use of high quality feeds.

Poor nutrition is identified as one of the most serious factors limiting small ruminant productivity throughout Africa but especially in tropical regions. Very little has been done on small ruminant feeds, particularly from by-product uses and other available wastes or draffs. Mastapha (1985) conducted a study in Swaziland that concluded that the feeding of concentrate does not appear worthwhile at the present time, but farmers can supplement grazing with household scraps, crop residues and

Table 3.3 Extraction rates for by-products

	By-product feed	Extraction rate
Maize grains		8-10
Rice (plant or grains)	broken rice	10
	rice bran	15-17
	rice husk	100
	rice straw	12-15
Sweet potatoes	sweet potato vines (stems + leaves)	24-34

Source: ILCA (1979)

industrial by-products. Smith, et al. (1989) report the results of a comparative study on the degradability of forage, browse, crop residues and agricultural by-products when fed to goats (degradability refers to the proportion of the feed which is absorbed by the animal). They found 68% for leucaena and 65% for the green corn stover, 78% for cassava leaves, 74% for plantain peels, 81% for maize bran, 83% for cassava peels, 86% for the peels, and 95% for sweet potato peels. In a recent study Ondulamini (1988) suggested that these feeds degraded much more rapidly than did the base forage, so that the food quantity requirements of the animal may not be met. For maximum benefit, maize and cassava products may have to be fed 2 or 3 times a day starting in the afternoon with animals that have grazed all morning. Alternatively, they can be fed all day if the feed is of a type that degrades slowly. Unfortunately, research has been implemented more on-station than on-farm.

For small ruminants in Rwanda (ILCA 1983), it has been estimated that a female needs 8 kgs of forage per day and that a kid needs 4 kgs per day for the first four months. A female and her two kids need 4 tons of forage a year. A number of options have been suggested for satisfying this demand through the use of feeds (ILCA 1983). A field of .13 ha of fodder crops yields 30 tons per hectare with 10 tons/ha of fertilizer. The second option is .65 ha of pennisetum and setaria with 20 tons of fertilizer will produce 60 tons of fodder plants. The third option is to use sweet potato vines, cassava skins, banana peels, and vegetable matter harvested from contour anti-erosion hedges. It is estimated that 1000 meters of hedge, combined with scraps, can feed 2 does and their kids. The quality of the fodder may be upgraded by intercropping legumes in the hedges.

The 1984 Rwanda Agricultural Survey showed that approximately half of the country's households own more than one hectare of land, or enough to raise 2 does and their kids by feeding them with the resources available on the farm, but as it will be pointed out, only if the goats are kept in permanent stables. Krueger (1981) suggested three fodders (Leukaena, Sesbania, Calliandra) to improve the quality of feed in Rwanda, but very little research has been done on the use of local crop residues such as cassava skins, banana leaves, peels and stems, and coffee pulps. There may also be possibilities for the use of substantial byproducts. The Primus beer brewery, for example, disposes of two thousand tons of dry draff in Lake Kivu every year. This is used to feed fish, but once again research is needed to explore alternative and potentially more profitable use of this draff. Table 3.4 reports the nutrient content of the principal forage, browse, crop residues and byproducts used for animal feed in Nigeria.

3.3.3 Animal health

Animal diseases constitute a major handicap for small ruminant development, but they are so varied that generalization is very difficult. Diseases seriously limit the productivity of small ruminants, particularly in humid and semi-arid areas. The effect of disease interacts with malnutrition: a malnourished animal is less resistant to disease, and disease control is more justified when an animal is well-nourished.

Table 3.4 Nutrient Content of Nigerian Forage, Browse, Crop Residues and By-products

Types of feeds	% of Dry Matter	Acid-detergent as % of Dry Matter	Crude Protein as % of Dry Matter
Elephant grass	26.6	41.9	12.5
Plantain leaves	33.0	44.3	16.2
Leucaena	24.0	33.8	30.0
Bamboo leaves	27.3	47.9	21.1
Cassava leaves	23.8	29.8	23.0
Fichus	22.0	36.8	18.0
Green corn stover	21.1	31.5	10.0
Mature corn stover	27.2	46.2	9.0
Corn bran	34.1	8.9	22.1
Plantain peels	26.0	31.8	7.7
Yam peels	26.8	11.5	5.2
Sweet potato peels	19.9	18.1	18.8
Cassava peels	--	15.9	4.8
Rice bran	87.2	54.0	11.3

Source: ILCA (1979)

The literature describes helminths as a disease which reduces the growth rate and fertility of goats. The disease PPR (Pest des petits ruminants) is still endemic in west Africa. Ticks cause serious economic loss by skin damage resulting in poor hide quality. Theileriosis in sheep and goats is usually a benign form. Another disease, "heatwater," is a problem in Africa's southern regions. Pasteurellosis causes pneumonia, contagious caprice pleuropneumonia, and brucellosis foot and mouth disease.

T.W. Schillhorn van Veen (1984) states that health is still a major constraint to efficient livestock production in Africa. Funding for livestock health programs has been limited, and the programs which have been implemented seem to have little return due to poor organization. Although services are very limited, disease prevention programs have reduced animal mortality during the last decade. The major constraint to improved livestock health is the availability of the funds for equipment, animal drugs, training for extension agents, and institutions for monitoring animal health.

3.3.4 Management

Good management techniques can improve goat production even among smallholders. McConnell and Kitivo (1975) report from a rapid diagnostic survey in Kenya that sheep and goats were grazed closest to the family compound, usually within a short radius, and herding is considered to be a job for children. In East Africa, animal management is generally considered the responsibility of men, but women are also responsible for many aspects of goat and sheep husbandry. The Samburi in Kenya keep all of their sheep and goats in corrals to protect them against predators and thieves. Shade is provided for young animals. Women have the responsibility for

maintaining the corrals and for preventative health tasks such as trimming. Women also have the responsibility for caring for sick animals and administering traditional treatments.

In Togo it was reported that animal production is a function of the crop cycle. During the growing season, animals are fixed on fallow lands or near the house. In the dry season, they are released and allowed to roam freely in search of food. Rutagwenda, et al. (1985) found in Kenya that seasonal forage affected animal fertility. For example, they found high conception rates in animals mated during the rainy season and low rates in those mated during the dry season. They also found that weights were higher for kids born shortly after the long rainy season when forage was good. High survival rates were recorded for animals born at the start of the long rain.

Akerejola (1970), van Veen and Njoku (1979) and Aklaku (1980) recommend managerial practices such as enclosure of animals at night, separation of males and females, construction of fenced pasture, vaccination, record keeping, salt feeding, controlled breeding, provision of fodder, and care of hooves. In addition, it is important to ensure that newborn kids receive all their mother's milk to guarantee adequate intake of colostrum. Ndamukong (1984) shows the effect of poor management on the mortality rate in Cameroon. On-station results on kids showed high mortality among imported dairy goats, 51.5%, compared to 42.0% for the local goats. In the case of litters of more than one kid, the percentages are 50.0% for the local and 71.4% for the imported dairy goats. The adult mortality was 23.7% for the local goats and 33.7% for the dairy goats. Peter et al (1984) reported that low-income households from Malaysia were losing an average of 14.3% with a range from 7.4% under intensive management to 17.4% under semi-intensive management. Adult losses were 6.4%, ranging from

3.6% in intensive systems to 7.5% in semi-intensive conditions. Wilson (1982) reports pre-weaning losses up to 40% and 10% in older goats. In Rwanda, Karangwa (1981) reported results from a survey of 367 households. He found that 25.3% do not give water to the goats and 53.7% give water only on occasion (less than weekly). He also reported that goats need four to five times as much water as dry matter in temperate climates. In a survey of 670 households in southeastern Rwanda, it was found that 29.9% had appropriate shelters for the goats while 70.1% kept their goats in the main family house (Karangwa 1981).

3.3.5 Economic considerations in goat production

Small animal production has attracted little public investment in necessary infrastructure, market facilities, research, and processing. This is unfortunate in light of the potential advantages of goat production. Goat meat is tender and has little fat. Goat milk contains less protein than cow milk, but is more digestible due to its similarity to human milk. Especially for individuals who are sensitive to cow's milk, or have hypersensitivity to cow's milk proteins or have hyperacidity, there is a preference for goat's because its alkaline nature makes it more digestible. Goat's milk also contains minerals such as calcium and phosphorus in greater abundance than does milk from cows or humans. Goat's milk is highly recommended for people with asthma, for old people, and for those who are ill for extended periods. In addition, goats survive easily in areas where vegetation is scarce.

Nassara (1983) reported that small ruminant production in Benin reduces meat imports and contributes to the nutritional status of the population. Small ruminants also provide wool, leather, hides and skins.

Hides and skins can provide the raw materials for many manufactured products. Leather can be used in a wide variety of ways, as can mohair. To date, however, the hides and skins of small ruminants have been exported for processing and manufacture. Rwanda has done little to generate value added through local small industry development.

Labor requirements in goat production vary according to the management system used. Traditional goat production uses little labor, while a more intensive system in which the animals are kept in stalls, labor consists of collecting feed for the animals. Upton (1966) estimates that a family might spend an average of a half an hour per week on livestock related activities. Goat production also involves relatively low initial investment. There is no particular investment under the traditional management except for the initial purchase of the animals. Though the element of risk is not addressed in this study, an epidemic has been known to kill entire herds more or less at random. Oluwasanmi also found a positive correlation between herd size and the rate of mortality.

Malyadi (1982) studied sheep and goat production in west Java, finding that livestock provides stable employment for farmers in both the dry and the wet seasons. Farmers identified a lack of cash as their most serious constraint to increasing production, preferring to spend their scarce cash reserves on fertilizer for paddy rice rather than on livestock medication.

Knipshcheer, et al. (1986), in their analysis of the small ruminant market in Indonesia, found that animals provide an insurance against the risk of crop failure. In addition, the manure can be a valuable input in the production of high-value crops. Little is known about how the animals are marketed, trends in market value or market

prices. Because it is difficult to estimate the labor input in livestock production, new packages of inputs, such as a new drug or mineral, need to have a clear pay-off to be adopted by farmers. This study in Indonesia concluded that it is difficult to incorporate into economic analysis many of the benefits of livestock production, such as manure, animal traction, the capacity to yield cash on demand, and the insurance value, because incorporating these elements requires a thorough understanding of farm enterprises, particularly those with low use of inputs other than labor. Since most of the farmers' savings are in livestock, they are reluctant to submit their animals to any risk. It is less risky for the farmer to test a new foodcrop variety than to submit his animals to experimental cross-breeding.

The market for small ruminants in Africa is generally less organized than it is for large animal markets. In most cases, small animals pass through the hands of many traders before reaching the consumer. Traders provide services to the farmer who may not be able to go to the market because of distance or other constraints. The market is also generally unregulated. Small ruminant owners have little access to market information and are very rarely involved in export markets. Small ruminants are an attractive export product for many African countries, although potential markets in North Africa, the Middle East and Southern Europe are relatively closed. For various reasons, these countries prefer live animals, which gives an advantage to the African producer (Holtzman 1982). Production for export is risky, being subject to changes in political conditions, changes in the quality of the product, and changes in demand. Likewise, the incidence of certain diseases in a given area may lead to an embargo on the small ruminant exports, if there is fear that the disease could spread to other animals.

The market for small ruminants may follow the agricultural market in general. Kamwanja et al. (1986) conducted a survey in Malawi on small ruminant marketing. They noted seasonal variations in goat slaughtering with highest rates in December and January and lowest rates from February to the first week of April. The authors point out that there are socio-economic variables associated with this pattern. In December farmers may sell goats to obtain money because the growing seasons for most of crops have just started. Between February and March, farmers have plenty of cash from the sale of crops and do not need to sell the animals. From April through June, the number of animals sold expands to meet pre-harvest cash needs of farmers. At harvest time, beginning in June, cash needs are met by crop sales so animal sales decline. This causes the price of animals to rise. Comparing the weights of animals slaughtered, they observed that females were heavier than males, most probably because the females were kept longer for breeding, while males were sold young.

One general observation emerging from this discussion is that market information has to be provided even to know if the small enterprises are going to be profitable or competitive. Economic analysis must point out the costs and benefits of introducing new technologies. The weakness of the models, however, is that they cannot capture the dynamic nature of the process of technological adoption. With small ruminant development, there are so many changing variables such as nutrition, feed/pasture, supplementation, reproduction, production efficiency (birth rate, mortality, age of first birth), management, risk, price, market structure, credit and other policies which introduce so many dynamic concepts, and which are so difficult to measure in real life, particularly when considering small livestock relative to the larger farming system, that

structural modeling has not been an effective tool for increasing animal production in specific contexts at specific points in time.

3.4 Conclusion

Modern technical inputs, even when available, may be beyond the financial capabilities of most small holders. More important, at least in the near term, are improved small ruminant management techniques, but this will require a strong research program and expanded extension capabilities. It is not clear why simple management improvements that are widely promoted are not yet accepted. Examples are feeding, controlled breeding, adequate feeding of pregnant does, ensuring intake of colostrum by the kids, and hoof care. Ecologically sustainable production systems have to be one of the priorities for future research, and public sector efforts are needed to improve access to credit, marketing facilities, market information, and research and extension.

More research is needed to improve local breeds. Breeds developed for meat production have been satisfactory, but more work is needed on dairy goats. In terms of feeds, rations must be developed out of local materials. Agro-industrial by-products such as brewery draff could be converted to animal feed. It is especially important that public investment in animal health be increased, and that research on the economics of systematic preventive animal care be further developed. Smallholder farming systems need to be seen as an integrated whole because resources given to one activity must be taken from another. Since on-farm research is more efficient when focused on specific groups of farmers who have similar problems and potential, the identification of groups of farmers with similar problems should be seen as a necessary

first step. Research must determine whether farmers in a given region are sufficiently alike to allow a common set of field trials and common set of recommendations.

Similarly, understanding individual farmers is an essential prerequisite to understanding their constraints. Almost all farmers have the same ambition to increase income while minimizing risk in meeting their subsistence requirements. The functions of subsistence households are multi-dimensional, and the models of subsistence economics should view the household as both a producing and a consuming unit.

In addition, extension programs must be expanded to assure the effective transmission of improved management and marketing techniques. And market conditions themselves need to be modified to help reduce the many risks inherent in small ruminant investment. On the list of potential rural industrialization interventions, small ruminants offer significant opportunities.

CHAPTER FOUR HOUSEHOLD-LEVEL ANALYSIS OF THE LIVESTOCK SECTOR

4.1 Introduction and Discussion of Sources of Data

The analyses presented in this chapter focus on all four major types of livestock: cattle, pigs, sheep and goats. Key variables such as farm size, household labor, education of the head of household, and animal mortality, are introduced in order to help understand and explain variations in livestock ownership.

There are three major sources of data on the livestock sector in Rwanda that will be analyzed in this section. The first attempt to systematically report livestock sector estimates was made by the Belgian colonial administration in 1953. Livestock estimates for 1963 and 1973 are drawn from the annual reports of the Ministry of Agriculture of Rwanda. The third source is the 1984 National Agricultural Survey conducted on a nationwide, stratified random sample of farm households. Follow-on surveys from this sample frame are also used. Weighting factors for the 1984 survey are based on a count from the Rwanda national population census of 1978 and were updated by complementary field work in 1983. Technical aspects of the sample design have been described in more detail elsewhere (SESA 1984). Many of the results presented in this section are reported by "prefecture." This is the primary Rwandan administrative subdivision, of which there are ten. This method of presenting results is employed because prefectures are the geographic units towards which government policies and programs are commonly directed.

4.2 Livestock Population In Selected Sub-Saharan Countries

Before examining the Rwandan data in detail, let us examine livestock populations in Africa in general. Table 4.1 shows the relative importance of different types of animals in selected African countries. In general the larger the animal population in a given country, the greater the role such animals play in that country's economy. East African countries and Nigeria have focused particularly on cattle and goat production. They have conducted research on these animals for the purpose of expanding both meat and milk production. In Kenya, Tanzania and Zimbabwe, beef has played an important role in the export sector, with 10.5, 10.0 and 18.3 thousand tons of meat, respectively, being exported from these countries in 1986 (African Statistical Yearbooks 1986). Sheep have been promoted for wool production, and some countries have invested in exotic breeds to upgrade their local breeds. In most of these countries, goats provide meat for local consumption, and hides and skins for exports. In Tanzania and Kenya, goats also supply milk for local consumption.

4.3 Livestock Population Trends In Rwanda: 1953-1989

This analysis covers four periods of the time: the first period runs from 1953 to 1963; the second from 1963 to 1973; the third from 1973 to 1984; and the last from 1984 to 1989.

A fundamental question in the analysis of livestock trends across the four periods involves the accuracy of the historical data available. The 1984 Rwanda National Agricultural Survey utilized scientific sampling procedures and undoubtedly yields the most accurate estimates to date. The estimation method used in 1953 by the colonial administration, as well as those utilized by the Ministry of Agriculture for the estimates

Table 4.1 Livestock In Selected Sub-Saharan Countries

Country	Cattle	Pigs	Sheep	Goats
Rwanda	837	222	560	1,919
Togo	225	240	102	45
Ghana	558	810	990	1,200
Ivory Coast	65	410	874	816
Liberia	38	120	190	190
Sierra Leone	92	40	20	59
Guinea	1,530	45	86	79
Kenya	13,082	92	6,588	7,775
Zambia	2,500	200	29	355
Malawi	910	220	170	650
Zimbabwe	5,500	195	450	1,100
Uganda	4,900	227	1,600	3,085
Tanzania	13,790	176	3,991	6,304
Nigeria	857	1,300	3,476	5,621

Sources: For West African countries (Ademosum 1984); for East African countries (African Statistical Yearbook 1984).

in 1963 and 1973, are for the most part undocumented, but are believed to have been systematically compiled and to be reasonably accurate, at least in terms of their general orders of magnitude.

Assuming that the available statistics shown in Table 4.2 are reasonably accurate, there appears to have been a relatively small drop in the cattle population from 1953 to 1963, and this was attributed to political events (revolution and independence) between 1959 and 1961. Up to 1973 the cattle population increased

significantly by 35%. During the period 1973 to the present, cattle increased in numbers albeit at a slower rate to 1984, and has since declined rather significantly.

Table 4.2 Rwanda's Animal Population and Animal/Human Population Ratios

Year	Cattle	Sheep	Goats	Pigs
1953				
Animals	619,000	258,000	836,000	N/A
Animal/Human Ratio	.29	.12	.40	
1963				
Animals	555,000	215,000	664,000	N/A
Animal/Human Ratio	.19	.07	.22	
1973				
Animals	740,000	243,000	628,000	N/A
Animal/Human Ratio	.18	.06	.15	
1984				
Animals	837,000	560,000	1,919,000	N/A
Animal/Human Ratio	.14	.09	.31	
1989				
Animals	728,000	711,000	1,895,000	222,714
Animal/Human Ratio	.10	.10	.26	.03

Human Population 1953: 2,101,900 (Ministry of Colonies, Brussels 1986)

1963: 2,971,000 (Estimated by the U.N.)

1973: 4,053,000 (World Population Census)

1984: 6,130,000 (World Population Census)

1989: 7,400,000 (World Population Data Sheet, PRB)

Also shown in Table 4.2, the sheep population decreased from 1953 to 1963 by 1.8% per year, and then increased from 1963 to 1973 by 1.2% per year. If these numbers are accurate, since 1973 the sheep population has increased by almost threefold.

The goat population also declined from 1953 to 1963 (by 3.7% per year). As is the case for sheep, there is no apparent explanation for this decrease except inaccurate (low estimates) statistics in the earlier years. In the next decade, the decline was slight at only 0.6% per year. Again, assuming the estimates are accurate, from 1973 to 1989 there was an important increase in the goat population by a factor of about three.

Overall the indicated increase since 1973 in the population of both sheep and goats is probably not realistic. A likely explanation is the underestimation of the sheep and goat populations before the surveys conducted in 1984 and 1989. Since cattle are comparatively easy to enumerate, and have always had a more concentrated economic focus, the likelihood that they were under-enumerated prior to 1984 and 1989 is relatively low, at least compared to sheep and goats.

Longitudinal statistics on the pig population are not available, although the data available for 1989 indicate the relatively minor role they play overall in Rwanda's livestock industry.

The general trend in animal-to-human ratios shows that while the cattle population has remained more or less stable over the years, but with a slight increase overall, the rapid growth of the farm population means that on a per capita basis cattle are only one-third as numerous as they once were. The same is true for goat production though to a lesser degree as the per capita production has declined from .40 in 1953 to .26 in 1989. The sheep population seems to have kept pace with human population growth on the whole, as the ratio has differed little from earlier estimates. Insufficient data on pig production at earlier periods in time prohibit comparable analysis for the pig population. In summary, two important trends emerge

from this data. The first is that human population growth has made it more difficult for farmers to own livestock, and second, overall the industry is shifting from large to small ruminants. These trends are examined more closely in sections that follow.

4.4 Livestock Distribution by Prefecture

As shown in Table 4.3, farmers in Rwanda own an average of .75 head of cattle, .50 pigs, .20 sheep and 1.73 goats (note: these averages are for all households, not just for those who own livestock). This table also shows a heavy regional concentration of cattle in Kigali, Gikongoro and Gitarama, where the household average is 1.17, 1.08 and 1.07, respectively. This concentration may be explained by the fact that the king's court was historically located in the region, the country's first livestock research center was established there, and a small dairy industry was set up in the nearby community of Nyanza, Butare.

Beginning in the 1950s, to relieve mounting population pressure the government organized resettlement schemes (paysannats) in some of the less populated southern and eastern provinces, notably in Butare, Gitarama and Kigali. As two hectares of land were allocated to each paysannat household, pasture was not a major constraint under this system. The number of cattle per household is the lowest in Cyangugu, Kibuye and Kibungo. Even though the average farm size in Kibungo is one of the highest, later analysis will show that exceptionally high cattle mortality rates there are likely to be the reason why households do not own more cattle. In the other two prefectures, we hypothesize that small landholdings account for the low level of cattle production.

The pig population is particularly large in Rwanda's southern provinces. Gikongoro has the highest per household average of all at .69, followed by Butare with

Table 4.3 Livestock Distribution by Prefecture

Prefecture	Cattle			Pigs			Sheep			Goats		
	Total Number	Mean # Owned (all HHs)	% HHs Owning	Total Number	Mean # Owned (all HHs)	% HHs Owning	Total Number	Mean # Owned (all HHs)	% HHs Owning	Total Number	Mean # Owned (all HHs)	% HHs Owning
Butare	130,811	.96	31.4	77,892	.57	35.6	51,089	.38	14.3	201,583	1.48	57.2
Byumba	71,954	.59	17.0	8,703	.07	1.7	105,845	.86	28.3	226,946	1.60	52.4
Cyangugu	15,965	.20	10.4	13,679	.17	10.5	15,296	.19	10.2	131,750	1.85	57.4
Gikongoro	88,140	1.07	40.5	56,611	.69	44.3	42,185	.51	19.4	126,327	1.53	52.4
Gisengi	121,978	1.05	23.5	10,997	.09	5.9	60,432	.52	22.7	203,582	1.80	59.4
Gitarama	142,408	1.08	39.3	15,098	.11	8.6	44,981	.34	12.0	188,483	2.43	52.9
Kibungo	36,466	.40	10.7	13,604	.15	12.6	4,961	.05	3.7	257,542	2.82	71.5
Kibuye	32,085	.35	12.6	2,531	.03	2.0	26,940	.29	12.0	185,523	2.02	63.8
Kigali	157,777	1.17	30.7	7,168	.05	3.1	64,368	.29	18.5	255,391	1.89	57.6
Ruhengeri	39,518	.31	12.8	16,432	.13	7.1	143,717	1.15	53.6	136,239	1.09	49.4
Rwanda	837,102	.75	23.7	222,714	.50	12.6	559,814	.20	20.6	1,919,366	1.73	56.2

.57 pigs per household. This region is historically unique from others in that pigs were introduced there for the first time anywhere in Rwanda by the Fathers of Save, located in a parish in Butare. Over the years, farmers have acquired management experience, and a market has developed in the vicinity of the church school, which maintains a steady demand for pork. Results from the national agricultural survey (ENA 1984) show, perhaps not coincidentally, that Gikongoro and Butare are the country's top producers of sweet potatoes, an excellent fodder crop for pigs.

The sheep population is more concentrated in the northern provinces. Ruhengeri has the highest number of sheep per household at 1.15 head while the national average is .20. The second prefecture is Byumba with an average of .86 head followed by Gisenyi with .52 head of sheep per household. These three prefectures have in common their high altitude and shared borders with Zaire where a market for sheep appears to exist, yet additional research is needed to confirm this observation.

Goat production is more evenly distributed among the different prefectures. The largest share of goats is found in Kibungo where households raise an average of 2.82 head. As observed above, this prefecture has the lowest number of cattle per household, probably because of its high rate of mortality. The large goat population may be at least partially explained by the absence of cattle, but also by the availability of large pastures where acacia, an appropriate feed for goats grows naturally. Research shows that savannah, which plays the same role as acacia, can still be found in parts of Kibungo. Goats also proliferate in Kibuye, where households raise an average of 2.02 head. This may be explained by extensive informal trade between that prefecture and neighboring Zaire.

It is hypothesized that the strength of goat production in almost all the prefectures of Rwanda may be explained by the low initial investment required, a high turn-over, the high level of adaptability of goats, and their relatively low rate of mortality. It is also important to stress that the demand for goat meat is now increasing as a function of rapid population growth in urban areas.

4.5 Livestock Combinations

Livestock are raised in various combinations. Some households raise several types at once while others raise only one or none. In 9 of 10 prefectures, goats alone are the most prevalent form of livestock ownership. This pattern is broken only in the mountainous region of Ruhengeri where sheep exceed goats in importance. Clearly, the majority of the farmers in Rwanda lean toward goat production, as suggested earlier in Table 4.3. Possible explanations for this general tendency are: the low initial investment required compared to cattle production, the high productivity rate of 1.4 kids per year and per doe, no special fodder plants required for feed, rapid market development in the urban sector, and low competition for crop land. Goat meat is gaining acceptance in the diet of Rwandans, replacing beef in terms of cost and perhaps even taste preferences.

Overall, among the more than 1.1 million households in Rwanda, 73.1% own livestock, 56.2% own goats. Of the households owning goats, about 55% own goats alone, while the remaining 45% own goats in conjunction with other livestock (Table 4.4). Among households that do own goats, the average number of animals per household is 3.1 head. Across prefectures, Gikongoro has the largest percentage of

households owning livestock at 80.2%, followed by Kibungo at 79.4%, Butare at 78.2%, and Ruhengeri at 77.2%.

Table 4.4 Goat and Other Livestock Ownership by Prefecture

Prefecture	Total Number of Households	% HH's With Any Livestock	% HH's With Goats	% HH's With Goats Alone	% HH's With Goats and Other Livestock	Average Number of Goats: (HHs Owning)
Butare	136,218	78.2	57.2	27.1	30.1	2.6
Byumba	122,473	66.2	52.4	26.8	25.6	3.5
Cyangugu	79,109	67.0	57.6	41.9	15.7	2.9
Gikongoro	82,307	80.2	52.7	17.0	35.7	2.9
Gisengi	116,628	71.5	59.4	32.5	26.9	3.0
Gitarama	132,027	71.7	52.9	25.8	27.1	2.7
Kibungo	91,201	79.4	71.6	55.7	15.9	3.9
Kibuye	91,745	69.6	63.8	48.0	15.8	3.1
Kigali	135,333	71.1	57.6	30.7	26.9	3.3
Ruhengeri	127,866	77.1	42.4	12.9	29.5	2.6
RWANDA	1,111,897	73.1	56.2	30.7	25.5	3.1

Many of the conditions necessary for livestock production are found in Kibungo which may help explain why animal husbandry is practiced by so many households there. Average farm size is the highest in the country in Kibungo, abundant shrubs and savannah vegetation provide food, and good communication with the capital city undoubtedly contributes to the development of the local livestock market. Gikongoro, Butare, and Ruhengeri are prefectures that are uniquely suited in their own ways to the production of livestock. Gikongoro is known to have poor soils, hyperacidity, and very low crop yields. Famines appear to have been harsh and regular there over the last decade. To cope with this food insecurity farmers may be investing in livestock in

order to reduce the risk associated with crop failure. In addition, Gikongoro and Butare are exceptionally strong producers of pigs due to their early introduction there by missionaries. One last reason why livestock production is so pervasive in these southern prefectures is because, historically, the king's court was located in the region. In Ruhengeri, a large proportion of households raise sheep. It is hypothesized that this concentration of sheep in the northwest is a response to the strong market across the border in Zaire.

These figures suggest that livestock do not necessarily compete with crop production. Indeed, the most densely populated prefectures of all, Ruhengeri and Butare, have among the ^{highest} lowest percentage of households with livestock. These are also areas settled long ago, and that maintain strong traditions and cultural attachments in the realm of animal husbandry. An alternative explanation is that a certain complementarity exists between livestock and crop production. The need to intensify crop production on small farms is obvious; increasing manure application is one way to achieve this goal. Small ruminants, which have less demanding grazing needs, may be especially well-suited for those who cannot afford to increase pasture if it means keeping land out of crop production.

The issue of animal population density was raised in 1951 when, in the preparation of the five year plan, a recommendation was made to reduce livestock production. It now appears that such a blanket recommendation did not fully consider the possibilities for integrating crop and livestock (particularly small ruminant) production.

4.6 Livestock and Farm Size

As the major constraint to livestock development is the availability of land, in the case where technology is limited, this factor is likely to be associated with livestock ownership. More households without livestock seem to fall in the small farm category, while large farms tend to raise cattle and have more livestock of varying types on the farm. This is true despite the finding reported earlier that at the regional level areas of high population density are the areas where livestock ownership is the most pervasive.

The national figures on farm size show operational holdings to be an average of 1.2 ha per household (ENA-1984). An estimated 26.6% of households are in the farm size class of less than a half a hectare, while 16.6% operate more than 2.0 hectares.

Looking at the relationship between type of livestock and farm size, we find that households without livestock tend to be those with the smallest holdings (Table 4.5). Among the smallest farms, 47.1% own no livestock at all while only 11.7% of the large farms, those with operational holdings in excess of 2.0 hectares, raise no livestock. This finding is consistent with the hypothesis that declining land availability is a constraint to livestock production. The second important figure in this table is the percentage of households in the smallest farm size category that own goats (25.4%). This indicates once again the importance of goats in Rwanda, particularly for the smallholder. Any policy with implications for goat development will have an effect on a quarter to a third of households operating small farms. The same generalization holds true for other small ruminants as well. Pigs and sheep, when raised alone, are more likely to be found on small and medium sized farms than on larger farms.

Large farms, on the other hand, tend to raise cattle alone or to raise various combinations of livestock. This reflects the relative advantage of larger farmers in

Table 4.5 Livestock Ownership by Farm Size

% of households	Farm Size In Hectare				
	0-.50 ha	.51-1.00	1.01- 1.50	1.51-2.00	2.00+
% of households in the category	26.2	30.3	15.5	11.4	16.6
% of households without livestock	47.1	27.3	19.2	11.2	11.7
% of households with only cattle	3.9	5.1	4.2	3.4	5.6
% of households with only goat	25.4	34.0	33.7	36.7	26.0
% of households with only pig	3.6	3.0	4.1	1.3	2.0
% of households with only sheep	6.2	6.7	3.4	4.3	1.8
% of households with two types	11.3	17.6	25.6	32.0	33.6
% of households with three types	2.4	5.3	13.1	9.1	17.0
Total	100%	100%	100%	100%	100%

terms of the principal factors of production (land, labor and capital) and their ability to apply these factors in the livestock market. Despite their lack of access to these factors of production, small farmers do engage in livestock production, albeit on a smaller scale.

4.7 Livestock and Pasture

The availability of pasture can be important for livestock production, particularly for cattle. Where pasture is not available, the need for fodder crops grows in importance. In Rwanda, pasture is scarce due to the pressure of population growth. Only in certain areas where ranches or communal land exist is pasture, in the traditional sense, maintained. Pasture represents only 9.3% of the total land operated by farm households in Rwanda or approximately .11 hectares per household (Table 4.6). Across prefectures, there is significant variation. Butare, the highest, has 16.0 % of its total land area in pasture whereas pasture represents only 1.7% of operational holdings in Gisenyi. It is rather surprising to find that Butare, the most densely populated area in the country, has the second highest proportion of its land resources in pasture. It should be noted that communal lands and those of commercial ranches (very small in number) are not figured into these estimates as the present study focuses exclusively on holdings operated by households.

Prefectures with large numbers of farms established under government settlement schemes known as "paysannats" have the highest percentage of land in pasture. These are Butare, Kigali, Gikongoro and Kibungo. These prefectures, with the exception of Kibungo, also have in common the highest concentration of the cattle at the household level. Farmers in Gisenyi own 17% of all cattle but place only 1.7% of their land in pasture. This may be explained at least in part by the fact that pastures located in the natural forest in Gishwati, Gisenyi, were not measured in the 1984 survey.

Table 4.6 Distribution of Land (ha) in Pasture in Different Prefectures

Prefectures	Mean holdings in pasture (ha)	% of holdings in pasture
Butare	.18	16.0
Byumba	.08	6.0
Cyangugu	.02	1.8
Gikongoro	.21	16.0
Gisenyi	.01	1.7
Gitarama	.16	11.2
Kibungo	.12	7.8
Kibuye	.07	5.7
Kigali	.25	15.4
Ruhengeri	.04	4.0
Total (ha)	.11	9.3

4.8 Area in Pasture by Farm Size

Given that larger farms own more livestock, it was expected that these farms would also have greater holdings in pasture. Table 4.7 confirms this hypothesis, showing that while the largest farms have an average of .11 ha of land in pasture, those in the smallest farm size category hold only .02 ha in pasture. There is clearly some competition between the use of land for crops and for pasture on the smaller farms. On the very largest farms there is relatively little competition since crop production is constrained only by the limited family labor supply. Land not cropped is generally devoted to livestock production and to woodlots.

Table 4.7 Average Size and Percentage of Households with Land In Pasture

Categories of Farm Size (ha)	Mean Holdings in Pasture (ha)	% of Holdings in Pasture
0 - .50	.02	6
.51 - 1.00	.16	22
1.01 - 1.50	.31	25
1.51 - 2.0	.46	26
>2.0	1.38	43
Total	.11	9

4.9 Animal Population Density

To develop sensible policies regarding livestock production, we must know how many head of livestock farmers raise in relationship to their holdings and management systems. This section deals with the question of animal population density and the future of the livestock industry given declining land resources and competing land use demands. The ratio accepted by most researchers as the minimum amount of land required under an extensive system is one hectare for one head of cattle, and .3 to .4 ha for one head of cattle in an intensive scheme (Deschuytener 1974). Based on these generalized assumptions, Rwandan farmers appear to be producing livestock beyond their means.

Because cattle, goats, sheep and pigs are different types of livestock with varying sizes and weights, a standard unit of measure is needed in order to examine the overall animal-land relationship. This unit is the Tropical Livestock Unit (TLU). The TLU standard is 250 kg, or the equivalent of one head of cattle. For present purposes, one TLU is also considered to be the equivalent of six goats, six sheep, or four pigs.

ISAR likewise estimates that one hectare of pasture may be enough to support one cow and its calf. Krueger (1981) estimated that under Rwandan conditions one head of cattle should be considered equivalent to six goats or six sheep. Others argue that cattle in Rwanda do not need an entire hectare each, but when the quality of local pastures is taken into account, it can be argued that even one hectare is not enough.

Two concepts in livestock management must be defined. An intensive scheme is when animals are kept in permanent stables most of the time. Under this system, raising livestock is done specifically for the purposes of milk or meat production. Animals often receive supplements and concentrates in order to enhance productivity. The concept of an extensive livestock system implies that animals are grazed outside and watered in or out of the stable. Animals are milked either a small amount or not at all. Generally speaking, neither pasture nor forage is viewed as a constraint.

Assuming the average farmer in Rwanda is willing to devote one third of his holdings (.40 ha) to livestock (either pasture or fodder crops), then, under an intensive system, researchers tell us that he should be capable of supporting approximately 1.0 TLU. Under an extensive system, however, which is the predominant practice in Rwanda, only .40 TLU can be supported on this same amount of land. Farmers in Rwanda currently raise an average of 1.20 TLU, or roughly 3 times the amount of livestock recommended for adequate animal nutrition and ecological sustainability.

This situation will ultimately have negative consequences for the ecological system. Deforestation and soil erosion are known to be connected to uncontrolled expansion of agricultural and livestock systems. Animals will be affected by a lack of adequate feeds, which in turn can affect the quality of animal products. Crop production can likewise suffer from weak manure production. Animals can be

transformed from a resource that generates income and helps improve nutrition to a destroyer of natural resources. Skilled resource management is needed to ensure that livestock remain a resource for, and not a threat to, future development in Rwanda. Planning in the livestock sector is vital. Comprehensive analysis of farmer comparative advantage will show where and what types of animals are most appropriate for small and large holders. A combination of animals will not only be a way of limiting risks associated with a shortage in food production, but also a resource to be developed and nurtured through appropriate policies, technologies, and improvements in extension and research.

Comparison across prefectures (Table 4.8) reveals a very large concentration of animals in Gisenyi, though, as mentioned previously, this may be due in part to the fact that pasture land available in the natural forest was not measured in this survey.

The overarching conclusion is that Rwanda's farmers are supporting a very large animal population relative to their available resources. The dilemma they face is to maintain this animal population over the long term without negatively affecting their resource endowment. A growing demand for meat and milk along with the farmer's desire to maximize returns to his investment, and the government's insatiable demand for foreign exchange earnings through the export of hides, will place a heavy burden on the shoulders of agricultural planners and decision-makers to ensure the adoption of a sensible and effective long-term strategy. At the very least a comprehensive farming systems approach that minimizes farmer risk and simultaneously integrates crop and livestock production in an environmentally sustainable fashion must be given priority consideration.

Table 4.8 Animal Population Density by Prefecture

Prefecture	Area in Farms (ha)	Total LTU	LTU per ha
Butare	154,007	192,395	5.7
Byumba	166,241	129,593	3.6
Cyangugu	74,235	43,891	2.7
Gikongoro	106,694	130,376	5.6
Gisenyi	91,281	169,729	8.5
Gitarama	174,747	185,091	4.8
Kibungo	136,705	83,616	2.8
Kibuye	106,375	68,127	2.9
Kigali	219,008	212,865	4.4
Ruhengeri	120,599	90,283	3.4
Total	1,349,900	1,305,976	4.4

4.10 Rates of Animal Mortality

Findings from the 1984 survey show substantial differences in mortality by type of animal and by prefecture. Examination of these differences can be instructive not only from a causative, or epidemiological standpoint, but also as the basis for decision making and long term veterinary planning and investment.

In general the annual percentage of animals lost due to mortality is quite high in Rwanda: 31.5% for sheep, 27.9% for pigs, 18.2% for goats and 14.8% for cattle (see Table 4.9).

A regional breakdown shows the highest mortality for cattle to be in the eastern part of the country. This has been confirmed by Pelleton International (1987), the reason being a high incidence of east coast fever in that area.

Table 4.9 Rate of Animal Mortality by Agro-ecological Zone In 1983

Zone	% of Cattle	% of Pigs	% of Sheep	% of Goats
North-west	12.5	20.3	21.7	21.4
South-west	10.4	15.6	16.6	15.1
Central-north	14.8	35.0	37.4	24.5
Central-south	10.2	35.7	19.0	12.3
East	22.1	22.9	56.4	17.5
Rwanda	14.9	27.9	31.5	18.2
(Estimated Deaths from 12 month period)	(123,780)	(62,088)	(176,228)	(349,739)

There are two regions in which the mortality of pigs is equally high: the Central-south (35.7%) and the Central-north (35.0%). Pellemon International estimated the total mortality for pigs raised by traditional methods to be 50%.

Two regions show high rates of mortality for sheep; these are the East region which lost 56.4% of its sheep in 1984, and the second was the Central-North region which lost 37.4%. Pellemon International reported a 32% loss on-station. Why sheep mortality is so high in the East is not entirely clear, but certainly such a finding warrants special attention and, quite likely, some form of intervention.

The overall annual rate of mortality for goats is 18.2%, which is confirmed by similar findings reported by Pellemon International. The Central-north and the North-west regions of the country suffer from the highest rates of mortality of all, at 24.5% and 21.4%, respectively. Comparing the four types of animals, regional variations in mortality rates appear to be the lowest for goats and cattle. Goats and cattle also have the lowest overall rates of mortality.

The Central-north region seems to be especially weak in terms of animal health. Across the four types of animals, the Central-north suffers from high mortality in every case. At the prefectural level the major problem is found in Ruhengeri and Byumba for small ruminants and in Kibungo for cattle. One suspects that the high population density in the northern provinces and reports of water contamination (MINAGRI 1979) may be a contributing factor in the exceptionally high mortality in that region.

According to annual reports of the Ministry of Agriculture from 1972 to 1975, Kibungo lost 10,411 head of cattle, representing 28.5% of the total cattle in that prefecture. Another report (Pellemon International 1987) presents figures showing that Gisaka, in Kibungo, had the highest incidence of east coast fever. Our analysis shows precisely the same pattern. Given that Kibungo has the second largest farm size per household, the largest holdings in pasture, and a relatively low livestock population density, it is likely that once the spread of east coast fever is controlled, mortality rates for cattle in Kibungo will decline significantly.

4.11 Livestock and Labor

The distribution of economically active household members (those between the ages of 15 and 65), across farm size categories shows a high concentration of active members on larger farms, particularly those of 2.0 ha or more (Table 4.10). Similarly, this table shows that a large percentage of households with two or fewer active members fall in the smallest farm size category of 0-.5 ha. The acquisition of farm land in Rwanda is closely linked to the family life cycle (Clay et al. 1989). This means that the young families begin with small holdings and accumulate

holdings over time as their families expand and their parents further subdivide the family holdings.

Table 4.10 Number of Active Members in the Household by Farm Size (ha)

Farm-size (ha)	Number of active members in household					Total
	0	1	2	3-4	5+	
0 - .50	47.8	32.5	33.9	13.6	3.7	26.4
.51 - 1.00	33.7	36.1	30.6	28.0	26.4	30.4
1.1 - 1.50	7.1	13.3	14.6	19.1	17.8	15.6
1.51 - 2.00	5.2	7.0	10.2	14.0	17.0	11.1
> 2.00	6.3	11.2	10.7	25.3	35.1	16.4
Total	100%	100%	100%	100%	100%	100%
Numbers of Households	(37,394)	(139,780)	(553,425)	(293,426)	(87,872)	(1,111,897)

An examination of household labor availability by type of livestock ownership reveals two general patterns. The first is that an increase in household labor is associated with increased cattle ownership (Table 4.11). This may be case of concomitant variation with farm size, as shown in previous tables, but also it is likely that the increased income generated by large families facilitates investment in livestock, notably cattle, and that the labor demands of cattle-raising can be easily met by large families. The second is that although no strong relationship exists between household labor and the ownership of pigs, other small ruminants (goats and sheep) tend to be disproportionately concentrated on farms where labor availability is low. For example, goats are found on over half of the farms with only two or fewer active

members, while only 37.6% of households with five or more members are raising goats. These findings suggest that sheep and goats are less demanding in terms of labor than are cattle.

Table 4.11 Number of Active Members in the Household by Type of Livestock Ownership

% of Households	Number of active household members					Total
	0	1	2	3 - 4	5+	
% with cattle	13.3	16.4	15.6	25.3	32.4	23.7
% with pig	9.5	5.3	12.2	10.4	14.1	12.6
% with sheep	24.1	22	17.9	17.9	15.9	20.6
% with goat pig	34.2	47.4	53.2	65.0	68.8	56.2
Number of Households	(37,394)	(139,780)	(553,425)	(293,426)	(87,872)	(1,111,897)

4.12 Age of Head of Household and Livestock Ownership

An extension of the life cycle hypothesis alluded to earlier is that livestock ownership is likely to be related to the age of the head of household. Along with age comes the accumulation of capital through inheritance, management of household labor and landholdings, and capital investments. These accumulating factors of production place farmers in favorable positions vis-a-vis the purchase, pasturing and maintenance of livestock, but especially of cattle. By contrast, we would expect to find that younger farmers, being owners of smaller farms and not yet in control of large amounts of capital or family labor, raise fewer livestock overall but especially fewer cattle.

Looking at the relationship between age of the head of household and livestock ownership in Table 4.12, it is found that young families do indeed raise fewer cattle.

Table 4.12 Age of Head of Household by Type of Livestock Ownership

Types of Animals	Age of Head of Household				Total
	15 to 30 years	31 to 45 years	46 to 65 years	66 and more	
% of households with cattle	8.9	23.2	34.8	26.7	23.7
% of households with pigs	9.7	14.0	13.7	11.7	12.6
% of households with sheep	14.2	18.2	27.8	21.4	20.6
% of households with goats	48.0	45.7	64.0	52.7	56.2
Number of households	(273,826)	(369,929)	(354,215)	(113,927)	(1,111,897)

Among heads of households aged 46 years or more, approximately 30% own cattle, compared to only 8.9% of household heads aged 30 years or less. Our hypothesis that the accumulation of capital, land, and labor necessary for long-term investments such as cattle raising is given strong support by these data. Contrary to our expectations, however, is the finding that small ruminants are not disproportionately owned by younger household heads. There appears to be no relationship between age of head and ownership of goats and pigs, and in the case of sheep, older heads of households are more likely to be owners than are the younger heads. In short, though many young household heads lean toward small ruminants when they invest in

livestock because there is less required in terms of start-up costs and maintenance, their older counterparts are equally invested in these small ruminants, and even more so in the case of sheep. It is likely that the reason that older heads are more apt to be involved in sheep production is because of their ownership of cattle. As discussed earlier, the tradition in Rwanda is that cattle and sheep are raised together.

4.13 Multivariate Analysis of Factors Associated with Livestock Population

Previous sections have examined the connections between livestock production and various correlates such as landholdings, land in pasture, household labor, age of head and agro-ecological region. This section analyzes the multiple and independent effects of these variables through a set of multivariate regression models. Each of the four major types of livestock plus an overall measure of livestock production in Tropical Livestock Units (TLU) are regressed across a set of key independent variables. Variations in agro-ecological region are reflected in measures of altitude and rainfall. Table 4.13 reports the zero-order correlations and betas for each of the five models.

Looking first at cattle population, Table 4.12 shows a positive and significant correlation (beta = .07) between the number of cattle owned and regional population density, likely a reflection of the historical importance of cattle in the southern provinces. Because cattle need relatively large amounts of pasture, the influence of farm size on cattle ownership is moderately strong and positive (beta = .24). Equally important is the number of economically active household members (beta = .23) confirming our earlier observation that the labor requirement for cattle is considerable. The zero-order correlation between age of head of household and cattle population ($r = .18$) drops off to .13 when other variables in the model are introduced. This indicates

Table 4.13 Regression Models for Cattle, Pigs, Sheep, Goats and Total Tropical Livestock Units (TLU) Ownership

Independent Variable	Cattle			Pigs			Sheep			Goats			TLU		
	r	beta	r	beta	r	beta	r	beta	r	beta	r	beta	r	beta	
Altitude	-.03	.01	-.01	.10*	.23*	.28*	-.07*	-.01	.00	-.04	.00	-.04	.00	-.04	
Rainfall	-.06*	-.06*	.08*	.12*	.08*	-.08*	-.08*	-.01	.03	.05	.03	.05	.03	.05	
Population Density	.01	.07*	.06*	.06*	.10*	.03	-.11*	-.07*	.03	.04	.03	.04	.03	.04	
Farm Size	.31*	.34*	.05	.03	.20*	.19*	.27*	.22*	.14*	.12*	.14*	.12*	.14*	.12*	
Household Labor	.32	.23*	.12*	.11*	.11*	.06*	.18*	.12*	.16*	.13*	.16*	.13*	.16*	.13*	
Age of Head	.18	.13*	.02	.00	.10*	.08*	.08*	.04	.04	.00	.04	.00	.04	.00	
Education of Head	.02	.03	.03	.02	-.03	-.01	.00	-.01	-.01	-.04	-.01	-.04	-.01	-.04	
R ²				.17				.11				.09			

*Significant at $p < .05$

that part of the influence of age is indirect, through farm size and family size. In other words, age is important because the accumulation and inheritance of wealth grows over time, but also, indirectly, by virtue of the fact that older farmers operate larger farms and have a larger family labor pool. Rainfall has a negative and significant relationship probably because in the south-east of the country, in parts of Butare prefecture and in the southern portion of Gikongoro, rainfall is relatively low, yet due to the large holdings found in the paysannats established in these regions, the cattle population is fairly large.

The regional concentration of pigs in Butare and Gikongoro that developed for historical reasons accounts for the finding that altitude is negatively correlated ($\beta = -.10$) with pig ownership while rainfall shows a positive correlation ($\beta = .12$). Because pigs are commonly raised in stables and fed fodder crops, they are the one type of livestock that is not correlated with farm size. Indeed, they have a positive correlation with population density. Though less demanding in terms of land, the results show that pig production does draw on household labor.

The concentration of sheep in the northern provinces, particularly along the border with Zaire where the market is strong accounts for the correlation with altitude ($\beta = .28$). As sheep are traditionally raised along side cattle in Rwanda, it is not surprising to find that the two types of livestock are influenced by the same set of factors. In particular, farm size, household labor and age of head of household are the primary associated factors.

Because goat production in Rwanda is so dispersed, and is practiced by farms of all types, there is little correlation found between goat ownership and either altitude ($\beta = -.01$) or rainfall ($\beta = -.01$). The reason why the zero-order correlations with

these two variables are significant is simply because the high altitude and rainfall areas tend to have very small farms and, consequently, fewer goats. In other words, these zero-order relationships are "interpreted" by the intervening effects of farm size. Again, the presence of household labor enables farmers to increase their production of goats (beta = .12).

When the model is run against an overall measure of livestock production, i.e., the Tropical Livestock Unit (TLU), only household labor and farm size show any net effect on production.

While populations of cattle, pigs and sheep were all individually influenced by regional differences in rainfall and altitude, overall, these differences balance out. In other words while there is considerable regional specialization in the industry, it appears that no particular altitude or rainfall region has a real advantage over any other. As a policy matter, expansion of the livestock industry overall will benefit all regions of the country, yet if only certain types of livestock are promoted, certain regions will stand to gain more than other regions, with the exception, of course, of goats, which are found everywhere. Though there appears to be some regional equity to the livestock industry, it appears that both land and labor are the necessary conditions for successful animal production almost across the board. Only pig production does not seem to favor the large holders.

4.15 Conclusion

As described in Chapter Two, prior to independence, livestock were a sign of wealth and prestige. But with growing population pressure, resources have become increasingly scarce over time. For many, particularly small holders, livestock

production provides some security against the advent of a poor harvest or a family crisis. The value of livestock is now determined in the marketplace, rather than by the social status it conveys to its owner. Though commercial interests now motivate livestock production, few farmers have adopted intensive livestock management systems. Fodder crops are not grown, and most farmers still permit their animals to graze wherever grass and other vegetation can be found. It is difficult to say that milk production is anything more than just a minor consideration for those who raise livestock, as the average production rate for cows is no more than one or two liters a day.

Though this study has focused mainly on goat production, we found it imperative that the larger farming system, including other types of livestock, be given full consideration. To reiterate from the multitude of findings reported in this chapter, we can make the following summary remarks:

- a. There are almost 2 million goats in Rwanda, more than any other type of livestock, and they are raised on over half of the country's farms.
 - b. For the smallholder, goats are the most important animal among the four types of animals commonly raised in Rwanda. Over 30% of farm households raise only goats.
 - c. Goats are the animal found most often in combination with other types of livestock.
 - d. Goats require less labor than other animals. Over 50% of households with no active members raise goats.
 - e. Large farms have more land in pasture than do small farms and they raise a disproportionately large number of cattle. Small holders tend to raise goats and other small ruminants.
 - f. Goats are the most evenly distributed animal across agro-ecological zones.
 - g. Among small ruminants, goats have far and away the lowest mortality rate.
-

The average farm size in Kibungo is 33% larger than the national average, has more land in pasture than the national average, and produces 50% of the national banana production, the residue from which makes an excellent feed for goats. Collectively these attributes comprise a very promising environment for the promotion of goat production. Especially given the high mortality of cattle in the area and concomitant low milk availability, the time may be right for promoting the consumption of goat's milk in Kibungo, along with the goat industry in general.

Next to Kibungo in goat production is Byumba, with an average of 1.86 goats per household. The potential for expanding this industry in Byumba is also very strong, yet due to exceptionally high livestock mortality in that prefecture, efforts to expand the industry there could be seen as a waste of resources. Research is seriously needed in Byumba to bring livestock mortality under control and set the stage for future development of the industry.

CHAPTER FIVE ECONOMICS OF GOAT PRODUCTION AND MARKETING

5.1 Goat Sales and Purchases

To illustrate the importance of goat production in Rwanda's rural economy, we refer to the rural component of the National Budget and Consumption Survey (ENBC) which was conducted in 1983. These figures show that the net income from all sources including home production was 55,259 FRW/household/year or \$586/household/year at the official exchange rate of 94.34 FRW/\$. Of this total, crop production represented 54% and animal production 8%. Breaking down the gross value of animal production, we find that cattle contribute 40%, goats 30%, pigs 13% and sheep 7%. The data from the National Agricultural Survey in 1984 indicate that households sold on average 15% of their goats, while their own consumption was 8% and mortality 18% of the total population.

Across the prefectures, Butare and Ruhengeri have the highest rates of goat sales to herd size, with 24% and 20% respectively. This may be due to land scarcity since Ruhengeri and Butare are the most densely populated prefectures. Goats may serve to increase cash availability on the farm. But in the case of Ruhengeri, which borders Zaire, international trade may account for some of this turnover. In Kibuye, 17% of the goat population is sold. Information derived from informal interviews carried out in Kibuye indicated the existence of exports to Zaire from there as well. A very low level of sales was found in Cyangugu where only 9% of the goat population

was sold per year. This prefecture also shares a border with Zaire, though it does not seem to have the same level of goat sales as Kibuye and Ruhengeri.

An examination of the ratio between goat sales and purchases shows significant differences from one prefecture to the next. Prefectures can be classified as one of three types. The first is where farmers sell approximately the same amount as they buy, which is the case for households in Ruhengeri and in Gisenyi (Table 5.1). This may mean that farmers have a good sense of the market and of risk. The second case is where purchases are greater than sales, and suggests that farmers may be building capital and holding back on sales, not trusting the market function, or expecting better market conditions in the future. Another possibility is that farmers may rely heavily on livestock, placing savings in livestock rather than in stored crops. Cyangugu is the one prefecture in which purchases are greater than sales. This interpretation is consistent with the finding that in 1988, the population of Cyangugu had the lowest daily caloric intake of all prefectures at 1,340 kcal per adult equivalent (ENA 1988). The third case is where farmers sell more than they buy. Kibungo and Gikongoro are illustrations of this situation. In Kibungo, crops may substitute for livestock as a mechanism for cash generation. In Gikongoro, where livestock densities are exceptionally high and soils are poor, farmers rely heavily on livestock as a source of manure, and only secondarily as a source of cash for special occasions or in case of hardship.

Because of the high demand for livestock in Gisenyi, Ruhengeri and Cyangugu, we expected to learn of goats being moved to these prefectures from other areas of the country. However, information gathered from informal interviews indicated that significant regional variations in price were not evident, and there was little indication

Table 5.1 Sales, Purchases and Own Consumption of Goats as a Percentage of Goat Population

Prefecture	% of sales	% of purchases	% of consumed
Butare	24	8	7
Byumba	17	8	11
Cyangugu	6	7	9
Gikongoro	12	3	1
Gisenyi	13	12	7
Gitarama	17	8	6
Kibungo	11	3	5
Kibuye	19	7	9
Kigali	9	6	7
Ruhengeri	20	20	25
Rwanda (N=)	15.0% (282,285)	8% (151,796)	8% (152,712)

that goats were being trucked into the high-demand prefectures.

5.2 The Structure of Goat Marketing In Rwanda

The information in this section is based on informal interviews with various participants in the goat marketing system. Observations made here are intended primarily to stimulate further discussion and help identify potential areas for additional research. The goat market is unregulated, with no standards in terms of quality or weight. Prices are not regulated for live animals, rather, they are based on physical inspection by the buyer and supply and demand forces in the market. The market takes place at the same site as the agricultural market place but sometimes at different times or on different days.

On the supply side are the producers, or livestock owners. In the market place the supplier is most often a man or an older boy. Maturity is important, as bargaining is an art. One must be both well-seasoned and very clever.

The second type of supplier is the trader or middleman. In most cases, the trader is a young man, for whom livestock transactions are a speculative activity. He generally knows the market very well. He may operate at different markets in the same prefecture or outside of the prefecture looking for a good price. He is not only a trader, but often a farmer who tries to raise his income by buying livestock for resale. Some of them still live with their parents.

A third category of supplier is comprised of cooperatives that own herds of goats and raise them to maturity for resale. Some agricultural projects also produce and market livestock.

Finally, there are the large-scale traders who service the urban sector, own or rent their own trucks, and whose livelihood depends entirely on goat marketing.

There are three types of buyers. First, households often buy goats for fattening and resale, or simply for consumption. The second type of buyer is the local restaurant or bar owner who serves goat meat to his customers. The last type is the urban retailer. Butcher shops specializing in goat meat can be found on market squares throughout the country. The demand for goat meat has expanded rapidly due to a growing urban population. These shops have refrigerators to conserve the meat and high quality is an important factor in sales.

The market is opened at 7:00 am, and during the first hour or so market participants size up the competition and market demand. Farmers, middleman, and restaurant owners all try to obtain a sense for the volume and quality of supply.

Sellers and buyers are reluctant to suggest a price. Sellers propose a high price and the buyers a very low price. Sellers or buyers who are in hurry can accelerate the process by buying at a high price or by selling at a low price. By mid-morning all parties know what the market has to offer in terms of both quantity and quality. Sellers have had time to compare their animals because it is an open market place. Good animals attract more buyers and competition between buyers is high. This is a good time to buy high quality animals but may last only a few hours. By noon, the risk increases that buyers and sellers will be forced to return without having accomplished the transactions they had hoped to make. Buyers begin to propose lower prices and sellers grow impatient. Decisions are made either to sell at low prices or to return home without a sale.

5.3 Seasonal Price Variation for Goats

According to interviews with market participants, goat prices follow a bimodal pattern with one peak in June and the second peak in December. June is the period of the coffee harvest. Rural incomes increase from sales of coffee and other crops. Animal owners are not in a hurry to sell their animals at this time, having other sources of cash to rely on. At the same time, the demand for meat increases, presumably due to the higher incomes. Results from the 1983 Budget-Consumption Survey show that the income elasticity of demand for meat was 2.15. Thus, supply and demand factors combine to raise the price of goats. More businesses are created during the coffee harvest, with new restaurants appearing in rented buildings. Traders get special short-term loans to buy coffee, and this has an overall positive impact on the rural economy during this period.

The second peak is in December when traditional holiday feasts increase the demand for meat. Supplies will typically increase in September and October when crops begin to mature and animals must be tied or stabled to avoid crop damage. The same pattern appears at the beginning of the second season in February and March. At this time, the price of goats is low because of their high supply. Outside of these two periods, the price of goats is more or less stable. One suspects that the more serious buyers are those who have more or less regular incomes, but this hypothesis needs empirical confirmation.

5.4 Evaluation of the Goat Market in Rwanda

The goat market is open and competitive. The skill of trading lies principally in one's ability to accurately assess an animal's value. Farmers, butchers, and restaurant and bar owners estimate the price of goats entirely by physical examination. There are no published guidelines on animal prices. Traders develop a market sense only by comparing animals and prices in different markets. Transportation costs are also an important factor in determining prices. The more isolated the marketplace, the higher the cost for sellers to take back their goats if they do not sell. Thus, isolated markets tend to have lower prices. Another element is the question of how urgently a particular seller needs money or a particular buyer needs goats. There are no facilities at the goat market, which in most cases is located outside. Sometimes even slaughtering areas are without a concrete floor or roof.

5.5 Estimating Goat Production and Consumption in Rwanda

Pellemon International (1987) identifies the following production parameters for local goat breeds in Rwanda raised under a traditional management system:

- Total mortality rate: 18.2%
- Litter size: 1.37
- Sex ratio: 50% male and 50% female.
- Proportion of males kept after one year for reproduction: 20%
- Proportion of females kept after one year for reproduction: 55%

Karangwa (1981) has proposed a slightly different set of parameters:

- Litter size: 1.41
- Sex ratio: 51% male and 49% female.
- Annual rate of mortality: 20%
- Sales as a percentage of adult herd: 25%

The following set of "average" parameters will be retained for analysis:

- Total mortality rate: 18.2%
- Litter size: 1.4
- Sex ratio: 50% male and 50% female.
- Proportion of males retained for reproduction: 20%
- Proportion of females retained for reproduction: 55%.

By applying these parameters to a total goat population of 1,163,445 head, over a twelve month period, we can expect to have 960,234 goats in the market. However, our 1984 figure shows that only 282,285 goats were actually marketed or 29% of the theoretical potential. The conclusion is that farmers are not maximizing their investment in the goat industry. Goat production is far from reaching its potential and is clearly responding to factors other than the market.

Figures on hides and skins exports in 1984, are compiled and reported by two different sources (Salah Eldin Saleh 1989). The Ministry of Agriculture reports exports of 1,021 tons of hides and skins, while the National Bank reports 922 tons. The first

figure corresponds to 2,042,000 hides (or the same number of goats). Figures from the National Bank correspond to 1,844,000 hides. Assuming that the correct estimate is somewhere between these two figures, or around 2 million, we are left with a huge discrepancy between this figure and the ENA-1984 estimate of 282,285 goats marketed, an estimate which was based on scientific sampling methods and which is believed to be quite accurate. One explanation for the difference is found in accounts of transshipments (imports and reexports). A 1986 report by the Ministry of Finance and Economy confirms the existence of imports of hides and skins (Annual Report 1986). At the same time, the country had an overstock of 478 tons of skins which were exportable.

The low level of meat consumption in Rwanda is caused by a lack of purchasing power in the rural areas. The National Budget and Consumption Survey estimated the value of gross household income in rural areas (including own-consumption) at 54,360 FRw (\$573) per year. This translates into expenditures of \$0.32/person/day. By comparison, the average price of meat in the rural areas was about \$1.20/kilogram. The same study found all the income elasticity to be positive even for staple foods, with the smallest elasticity being .14 for sweet potatoes.

Laure (1980) compared the price of commodities to daily wages. He indexed the price per 1,000 calories and per 100 grams of protein to be very cheap when its ratio was less than 1/16 for calories and 1/8 for proteins. The commodity was classified as very expensive when the price per 1,000 calories was 2 times the daily minimum wage, and 4 times when measured in proteins. In 1968, the ratio for beans was considered to be moderate at .134, when the ratio for goat meat was 1.553 or extremely high. Ten years later, the ratio for dry beans was .127, and for goat meat

2.392. The ratio for 100 grams of protein in 1968 for dry beans was .207, and 1.408 for goat meat in 1970. In 1978 the ratio was .197 for dry beans and 2.168 for goat meat. This example illustrates the high cost of meat relative to the cost of beans and relative to purchasing power in rural areas.

Several important conclusions can be drawn from this discussion. We have found that the goat population is large because sales are far below their estimated potential. Meat is exceptionally costly given farmers' low purchasing power. At the same time, the high cost of goat meat limits the production of hides and skins, a source of rural income.

5.6 The Economics of Goat Production at the Household Level

It has been reported by ISAR (1974) that a farm size of one hectare will have a minimum of 1,000 m of hedgerows where enough fodder plants can grow to feed 2 does and their kids. We know that in Rwanda, 50% of households operate less than 1.14 ha of land. Two does can produce for sale within 12 months .92 males and .50 females. According to informal interviews, the current price of year-old goats is 2,500 FRws for males and 2,000 FRws for females. This would yield a gross income of 3,300 FRws, or 6% of the annual net income per household in the rural areas, and over half of the current value of net cash income from agricultural activities (ENBC 1983).

For purposes of increasing the production of animal feed, it has been recommended that farmers plant legumes such as desmodium in their anti-erosion hedges. Desmodium must be cut and fed to livestock in the stall.

Farm annual budget estimates:

<u>Raw material:</u>	<u>Types</u>	<u># of units</u>	<u>Total annual costs</u>
	Trees	3	450
	Ropes	2	200
	Nails	2 kgs	300
	Tile	50	500
	Sub-total		<u>1250</u>
<u>Labor</u>	Plowing	2 days per season	400
	Weeding	2 days per season	400
	Cutting and feeding	30' a day	750
	Transportation	2 days per season	400
	Sub-total		<u>1950</u>
<u>Animal medication</u>			100
<u>Total</u>			<u>3200</u>

The budget shown above reflects the cost of such a system to the average farmer. It assumes that the household owns two does. For animal medication, personal interviews indicate that 100 FRws should cover the cost of medication each year. The budget does not include the initial purchase of fodder plants because they are currently subsidized.

The first-year costs are estimated to be 3,200 FRws or slightly less than average yearly sales of 3,300 FRws as described above. Thus, in the first year, net income is only 100 FRws. In the second year, farmers will have to pay for their labor,

30% of their investment if the depreciation is assumed to be one third each year. The total cost will be 2,425 FRws which gives a net income each year of 875 FRws. It was estimated by Karangwa (1981) that each goat can produce 200 kgs of manure each year. If we value it at the market price of 20 FRw/kg, this gives us an additional 4,000 FRws each year. However, the market price may overestimate the value of manure on the farm. An alternative would be to value the manure by its impact on crop production. This brief analysis suggests that without using land for pasture or fodder crops, even small farmers can profit from small scale goat production.

5.7 Thoughts on the Development of Goat Production and Small-scale Rural Industries

One of the major constraints to goat production in Rwanda is the low effective demand for meat in rural areas. Informal interviews confirmed the dependence of the rural economy on the coffee harvest. The need to promote small-scale rural industries and to bring money into the rural areas is clear. Other multiple effects will then follow.

A second constraint on goat production is the demand for goat products in urban areas. In this regard, manufacturing shoes may be an option worth investigating. A study by Saleh (1989) reports that Rwandan imports of shoes and other leather products were valued at \$5.67 million and the value of hides and skins exports was \$5.33 million. Import tariffs are generally higher than export taxes. Saleh indicates that taxes on imports vary from 50% to 90% while taxes on exports were only 20% for fresh hides, 10% for pre-tanned hides, 5% for crude leather and 0% for finished leather.

Initial development of small-scale rural industries for tanning and shoe making might look like the following: five small units could be established in five different

prefectures where the goat population is the largest. Based on this criterion, the units would be located in Kibungo, Gitarama, Gisenyi and Cyangugu. Since there is already one in Gisenyi, the fourth unit might instead be established in Kigali.

The objectives would be to process goat hides and skins, to manufacture shoes meeting international standards in terms of quality, to offer good service to consumers and to pursue Rwanda's comparative advantage in terms of raw materials and cheap labor.

The industry could be promoted with policies such as increased import tariffs to limit import consumption, though experience in the international market shows that such policies often introduce inefficiencies in the local industry because of protection. Protection may cause a negative effect on industry performance in the sense that competition will be reduced and quality will not have to conform to international standards.

5.8 An Initial Review of Parameters and Potential

We begin with the assumption that each of the five units will process 2,000 hides per month. The small factory in Gisenyi processes 400 skins a month but could process more if the raw materials were available. This factory uses nine workers who are paid a daily wage of 135 FRws a piece. The total cost for labor, chemicals and other inputs, and capital depreciation is 480 FRws per skin. The total revenue per skin is 640 FRws which gives them a marginal profit of 160 FRws apiece. Assuming that one unit can process 2,000 skins a month, this means 24,000 goats a year per unit and 120,000 goats for all five units.

The anticipated impact in each of the sites will depend on the number of sales and home-consumption in each area. In Cyangugu, the total sale and consumption of goats will have to increase by 21% above current levels. In Gisenyi, the increase would be 71%. In Gitarama, Kibungo, and Kigali sales would have to increase by 77%, 73%, and 66%, respectively.

At the household level, if the average price per goat remains at 2,000 FRws or US \$20 (using the 1984 exchange rate of 100.17 FRws for one \$US). An increase in sales will have a positive effect on gross income. Based on 1984 ENBC figures, farmers in Cyangugu would see an increase of 23% in gross household incomes. In Gisenyi it would be 15.5%, in Kibungo 20.3%, in Gitarama 14%, and 13.7% in Kigali. Such income growth would likely have an impact on goat meat consumption. The elasticity for meat demand has been estimated at 2.15 by the same study. The second effect of this hypothetical development could be measured in terms of foreign exchange savings. Figures published by the Ministry of Finance and Economy show that in 1987 the country had a balance of payment deficit equivalent to 6% of the national budget.

Goat hides and skins on the international market seem to be more stable in terms of quantity and in terms of price. Over the period 1961-1986, global output of goat skins grew more than 45% (FAO 1987). Production in developing countries rose by 55%, but in developed countries it declined by more than 9%. This decline in developed countries reflects the steady reduction in goat numbers in favor of more profitable types of meat. In sharp contrast to cattle hides, the proportion of goatskin production entering international trade channels fell from 50% two and half decades ago to less than 23% reflecting rapid growth of domestic utilization. In fact, world

shipment in raw skins shrank by almost one third. As tanning capacity expanded, developing countries reduced their exports of raw skins by more than 37% and exports from Asia and Pacific, the chief supplying region 25 years ago, almost disappeared.

Exports from the developed countries rose, but the absolute quantity was minimal in the world context. In last 25 years, it may be noted that while developing countries increased their aggregate export earnings from raw hides and leather products, their share in the sector rose only marginally from 25% to 26%. Asia became by far the most important export region among developing countries. The share of Latin America in total exports of developing countries in the sector has risen sharply and those from Africa and the Near East have actually declined. The continued strength in the raw hides, skins, leather and leather shoes economy of developed countries, and more particularly of Western Europe, is shown by the growing share in the global sectorial exports value from 46% to 55%.

In Africa, goat skins and hides show very stable growth with an increase of 23% in the last 18 years of the total goatskins and hides when in Rwanda the increase was 200% (Table 5.2). Exports from Africa varied from 30% to 50% of the world total exports. Rwanda exports almost 100% of its production.

The price on the international market has increased 25% in normal terms, but adjusting for inflation the real price has fallen somewhat.

Processing hides locally would have a positive impact on rural employment. This is true not only because people would be hired to work in the new factories, but growth would occur in the connected services such as transportation facilities, communication equipment, market infrastructures, and support services. The success of these factories would depend heavily on the quality of labor. If the objective in the

Table 5.2. Goat Hides and Skins Production and Exports In Africa and In Rwanda

Year	Production in Africa	Rwanda	Export Africa	Rwanda	Price \$/lb	CPI
1970	19.8	.2	9.0	.2	.13	32.0
1971	19.9	.2	9.6	.1	.14	30.4
1972	20.2	.2	9.3	.1	.30	31.3
1973	20.1	.2	9.3	.2	.34	34.3
1974	20.0	.1	8.9	.1	.24	44.9
1975	19.3	.2	7.9	.2	.23	58.5
1976	20.4	.3	8.5	.3	.34	62.5
1977	20.7	.4	6.9	.3	.37	71.6
1978	21.8	.4	7.4	.3	.48	80.6
1979	22.7	.4	8.3	.4	.73	93.3
1980	22.2	.4	6.9	.4	.46	100.0
1981	22.1	.5	6.6	.4	.42	106.6
1982	22.8	.4	6.0	.5	.39	119.6
1983	22.7	.5	5.5	.3	.45	127.7
1984	23.1	.4	5.1	.4	.59	134.6
1985	24.0	.9	6.9	.8	.51	137.0
1986	2.42	.6	5.7	.6	.64	135.5

Source: IFS (1987).

long term is to develop a product that offers comparative advantage, skilled labor is a prerequisite.

The development of such an industry cannot occur without parallel increases in public expenditures. Associated costs for training, infrastructure, and research are always public expenses, but we would not expect the government to be involved in initial investment. Ultimately a growing and vibrant leather processing industry would

lower the government budget deficit through increased income taxes, consumer taxes and more public service consumption such as water and electricity.

5.9 Conclusion

Findings reported in this chapter indicate that goat marketing in Rwanda is far from its potential given current levels of production. It has been suggested that marketing has been constrained by the fact that purchasing power in rural areas is very low and that goat meat is still a very expensive item relative to other traditional foodstuffs. Moreover, farmers still find livestock to be a convenient mechanism for capital savings. Traders know the goat market better than producers do and this may introduce a bias in market performance. Very little research has been done in Rwanda on goat marketing facilities. Traders may derive greater profit from importing skins and hides rather than buying and selling on the local market. The international market seems to be relatively stable in terms of the supply of goat skins and hides, which may leave some room for growth, particularly for high quality skins.

A review of typical costs for converting from extensive goat production to an intensive scheme suggests that even though the initial investment may be high it will pay for itself in the long run and the added manure production will have a supplementary pay-off as well.

Some initial thoughts on the possibilities for developing small-scale leather processing in rural areas were forwarded and discussed. The potential effects of this industry would likely be to boost rural employment, household purchasing power, and levels of nutrition, and to improve the national balance of payments. The next step will

be for these initial considerations to be further developed and put through the rigors of a formal cost-benefit analysis.

CHAPTER SIX SUMMARY AND CONCLUSION

This study takes a broad perspective on livestock production in Rwanda. Though the focus has been largely on goats, it has been necessary at times to examine the livestock industry in general. Because the role of livestock in Rwandan society has evolved over time, special attention has been given to historical context, and to how such changes have influenced institutions and policies over three discrete periods of time: the pre-colonial period, the colonial period, and the most recent, or post-independence period.

During the pre-colonial period cattle were seen as a sign of wealth and prestige. They were an instrument of the dominance held by the ruling class over all others, and they were a means of exchange for goods and services. Cattle ownership determined who had rights to the land and who did not. The second, or colonial period, introduced full ownership rights to land for livestock owners and agriculturalists alike. Policies were implemented to increase milk, meat, and skins production. This was accomplished through the establishment of milk processing factories, the introduction of exotic breeds, and the creation of livestock research centers.

The period following independence has been marked by mounting population pressure, increasing demand by the urban population for meat and other high-value agricultural items, emerging international trade, and improved infrastructure. Livestock has become more integrated with crop production and the two often play

complementary roles. Population growth has caused the disappearance of traditional pasture, and more intensive fodder plants have become increasingly important. Research on the stabling of animals was initiated, and programs were implemented to reverse the environmental degradation caused by extant livestock and cropping practices. The capacity of dairy processing, meat marketing, and hides and skins processing have all increased but the lack of raw materials has kept production below optimal levels. Milk imports have grown as a result. Chemical fertilizers and the use of manure was added to the program of the extension service.

In short, the evolution of animal husbandry in Rwanda has seen a dramatic shift from livestock as a source of social differentiation to livestock as a combination of marketable products. This evolution has paralleled changes in sociocultural and political organization in Rwanda. Yet, despite these changes, the majority of Rwanda's population still receives little nutritional benefit through the consumption of livestock products.

A longitudinal analysis of livestock data shows a decline in the ratio of animals to humans over the period 1953 to 1984, largely because of growth in the human population. At the same time, the population of small ruminants has increased; only the number of cattle has decreased significantly over time.

The largest concentration of cattle is found in the south of the country, where the king's court was located and where the first livestock research centers were established. Pigs, too, are concentrated in the south, where they were first introduced by missionaries. Sheep are found principally in the northern provinces where the existence of markets on the border with Zaire has stimulated production.

Goats are distributed throughout the country but have discernible concentrations in the north and southeast. High productivity, low mortality, low initial investment, and low labor demand are some of the factors that make goats the most commonly owned animal in virtually every region of the country.

Overall, livestock production is highest in Gikongoro, a prefecture with exceptionally poor soils and weak agricultural production. We are led to suspect that farmers in Gikongoro have looked to livestock production in an effort to diversify and avert the risk associated with a prolonged drought. Additionally, more livestock means more manure, the use of which enables these farmers to cultivate holdings of marginal fertility. Two other prefectures in which livestock ownership is uncommonly pervasive are Butare and Ruhengeri. Though soil fertility in these areas is not poor, population density is exceptionally high and every farm is concomitantly small. Historical circumstances are the most plausible explanation for these anomalous findings.

In general, we found that farmers operating relatively large landholdings, and those with more land in pasture, were more likely to own livestock. This is particularly true for cattle, which require more pasture than do small ruminants. When small holders do raise livestock, small ruminants seem to be best suited to their resource levels and economic needs. At a certain point, however, farms can become too small even for the production of small ruminants. Currently in Rwanda most livestock are allowed to graze in pasture or wherever vegetation can be found. Few are raised under more intensive schemes that require the construction of stables and that fodder be grown and cut specifically for this purpose.

Given available pasture in Rwanda (9.3% of holdings), it has been estimated that farmers currently own roughly three times the amount of livestock that is commonly

thought to be ecologically sustainable. Likewise, an analysis of turnover in the goat industry has shown that farmers are selling only a fraction (approximately one-third) of their potential at least in 1984. In other words, Rwandan farms appear to be overstocked with livestock. There are two factors that may account for the fact that farmers do not more actively market their animals. The first is that livestock have traditionally served as a mechanism for capital savings, which are "cashed in" only on special occasions or in times of need. Second, purchasing power in rural areas is very low and meat consumption is still viewed as a luxury, with per-calorie and per-protein costs upward of ten times that of traditional staple crops such as beans and sweet potatoes. Only in the urban areas, where incomes are higher, has the consumption of meat and milk products seen an appreciable increase.

The export of hides and skins from Rwanda far exceeds domestic production. Evidence suggests that hides and skins are imported into Rwanda for re-export. This export market has been a consistent source of foreign exchange in the past and should undoubtedly be maintained. How the flow of skins from other countries through Rwanda is constrained or promoted by current exchange rates is certainly a question that merits further study. By contrast, the fact that Rwanda exports skins and hides while simultaneously importing shoes and other high-cost leather goods is a source of some consternation. This study has advanced some initial thoughts on the potential for developing a stronger domestic tanning industry. It is recommended that a more comprehensive cost-benefit analysis be conducted to assess the feasibility of such a proposal and to strategize about its promotion and development.

Animal health is another area of concern. Diseases are so prevalent that helminths, pests des petits ruminants, ticks and theileriosis are now agreed to be the

major constraints to livestock development in Africa. This study has found an exceptionally high rate of mortality among cattle in Byumba and Kibungo. It has been reported that the incidence of east coast fever in that area is high, which may help account for our findings. In Ruhengeri and Kibuye, sheep have high rates of mortality, and in the northeast mortality among goats is high. The unusually high rates of mortality we have found in Rwanda's northern provinces should be seen as a priority need in terms of research and intervention.

Research on goats in Africa has stressed the notion that goats can provide immediate cash for the smallholder and milk during dry season when the production of cow's milk is low. More needs to be known about the genetic characteristics of local breeds. Many regional cross-breeding experiments on goats have failed, the one exception being in the highlands of Kenya. Constraints to the development of new breeds have been both environmental and management-related. The local breeds seem to be extremely well adapted and it appears that there exists adequate genetic material in the indigenous breeds for a significant increase in production.

Goats have traditionally been allowed to feed on their own in the African system, but alternative feeds exist such as cassava, banana peels, corn bran, sweet potato vines, and agro-industrial byproducts. Some legumes may also be added in order to upgrade basic feed. Little research has been done on-farm to determine how the local breeds fit into the overall farm production and consumption system. However, statistics in Rwanda have shown that certain varieties of anti-erosion hedge produce on a one-hectare farm enough feed for two does and their four kids even without using supplements such as cassava and banana peels. The future of goat production in Rwanda will depend on the adoption of such varieties and on altering traditional

management systems toward a more intensive, permanent stabling of goats and other livestock. Other management practices such as separating males and females, systematic vaccination and castration, providing adequate fodder plants and salt in the diet, and ensuring the intake of colostrum by kids will also be needed to improve goat production over the long term.

The economics of goat husbandry are poorly documented in Africa. Despite the fact that goat's milk is more nutritious than cow's milk, that goat skins and hides generate sorely needed foreign exchange, and that goat meat is often preferred over other meats, development of the goat industry has had difficulty attracting public funds. Perhaps this state of affairs should not be surprising at all in the Rwandan context. Traditionally, cattle have been all-important. Small ruminants have never overcome their secondary status in the eyes of government officials and even of the larger development community. The market is not well organized, little information exists on market margins and price trends, and research on goat production in Rwanda is extremely limited. Goat husbandry would appear to have potential given shrinking farm sizes, low start-up costs and relatively low mortality rates. This study has tried to bring together historical reports and current data in an effort to broaden our understanding of goat husbandry in Rwanda, to illustrate how the industry intersects with key dimensions of local farming systems and to identify potential targets for related research and development in the future.

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