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AN ECONOMIC APPRAISAL OF TICK BORNE DISEASE CONTROL IN TROPICAL AFRICA: THE CASE OF UGANDA

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University for the Degree of

Doctor of Philosophy

by

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BIOGRAPHICAL SKETCH

Donald Stewart Ferguson was born on May 5, 1937 in Salem, New York, the son of Stuart H. and Isabel S. Ferguson. He graduated from Salem Central School in 1955 and attended Cornell University, graduating in June of 1959 with a B.S in Dairy Science. After graduation he spent six months in the Army Reserve and worked for a short time as a Field Enumerator for the Department of Agricultural Economics at Cornell. In October 1961, he joined the Peace Corps and was assigned to the Western Region School of Agriculture, Moor Plantation, Ibadan, Nigeria where he supervised the School Dairy Farm, lectured in dairy, beef and swine management and conducted many of the practical farm classes.

In February 1964, he entered the Graduate School at Cornell University and received an M.S. in Agricultural Economics with a minor in Animal Science. In August 1965 he returned to Nigeria for three months to collect data for a thesis entitled "The Nigerian Beef Industry."

In February 1967, he was accepted as a Doctoral Candidate at Cornell University, majoring in International Economics and Development with minors in Economic Development and Animal Science.

From January 1968 to December 1969 he conducted his dissertation field work in Uganda while a Research Fellow in the Department of Economics, Makerere University College, Kampala, Uganda. He completed the requirements for the degree of Doctor of Philosophy in August, 1971.

To

the African

Husbandmen

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Chapter I

A STRATEGY FOR LIVESTOCK DEVELOPMENT IN UGANDA

In comparison with the wider spectrum of agricultural products, the development of animal protein production in developing nations has been neglected. Although the expansion of the animal protein supply is often mentioned prominently in development plan objectives, it has seldom received the emphasis it deserves in the allocation of research or development funds. Perhaps the least studied aspects of the East African rural economy are the livestock development problems. However, few major development projects for traditional livestock owners have experienced any lasting success (104, pp. 24-25).

There are a number of reasons for the neglect of animal protein production and the poor success record of livestock development projects. First, the export crops and the calorie crops have received priority in research and development funds because of their greater immediate urgency. Second there is a general lack of knowledge and understanding of the physical, economic and social factors which have constrained past development. Third is the complexity of the developmental problems which often require that progress be made simultaneously on many fronts. These include disease control, the development of markets and market infrastructure, the introduction of improved breeds of cattle and the enclosure of communal grazing lands.

A prerequisite for the expansion of animal production must be a successful disease control program. In tropical Africa, disease reduces meat and milk production by more than 30 percent (83) and delays the adoption of improved breeds (see Chapter IV). The more devastating contageous diseases are now controlled by vaccination and quarantine. Those which remain to be controlled are often associated with poor husbandry practices. The control of these diseases requires the education and co-operation of farmers in addition to the expenditure of development funds.

In this study the complexities of identifying, planning, implementing and evaluating a livestock development program are examined. As a focus, an animal health program--the Uganda Tick Control Project--has been chosen. Its objectives are the eradication of East Coast Fever (ECF), a tick borne disease, and the amelioration of the debilitating effects of tick parisitism. At the completion of the Project, the greatest share of the cattle owning farmers in the higher land resource zones will be included in a system of more than 2,000 community tick control centers. A similar project is being undertaken in Tanzania. Previous programs for disease eradication in Uganda and in other African countries have been only partially successful because of the difficulty of obtaining the long run cooperation of livestock owners. This Project provides a valuable case study of the problems associated with modernizing animal industry within the existing production units.

Geography and Population

Uganda is located on the equator in the heart of Africa between 1° south and 3° north latitude, lying north and west of Lake Victoria. It borders Congo (Kinshasha) on the west, Sudan on the north, Kenya to the east and Tanzania and Rwanda on the south. The total area is just over 91,000 square miles, about the size of Britain or twice the size of New York State. However the total area includes 16,400 square miles of open water and swamp, leaving 74,700 square miles of land (218, p. 1). The cattle population in 1964 was an estimated 4.1 million head (Table 1.1).

The land mass of Uganda may roughly be described as a plateau averaging 4,000 feet in elevation. The western boundary with the Congo corresponds through much of its length to the western continental rift valley and is delineated by Lakes Edward and Albert. Uplifting, associated with the rifting, tilted the plateau, forming Lake Victoria, Lake Kyoga and an extensive system of papyrus swamp valleys. The Karamoja District boundary with Kenya is marked by a sharp escarpment along the eastern continental rift. Important upland areas include Kigezi District, the Ruwenzori Mountains in Toro District and Mount Elgon which is located on the southeastern boundary with Kenya. The lowest elevation in Uganda is 2,000 feet in Madi District where the White Nile flows north into the Sudan.

Uganda is noted for great variability in climate and vegetation over short distances. Although straddling the equator, the elevation moderates the temperature to comfortable levels (see Table X). The

MAP I: UGANDA : DISTRICT BOUNDARIES AND MAJOR URBAN CENTERS

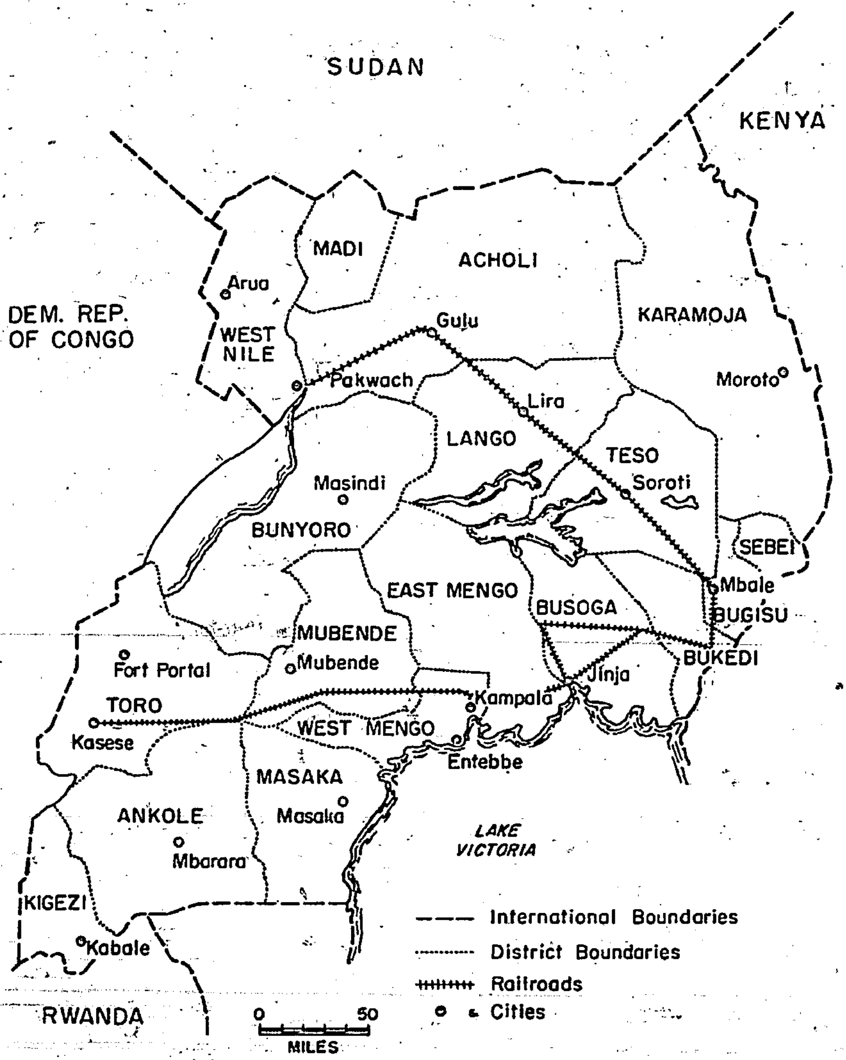


TABLE 1.1 UGANDA: HUMAN AND CATTLE POPULATION AND CATTLE PER PERSON CENSUS YEARS, 1931-1969*

Census Year	Human Population	Cattle Population	Cattle per Person
	(millions)	(millions)	
1931	3.536	2.104[a]	.60
1948	4.918	2.485	.51
1959	6.450	3.590	.55
1969	9.526	4.145	.43

* Source of data: Uganda, Min. of Planning and Econ. Dev. Stat. Div., Statistical Abstract, various years; and Uganda, Dept. Vet. Ser., Annual Report, various years.

a/ Population for 1933.

rainfall pattern in southern Uganda is bi-modal, accounted for by the northward and southward passage of the inter-tropical convergence zone. The northern half has a single rainy season. Rainfall is modified by proximity to Lake Victoria and by elevation. Rainfall levels decline from roughly 60 inches near Lake Victoria to less than 20 inches in parts of Karamoja. The diversity of climates make Uganda ideal for a case study of tropical development. The climate and agriculture are described in greater detail in Chapters II and IV.

The preliminary results of the 1969 Census place the population at 9.53 million, an increase of 45.7 percent in 10 years, suggesting a 3.8 percent compound growth rate (Table 1.2). The total is 1.2 million above the projected population for that date. A preliminary analysis indicates that even when an adjustment is made for previous undercounting, the actual growth rate may have been as high as 3.5 percent per year. The natural rate of growth is thought to be approximately 2.9 percent per year. The additional growth is the result of an influx of refugees from Congo, Sudan and Rwanda and by immigration from Kenya, Tanzania and Rwanda (175, pp. 1-12). Uganda's areas of underpopulated countryside will continue to attract immigrants from densely populated areas in Rwanda and Kenya unless political barriers to immigration become more stringent. Population can be expected to continue to grow by at least 2.9 percent per year in the next decade.

Uganda has one of the world's lowest rates of urbanization. Preliminary estimates from the 1969 Census show that the population of Kampala is 332 thousand, Jinja 47 thousand and Mbale 24 thousand. These

TABLE 1.2. UGANDA: POPULATION CENSUS 1959 AND PROVISIONAL CENSUS RESULTS 1969 BY DISTRICT

Regions/Districts	1959 Population Census	1969 Provisional Results	Percentage Increase 1959-1969
Northern Region			
West Nile	385	579	50.4
Madi	51	90	76.5
Acholi	287	465	62.0
Lango	354	505	42.7
Total	1,077	1,640	52.3
Eastern Region			
Teso	458	568	24.1
Bugisu/Sebei/Mbale	367	486	32.4
Bukedi	400	519	29.8
Busoga	677[b]	898	39.6[a]
Jinja	--	47	--
Karamoja	172	283	64.5
Total	2,074	2,801	35.1
Western Region			
Kigezi	494	642	30.0
Ankole	531	855	61.0
Toro	349	571	63.6
Bunyoro	191	348	82.2
Total	1,565	2,416	54.4
Buganda Region			
West Mengo	545[a]	515	55.4[b]
Kampala	--	332	--
East Mengo	613	844	37.7
Masaka	444	641	44.4
Mubende	217	336	54.8
Total	1,819	2,668	46.7
Total Uganda	6,536	9,526	45.7

Source: S. R. Tabor, "A First Look at the Provisional Results of the 1969 Uganda Census" (Seminar on Population Growth and Economic Development, Univ. College, Nairobi, December, 1969).

a. Includes Jinja.

b. Includes Kampala.

three cities now contain about 4 percent of the total national population. However, the rate of urban growth probably exceeds 6 percent per year.

In 1968 prior to the census, the G.D.P. was estimated to be Uganda Shillings 5 billion ($700 million), placing the per capita income at Shs. 600 per annul ($85).[1] Monetary and nonmonetary agricultural production is estimated to be between 50 and 55 percent of the total. The G.D.P. shows large fluctuations between years as the result of climatic conditions which affect crop yields and the value of cotton and coffee production (Table 1.3). Real per capita income increased an average rate of 3.5 percent per annum between 1962 and 1967.

The contribution of animal industry to the G.D.P. is comparatively small. Published estimates include animal production under "agricultural production." In an estimate prepared as part of this study, the value of beef and milk production to National Income in 1969 is estimated to be roughly Shs. 390 million ($55 million) (see Chapter X).

Because of differences in climate, population density and tribal preferences, the basic diet varies between the districts. A recent food balance sheet for Uganda is included to indicate the general make-up of the diet (Appendix Table I). Per capita availability of animal protein is below recommended standards (33, passim) and a sizable "animal protein gap" exists between requirements and production (192, passim). Estimates of the current per capita availability of beef and milk by region are developed in Chapters VIII and IX.

1. The monetary unit used throughout the thesis is the Uganda Shilling. Its current value is 7.14 shillings per U.S. Dollar or Shs. 17.14 per Pound Sterling.

TABLE 1.3 UGANDA: AGRICULTURAL AND NON-AGRICULTURAL GROSS DOMESTIC PRODUCT AT FACTOR COST*
(shillings millions)

Year	Agriculture[a]			Non-agriculture			Total Product	Agriculture Percent of GDP
	Monetary	Non-monetary	Total	Monetary	Non-monetary	Total		
1964	1,210	946	2,156	1,606	140	1,746	3,902	60.1
1965	1,139	1,276	2,415	1,863	190	2,053	4,468	59.5
1966	1,341	1,103	2,444	2,029	202	2,231	4,675	57.8
1967	1,416	1,222	2,638	2,109	215	2,324	4,962	58.7
1968[b]	1,385	1,184	2,569	2,246	177	2,423	4,992	56.4

* Source of data: Uganda, Background to the Budget 1969-70 (Entebbe, 1969).

a/ Excludes forestry and fishing.

b/ Estimate.

In summary, the growth of population, urbanization and income, combined with present low levels of consumption will result in a rapid growth in demand for all animal products, particularly if present price levels can be maintained or reduced.

Owner "Attitudes" and Economic Development

All too frequently, the lack of success with development programs and the slow adoption of new technology by peasant farmers is attributed to their presumed conservative nature and to "social constraints" operating within the social system. Promoting innovation among African livestock owners has usually been assumed to be particularly difficult. African pastoralists and some semipastoralists were said to have a "cattle complex" (69, pp. 230-272) or a "livestock complex" because of the central role livestock have played in their lives (154, pp. 278-299). Presumably their inherent conservative nature caused them to "love the nomadic way of life" and to value "quantity of stock more than quality." This livestock complex included such decidedly un-European habits as dowery paid in cattle. The failure of destocking programs and the like were accepted as proof of an irrational attachment to cattle. Only recently have the pastoralists and semipastoralists' economy received a more sympathetic hearing (39, p. 55; 46, p. 71), but there is little doubt that lack of an understanding of the economic and ecological world they inhabit leads to prejudices toward them in official circles and has resulted in costly mistakes in development programs (145, passim; 233, passim). Lack of appreciation of the economic problems of husbandmen may have delayed livestock development in Uganda (see Chapter IV).

Most authorities now feel that "social obstacles" or "social constraints" are not significant constraints to development. They would argue that it is the lack of technically or economically appropriate innovations, poor administration, poor communication, a deficit of imputs and markets, land tenure arrangements and perhaps other political and physical factors that account for an apparent slow adoption rate of innovations (28, passim). The former places the onus for the slow observed rate of agricultural change on the "attitudes" and "values" of the farmers, the latter, uncomfortably, on the agents of change who failed to recognize economic and technical constraints on the farmers' activities and to devise programs to minimize or eliminate them. The argument hinges on whether a backlog of appropriate innovations exists which farmers have yet to adopt which would improve the profitability of their farming or grazing operations. All would agree that the rate of change will be enhanced if the innovation is simple and profitable. Although the economist is poorly equipped to study social constraints as such, he can investigate the production possibilities of farmers and test whether the suggested alternatives will be more profitable than the methods currently in use (155, p. 22).

Assessing the profitability of propoced innovations and the typical livestock owner's "propensity to change" is of more than academic interest as it could affect the whole philosophy of development in Uganda. Faced with the large areas of underutilized land and with an urgent need to expand animal production, the Government could be justified in giving priority to development projects which by-pass traditional producers and create "modern" farms and ranches. On the other hand, if they are economically "rational," a greater expansion in production accompanied by greater social benefits in terms of income distribution and rural welfare could result from development projects designed to bring about a step by step improvement in the productivity of the majority of livestock owners. As development funds are limited, the return to various types of development programs needs to be carefully considered. The average livestock owner's propensity to change will, in a large part, determine the program which will bring about the most rapid expansion of meat and milk production.

Rationale for Investment in Animal Industry

Low-income countries are being encouraged by local health officials and by international development agencies to place greater emphasis on animal protein production within the overall development program. In Africa the quantity and quality of protein in the diet is low, particularly in areas where yams, cassava and bananas are the staple foods. Although prices for meat and milk are often low by European or North American standards, animal proteins are luxury food items in a majority of African households.

In many of these same countries, the supplies of meat and milk are growing slower than demand, and in some the per capita availability is actually declining (54, p. 3). Human populations are growing faster than cattle numbers. Ever-increasing acreages of the best range lands are being cultivated for food and cash crops. As a result, cattle numbers over wide areas are declining. The man/cattle ratio has declined in Uganda over the past 40 years (see Table 1.1). This ratio is expected to decline further in the years ahead and unless the average productivity of the national herd is improved, per capita meat and milk availability will decline. At present rates of population and income growth, the demand for animal protein at present prices could double every 10 years, making animal protein production an attractive growth industry.

Agricultural scientists now cautiously believe that over the next few years there may be a growing surplus of food grains generated by higher yielding varieties and greater use of fertilizers. Hence there may be limited amounts of additional land for feed grain production and for pasture. Although grain prices are declining on world markets, there is a buoyant demand for animal proteins--with the temporary exception of powdered milk--and world prices are expected to improve further.

The development plans of many nations emphasize the presumed need to diversify production in the agricultural sector and to expand export earnings. This is of particular concern in Africa where over 90 percent of the population live in nonurban areas and are primarily dependent on agriculture as a source of livelihood. Agricultural exports provide roughly 75 percent of Ugandan foreign exchange earnings, and two crops, cotton and coffee, are responsible for 90 percent of this total (218, p. 19). Other goals of the development program in Uganda are to increase per capita income, to expand employment opportunities, to encourage import substitution and increase export earnings (191, passim). An accelerated growth of livestock production would materially contribute to achieving these goals.

Another important reason for increased attention to animal production is that there are major resources of land and cattle currently invested in the production of meat and milk at low rates of return. In the arid zones of low agricultural potential, the marketed surplus is particularly low. The immense problems of the arid zones will only be touched on briefly in this essay. However, a majority of cattle in Uganda are in zones of moderate to high agricultural potential. In these zones, fallow lands and crop residues are grazed, turning otherwise useless fodder into high value food. A greater integration of crops with livestock is required if crop yields are to be maintained and grazing is not to give away entirely to cultivation. Many areas have low population densities because of water shortages and tsetse fly. There is also the need to improve rural incomes and levels of living.

Livestock development is an easy area in which to attract foreign assistance, permitting local resources to be applied to other agricultural, industrial and social priorities. Furthermore, most major aid granting countries are importers of animal protein and imports are not severely hampered by supply control agreements. Animal protein production is also an area where Europeans and North Americans are presumed to have particular insight and expertise. In point of fact, all of the major development projects for animal production in Uganda have been assisted by one or more technical assistance or loan programs (see Chapter X). These agencies have expressed interest in providing an even greater level of assistance provided suitable projects can be identified.

There are, however, distinct drawbacks in relying upon foreign assistance for a major part of capital development funds for any phase of agricultural development. Too great a reliance on foreign assistance, particularly those with tied grants in aid or long-term loans, may bias development programs in favor of capital intensive projects which may be inappropriate for a developing nation. National and international agencies are most easily attracted by transformation projects which are designed to create "modern" farms and ranches. These projects often involve mechanization, large capital costs per unit and usually benefit only a small number of individual farmers directly. Examples of transformation projects in East Africa include group farms, farm settlements, irrigation projects, ranching schemes and mechanized bush clearing. Transformation projects invariably have high import components, can be easily identified with the donor and employ foreign advisors.

To the credit of the foreign assistance programs, they have also supported a wide vareity of improvement projects designed to raise the average productivity of many farm units but within the existing framework of methods and resources. Examples in Uganda include artificial insemination programs, equipment for milk collection centers, special equipment for disease control and the Uganda Tick Control Project. Improvement projects would attract greater levels of support were it not for their poor record of successes and the greater difficulty in evaluating and packaging the potential projects in formats acceptable to international agencies.

Primary responsibility for livestock development in Uganda rests with the Ministry of Animal Industry, Game and Fisheries and within the Ministry, the Department of Veterinary Services.[2] The early program of the Department principally involved the control of the major epidemic diseases of cattle. It is now in a position to greatly expand the extension education activities of the Department and to plan and implement a variety of programs designed to "improve" animal industry in Uganda. It has experienced the difficulties of many developing institutions in that there are few Ugandans trained in data collection and in project planning and evaluation.

The economic evaluation of improvement projects presents many practical and technical problems. First, basic farm level and national production data necessary to evaluate the project properly may be lacking and must be estimated. Second, by their very nature, it is almost inevitable that they will require large local development and recurrent costs in the form of staff salaries and expendables, such as fertilizer and pesticide, in relation to the requirements for imported capital. It may also be extremely difficult to capture directly the Government recurrent costs in the form of fees or taxes for services rendered. Hence, a scheme balance sheet will almost always show a deficit. These characteristics make it more difficult to sell the project to the Ministry of

2. A separate Ministry of Agriculture and Forestry is responsible for crop development. The Ministry of Animal Industry was formerly the Veterinary Department under the Colonial Government.

Finance and the Ministry of Planning or to international development agencies, particularly the World Bank, which usually require that projects have a strong prospect of independent economic viability. Consequently, further biases in favor of transformation projects are that they can be easily evaluated by traditional benefit/cost techniques and a greater share of their cost can be financed by foreign loans.

Improvement projects can still attract foreign assistance if they promise to have major secondary benefits to the economy, but it is imperative that they be evaluated in respect to their profitability to the farmer and to the economy. It is also necessary to correctly anticipate the requirements for the scarce resources of trained staff, foreign exchange and the ability of the Government to underwrite the recurrent costs. Particular attention should be given to identifying projects which will initiate sustained economic growth.

The Prospect for Improving Production Methods

Only one decade ago, meat and milk production in Uganda was almost exclusively from the indigenous breeds of cattle maintained under conventional (traditional) management practices and conditions without the benefit of land enclosure.[3] The prospect of a major expansion of modern

3. The further use of the adjective "traditional" has been avoided in reference to cattle owners because of the negative connotations it evokes. In its place, the adjective conventional is used. "Conventional" husbandmen have continually modified management practices in response to changing conditions as will be demonstrated later, yet, their basic techniques often remain little changed.

forms of livestock production in Uganda was considered to be remote. The reasons for this pessimistic outlook are reviewed in Chapter IV. The past decade has seen a remarkable reversal in the perceived prospects, and livestock production is now seen to represent a major development opportunity.

Following the adoption of a more positive attitude toward livestock development, there has been an impressive expansion of enclosed farms and ranches. As of 1969 there were over 1,200 enclosed dairy farms with over 20,000 exotic (nonindigenous) and crossbred cattle. Most of these farmers who have enclosed their land are "yeomen" dairy farmers who have made the transition from conventional to modern production methods with a minimum of direct assistance from Government. There are also roughly 120 large ranches which have been enclosed with Government assistance. Some ranches are also using exotic cattle.

Although the enclosed farms and ranches are making a growing contribution to total national production, they produce only a small fraction of the total supply of meat and milk (see Chapters VIII and IX). For this reason it is still possible to make a greater impact on total production through modest improvements in yields and off-takes from the large number of conventional herds than by growth in output from enclosed farms and ranches. The development project which offers the greatest opportunity to quickly expand production, improve the productivity of conventional herds and create a foundation for a continued expansion of production is the Tick-Control Project.

This Project represents the first major effort on the part of the Ministry of Animal Industry to involve the entire cattle owning population in a coordinated development effort. Because of the size and complexity of the Project, the scarcity of trained staff and the absence of data for evaluation, it has not been adequately costed or evaluated by the Ministry. In the chapters which follow, the data are developed to permit an evaluation of the Project by geographic area, and realistic costs and benefit projections are provided. Particular attention is given to the reasons previous programs have failed and the potential role of the Project in promoting rural development.

Chapter II

LAND AND HUMAN RESOURCES

Formal development planning in Uganda is a recent phenomenon. The first agricultural planning document of major importance is the Report of the Agricultural Productivity Committee, compiled as a background paper for the 1955-60 plan period (222). It was the recommendation of this committee that the necessary data and descriptive material be assembled to permit indicative development planning. As a result of this recommendation, a surprising variety and depth of physical resource data is available for Uganda. However, the final step, the compilation of the indicative land use plan or map required for regional development planning has not been undertaken. To facilitate evaluation of the Tick Control Project, it proved necessary to define and map indicative land use zones.

The Land Resource Zones of Uganda

The rationale for compiling an indicative land use map is to allow disaggregated planning at the national level. It is an aid in siting pilot projects and experimental stations, in preparing general extension recommendations and in predicting the impact development programs will have on farm and national income. In indicative land use mapping, agricultural regions or zones are defined which are as homogeneous as possible in the more important physical resources. Zone definition may also take into consideration economic criteria such as proximity to transportation and markets, social criteria such as population density, general educational level and cultural background. Indicative land use maps which utilize non physical factors in zone definition are usually termed "economic" or "land resource" maps (36; 37).

In absence of a land resource map for Uganda, it proved difficult to evaluate the proposed program for tick control and the other programs to promote livestock development. To facilitate evaluation, a preliminary mapping of land resource zones has been prepared which draws upon the existing physical, economic and social data in zone and subzone delineation. Two research memoir series, published by the Ministry of Agriculture, provide the basis for the preliminary mapping and are described briefly.

Systems of Agriculture

The previous mapping of agricultural regions in Uganda has usually followed one of two patterns: those based on current land use and those based on physical resources. An example of the former is the "systems" of agriculture practiced in Uganda, described in a series of memoirs of the Research Division of the Ministry of Agriculture (135; 136; 137; 138; and 139).[1] This series provides a detailed description of agriculture as it currently exists in Uganda. It draws upon a wide range of information

1. Other descriptive land use mappings of Uganda agriculture are included in 12, 106 and 247.

including experiment station results, the reports of extension personnel in the field and the works of geographers and anthropologists. It explicitly takes into consideration the impact that cultural differences have had on shaping agricultural practices and determining the types of crops grown. The seven systems are:

1. Teso System
2. Plantain-Robusta Coffee System
3. Plantain-Millet-Cotton Area
4. Lango-Acholi System
5. West Nile System
6. Montane System
7. Pastoral System

However, the systems as defined do not constitute a satisfactory economic land resource classification. Several important systems--particularly the Plantain-Millet-Cotton area--are inadequately described. This reflects in part the unavailability of data. More importantly, the systems are not comprehensive. Large areas are not included specifically, nor are the systems mutually exclusive. The system boundaries are usually drawn along district boundaries (often tribal boundaries) which seldom correspond with physical resource boundaries. No attempt was made to anticipate changes in land use.

For these reasons the "systems" of agriculture boundaries cannot be adopted directly as an economic land classification. Nevertheless the descriptions of typical farm units for each area are invaluable in subzone delineation and description in any land resource mapping.

Vegetation Zones

A second series of research memoirs describes the vegetation of Uganda and its bearing on land use (91). It also interprets the impact man and fire have had on determining current vegetative communities. Four descriptive maps are the end product of this series:

	Title	Scale
A.	Vegetation	1:500,000
B.	Current Land Use	1:1,500,000
C.	Ecological Zones	"
D.	Range Resources	"

Maps A and B were compiled by traversing the countryside, plotting the observed vegetation and land use on 1:50,000 topographic maps. Aerial photographs of a 1:30,000 scale were used for detailed mapping. In the map of Vegetation, 22 distinct vegetative classes and 87 subclasses were defined. However, the current land use was generalized into only five categories: (a) mixed agriculture with both annual and perennial crops and grazing; (b) mixed agriculture with annual crops and grazing; (c) grazing with scattered cultivation; (d) forestry; (e) nature conservation (91, p. 76).

The detailed vegetation and land use maps were used to delineate 22 ecological zones. Ecological zones were mapped after comparing current land use and the sequence of changes in vegetation following the cessation of cultivation (91, p. 33). The ecological zones are purported to represent the climax vegetation following the cessation of man's activities, and hence, the best available indicator of land use and agrinomic potential.

Although an economic land resource map could be based on the 22 ecological zones, it is impractical to do so. In most instances, individual areas mapped as particular ecological zones are small and irregular in shape. Agricultural practices are not observed to change exclusively as a result of ecological zones, but change as the result of many complex factors. In short, ecological zones may not be closely correlated with agricultural practices nor can ecological zones be easily generalized into land resource zones of sufficient size to permit census and other data to be compiled for each zone.

The research memoir mapping and description of the range resources do provide a logical starting point in the process of defining land resource zones. The country is divided into only ten generalized range resource zones. Range resource zones are composed of one or more ecological zones.[2] The principal criteria for delineating range resource zones are the dominant grass species in the natural rangeland and pastures. Zones are named after either the predominant grass species or some other easily distinguishable characteristic (see Figure 1.2). The presence of certain grasses or shrubs are often used as a guide to suggest which crops can be successfully cultivated and are a rough indicator of the carrying capacity of the vegetation. The ten range resource zones are thus a useful index of physical resources and land use

2. The relationship between the ecological zones, range resources and current land use is illustrated in Figure I.1 and the characteristics of the major range resources, including location, elevation, rainfall, original vegetation, soils, present land use, grazing and forage potential and special grazing problems, are summarized in Figure I.2.

potential and are used as the starting point for the description and delineation of a preliminary economic land resource zone mapping for Uganda.

Land Resource Zones Defined

Beginning with the ten range resource boundaries, it is logical to define seven land resource zones (Figure 2.1 and Map 2). The land resource boundaries are delineated to conform as closely as possible with the existing range resource zones but are generalized in most instances along convenient political boundaries. This step is necessary in order that census and other data can be compiled for each zone. When county boundaries approximate resource boundaries they are used as this is the smallest political unit for which data are readily available. However, where counties are particularly large or where relief, rainfall or soils cause rapid changes in agricultural potential, zone boundaries are drawn along subcounty boundaries. In the Western Region it is sometimes necessary to arbitrarily construct land resource boundaries along range resource boundaries and approximate the data for each zone.

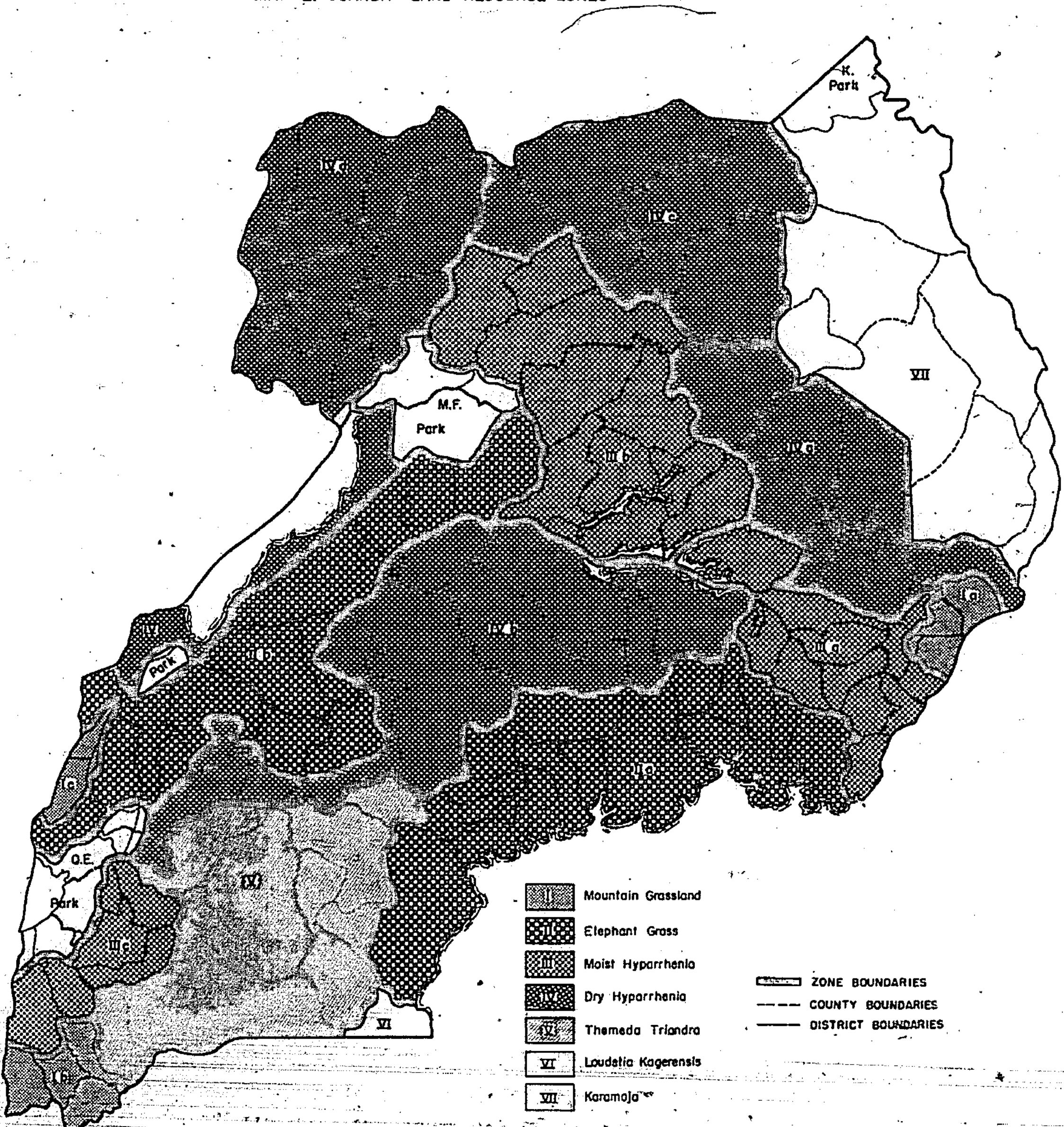
For ease of reference, five of the land resource zones are named after the range rezource zones with which they closely coincide and two for the geographic areas where the zones occur. "Valley Grassland" range resource occurs as part of the vegetative catina within several zones and is generalized in with the dominant range type. The six land resource zones for areas outside of Karamoja are subdivided into fourteen subzones. The criteria for these divisions include location, intensity of land use and various economic and social factors. Zones and

FIGURE 2.1. UGANDA: RANGE AND LAND RESOURCE ZONE DESIGNATIONS*

A. Mountain Grasslands	I. Mountain Grasslands a. Mount Elgon b. Kigezi Highlands c. Ruwenzori Mountains
B. Elephant Grass	II. Elephant Grass a. Fertile Crescent b. Toro-Bunyoro
C. Moist Hyparrhenia	III. Moist Hyparrhenia a. Bukedi Plains b. Central Uganda Ridge c. Ankole--Kigezi Uplands
D. Dry Hyparrhenia	IV. Dry Hyparrhenia a. West Teso b. North Buganda c. North Acholi d. West Nile-Madi
E. Themeda Triandra	V. Ankole/Masaka Grassland
F. Loudetia Kagerensis	VI. Loudetia Kagerensis
G. Setaria Incrassata H. Chrysopogon Steppe I. Bushland and Thicket	VII. Karamoja

*Range Resource Zones are described in I. Langdale-Brown, et al., The Vegetation of Uganda and Its Bearing on Land Use (Entebbe, 1964), and in Figures 1.1 and 1.2. Land Resource Zones are described in Appendix I.

MAP 2. UGANDA: LAND RESOURCE ZONES



subzones, listed roughly in order of declining rainfall and agronomic potential in Figure 2.1, are described briefly in the following section. A more detailed description of each subzone, which pays particular attention to future livestock development possibilities, is included in Appendix I.

Land Resource Zones Summarized

I. Mountain Grassland. This Zone, at elevations in excess of 5,500 feet, occurs in three subzones; Mount Elgon in Bugisu and Sebei Districts, The Kigezi Highlands in southwestern Uganda and the Ruwenzori Mountains in Toro District. They contain less than 3 percent of the total land area or about 2,100 square miles. Land at lower elevations receives adequate rainfalls and lands suitable for cultivation support high population densities. Topography, location and intensive cultivation limit livestock development.

II. Elephant Grass. This Zone is comprised of two subzones: the Fertile Crescent north and west of Lake Victoria and the Toro-Bunyoro subzone. The Zone occurs at elevations between 3,000 and 5,500 feet under rainfalls in excess of 45 inches on one of the largest areas of well drained fertile soils in Africa. Naturally deciduous and evergreen forest, it covers roughly 14,000 square miles or 19 percent of the total land area. Principally a perennial cash crop zone, it contains little natural grazing. But because of the fodder production potential, it offers excellent prospects for the development of small scale intensive dairy units.

III. Moist Hyparrhenia Zone. This Zone occurs between elevations of 3,400 and 5,500 feet on generally fertile, well drained soils under rainfalls of 40-65 inches where the climax vegetation would be either semi-deciduous forest or savanna woodland. It contains about 11,200 square miles or about 15 percent of the land area. Both annual and perennial crops are grown. It has been divided into three subzones: the Bukedi Plain lying west of Mount Elgon, the Central Ridge in Lango, Teso and Acholi Districts, and the Ankole Uplands in western Ankole District. Because of good rainfall and forage production potential, it could become an important dairy or dairy/beef producing area, combined with ox-cultivation agriculture.

IV. Dry Hyparrhenia. This Zone occurs between elevations of 2,000-5,000 feet on soils of poor to moderate fertility under rainfall of 30-55 inches in areas where the climax vegetation would be orchard savanna. Rainfall is seasonal, limiting cultivation to annual crops. It contains roughly 27,700 square miles or 37 percent of the land area. It has been divided into four subzones: West Teso, North Buganda, North Acholi and West Nile/Madi. Because of more seasonal rainfall and lower forage production potential, areas within the Zone are likely to continue as (or will develop as) beef/ox-cultivation agriculture.

V. Ankole/Masaka Grassland. Ankole/Masaka Grasslands occur between 4,000-6,000 feet in Ankole and Maska Districts, under rainfalls of 30-56 inches. They are characterized by *Themeda triandra*. They include roughly 7,000 square miles or 9.4 percent of the land area. Although generally considered to be the best natural grasslands in Africa, shallow soils on hill slopes and seasonally flooded valley bottoms severely limit crop production. The best use of this Zone will continue to be as an extensive grazing area.

<u>VI. Loudetia Kagerensis</u>. This Zone is the smallest Zone described and is an area of seasonal swamp forests in southern Masaka and the Sese Islands. It is defined separately because of low agronomic potential and location.

<u>VII. Karamoja</u>. This Zone includes the entire District of Karamoja, roughly 12,200 square miles or 17.5 percent of the land area. Three <u>range</u> resource zones--Setaria incrassata, Chrysopogon Steppe and Bushland and Thicket--occur with minor exception only in Karamoja. The complex developmental problems created by unpredictable rainfall and severe overpopulation dictate that this District be considered as a separate Zone.

In summary, Uganda has an extremely varied climate and topography and the agricultural potential varies greatly between areas. Uganda has been well described in the past, but to date there has been no indicative land use planning. A preliminary delineation of land resource zones and subzones is suggested which permits a comparison of areas with similar agronomic potential but differing levels of present development. The land resource zones and subzones provide the basis for describing existing and potential patterns of livestock development. Whenever possible, data will be presented by land resource zone in the sections and chapters which follow. Where not possible or feasible, the available district or regional data are presented as they do suggest the general characteristics of each zone.

Tribal History and Husbandry in Relation to Land Resource Zones

Uganda is located on one of the principal ethnic crossroads of Africa. The inhospitable Congo Rain Forest to the west and the dry, barren semi-desert areas of northern Kenya directed the routes of many tribal dispersals through the well watered grasslands of Uganda. Four ethnic groups are recognized: the Bantu and Hamitic which occur together in Buganda and the Western Region, the Nilotic tribes which occur primarily in the Northern Region and the Nilo-Hamitic tribes in the Eastern Region. These tribal divisions have demonstrably affected agricultural practices in the different resource zones, particularly the preferences in food crops and the role cattle play in the diet and economy. In relating animal husbandry and cultivation practices to the Land Resource Zones of Uganda, it is important to understand both the similarities and the differences of these groups.

Southern and Western Area--Bantu and Hamitic Groups

Of the major tribal groups now represented in Uganda, the Bantu are believed to be the earliest settlers. They dispersed from the rain forest of West Africa, bringing a planting culture which included root crops such as yams and sweet potato and the banana. The matoke banana, which is their most important staple food, requires well distributed rainfall and generally fertile soils. Consequently the Bantu chose to settle in the higher rainfall areas of southern and western Uganda (Land Resource Zones II, IIIc and IVb). Some groups either chose or were forced to settle on the steep mountain slopes of Kigezi and Toro (Land Resource Zones Ib and Ic).

The Bantu did not bring with them a cattle culture because cattle were not part of forest agriculture, although they do husband small stock such as poultry, sheep, goats and pigs. The dispersal of cattle keeping into most of the areas settled by the Bantu was hindered by the lack of natural grassland, by animal diseases and by competition for land and labor usage. Therefore, beef and milk are not important diet items in the average Bantu household. Cattle found within Bantu areas are usually the property of the more prosperous farmers and businessmen who have purchased cattle as an investment. It is common for the Bantu cattle owners to employ a herdsman in order that they may devote full time to crop or business interests. The few areas suited to extensive grazing are frequently many miles from the household, making it impractical for the owners to herd their cattle personally. A growing number of Bantu cattle owners graze their cattle on enclosed farms.

At various times Hamitic groups pressed into the open grassland areas of central Africa, bringing with them herds of distinctive long-horned Sanga cattle. In suitable areas of western and southern Uganda they settled among the Bantu cultivators, becoming a cattle owning royal elite.[3]

Bahima who have retained earlier pastoral forms of husbandry, occur in greatest numbers in areas marginally suited to food crop cultivation, but ideally suited for extensive grazing, particularly in Land

3. The authorities are not in complete agreement as to whether the Bahima were Hamitic, Nilo-Hamitic or Nilotic in origin or whether pastoralists preceded or followed the cultivators (124, passim). The Bahima have adopted the Bantu language spoken in Western Uganda and are no longer identified separately in the population census.

Resource Zone V. They also occur in significant numbers in northern Buganda (Land Resource Zone IVb) where cultivation intensity is light. These Bahima households have retained a special pride in cattle ownership and a preference for a diet composed mainly of milk, milk products and veal. Matoke banana and various other foods are now grown near their boma or camp to supplement their diet. The extensive sale or barter of milk and milk products by the pastoralists for the food crops of the cultivators has not developed in Uganda as it did in West Africa.

Although the Bahima were at one time seasonal migrators, transhumance is now uncommon in western Uganda because year round watering sites have been constructed. But herdsmen still on occasion move their camps in search of greener pastures. The Bahima, particularly young men without herds of their own, have spread throughout Uganda where they find employment as itinerant herdsmen. Their wages may be either cash or a share of the milk supply. Because they choose to remain as pastoralists or hired herdsmen, the Bahima have been able to retain their traditional diet. Their herd organization reflects the Bahima desire to maximize milk production for family consumption (see Chapter III).

It did not prove possible to estimate the proportion of cattle in the Bantu-Bahima areas which are owned by pastoral households and the proportion owned by households which are predominantly agriculturalists. Unexplainably, the Census of Agriculture did not report the percentage of households which owned cattle in each district (see footnote Table 2.1). However, a general impression of the percentage of rural households in each district which own cattle may be obtained in Table 2.1 and an indication of the ratio of cattle to people in Table 2.2.

TABLE 2.1. UGANDA: TOTAL HOLDINGS, HOLDINGS WITH COMMUNAL GRAZING AND HOLDINGS WITH CATTLE, AGRICULTURAL CENSUS 1963/64

(Thousands)

District	Holdings[a] Number	Holdings with Communal Grazing[a] Number	Holdings with Communal Grazing[a] Percent	Holdings with Cattle[b] Number	Holdings with Cattle[b] Percent
Northern Region					
Lango	70.8	29.1	41.4	26.9	38.0
Acholi	50.7	10.2	20.2	--	--
W. Nile/Madi	71.6	16.6	23.2	--	--
Total	193.1	55.9	29.0	--	--
Eastern Region					
Busoga	149.0	26.5	17.8	--	--
Bukedi	82.8	28.1	34.0	--	--
Bugisu/Sebei	70.2	20.1	28.7	--	--
Teso	100.4	52.0	51.8	53.3	53.1
Total	402.4	126.8	31.5	--	--
Western Region					
Kigezi	85.7	21.3	24.9	--	--
Ankole	92.2	19.3	20.9	19.5	21.9
Bunyoro	40.5	1.9	4.7	--	--
Total	218.3	42.5	19.5	--	--
Buganda Region					
West Mengo	124.5	13.1	10.5	17.0	13.6
East Mengo	126.7	11.2	8.8	15.7	12.4
Mubende	24.4	1.8	7.5	2.3	9.3
Masaka	81.2	7.6	9.3	8.5	10.5
Total	357.0	33.7	9.4	43.5	12.2
TOTAL UGANDA	1,170.9	258.9	22.1	--	--

a. Source, Uganda Ministry of Agriculture and Co-operatives, Report on Uganda Census of Agriculture Vol. I, 1965, Table IX-9. The Census did not include Toro and Karamoja Districts with roughly 60,000 and 30,000 holdings respectively.

b. Unpublished record of the Census of Agriculture. The Census reported the percentages of households which said they had access to communal grazing but surprisingly did not report the percentage of households which owned cattle. Unpublished Census summaries suggest that roughly the same proportion which reported access to grazing owned cattle.

TABLE 2.2. UGANDA: ESTIMATED HUMAN POPULATION AND CATTLE POPULATION BY DISTRICT, 1969

(Thousands)

Region	Human[a]	Cattle[b]	Cattle per Capita
Northern Region			
Lango	505	408	.81
Acholi	465	219	.47
W. Nile	579	130	.22
Madi	90	21	.23
Total	1,640	777	.47
Eastern Region			
Busoga	945	232	.25
Teso	568	636	1.12
Bugisu	422	181	.37
Sebei	64		
Bukedi	519	160	.31
Total	2,618	1,209	.46
Karamoja	283	690	2.43
Western Region			
Ankole	855	470	.55
Kigezi	642	94	.15
Toro	571	87	.15
Bunyoro	348	63	.18
Total	2,416	719	.20
Buganda			
W. Mengo	847	108	.13
E. Mengo	844	351	.32
Mubende	336	119	.33
Masaka	641	170	.27
Total	2,668	749	.28
TOTAL UGANDA	9,526	4,145	.44

a. Source: S. R. Tabor, "A first Look at the Provisional Results of the 1969 Uganda Census," Seminar on Population Growth and Economic Development, University College Nairobi, December 1969 (mimeograph).

b. Source: Uganda, Dept. of Vet. Services, Annual Report 1969.

In southern and western Uganda less than 15 percent of all households own cattle and there is less than one head per 4 persons (Table 2.2). There is roughly one head for two persons in Ankole District where about 20 percent of the households own cattle. In Bahima areas where few crops are grown, cattle are concentrated in fairly large herds.

Over the course of time, the cultural and husbandry distinctions between the primarily agricultural Bantu and the cattle owning Bahima have been considerably blunted by inter-marriage. Also pesticides and disease control techniques now make the higher rainfall agricultural areas the most suited for the introduction of exotic or improved breeds of cattle. Indeed, it is the more wealthy and educated Bantu farmers who may also be less bound by tradition, that have led the way in the introduction of commercial dairy farming (see Chapter IV). However, the small proportion of farmers that own cattle in these higher potential areas will continue to retard the development of an integrated crop/livestock agriculture.

To summarize, a majority of households in southern and western Uganda own no cattle and a sizeable (but unknown) proportion of the cattle population are owned by households which grow few crops. Crop farmers who do own cattle often hire herdsmen. Because cattle grazing and crop production are separate enterprises, little integration of crops with livestock has occurred. This separation of activities may have delayed the introduction of ox-cultivation south and west of the Nile River.[4]

4. In addition, soils and natural vegetation of this area are less suited to ox-cultivation than those of the east and north.

Northern and Eastern Area--Nilotic and Nilo-Hamitic Groups

A majority of the Northern Region peoples are Nilotic. The Nilotes are the second largest tribal group and comprise roughly 17 percent of the Ugandan population. They migrated into the savanna and the savanna woodland areas of northern Uganda--perhaps 300-500 years ago--from expansion areas in the Sudan. They brought with them an agriculture based upon cultivated annual crops, millet and sorghum, combined with animal husbandry. It is believed that cattle husbandry in Nilotic areas formerly was more important than it is today. Cattle raiding at the time of the Egyptian slave trade, Rinderpest in the 1890-1940 period and Trypanosomiasis in the 1910-1945 period all acted to reduce cattle numbers. At the present time less than 30 percent of Northern Region households own cattle. The data indicate that 20-25 percent of households in West Nile, Madi and Acholi Districts own cattle, but that roughly 40 percent own cattle in Lango (Table 2.1). On average, there are about one cattle per two persons in the Northern Region (Table 2.2). Nonetheless, among the Nilotic peoples, cattle ownership is still a matter of considerable prestige and cattle still play an important role in their economy.

Traditionally, the Nilotic people have lived in small settlements and have communally cultivated large blocks of land. Similarly, their cattle are kraaled in large herds although individually owned. The cattle may be grazed either by the several owners in rotation, by one owner for some consideration or by an employed herdsman. Cattle are seldom directly integrated into the crop operations. Partly for this reason ox-cultivation was slower to develop in the Northern Region than in the Eastern Region, but it is now spreading rapidly in all areas.

To summarize, there is a widespread knowledge of cattle husbandry in Nilotic areas and a significant minority of households own cattle. Growing numbers of households are husbanding their own cattle as ox-cultivation becomes more general. It is reasonable to expect that closer integration of crops with livestock will develop in the Northern Region.

The Nilo-Hamitic people, although found throughout the Eastern Region, are concentrated in Teso and Karamoja Districts. The largest subgroups are the Karamojong in Karamoja District and the Itesot of Teso District who split off from the main body of the Karamojong and migrated southwestward from Karamoja about 100-150 years ago.[5] Like the Nilotic people, the Nilo-Hamitic people also cultivate millet and sorghum as their principal food crops. However, their husbandry pattern tends to be on a household or extended family basis with each unit independently cultivating crops and herding their own cattle. These are the only two districts where there are more cattle than people. Although they comprise only 11 percent of the population of Uganda, they own at least one third of the cattle.

Although their basic husbandry patterns are similar, there are striking differences between the Itesot and Karamojong husbandry which are the direct result of different land resources and accidents of colonial history. Karamoja is the least developed area of Uganda and

5. Karamojong will be used here to refer to the closely related Karamojong cluster of tribes which inhabit separate areas of Karamoja District (60, passim). They are related to several of the pastoral or semi-pastoral tribes of Eastern Africa including the Massai, Galla and Boran.

the inhabitants have a reputation for being traditional and uncooperative with Government programs. Almost the only cash income is from the sale of cattle. Meat, milk and blood are important diet items but food crops comprise over half the average food intake (42, passim). Rainfall is not reliable and food crops fail on the average of one year in four (13; 14). Because cattle are the Karamojongs' insurance policy against starvation, households are reluctant to dispose of cattle. Cattle sales for export are low in relation to cattle numbers and are greatest when cash is needed to purchase food. However, there is no evidence that males are retained in the herd for prestige purposes. The problems of this semi-arid region are only peripheral to the Tick Control Project, and will be touched upon only briefly in this study (see Appendix II).

In contrast, the Itesot are "an embarrassment to those who think that all Nilo-Hamites should be backward" (38, passim). However, they inhabit an area which usually receives ample rainfall and where soils are productive. They were one of the first groups to adopt cotton as a cash crop and this area remains the most important cotton growing district. Data indicate that fully 50 percent of the households own cattle (Table 2.1). Most of the households which own cattle have one or more ox teams and nearly all land under cultivation is ox plowed. Trade cattle purchased in Teso District provide over half the meat supply for the Kampala and Jinja urban markets. Trade cattle are usually surplus plowing cattle.

The other Eastern Region districts--Busoga, Bukedi, Bugisu and Sebei--contain a mixture of Bantu, Nilotic and Nilo-Hamitic elements.

The basic agriculture pattern is complex with annual crops and ox-cultivation common in drier areas. However, perennial crops are grown in the Fertile Crescent area of Busoga and on the slopes of Mount Elgon. Nonetheless, most households have had a close association with cattle husbandry even if they own no cattle themselves. For this reason, the development of a greater integration of crop and livestock production is a distinct possibility in the Eastern Region.

In summary, differences in agricultural practices and animal husbandry which are often linked with tribal or attitudinal differences are more accurately a reflection on land resource differences. Agricultural techniques and methods of animal husbandry associated with particular groups were perpetuated by the fact that migrating groups tended to settle in areas similar to those of their dispersal. Differences are becoming less with the advent of the cash economy, inter-tribal settlement and the increasing pressure on grazing lands.

The data indicate that only two districts have more cattle than people: Karamoja and Teso. The national average is roughly 0.40 cattle per person. Thus there are some areas with a relative surplus of animal products and some with relative deficits, but beef and milk are produced (and consumed) in all districts. Few areas boast production in excess of dietary needs. As will be shown in Chapter VIII, relatively more beef is consumed in the cities and in the Fertile Crescent where incomes are higher. Teso, Lango and Karamoja Districts which have the highest cattle population in relation to the human population are the main sources of trade cattle marketed in the deficit areas. The data indicate that cattle ownership varies from under 10 percent of households in the more heavily wooded or populated districts to over 50 percent of households in Teso. However, not more than 20 percent of the roughly 1.2 million rural households in Uganda in 1964 owned cattle or about 300,000 households. Livestock development programs must reflect the cultural and resource differences of various areas if they are to be successful.

The Role of the Tsetse Fly in Shaping Animal Industry

The early explorers in Uganda 70 to 100 years ago reported that much of Uganda was open savanna with few scattered trees in contrast to the woodland and orchard savanna most common today. A balance had been achieved between game, particularly elephant,[6] hunting, cultivation, grazing and burning which kept suitable tsetse habitat to a minimum. Tsetse fly was almost absent from Uganda and cattle were present in all areas. Although the size of the cattle population of a century ago is unknown, it is known that the cattle population has declined in many areas.

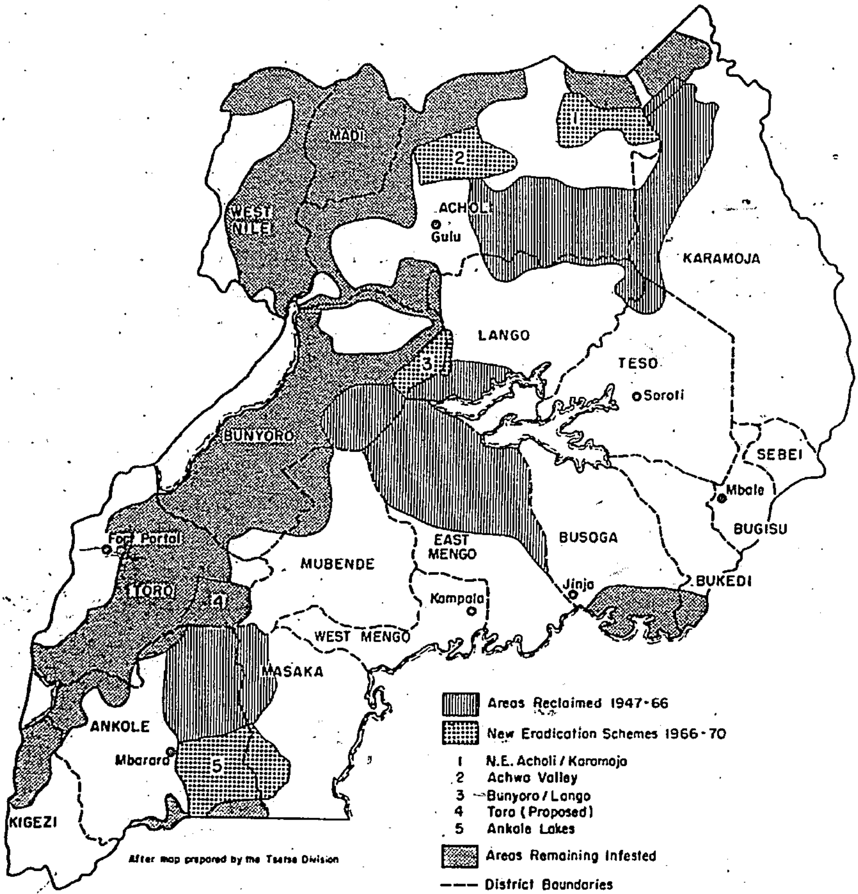
Several events related to the exploration of eastern Africa upset this balance and resulted in a major change in the Uganda landscape. First, Rinderpest epidemics drastically reduced the cattle and game population beginning in the 1890's. Second, well intentioned agricultural by-laws which prohibited burning were established by the Agriculture

6. Elephants, by systematically girdling trees, have reduced heavily wooded areas to open grassland in several game parks.

Department as a soil conservation measure. This allowed the bush and trees once controlled by burning to become re-established (92, pp. 21-37). Third, the small game proved more prolific than cattle and increased rapidly in numbers (146, pp. 254-261).

With the recreation of a suitable habitat for the tsetse fly and the growth of the game population as a suitable host, there was a gradual spread of the tsetse from foci in Congo, Sudan, Tanzania and possibly from within Uganda. As a result of the movement of explorers and forced migrations, Gambian and Rhodesian forms of human sleeping sickness were introduced. These diseases were to eventually force the evacuation of the human population from several areas, permitting game and bush to encroach even faster on the grasslands (120). Cattle and humans were first forced out of the western rift valley which now contains Queen Elizabeth and Murchison Falls Parks and from parts of Bunyoro and Toro (Zones IIb, IVb), West Nile and Madi Districts (Zones IVd). As the situation grew progressively more serious, the tsetse spread across Acholi and Lango (Zones IIc, IVc) and north from Tanzania into Ankole and western Buganda (Zone V). Rhodesian human Trypanosomiasis spread across southern Busoga (Zone IIa) where large areas are still closed to human habitation, and threatened Buganda from the east. The situation was desperate in the mid-1940's, but the tide was turned by game elimination, shear clearing and insecticidal spraying (146, p. 255). At the height of the crisis, about 40 percent of the land area was invaded. Today roughly 20 percent of the land area, concentrated in the west and north, remains under fly invasion (Map 3). However, cattle Trypanosomiasis still occurs in 17 of

MAP 3. UGANDA: AREAS OF TSETSE INFESTATION, AREAS RECLAIMED 1947-1966 AND ACTIVE AND PROPOSED ERADICATION SCHEMES



18 districts but it is controlled by prophylactic and curative drug treatments. Over 250,000 treatments were required in 1968 (199, p. 8). Most cases were of the milder forms of Trypanosomiasis transmitted by riverine tsetse species.[7]

The history of tsetse advance throughout Africa is an interesting case study of man's inadvertent disruption of plant, animal and insect relationships. The invasion of the tsetse fly had a major effect on cattle numbers and their distribution, human settlement and food consumption patterns. It also created large areas with low cattle population densities which could support greatly expanded cattle numbers.

The Tsetse Control Division is within the Ministry of Animal Industry, Game and Fisheries. Perhaps because tsetse eradication work has been undertaken by this Ministry, there appears to be an underlying ascumption that land cleared of tsetse will be used for grazing and ranching schemes (76, p. 10). All of the ranching schemes, except one, are in former tsetse areas. As most of the land remaining to be cleared of tsetse is of moderate to high agricultural potential, there is a need for a more comprehensive approach to developing these areas. Resettle-

7. There are three recognized groups of tsetse fly (*Glossina sp.*) which occur in Uganda. The *fusca* or forest group are of minor importance to cattle. The *palpalis* or riverine species occur along wooded lake shores and rivers throughout Uganda. They carry *Trypanosoma vivax*, a mild form of cattle sleeping sickness which does not always prevent cattle keeping, provided cattle receive prophylactic treatment. Two members of the *morsitans* or savanna tsetse groups occur, *Glossina morsitans* and *Glossina pallidipes*. They carry the more lethal *Trypanosoma congolensis*, which may prevent cattle husbandry. *Glossina morsitans* occurs along the Tanzania border and in the rift valley north of Murchison Park. *Glossina pallidipes* occurs in Bunyoro, Toro, Queen Elizabeth Park, and southern Bugosa. This latter species may transmit the human or Rhodesian sleeping sickness (211, p. 56).

ment programs incorporating mixed crop/livestock farming with oxen providing tractive power need to be considered. Tick control would be a vital part of a successful program.

The Tick Control Project is highly complementary to the tsetse eradication schemes. It will not only raise the productivity of indigenous herds introduced to scheme areas, but by reducing mortality and speeding cattle population growth, it will reduce the time required to fully exploit the newly available grazing areas. Further comments on the relationship of the Project to integrated agricultural development are included in Chapter X.

Chapter III

INTRODUCTION TO THE CATTLE ECONOMY

One legacy of the colonial period in African countries is a requirement that all units of government compile statistics on a wide variety of topics. Although the collection of data has become a habit and is part of the discipline imposed upon civil servants, inadequate use is made of this potentially valuable resource.

Within the Department of Veterinary Services, monthly and annual reports are required from all levels of administration. Local staff are often required to report monthly or annual data normally gathered by farm or statistical surveys. The Department does compile and publish an annual report, but it contains only a fraction of the data collected by local staff. As a rule, only that data needed for continuing historical tables are summarized and published. The unpublished data, if extracted and used with caution, do give valuable information on the livestock economy and land resource zones necessary for evaluating livestock development projects.

Uganda probably has more detailed and accurate cattle census data than any other tropical African country. There are no direct cattle taxes or transhumance which lead to census inaccuracies in other countries. Travel is possible in all districts except Karamoja.[1] Standing

1. Because of difficult conditions the only complete census of Karamoja

orders are that the Veterinary scouts and assistants are to conduct an annual census of livestock in the area for which they are responsible. These annual census estimates are available for all years since 1933. The accuracy of estimates, particularly for earlier years, is not known, but given the organization of the Veterinary Department, they are believed to be acceptably accurate.

Cattle Numbers and Density

The annual census data allow a thorough examination of population density between areas and the growth of the population over time. The Uganda census data clearly indicate an unequal distribution of cattle between districts and land resource zones. The cattle population of each of the land resource zones is summarized for 1968 in Table 3.1. Roughly 70 percent of the cattle are in areas of moderate to high agronomic potential (Zones I-IV), roughly 12 percent are in the Themeda Grasslands (Zone V) and 18 percent are in Karamoja (Zone VII). The data indicate only minor differences in the average cattle density between land resource zones with most zones lying near the national average of 57 cattle per square mile (11 acres per animal).

There are, however, important differences between the land resource subzones. The cattle population density varies from 120 animals per square mile (5.3 acres per animal) in the Bukedi Plain subzone to

1. (cont'd.)
District is for 1963 (207). Annual data for Karamoja are no more than informed guesstimates.

TABLE 3.1. UGANDA: AREA, CATTLE POPULATION AND CATTLE DENSITY OF LAND RESOURCE ZONES, 1968
(Thousands)

Land Resource Zone	Area Square Miles[a]	Cattle 1968	Cattle per Sq. Mile	Acres per Animal
I. Mountain Grassland				
a. Mt. Elgon	692	31	44.8	14.3
b. Kigezi	945	81	85.4	7.5
c. Ruwenzori	429	--	--	--
Total - Average	2,066	112	--	--
II. Elephant Grass				
a. Fertile Crescent	7,353	369	48.7	13.1
b. Toro-Bunyoro	6,560	66	9.9	64.1
Total - Average	13,913	435	31.3	10.5
III. Moist Hyparrhenia				
a. Bukedi Plain	2,921	350	119.9	5.3
b. Central Ridge	6,680	392	58.7	10.9
c. Ankole Uplands	1,560	180	115.5	5.5
Total - Average	11,161	922	81.6	7.7
IV. Dry Hyparrhenia				
a. North Teso	4,997	587	117.5	5.5
b. North Buganda	7,886	349	44.0	14.5
c. North Acholi	6,324	142	22.4	28.5
d. W. Nile-Mädi	8,524	182	20.7	31.0
Total - Average	27,731	1,260	45.4	14.0
V. Ankole-Masaka Grassland	6,877	326	47.4	12.7
VI. Loudetia Kagerensis	493	10	--	--
VII. Karamoja[b]	12,216	700	57.3	11.2
Total - Average Uganda	74,457	3,148	23.7	15.1

a. Areas estimated where possible from that of political subdivisions. Where zonal boundaries do not follow political boundaries, graphical techniques were used. Game parks were excluded.

b. Includes Karasuk.

only 9.9 cattle per square mile (64 acres per animal) in the Toro-Bunyoro subzone (Table 3.1). Within each subzone, sizeable areas are unavailable for grazing because of game parks and reserves, forest reserves, tsetse infestation and because of crop cultivation.

It was not possible to assemble data on the acreage in each land resource zone which is not available for grazing. The acreage available in each district for grazing per head of cattle and per animal unit is included in Table II. Livestock density per square mile of available grazing varies from only fifteen animal units per square mile (one unit per 24 acres) in Acholi District to over 600 animals per square mile (1.13 acres per unit) in Bugisu District on the lower slopes of Mount Elgon.[2]

It is possible to pinpoint with somewhat greater precision the counties with the greatest cattle densities in relation to available grazing. The cattle population in 71 of the 104 counties for circa 1958 and in all counties for the year 1968 are given in Table III. Although data on the full range of land uses are not available by county, data on land under cultivation have been estimated. In the more important agricultural counties, land under cultivation is by far the most important non-grazing land use. The estimated acreage of grazing per head of cattle, exclusive of land under cultivation, is shown in column G in Table III.

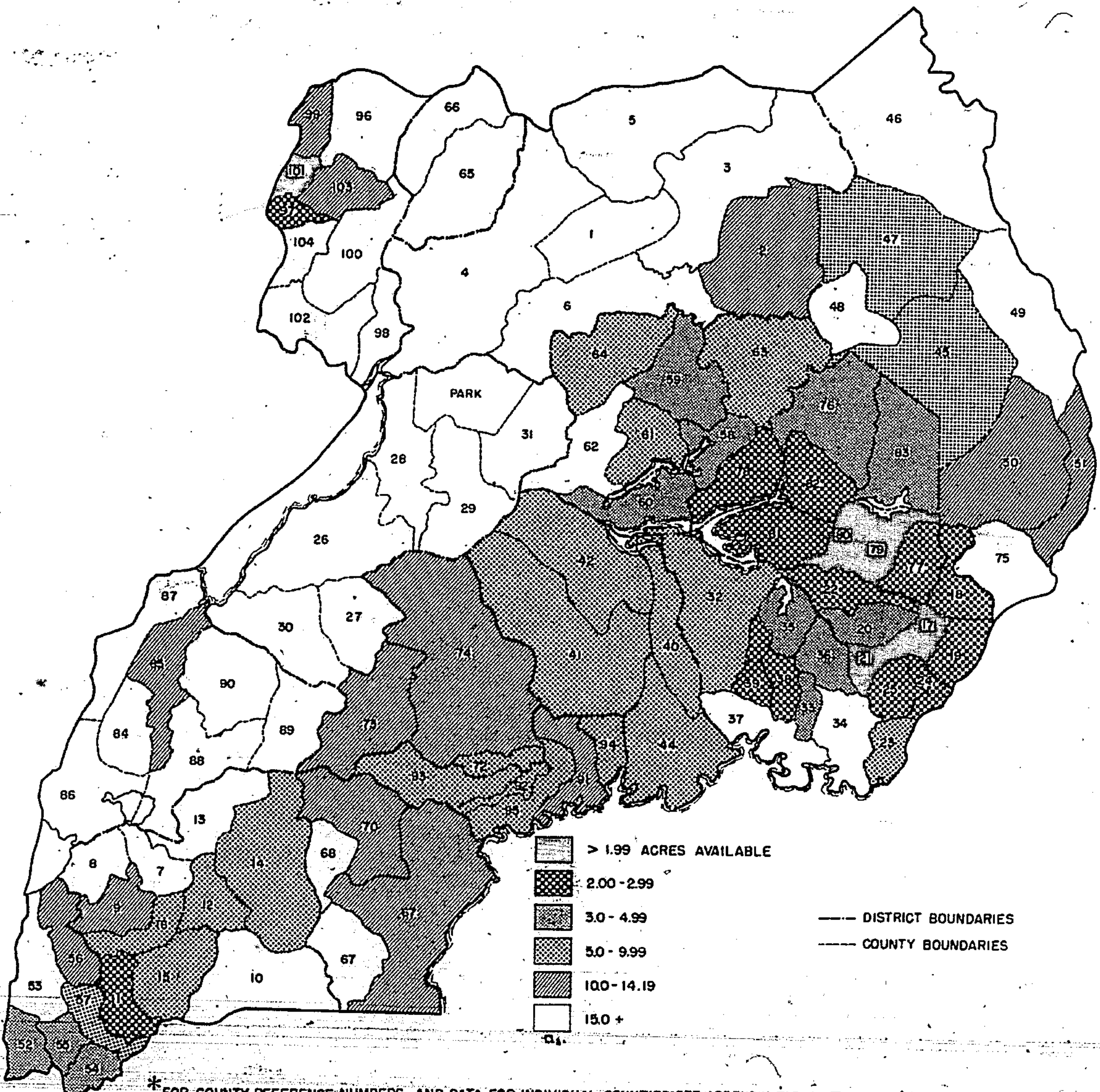
2. For a further descriptive review of the distribution of cattle in Uganda, including dot maps, see 12, pp. 63-73 and 40, pp. 541-554; and in Africa 41, pp. 52-58.

The acres of available grazing per head of cattle are summarized by county in Map 4. Map 4 illustrates the variability in stocking rates between counties and the concentration of cattle in the Eastern Region. Individual counties in Ankole, Kigezi and West Nile also have above average stocking rates. It is of particular significance that the cattle population in 28 of 71 counties for which comparative data are available declined between 1958 and 1968. Eighteen of the 28 are within the Eastern Region. These 28 counties contain about one-third of the existing cattle population. The cattle population of these counties cannot be expected to expand significantly without pasture improvement. The reasons for the decline in cattle population in these counties are not known precisely, but they certainly include the growing pressure of cultivation.

Zones with low population densities in relation to carrying capacity can easily absorb a rapid population increase. However, the fear is often expressed that in zones at or near their maximum carrying capacity, animal health projects designed to reduce calf mortality will be self defeating. This fear follows from the presumption that cattle owners will retain additional cattle resulting in more severe overgrazing, a decline in average productivity, and ultimately an increase in mortality from starvation. While using this argument as an excuse to do nothing about disease losses is a "classical example of negative thinking" (5), it does raise important questions which cannot be ignored.

It is paradoxical that, provided bush regeneration is under control, controlled overgrazing appears to be a desirable management prac-

MAP 4. UGANDA: ACRES OF AVAILABLE GRAZING PER HEAD OF CATTLE BY COUNTY*



*FOR COUNTY REFERENCE NUMBERS, AND DATA FOR INDIVIDUAL COUNTIES SEE APPENDIX TABLE III tice and the one which will maximize the production <u>per unit area</u> from Ugandan pastures. Dense stocking rates which force cattle to graze down the coarse, woody grasses (*Hyparrhenia sp.*) combined with the removal by hand of weed grass (*Cymbopogon afronardus*) permits the spread of some of the shorter, more nutritious species (*Brachiaria sp.*, *Andropogon sp.*, *Panicum maximum*, *Cenchrus ciliaris* and others) (67, pp. 40-51; 171, p. 17). Intensive grazing also makes for easier ox-cultivation (84, passim). For these reasons, in the more favored agricultural areas of Uganda, overstocking may be a serious problem but is seldom catastrophic. In fact, increased cultivation and stocking density in many areas would be expected to improve pasture quality and total meat and milk production. In forest and savanna woodland areas the removal of trees for cultivation and firewood reduces the competition for soil moisture and sunlight and encourages a more vigorous sward of pasturage, improving the carrying capacity. At the other extreme, continuous cultivation of food or perennial crops may prevent grazing or fodder production as land uses. It is commonly observed that in conventionally managed Zebu herds, cattle which are not under the immediate effects of lactation, plowing, weaning, disease or prolonged drought appear to be in good physical condition. Death by starvation is rare. Nevertheless, there is little doubt that malnutrition is the principal cause of observed differences in production per animal between conventionally managed herds and herds on experimental stations.

The evidence is that where there are agricultural alternatives to grazing as a land use, as there are in Zones I-IV, the cattle population has been voluntarily controlled before the advent of severe overgrazing and losses by starvation. The irreversible expansion of land under cultivation will continue to act to restrict any general improvement in productivity and will increase the labor required to herd cattle and protect fields from trespass. Because the general level of profitability has constrained the cattle population in the past, tick control should not result in an explosion in the cattle population in areas with above average agronomic potential. However, lower calf mortality will have an impact on the age/sex structure of the herds in these areas (see Chapter VII).

Disease control may contribute to overgrazing and range deterioration in the semi-pastoral areas where arable cash cropping is not a viable alternative to grazing as a land use (Zones V and VII). The western counties of Ankole which were not invaded by tsetse have excessive cattle populations under present forms of management. In the counties recently cleared of tsetse, the cattle population is growing rapidly. This fact is illustrated by the cattle population data for Ankole District and for Nyabushozi County in eastern Ankole:

Cattle Population Ankole

Year	Nyabushozi	Total Ankole
1959	10,009	238,398
1967	84,125	333,715
1969	120,374	431,176

Cattle population in Ankole District increased 81 percent between 1959 and 1969, or 190,000 head. The growth resulted from the migration of herds into the area from Buganda and Rwanda and from natural increase. In this same 11 year period, the population of Nyabushozi County grew by 110,000 head, absorbing nearly two-thirds of the increase. Excluding this county, the population of the District grew only 35 percent in 11 years.

The tsetse clearance program temporarily defused the overstocking problems of Zone V. If the full benefits of production and productivity from tick control and tsetse clearance are to be realized, the cattle population must be limited to the carrying capacity of the range land. Reserving land for the exclusive use of "modern" ranching schemes will only compound the problems and repeat the mistake made so often in Africa of confining the conventional cattlemen to a restricted acreage (70 and 99). It is also imperative that ways be found to facilitate the migration of herds from areas of overstocking to those with lower stocking densities, and where it is necessary to limit cattle numbers, to provide households with alternative sources of food and income.

Although there are areas of overgrazing, Uganda is fortunate in that there is still room to expand the cattle population substantially. The acreage of land available for grazing and the acres of unimproved grazing required to support one head of cattle in each district are shown in Tavle IV. These range from two to five acres, depending on soils and rainfall. The theoretical maximum cattle population each district could support without pasture improvement--exclusive of game parks and reserves--is also given in Table IV. Without pasture improvement the total cattle population of Uganda could more than double from the present 4.1 million to over 11 million head. This increase will not be costless as it presumes further tsetse elimination, bush clearance and the settlement of livestock owners in new areas. With enclosure and pasture improvement the future cattle population could exceed this hypothesized maximum.[3]

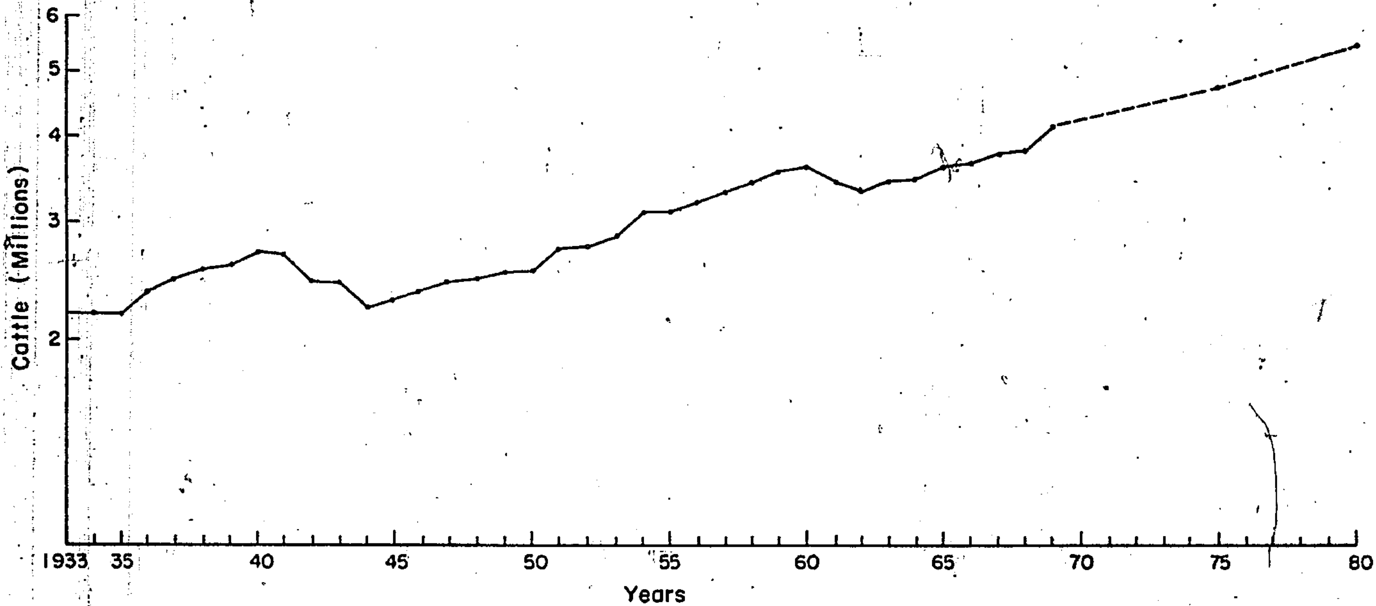
The Projected Growth of Cattle Numbers

Drawing upon historical trends in cattle numbers, knowledge of present and possible stocking densities and a subjective assessment of growth possibilities in each district, it is possible to project the probable growth rate of the cattle population during the next two plan periods.

The long run trend in total cattle numbers over the period 1933 to 1969 has been upward at roughly two percent per year (Figure 3.1). Fluctuation in the rate of growth between years is probably exaggerated but can often be traced to actual events (floods, droughts, migrations, political unrest, epidemics or price fluctuations). For example, cattle numbers declined during the war years. This period coincided with the furthest advances of tsetse fly and rapidly rising cattle prices. Annual Reports indicate that because of a marked improvement in cattle prices, it was necessary to start a campaign in Teso and Lango Districts to discourage the sale of large numbers of immature and productive stock (115, p. 106). Cattle numbers in 1960-61 declined as a result of unusual

3. With pasture improvement and rotation, carrying capacities in Uganda range from 0.5 to 2.0 acres, depending upon soils and rainfall.

FIGURE 3.1 TREND IN CATTLE NUMBERS 1933-1969 AND PROJECTION TO 1980 (Semi Logarithmic Scale)



weather conditions. Numbers were up sharply in 1969 because of more accurate enumeration during a Rinderpest vaccination campaign and the organization of owners for tick control and also because of declining mortality.

The cattle population of each region for the years 1945, 1955, 1967 and 1969 and a projected cattle population for the years 1975 and 1980 are shown in Table 3.2. The percentage annual rate of growth in the population of each region for the periods 1945-1955, 1955-1964 and 1945-1969 and the projected growth rate for the cattle population over the period 1969-1980 are given in Table 3.3. The projected growth rate of each region is the average of district projections contained in Table V. Positive growth rates of 1.0 percent are anticipated for the Eastern Region and Karamoja District, where cattle densities are high and positive rates of 2.3 percent in the Western and Northern Regions and 3.8 percent in Buganda where the population can expand more easily. The average rate of growth for the nation should be about 2.5 percent per year or about 0.5 percent faster than the historical average. If Karamoja is excluded the projected growth rate increases to roughly 2.6 percent per year. The population should grow from the 1969 estimate of 4.1 million cattle to 5.4 million by 1980. The increase in cattle numbers will contribute to an expansion of meat and milk production (see Chapters VIII and IX).

Over the next two plan periods a growing proportion of cattle will be on enclosed farms. The present and a projected breakdown of the population between conventionally managed herds and enclosed farms and

TABLE 3.2. UGANDA: CATTLE POPULATION BY REGION, 1945, 1955, 1967, 1969 AND PROJECTIONS FOR 1975 AND 1980*

(Thousands)

Region	1945	1955	1967	1969	1975	1980	Projected Growth Rate per Year[a]
Northern	432	507	704	777	948	1,126	3.5
Eastern[b]	937	1,191	1,108	1,201	1,283	1,350	1.0
Karamoja	392	557	729	690	732	770	1.0
Western	288	358	544	719	882	1,057	3.5
Buganda	245	481	696	749	930	1,128	3.8
Total	2,294	3,094	3,780	4,145	4,765	5,431	2.5

*Source of data for 1945, 1955 and 1967; Uganda Veterinary Department, Annual Report, various years.

a. Probable future growth rate based on historical trend, 1945-1967 and subjective assessment of future growth potential, 1969-1981.

b. Excludes Karamoja, an Eastern Region District.

TABLE 3.3. UGANDA: PAST TRENDS IN CATTLE NUMBERS BY REGION, 1945-1968 AND EXPECTED GROWTH RATE, 1968-1981*

	Compound Growth Rate, Percent			
	1945-1955	1955-1969	1945-1969	Projected Growth Rate[a]
Northern	1.6	3.1	2.5	3.5
Eastern[b]	2.4	0.1	1.0	1.0
Karamoja	3.6	1.6	2.4	1.0
Western	2.2	5.1	3.8	3.5
Buganda	7.0	3.2	4.8	3.8
Uganda	3.0	2.1	12.5	2.5

*Compiled from census records of the Dept. of Vet. Services.

a. Probable future growth rate based on historical trend, 1945-1967, and subjective assessment of future growth potential (see Table V).

b. Excludes Karamoja.

ranches is shown in Table VI. The estimated growth rate of the cattle population under conventional management is 2.2 percent per year and that of enclosed farms and ranches, 6.6 percent per year. The basis for projecting cattle on enclosed dairy and beef ranches may be found in Chapter VIII.

The Age/Sex Structure in the National Herd[4]

In addition to the annual census of cattle conducted by the Department of Veterinary Services, census data are also available from the sample Census of Agriculture compiled by the Ministry of Agriculture in 1963/64.[5]

Although the principal objective was to compile data on size of holdings, crop acreage and the like, the Census of Agriculture enumerated the herds by age and sex during each of three visits. The cattle population was divided into six major categories:

Male calves	Female calves
Bulls	Heifers
Bullocks	Cows

4. This section and the following one draw heavily on Chapters I and IX of Uganda, Ministry of Animal Industry, Game and Fisheries, Report of the Committee on the Marketing of Livestock, Meat, Fish and Their Products in Uganda (Entebbe, 1969). The author was a member of this committee and prepared these two chapters as well as sections on cattle prices and cattle available for export.

5. The basic design of the Census was a two-stage sampling frame with the district as the first stratum. A 10 percent sample of parishes was drawn and roughly one farmer in 10 within the parish was visited three times during the enumeration period. The final sampling fraction was roughly one in one hundred farms or about 12,000 holdings (206, pp. 7-14). Certain previously confidential summaries of parish totals and individual questionnaires were made available for this study.

The results of this Census are given in Table VII, and the percentage of the population in each category in Table VIII.

In either 1967 or 1968 or in both years, the staff of the Department of Veterinary Services also enumerated the cattle population by age and sex in all districts except Teso and Karamoja. The objective was to obtain benchmark data which could be used to assess the impact of tick control.

The gross estimates of the cattle, sheep and goat populations by district from the Census of Agriculture and the Veterinary Census for 1964 are compared in Table VII. The comparability of the gross estimates for Eastern and Northern Region districts are generally good. However, the Census of Agriculture estimates of the cattle, sheep and goat populations are substantially below that of the Veterinary Census in Ankole and Kigezi and roughly 100 percent below those for Buganda Region. The most probable explanation for this discrepancy is that the Census of Agriculture undersampled transitory Bahima herds.

There is, however, substantial agreement between the two censuses as to the age/sex composition of the herds by district (compare Tables VIII and 3.5). There is one important difference in definition--the Agricultural Census defined "calf" as any animal under one year of age, while the Veterinary Department used the more practical field definition of any animal still nursing. The estimated number of cattle in each category for each region is given in Table 3.4, and the percentage in each category by district in Table 3.5.

TABLE 3.4. UGANDA: ESTIMATED NUMBER OF CALVES, FEMALES, MALES AND TOTAL CATTLE, BY REGION, 1967*

(Thousands)

	Calves	Females	Males	Total Cattle
Northern	121	385	197	704
Eastern[a]	181	620	306	1,109
Karamoja	124	452	153	729
Western	87	363	93	543
Buganda	101	462	133	696
Total	614	2,283	882	3,780

*Source of Table: Uganda, Min. of Anim. Ind. Game and Fish, Report of the Committee on the Marketing and Livestock, Meat, Fish and Their Products in Uganda (Entebbe, 1969). Estimated and compiled from Records of the Veterinary Department and the Uganda Department of Agriculture, Sample Census of Agriculture, vols. I and II.

a. Excludes Karamoja.

TABLE 3.5. UGANDA: ESTIMATED AGE/SEX COMPOSITION OF CATTLE BY DISTRICT, 1968*

(Percentages)

Region	Calves	Heifers	Cows	Males
Northern Region				
Lango	16.4	19.1	34.1	30.4
Acholi	16.0	19.0	35.0	30.0
W. Nile	21.4	18.0	43.8	16.7
Madi	18.1	20.1	42.5	19.3
Average	17.3	18.9	36.3	27.5
Eastern Region				
Busoga	16.5	22.5	39.4	21.6
Teso[a]	15.4	19.8	33.4	31.4
Bugisu (1967)	19.5	19.4	43.3	17.8
Sebei	15.8	15.9	36.8	31.5
Bukedi	16.5	20.7	34.5	28.3
Average	16.1	20.3	35.7	27.8
Karamoja	17.0	16.4	45.5	21.0
Western Region				
Ankole	15.6	25.4	41.7	17.3
Digezi	16.0	23.7	44.3	15.9
Toro	20.5	25.5	38.3	15.7
Bunyoro[b]	16.6	23.6	40.2	19.5
Average	16.4	25.0	41.6	17.0
Buganda				
W. Mengo	17.0	24.5	43.7	14.9
E. Mengo	13.9	21.5	43.3	21.3
Mubende	13.7	21.4	47.1	17.8
Masaka	13.8	23.7	46.2	15.9
Average	14.5	22.2	44.7	18.7
Average Uganda	16.3	20.4	40.2	23.1

*Compiled from unpublished records of the Dept. Vet. Services.

a. Percentages for Serere County Special Census conducted by the Research Division.

b. Excludes 20,000 cattle on ranching schemes.

The data clearly illustrate the differences between the eastern and western management areas. In Buganda and Western Region, female calves exceed male calves in the herds. In the western management area the herds are definitely oriented toward supplying milk for family consumption rather than toward beef production with more than 60 percent of the population recorded as heifers and cows. Yeomen farmers in Zone II and those farmers with access to milk collection centers are also concentrating on commercial milk production rather than beef, a factor which will tend to curtail the growth of the meat supply.

Referring again to Tables VIII and 3.4, the often stated impression that the ratio of adult females to males is 1:1 has no basis in fact. For Uganda the ratio is close to 2:1. The ratio is lowest in the eastern ox-cultivation area where the economic value of bullocks is greater. In this area the ratio of male calves to female calves is 1:1. Where ox-cultivation occurs, all male calves are retained in the herds as potential plowing cattle. Unpublished records from the sample <u>Census of Agriculture</u> suggest that over 22 percent of the cattle in Teso and 15 percent of those in Lango are trained as draught animals. In a very real sense, a man's present and future wealth and well being are determined by the cattle he owns.

Although the exact number of trained oxen is unknown, it is possible to estimate their numbers. The percentage of male cattle in the population of each district as estimated by the 1964 and 1968 censuses are shown in Table IX. The percentage of males in the population of the Eastern and Northern Region districts where ox plowing and cotton production occur widely is roughly 28 percent. That for the Western and Buganda Region districts and that of Karamoja is only 15 percent. There would need to be at least 100,000 plowing cattle in the Northern Region and 175,000 in the Eastern Region to account for the differences in herd composition, indicating the importance of ox-cultivation in shaping the age/sex ratio and marketing patterns of the Eastern management area.

The contribution of ox-cultivation to rural incomes is substantial. Uganda leads in the development of ox-cultivation in East Africa (22, p. 3) and there were an estimated 84,000 ox plows in 1960 (115, p. 96). A major proportion of the land cultivated in the Eastern and Northern Regions is believed to be ox plowed, but this is inadequately documented. Ox teams of two or four animals are said to be able to plow one half acre per day and to supply tractive power for 15 acres of cultivation per year (63, p. 13). It can be conservatively estimated that oxen are cultivating upwards of 1 million acres per year. The standard charge for plowing one acre is Shs. 40 with two plowings required for an adequate seed bed preparation. Thus the value of ox plowing may be on the order of Shs. 40-80 million per year to cattle owners.

The benefits of tick control to the ox-cultivator could accrue in several ways. The lower calf mortality and faster gain in weight could reduce the initial cost of ox teams and speed the adaption of ox-cultivation. Second, it is quite probable that oxen, freed of the tick burden, could cultivate a greater acreage. The better grown cattle might permit the use of more sophisticated equipment which requires more draft power. Finally, culled oxen would have a higher salvage value. Further comments on the benefits of ox-cultivation to the economy are found in Chapter X.

The Extraction Rate in Uganda

The data on the age/sex structure of the herd also provide a basis for a preliminary estimate of the percentage of the cattle population marketed annually, or the "extraction rate."

It is first necessary to define "extraction rate" rather carefully. The definition in common East African usage amounts to a "hide extraction rate," or the number of hides purchased for export, divided by the cattle population. The East African Livestock Survey (52, Chapter XIV) and the Department of Veterinary Services use this definition. The presumption is that each hide exported represents one animal slaughtered for beef. In the last 12 years the "hide extraction rate" has varied from 11 percent in 1958 to a high of 20 percent in 1966 and declined again to roughly 12 percent in 1968. Surprisingly, numbers of cattle marketed have not changed or fluctuated markedly during this period in the way one would expect if hide purchases in Uganda accurately defined slaughter for consumption.

One simple table showing the hide extraction rate by district would have deflated downward by 6-8 percent the average "hide extraction rates" of the period 1960-1966. Hide purchases by district for selected years are compared with the cattle population of 1967 in Table 3.6. The 1966 "hide extraction rate" for Kigezi is 69 percent, a rather improbable figure. The rates for Ankole, West Nile and probably other districts are above normal expectations and reflect a large number of hides, and to a lesser extent cattle, originating in Tanzania, Rwanda, Congo and the Sudan. Aldington and Wilson in a rather careful analysis of Kenya

TABLE 3.6. UGANDA: HIDES PURCHASED BY DISTRICT, 1958, 1961, 1966 AND 1967 AND ESTIMATED CATTLE POPULATION, 1966

District	Cattle Population 1966	Hide Purchases 1967	1966	1961	1958
	Thousands				
Region I					
Masaka)		31.4	39.2	45.9	31.0
Mengo)	658	78.7	115.4	122.4	95.5
Mubende)		2.9	4.2	5.8	3.8
Ankole	334	40.7	72.2	41.4	18.2
Kigezi	97	23.2	67.5	44.2	5.5
Toro	70	16.0	18.9	10.8	7.9
Bunyoro	38	3.6	5.6	2.5	c
Sub Total	1,197	196.5	333.0	273.0	161.9
Region II					
Mbale[a]	298	89.6	105.7	120.0	82.0
Busoga	219	44.5	50.5	40.0	26.1
Toso	577	62.0	73.6	74.5	53.5
Lango	327	31.2	42.6	29.5	25.0
Karamoja	742	24.6	31.3	53.8	8.3
W. Nile[b]	145	46.4	71.5	61.8	32.1
Acholi	177	5.8	10.0	3.9	c
Sub Total	2,485	304.1	385.2	383.5	227.9
Total	3,682	500.5	718.2	656.5	389.8

Source of Table: Uganda, Min. of Anim. Ind. Game and Fish, Report of the Committee on the Marketing of Livestock, Meat, Fish and Their Products in Uganda (Entebbe, 1969).

a. Includes Bugesu, Sebei, Bukedi.

b. Includes Madi.

c. Less than 500.

data suggest a 13.2 percent hide extraction rate for Kenya (2, p. 8). Because Uganda does not have a large ranching sector, it is doubtful that the rate in Uganda is as high as the Kenya figure. Assuming a more realistic average "hide extraction rate" of 12 percent, over 250,000 hides exported from Uganda in 1966 were very probably of foreign origin and did not represent slaughter for meat in Uganda. This large influx of hides, touched off by the political disturbances in the Sudan, Congo and Rwanda, dropped off drastically in 1967 and again in 1968 when hide prices fell in world markets.

Clearly, hide exports are an unsatisfactory index of herd productivity. The "hide extraction rate" includes nearly all cattle which succumb to a butcher's knife regardless of their age and health plus any fallen hides. Throughout Africa where incomes are low, cattle about to die of old age and disease are salvaged and the meat used for family consumption, or the meat is used in lieu of cash to pay for casual labor. It is particularly difficult to estimate this contribution to the meat supply.

A second possible definition of extraction rate would be the "commercial extraction rate." This would include cattle slaughtered commercially and also those cattle retained in the national herd to increase the size of the breeding herd. Retaining additional breeding stock reduces the number of cattle marketed in the short run but obviously increases it in the long run. In an area with a markedly growing cattle population, the extraction rate would be expected to be below the national average.

A final definition of extraction rate we will call the "marketed extraction rate," or the cattle available for commercial slaughter. This latter ratio is generally lower than the "hide extraction rate" but could exceed temporarily the "commercial extraction rate" if cattle in excess of natural increase were to be marketed. It is the marketed extraction rate which defines the beef supply in any one year (see Chapter VIII).

The data on herd composition indicate that unweaned calves comprise only 16.6 percent of the total cattle population, and there are roughly 41 unweaned calves per 100 cows. Calves born would be considerably greater than this, perhaps 60-70 percent of cow numbers, but because of high calf mortality and the slaughter of unweaned male calves, it is doubtful whether more than 15-18 calves would enter the herd per 100 cattle. Adult mortality is not known precisely. The long calving interval and high calf mortality require that cows stay in the herd to advanced ages just to replace the present population and to account for the observed growth in cattle numbers. Only the male calves are surplus for sale in most herds or at the most 6-7 percent of the cattle population yearly. In addition, cull cows and barren heifers add to the meat supply.

In 1967, only 882,000 of 3.8 million cattle were males past weaning age (22 percent). If 35 percent of this group were to be marketed each year--35 percent of 882,000, or 7-8 percent of the cattle population--at most 300,000 would be available for sale. To this would be added any cull heifers and cows to make up the "marketed extraction rate." It would appear that in the recent past, perhaps 10 percent of the cattle population were surplus for sale from Uganda herds. Another one or two percent may be salvaged and consumed on the farm. A further confirmation of this crude estimate may be found in Chapter VIII.

The "marketed extraction rate" in Uganda is very low in comparison with European and North American figures where the extraction rates in beef herds exceed 30 percent. This reflects the late age of maturity of Zebu cattle, high calf and adult mortality, an emphasis on milk rather than beef production in some herds, the importance of ox-cultivation in some areas, the growth of the cattle population, and to a very insignificant extent, the retention of cattle in the herds past optimum marketing time for social and security reasons. By comparison, the projected marketed extraction rate for the Ranching Schemes in Uganda is 20 percent (152, p. 94), or perhaps twice that of the national herd; this represents the maximum figure which could be obtained in the national Zebu herd.

In summary, the productivity of the national herd as measured by the marketed extraction rate is demonstrably low, as are other common measures of productivity (see Chapter VII). The reasons for low productivity are discussed further in subsequent chapters. Present animal husbandry and agricultural practices reflect the physical resources of each land resource zone, and, to this extent, cattle are integrated into the agriculture of each zone. Programs to modernize livestock production must consider the entire gamut of factors in devising programs to modernize annual production.

Chapter IV

THE HISTORY OF GOVERNMENT PROGRAMS TO MODERNIZE ANIMAL INDUSTRY

The preceding decade, 1960-1970, has witnessed an important shift in Government policy toward the cattle industry. Since Independence, a fact which is by no means coincidental, Uganda has been pressing forward with a vigorous program for the expansion of beef and milk production with a view toward self sufficiency in milk production and the possible export of livestock products. Livestock products are expected to play an important role in the diversification of the economy. By contrast, prior to 1960, livestock development had a low development priority and was not thought to offer a significant development opportunity. In order to understand the reasons for the reversal in the felt prospects for livestock development and the true potential for development, it is necessary to look at the history of Government attempts to modernize animal husbandry in Uganda.

Climate and the Introduction of Exotic Cattle

The important breeds of the world's cattle are usually divided into two distinct species, the *Bos taurus* family without shoulder hump and the *Bos indicus* (Zebu) species which usually carries a shoulder hump.

It has long been recognized that breeds of the _taurus_ group which were developed in the temperate areas of Europe were capable of much higher levels of milk and meat production than those of the _indicus_ group of tropical Asian origin. The differences in productivity result from the higher basic metabolism of the _taurus_ group and their typically faster growth and maturity. Consequently, early attempts were made to introduce _Bos taurus_ or "temperate" breeds into tropical areas as a replacement for less productive _indicus_ types.

Almost without exception, early attempts at the introduction of temperate breeds met with failure. The cattle were observed to graduallly deteriorate, losing weight and producing at rates well below those obtained in temperate climates. The experience in Uganda was no exception and of the "numerous attempts" by both individuals and Government to introduce European breeds into Uganda before World War II, none met with success. Temperate cattle usually died within months of their introduction (85, p. 118). Because veterinarians and animal scientists had failed in their attempts at introduction, they took the position that "climatic factors" made the probability of the successful introduction of temperate breeds of cattle remote (49, pp. 73-84; 148, pp. 523-535; 24, p. 79). These "climatic factors" appeared to include a mix of physical, herd management and social conditions.

The data in support of the position that climate was too severe to allow the introduction of temperate cattle was transposed from other parts of the tropics and from areas where temperate cattle originated. Climatographs, similar to those shown in Figures 4.1 and 4.2, were compared to representative areas of Uganda. Those for elevations below 6500 feet fell outside what has been described as the "comfort zone" of temperature and humidity for temperate breeds of cattle.

The comfort zone of cattle is that range of temperatures within which no demands are made on the temperature regulating mechanism of the animal. This range is from +30° to 60°F (-1 to 16°C) for temperate breeds and 50 to 80°F (10 to 27°C) for Zebu breeds. Below the upper limits no stress due to temperature should be encountered. The comfort zone for crosses between Zebu and temperate cattle are intermediate between these ranges. Ambient temperatures above the comfort zone can result in an abrupt rise in rectal temperature, a decline in food intake, a decline in growth rate, milk production and reproductive performance, and a loss of body weight. This explains in part the observed deterioration of highly productive cattle in tropical climates (239, p. 10). In addition, high absolute humidity adds to the heat load of the animal by depressing evaporative heat loss. At any given temperature, heat stress will be less at lower humidity levels. Also solar radiation in tropical and semi-arid areas can add to the discomfort. Using the criterion of "comfort zone" as a rule of thumb, temperate cattle would not have been expected to thrive in Uganda.

Recent experiences in Uganda and in other tropical areas has indicated that it was the indirect as opposed to the direct effects of climate which were primarily responsible for the past failures of temperate breeds of cattle in tropical areas. These include the effects of climate on forage quality, disease transmission and disease vectors.

Forage production per acre in the tropics often exceeds that of temperate zones but growth of forage and forage quality may be seasonal because of fluctuating rainfall patterns. Most tropical grasses, because of rapid growth and maturity, are high in fiber and low in digestible protein and energy. Temperate dairy cattle with higher biological and productive needs, are unable to consume sufficient energy from grazing "natural" vegetation to maintain production and rapidly lose condition. The extremely poor feeding value of most naturally occurring vegetation was not appreciated until after research on tropical grasses and legumes had begun.

As knowledge of forage production and disease control techniques improved, exotic cattle were introduced successfully into an increasing variety of tropical situations. For this reason the rules of thumb concerning the climatic conditions where temperate breeds of cattle can successfully be introduced have had to be modified. The current rule cautions against their introduction into areas where the mean maximum daily temperature exceeds 80°F (27°C) and relative humidity exceeds 65 percent at 15:00 hours. Temperatures above this level can be tolerated for extended periods of time only if humidity levels are reduced (2: 102). The 27° centigrade rule of thumb presumes that management levels are sufficiently high to provide year round feeding, either from pasture or harvested roughages, and that disease will be adequately controlled. Usually temperatures and humidity above these levels require the use of crossbred or Zebu cattle.

In order to compare the 27° centigrade rule of thumb with actual conditions in Uganda, climatographs for six representative stations are shown in Figure 4.1 and Figure 4.2. Data on the temperature and humidity at these stations is shown in Table X. Figure 4.3 depicts histograms of monthly rainfall at these six stations and several others and Map 5 shows the probability of receiving various rainfall levels, four year in five. Data on the rainfall and a rainfall index of the six stations are given in Table XI.

Within Land Resource Zones I, II, IIc and the more favored parts of Zone V, monthly average temperatures are generally below 27° centigrade and 65 percent humidity and would be considered acceptable for exotic cattle introduction following enclosure and pasture improvement. All have short dry seasons, usually of less than two months and an 80 percent probability of more than 40 inches of rainfall. Land in Zone I, II and IIIc also have above average soil fertility, permitting intensive pasture and fodder management. Almost all of the dairy farms of Uganda are located within these Zones or sub-zones (see Table 9.2). The successful Ankole-Masaka Ranching Scheme is in Zone V.

However, data from stations occurring in Land Resource Zones IIIa and IIIb, IV and VIII indicate that these Zones must be considered submarginal for the introduction of exotic cattle, except under superior management conditions. On average, temperatures are higher, rainfall less well distributed and soils of lower fertility, making successful temperate cattle husbandry more difficult but not impossible. Nowhere in Uganda are climatic conditions severe enough to preclude the use of

FIGURE 4.1. FORT PORTAL, GULU, KABALE: CLIMATOGRAPHS OF MEAN MONTHLY TEMPERATURE AND RELATIVE HUMIDITY

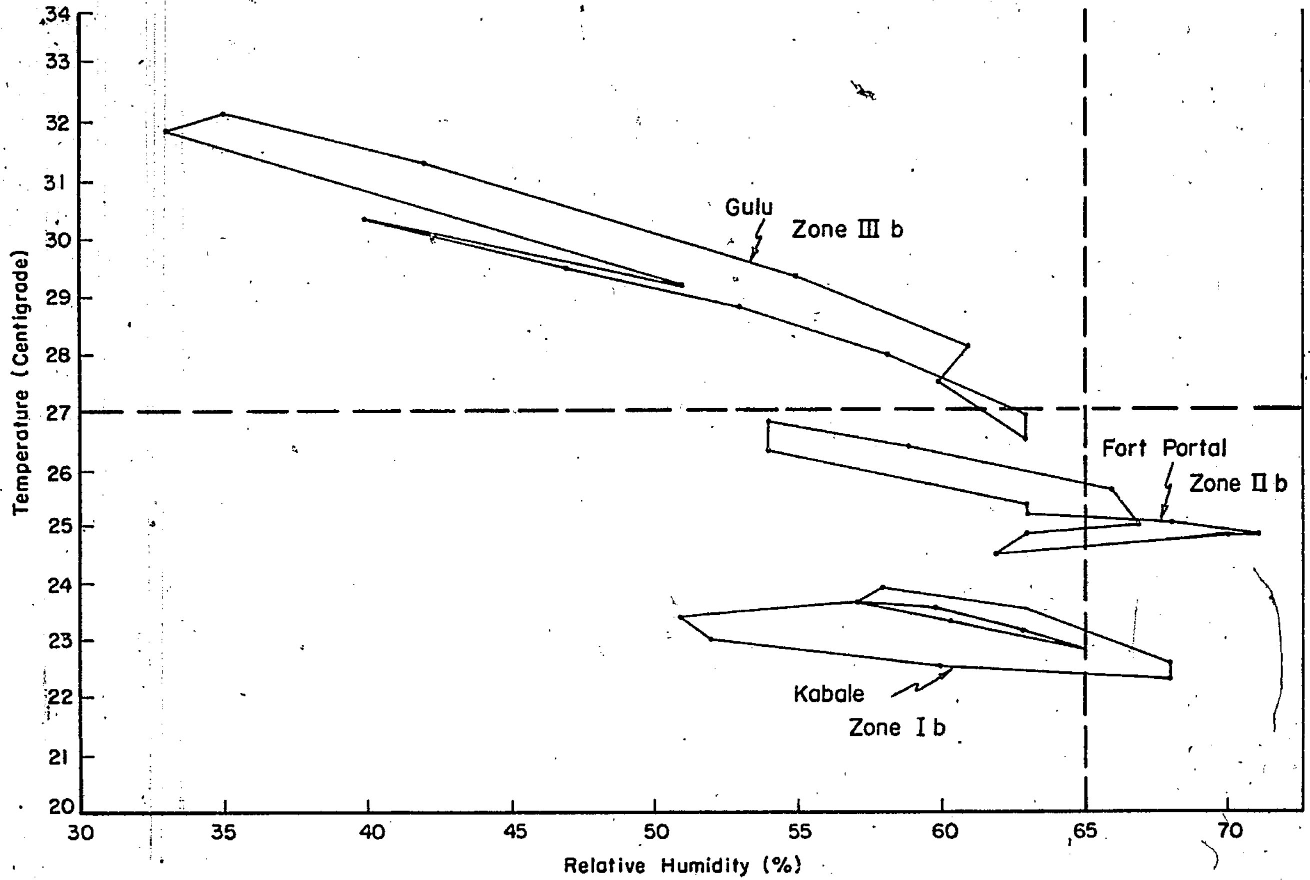


FIGURE 4.2 ENTEBBE, MBARARA, TORORO : CLIMATOGRAPHS OF MEAN MONTHLY TEMPERATURE AND RELATIVE HUMIDITY

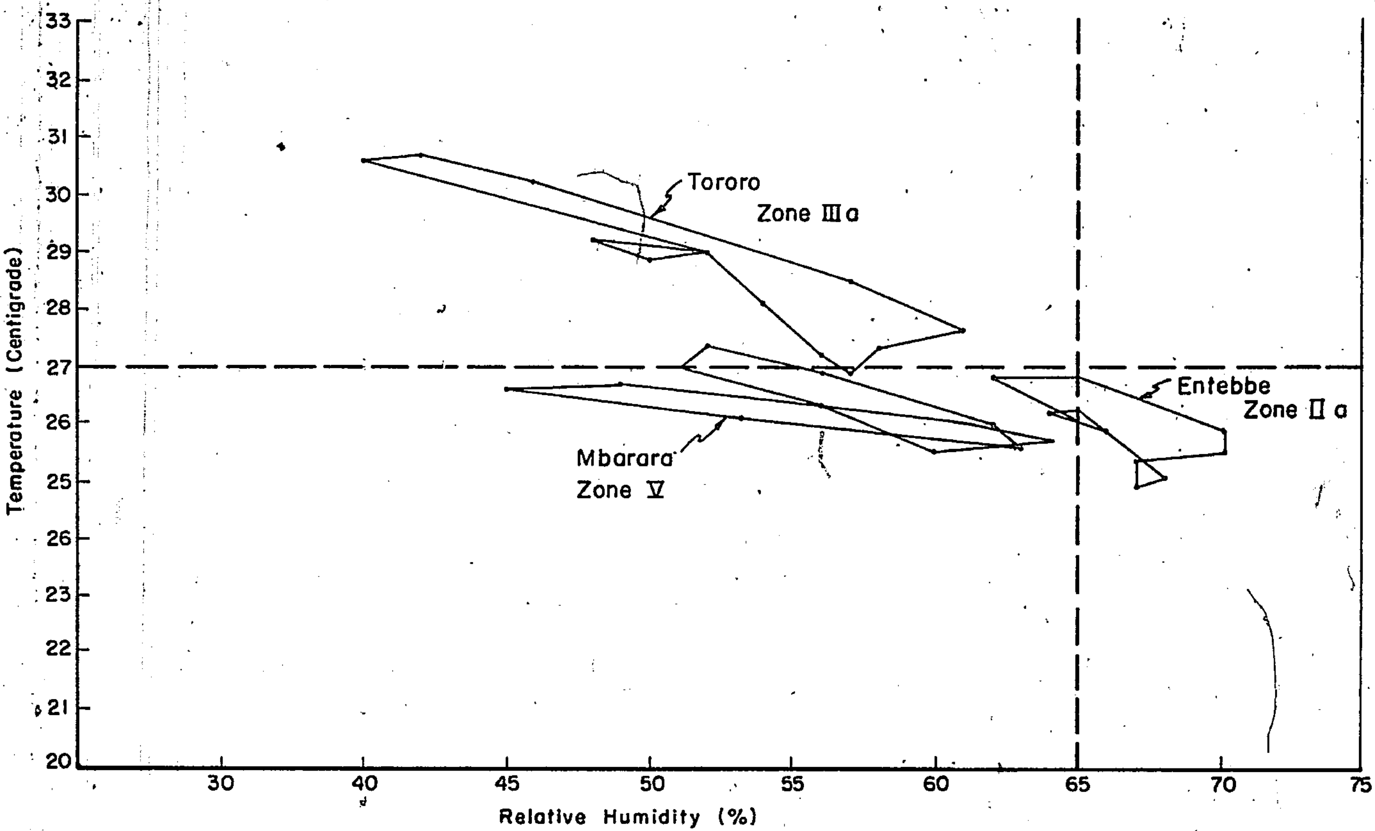
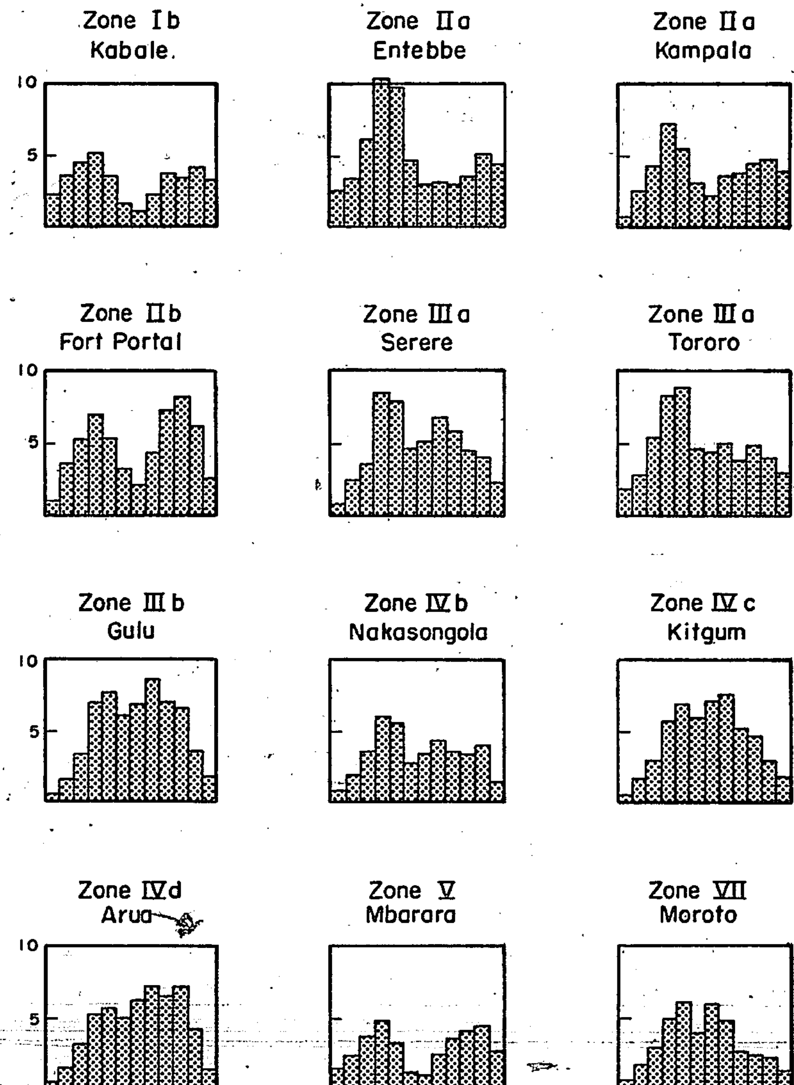
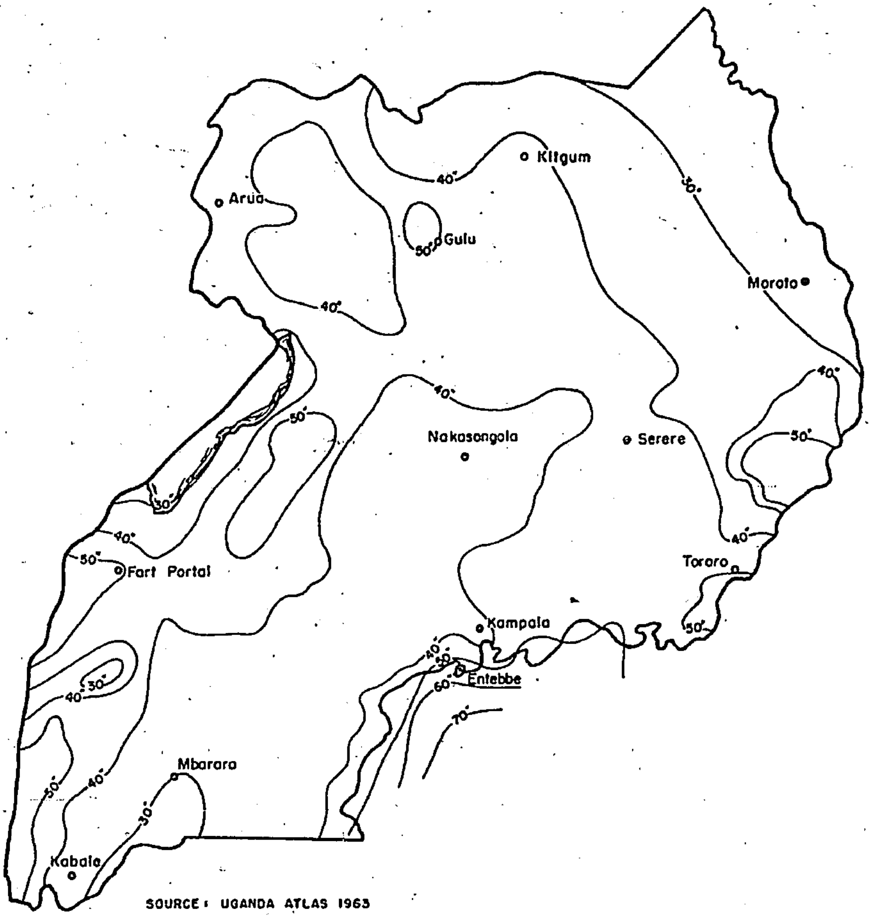


FIGURE 4.3 UGANDA: MEAN MONTHLY RAINFALL SELECTED STATIONS



SOURCE: UGANDA ATLAS, 1963

MAP 5. UGANDA: 20% PROBABILITY OF MEAN ANNUAL RAINFALL (amounts of rainfall that should be exceeded FOUR YEARS IN FIVE)



SOURCE: UGANDA ATLAS 1963

crossbred Zebu/exotic cattle by yeomen farmers where enclosure has occurred, allowing some pasture improvement. The stage was set for major changes in husbandry throughout Uganda with implications for other aspects of agriculture if a minimum level of husbandry could be achieved by farmers.

The following widely quoted excerpt from The East African Livestock Survey summarizes what are now considered to be the prospects for dairy production and exotic cattle introduction in Uganda:

> Few countries in the world can boast of large areas with a higher ecological potential for dairy production than Uganda. The reliable and high rainfall (40 to 60 inches annually), the generally fertile soils, the favorable temperatures (ranging from a mean annual minimum of about 52°F to a mean annual maximum of about 75°F), and the moderating influences of an altitude ranging from about 3,500 to 5,000 feet (which occur together in certain areas of Uganda), combine to produce conditions which are extremely favorable to pasture growth and which, according to present evidence, are compatible with high and sustained levels of production and reproduction in exotic breeds of dairy cattle. (52, p. 174)

The physical factor of climate in itself can no longer be considered a barrier to improved husbandry. On the contrary, the potential for year-round grazing and forage production become extremely favorable factors for change. It now becomes a question of overcoming the secondary effects of climate, particularly disease control but also of obtaining the necessary standards of husbandry to nullify them.

Development Program Prior to Tick Control

The slow pace of livestock development in Uganda in light of the potential for development can be attributed to a number of factors in addition to the perceived low climatic potential. There clearly were prejudices within the colonial administration that for the African livestock owner any livestock development program was unlikely to be successful. The development policies of the Veterinary Department were the selective breeding of indigenous local cattle for use by African owners and the education of the livestock owner in improved husbandry practices.

Although of low production potential, the indigenous stock, through generations of natural selection, are tolerant of local husbandry practices and were at least partially immune to many cattle diseases. It was felt that significant improvements in production could be made if African owners would only "exploit the lead" being given by Government departments and bring their levels of management to that of experiment farms and stations. "Overseas ideas" of desirable levels of milk and beef production and age at maturity were seen as "fundamentally different than those economically possible under systems of management--which could be foreseen in African areas," (paraphrased from 49, pp. 74-79). In other words, until farmers demonstrated their willingness to follow simple management procedures and advice, there was no point in vigorously attacking the problems of expanding animal production. The underlying presumption of the limited extension effort was that a package of improvements was already on hand which would both materially increase production and improve owner income.

The agricultural research budget in Uganda has always been weighed in favor of the export crops with very limited attention given to livestock breeding and husbandry research. Research on the economics of production is notably lacking. Livestock research is divided between two Government departments and several research stations. The important research stations under the Veterinary Department are the Entebbe Livestock Experimental Station on Lake Victoria, the Mbarara Stock Farm in Ankole, and the Nakyesasa Livestock Husbandry Experimental Unit ten miles north of Kampala. The Veterinary Stations concentrate on animal health and production problems. Those under the supervision of the Agricultural Department are the Kawanda Research Station also near Kampala and the Serere Agricultural Research Station in Teso. The Agricultural Stations take a greater interest in integrating crop and livestock production (see Chapter X).

The breeds selected for improvement were the small East African Zebu, common throughout the Eastern and Northern Region, the long-horned Ankole cattle of the Western Region and several intermediate breeds such as the Nganda cattle of Buganda.[1] Of the productive traits, selection

1. Cattle in Uganda are divided into three breed types. The East African Zebu type, found throughout the Eastern and Northern Region, are small animals with a well developed thorasic hump and short lateral horns. Adult females average 260 kg. and males 320 kg. in farmers herds. The Karamojong sub-type is slightly larger. They are about 60 percent of the total population and are used for milk, meat and tractive power. The Sanga or Ankole type, found in the Western Region, are large and up-standing with long lateral horns and a slight cervico-thorasic hump. Adult females average 320-365 kg. and adult males up to 500 kg. in farmers herds. They are about 20 percent of the total population and are used for milk and meat. The Intermediate or Nganda type are crosses of the Zebu and Ankole and exhibit considerable variation in size and conformation. They occur in

was primarily for milk production, because of the importance of milk in the local diet and to the successful rearing of calves. Rate of growth or draft ability apparently were only minor selection criterion (181). Selection was also attempted for resistance to the tick borne disease, East Coast Fever (ECF).

Research in Uganda and elsewhere has shown that there were definite breed differences in the susceptibility to ECF. Calf mortality among healthy, well fed indigenous cattle is on the order of 20-25 percent but mortality among temperate breeds approaches 100 percent. Research has also shown that a reduction in the number of ticks results in a marked improvement in general herd health and productivity and a significant reduction in calf mortality (see Chapter VII). For this reason, a policy of partial tick control was initiated on experimental stations designed to reduce calf mortality and the other deleterious effects of heavy tick burdens. Calves were allowed to contract ECF on the assumptions that survivors would have a greater genetic resistance to disease and improved stock could be distributed to progressive farmers with less fear of mortality.

The extension education effort of the Veterinary Department suffered from a shortage of funds and lacked staff specifically trained to work with livestock owners. As part of the presumed package of available husbandry improvements, the Veterinary Department considered the

1. (cont'd.)
Buganda, Toro and Lango. They are about 20 percent of the population and are used for milk, meat and occasionally for tractive power (115, passim; 149, pp. 298-308).

possibilities of initiating a program of tick control in conventionally managed herds. Individual dips were constructed in the 1930's and a national program of dip construction was considered as early as 1948. However, the expense of constructing the requisite number of dips to deal with the entire cattle population was not thought to be an economic proposition at that stage. However, a research program was begun to find the best ascaricides for use in such a program if it were to prove practical at some future date (219, p. 13).

An interesting innovation in the search for an effective extension approach was initiated about 1944 with the establishment of a limited number of "livestock improvement areas." An advisory committee of both Veterinary and Agricultural officers was set up in an attempt to take advantage of the research and expertise of both services (85, pp. 116-119). One of the first "improvement areas" was established in Kyagwe County Buganda in the heart of the Fertile Crescent.

By concentrating extension efforts on a few farmers it was hoped that once new practices were introduced they would have a spread effect to cattle owners on adjoining farms and in nearby areas. To test out the possibilities of tick control while avoiding the capital and recurrent costs of dip tank construction, the practice of hand spraying with simple bucket and stirrup hand pumps was introduced. The efforts to initiate hand spraying were moderately successful and by 1949 the hand spraying of cattle in the Kyagwe County improvement areas, was a very popular method of tick control. Many farmers and cooperative societies were induced to purchase their own bucket pumps (220, p. 12) (see also Chapter V).

Because of the progress made in Kyagwe County, in 1949 several livestock improvement areas were designated in range areas of Ankole District among Bahima herdsmen. There, according to the officer in charge, "Cattle are owned by Africans, most of whom hold extremely conservative views, especially in respect to their cattle." Tick counts occasionally identified over 1,000 nymphs and adult ticks on individual animals. Less than half this number can cause anemia and tick bite toxicosis. Spraying with "Gamatox," a newly available inorganic ascaricide, reduced tick numbers by 85 percent and brought marked improvements in the health and general appearance of the cattle, presumably improved productivity and the "routine" of regular tick control was accepted. By 1952, 40 cooperative spray centers, catering to about 40,000 cattle were functioning or planned in Ankole. Members paid a subscription of one shilling per year per animal and were seen to be thinking "in a modern way." The officer in charge found the sight of Bahima tribesmen bringing their herds to the crush on the appointed day of the week and with their own hands using a bucket pump to spray their cattle, "a significant advance." He concluded that spraying was only part of a package which involved, "the gradual acceptance, step by step, by the African, of advice and instruction, and much of this can conveniently be given by example" (<u>35</u>, pp. 19-26).

The desirability of not attempting disease eradication but maintaining the natural immunity of the local cattle was stressed in the *Annual Report*. It was stated in 1949 and repeated with minor variations through 1958 that "an accumulation of evidence from many districts suggested that malnutrition and poor husbandry were a far more important cause of calf mortality than disease per se, and that if calves in East Coast Fever endemic areas are maintained in optimum condition, mortality from disease is markedly reduced" (221, p. 3; 177, pp. 391-392). Therefore it was concluded that simple improvements in animal husbandry, of which spraying to reduce tick numbers was a part, would result in a substantial reduction in calf mortality and improved productivity.

The unstated presumption was that Ugandan farmers were not yet at the stage where they would benefit from a program designed to eradicate East Coast Fever. As early as 1950 compulsory disease eradication schemes for African owners had been initiated in other African countries, including South Africa, Rhodesia, Malawi and parts of Kenya and Tanzania. The schemes in South Africa, Rhodesia and Kenya had been initiated at the instance of settlers in order to create a disease free buffer zone around settler farms. As Uganda did not have any large European farms with highly susceptible exotic cattle, there was no pressure from settlers for protection from ticks on African small holdings (35, p. 26). As recently as 1957 the Annual Report stated that the economic importance of (disease) eradication had been "over estimated" for African cattle under African ownership (193, p. 7). The question of the economics of tick control which allows calves to contract diseases and obtain natural immunity versus disease eradication for conventional husbandmen is discussed in detail in the next two chapters.

Abruptly in 1958, the tone of the Annual Report of the Uganda Veterinary Department began to change and it was concluded that, "the time will no doubt come when tick eradication areas can be scheduled" (194, p. 8). A number of private farmers had observed that postwar vector control materials and drugs had permitted farmers in climatically similar areas of Kenya to introduce temperate breeds of exotic cattle to their farms and ranches. However, the Uganda Veterinary Department was so convinced of the inadvisability of introducing exotic cattle to Uganda that the policy was to refuse to issue the health and import permits needed for this importation. After an appeal to the Governor General, two prominent Ugandan farmers, Mr. Jamal Walji and Mr. Mugerwa, were allowed to import cattle after they persuaded the Department that they had only their own money to lose.[2] Both had previously owned indigenous cattle and by systematically spraying their cattle were able to demonstrate that their enclosed farms were substantially free of disease. Their early importations were restricted by the Veterinary Department to the Channel Island breeds because Jersey and Guernsey were presumed to be more heat tolerant (148, pp. 123-29). These two farmers were followed quickly by others who were looking for the higher yielding cattle needed to supply the lucrative fresh milk in the rapidly growing urban market. In so doing they proved that "climate" was not an absolute barrier, that disease eradication was possible on Uganda enclosed farms and that given sufficient opportunity, African farmers could successfully husband exotic cattle.

The Veterinary Department remained convinced that even if disease

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2. Earlier successful introductions may have occurred under zero grazing conditions. These were the first two introductions which could be verified where cattle were grazed on pasture.

were to be controlled climate would quickly prove too extreme for purebred temperate stock. Therefore, a cross breeding experiment using imported Jersey semen on Nganda cattle was started at the Entebbe and Nakyesasa Livestock Experimental Stations in 1959. However, it continued separate breeding herds of indigenous cattle selected for disease resistance. This program was not abandoned completely until 1966.

In the same year, 1959, high grade and purebred exotic cattle began to be successfully introduced by small scale African farmers in Kyagwe County. The stage had been set 15 years earlier by the Livestock Improvement Project Areas which were important in introducing the improved husbandry techniques necessary for the successful introduction of temperate cattle. Farmers in the area had been organized into educational, self-help and tick control societies and it was the members of these societies who demanded policy changes and were to lobby for tick control legislation. One Veterinary Assistant, a dairy farmer himself, led a delegation of farmers to Kenya at their own expense to observe husbandry techniques and to dramatize the fact that African farmers were already keeping exotic cattle in Kenya (156). The pressure for more progressive policies on the part of the Veterinary Department Administration came from the bottom up and was prompted by the prospects for milk sales to the newly prosperous coffee farmers and expanding urban population (see Chapter IX).

The example of yeomen farmers successfully maintaining exotic cattle and "insistant farmer demand for legislation to make tick eradication compulsory," won over even the most "conservative" Veterinarians. Farmers, principally those in the area around Kampala and in parts of Ankole, Toro and Busoga were already voting for a more progressive program of tick control by supporting 324 communal spray centers while an additional 329 individual farmers had private facilities by the end of 1960 (196, p. 5). These were all prior to the enactment of any national tick control ordinances mandating tick control but it should be noted that the hand spraying program had reached less than five percent of the cattle population (see Table 5.1).

By 1961 the Veterinary Department had begun to press for new disease ordinances which would allow the establishment of compulsory tick control in selected areas. In contrast to three years earlier when tick eradication was seen as uneconomic, the Annual Report concluded:

> Very little can be accomplished in terms of increased productivity until Uganda follows the lead of most other African states and introduces compulsory tick eradication. African farmers have demonstrated the undoubted value of exotic stock under isolated regimes of strict tick control. However, sooner or later the hazards of tick borne diseases will put these people out of business unless their complacent and indolent neighbors can be compelled to take a more realistic attitude towards tick control. If Uganda is to attain the wealth from livestock it richly deserves, progressive farmers must be given every encouragement, even if it involves exclusion of the poor farmer from the better land (197, p. 5).

This quote is extremely significant for three reasons. First, compulsion rather than persuasion was seen as being necessary to obtain compliance among the majority of livestock owners even when tick control was of "undoubted value." Second, most livestock owners were still seen as "complacent" and "indolent" by which the writer appeared to mean not economically oriented and therefore slow to change traditional ways.

Third, was the controversial suggestion that "poor" farmers should be excluded from the better land. This would introduce the criteria of proper land usage and cattle management as prerequisites for permission to use land and own cattle, an echo from an earlier colonial period. This argument underlies the rationale for ranching schemes and some other major livestock development projects. Land tenure issues are discussed more fully in Chapter X. The 1961 Report continued:

> The general apathy towards preventive medicine results in the unnecessary mortality of many thousands of livestock. So long as the average man can indulge in the luxury of regarding his cattle as a mark of his social prestige, rather than a source of income, incalculable numbers of animals surplus both to the economic requirements of the farm and available grazing, are left to die either of old age or starvation (197, p. 5).

These statements made in the Annual Report of the Department charged with extension work among livestock farmers, indicate a curious lack of understanding of their economy. It is a prime example of the prejudice toward farmers who own livestock which existed even within the Veterinary Department. It also is an example of transferring blame for the limited success of an extension program to the "conservative" farmer, rather than examining the program for weaknesses. Producers interested only in large numbers would be expected to clamor for disease control in any form in order to prevent mortality. One might have expected this argument to be used to explain the surprising early success with tick control in southern Ankole. An alternative interpretation of their seeming "apathy" would be that the benefits of tick control using hand spraying techniques were not sufficient to induce farmers to incur the costs of tick control except in special circumstances.

Indeed, until just three years previously, the Department held, possibly with good reason, that disease eradication was at that time uneconomic under most conditions prevailing in Uganda. It remains to be seen whether economic conditions have changed sufficiently to induce a majority of farmers to comply with the new tick control ordinances.

Breeding and Selection Policy for Indigenous and Exotic Cattle

Additional factors which brought about the reversal of policy toward livestock development were expanding meat and milk imports from Kenya and the growing realization that the indigenous breeds of cattle could not supply these needs. As breeding and selection work with local cattle progressed, it became increasingly evident that the genetic potential of the indigenous Zebu breeds for milk production is very low. Data on general herd productivity including age at maturity, lactation lengths, calving interval and milk yields from the Entebbe, Mbarara and Serere herds are summarized in Tables 4.1, 4.2 and 4.3. The records are similar to those obtained elsewhere in tropical Africa with Zebu stock. Milk production per lactation averaged slightly more than 200 gallons (900 liters) after records of less than 100 days are excluded. Only an occasional record exceeded 300 gallons (1,400 liters), yields well below those obtainable with temperate dairy breeds under moderate levels of management by African farmers. Ugandan farmers are able to achieve herd averages of 3,500 to 6,400 pounds (1,000-2,960 kilo) per year with tem-

TABLE 4.1. MBARARA AND ENTEBBE: MEANS OF PRODUCTIVE TRAITS--ANKOLE, EAST AFRICAN ZEBU AND NGANDA FEMALES

Trait	Ankole[a] (Mbarara) First Lact.	Ankole[a] (Mbarara) Mature Lact.	E.A. Zebu[b] (Mbarara) First Lact.	E.A. Zebu[b] (Mbarara) Mature Lact.	Nganda (Entebbe) All Lact.
Lactation Milk Yield (lb.)	1662	1945	1346	1356	2270
Length of Lactation (da.)	243	238	244	226	267
Length of Dry Period (da.)	--	97	--	106	153
Calving Interval (da.)	--	342	--	347	420
Age First Calving (mo.)	51.3	--	51.7	--	42.0
Number of Records	33	42	26	37	440

a. Source: G. D. Sacker and J. C. M. Trail, "A Note on Milk Production of Ankole Cattle in Uganda," Tropical Agric., vol. 43, no. 3, 1966. Records below 100 days excluded or roughly 24 percent of Ankole and 35 percent of Zebu records. Completed during the period 1956-1961. Cows milked 2 times daily and calves bucket fed.

b. Source: P. Mahadevan and J. H. S. Marples, "An Analysis of the Entebbe Herd of Nganda Cattle in Uganda," Animal Prod., vol. 43, no. 1, 1961. Lactations below 100 days excluded and yields after 305 days ignored. Period of analysis 1946-1960.

TABLE 4.2. SERERE RESEARCH STATION: MEANS OF PRODUCTIVE TRAITS--EAST AFRICAN ZEBU FEMALES, 1965, 1966 AND AVERAGE RECENT YEARS*

	1966	1965	Previous Mean	Years in Mean
Milk Yield Normal Lactations[a] (lb. a.m. milk)	1051.7	1173.3	1298.0	1953-66
Milk Yield All Lactations (lb. a.m. milk)	890.2	884.2	--	--
No. of Completed Lactations	181.0	134.0	56.0	1953-66
Estimated Total Milk Production (lb.)[b]	1910.0	2130.0	2330.0	1953-66
Days in Milk for Normal Lactation	219.0	255.0	259.0	1953-66
Av. Daily Yield Normal Lactation[a] (lb.)	4.8	4.6	4.9	1953-66
Calving Interval (All Stock) (days)	390.0	381.0	380.0	1942-66
Dry Period (All Stock)	171.0	126.0	142.0	1942-66

*Source: T. H. Stobbs, Serere Research Station, <u>Annual Report Part II (Livestock)</u> 1966-67.

a. Excludes those terminated by death of calf.

b. Estimated by assuming semiranged calves nursed 45 percent of the total milk production.

TABLE 4.3. SERERE RESEARCH STATION: MEANS OF PRODUCTIVE TRAITS--EAST AFRICAN ZEBU FEMALES UNDER VARIOUS MANAGEMENT SYSTEMS 1943-1963*

Trait	Milked-out	Semi-ranged	Suckled
Lactation Milk Yield (lb.)	1737	1177	1167
Length of Lactation	229	232	221
Length of Dry Period	123	156	159
Length of Calving Interval	373	387	382
Age First Calving (mo.)	43.3	43.7	41.2

*Source: T. H. Stobbs, "Management of Small East African Zebu in Relation to Milk Yield, Calf Growth and Mortality," E. Afr. Agric. For. J., vol. 32, no. 3, 1967.

perate breeds--some two to four times those obtained with indigenous breeds (34, p. 50 and Table 4.4).

The continued selection of local cattle for milk production for the conventional husbandman became to be seen as a "most futile and unrewarding occupation" (104, p. 321). As a result, the policy was reversed and breeding and selection work with Zebu breeds was abandoned entirely. Purebred Freisian cattle were successfully introduced at Entebbe in 1962 and at Mbarara in 1964 and purebred Jerseys at Nakyesasa in 1964.

Because exotic dairy cattle introductions were successful, the Department of Veterinary Services introduced Kenya Boran and initiated a Red Pole and a Black Angus crossbreeding experiment at the Ruhengere Field Station, attached to the Ankole-Masaka Ranching Scheme. Both the Boran and crosses of temperate and local Zebu breeds outperform local breeds under enclosed ranch conditions and crossbreeding is now advocated for enclosed beef ranches (200, pp. 33-50). Furthermore, it is now presumed that over the next few generations most Zebu herds will be upgraded with exotic breeds.

As a result, the selection program for superior local stock has been abandoned by all Veterinary Research and Agricultural Stations. The limited research capacity is directed exclusively toward the production problems of the few thousand enclosed dairy farms and ranches.

Because of their much higher productivity and the sizable areas suited for their introduction, it is reasonable to anticipate the continued expansion of the use of temperate breeds of dairy cattle on

TABLE 4.4. ENTEBBE: LACTATION AND ANNUAL MILK PRODUCTION AVERAGES AND CALVING INTERVALS OF TEMPERATE BREEDS, EXPERIMENTAL AND COMMERCIAL HERDS 1962-1966

	305 Day Average Milk Yield (gal.)	(lit.)	Lact. No.	Annual Milk Yield (gal.)	(lit.)	Calving Interval (days)	Lact. No.
	Livestock Experimental Station[a]						
Friesian (heifers)	760	3480	57	702	3190	--	--
Friesian (cows)	850	3870	47	782	3560	450	47
	Commercial Farm[b]						
Friesian	704	3200	16	643	2920	447	15
Jersey	441	2220	29	452	2050	379	27
Guernsey	508	2310	102	501	2280	401	97

a. Uganda: Dept. Vet. Ser., Annual Reports, 1964, 1965, 1966.

b. H. J. S. Marples and J. C. M. Trail, "Analysis of a Commercial Herd of Dairy Cattle in Uganda," Trop. Agric., vol. 44, no. 1, 1967.

enclosed farms. However, the advantages of introducing temperate beef breeds and their crosses over local breeds in beef production are not as great because the heritabilities of the important beef traits are high and rapid genetic progress can be made in a few generations. The present policy ignores the importance of ox-cultivation and the reasonable expectation that most local cattle will continue to use communal grazing for many decades. But, because East Coast Fever must be eradicated before upgrading can take place, the eradication of ECF came to be seen as "the greatest single limiting factor to livestock development" (198, p. 4).

In line with the revised policy, the first compulsory tick control area was implemented in Kyagwe County in 1964 (County No. 44, Map 4). This county is isolated from other livestock areas, making it an ideal pilot disease eradication area. With the growing evidence that upgrading was possible, about half of Uganda was gazetted for disease eradication in 1967 and in July 1968 the Minister of Animal Industry, Game and Fisheries issued an ordinance making most of Uganda a "tick free area." It is now the legal responsibility of farmers to control ticks. Under the ordinance persons found with ticks on their cattle can be prosecuted. The Tick Control Project was initiated in order to enable farmers in endemic East Coast Fewer areas to comply more easily with the new ordinance. In support of this program, sizable resources of money and staff have been committed to the scheme and loans have been obtained from United States and British sources.

Many factors will determine the eventual success or failure of the National Tick Control Project. First, can the technical and organizational problems of the Project be resolved? Their resolution requires greater attention to planning and project management than evidenced in the past, and a major commitment on the part of Government to underwrite the necessary infrastructure and recurrent cost to make the Project a success.

Second, is the upsurge in tick control a genuine awakening of farmers motivated by the economic benefits of tick control or is it in response to some degree of compulsion from the new legislation? For various reasons cotton and coffee, the major cash crops, are becoming less attractive and hence farmers are taking a greater interest in improving or establishing a milk or beef enterprise. Some farmers in Buganda have uprooted coffee to establish pastures. Enclosure is becoming much more attractive as pasture improvement is necessary before the introduction of exotic stock.

Thirdly, can a tick control program succeed where communal grazing remains the rule? Will productivity increases accruing to the typical livestock owner be sufficient to guarantee the willing compliance of 100 percent of the livestock owners. This will be necessary to eradicate East Coast Fever.

These three areas of questioning will be the central themes of the chapters which follow.

Chapter V

PROGRAMS OF TICK CONTROL IN UGANDA AND EASTERN AFRICA--
THE EVOLUTION OF THE TICK CONTROL PROJECT

The Ministry of Animal Industry has stated the goal of the Tick Control Project to be the eradication of East Coast Fever not only from the enclosed farms and ranches but also from conventionally managed herds. While there can be little doubt as to the desirability of eradicating disease, there are serious doubts as to the economic feasibility and the commitment of the Uganda Government to devote the necessary resources to assure its success.

The planning and evaluation of projects of this size and complexity are new to the experience of the Ministry of Animal Industry. Indeed, it lacks both the staff and the data for planning and evaluation. As a result, the program of tick control was to evolve by a process of trial and error, and the solicited and unsolicited offers of foreign assistance and advice rather than by deliberate planning after consideration of alternatives, costs and the experience with similar programs in neighboring countries. It also lacked a clear rationale for determining the appropriate size of the investment in the program.

In planning, costing and evaluating development projects or ongoing programs, appropriate goals can be established only after considering the constraints of budget and manpower and the other priorities which compete for scarce resources in a low income country.

Except for the most dangerous infectious diseases for which inexpensive vaccines are available making eradication practical, the choice in health control programs is usually between attempted disease eradication and the control of disease losses. Providing the relevant data is available, expenditures on specific disease control (or eradication) programs would ideally be expanded until the marginal expenditure on control would equal the marginal return in greater income which could be attributed to that program. In the case of several competing disease control programs or development projects, each program should, in theory, be expanded to the point where the marginal benefits accruing from each program would be equal. There is no guarantee that the optimising point will be the same for the individual livestock owner as for the national economy. More formally, a divergence might exist between the private and the social net marginal product justifying public participation and subsidy.

Animal health programs in Africa have always been highly subsidized. Typically, services are provided free with only minimum charges for vaccinations and drugs. Disease control is considered a public good because the entire society benefits from greater meat and milk production and the resultant lower prices. Furthermore, many disease control programs cannot be organized on a private basis.

Because of a diversity of national development objectives and many unknowns, it is seldom possible to achieve an optimum allocation of funds or to achieve a perfect ranking of development projects. It is, however, possible to investigate the probable financial benefits and costs of projects and the relevant social benefits and costs. In the broadest terms, the objectives of the overall livestock development program are to increase the production of meat and milk as rapidly as possible, consistent with the objective of initiating a broad based advance in household and national income.

The technical and economic considerations which shape the design cost and evaluation of the Tick Control Project are complex. It is not a matter of controlling or eradicating a single disease but rather a combination of four diseases and their vectors and the related secondary infections and debilitation from parasitism. Briefly, there are three alternative objectives for the Tick Control Program which could be adopted either in toto or selectively by area.

A. The first alternative is disease eradication through *tick eradication*. Early documents relating to the program proposed a once and for all tick eradication program supported by an elaborate program to prevent the reintroduction of the economically important disease vectors. A *tick eradication* program is now generally conceded to be beyond the resources of society at this time because of the multiplicity of ticks and diseases, the climate and vegetation, the prohibitive initial cost and the absence of appropriate technology.

B. The second alternative, usually termed *disease eradication*, would be the implementation of a program sufficiently rigorous to eradicate the most economically important disease, East Coast Fever. East

Coast Fever can be eliminated by reducing the incidence of its ~~only vec-tor~~, _Rhipicephalus appendiculatus_, to low levels; East Coast Fever has been successfully eradicated from Southern Africa in this manner. A program with this objective would be considerably less expensive but would require sizable recurrent expenditures for the indefinite future and a rigorous enforcement of control measures.

C. The third alternative would be a program designed to substantially reduce the numbers of ticks and the high mortality associated with tick borne disease, but which would not attempt to eliminate disease. This last alternative, usually termed _partial tick control_, would be the least expensive alternative to implement and could be terminated without risk of severe disease losses.

Although the eventual objective must be to eliminate all disease, the immediate choice is between _disease eradication_ and _partial tick control_. Before budgeting the Tick Control Project in Chapter VI, the arguments for each approach, the experience with eradication programs in neighboring countries, and the experience with the early programs in Uganda, require study. The four diseases--East Coast Fever, Anaplasmosis, Red Water and Heart Water--and their principal vectors are discussed in greater detail in Appendix II. In addition, certain historical information on acaricides and the development of tolerance by ticks to acaricides are discussed in Appendix III.

Partial Tick Control Versus Disease Eradication for Conventional Husbandmen

Although the objective of the Uganda Tick Control Project is often stated to be the eradication of all tick borne disease, the probability of eradicating any of the diseases other than East Coast Fever is remote. The term, eradication, is more appropriately used in connection with the Project to mean solely the eradication of East Coast Fever.

The protagonists for disease eradication in Uganda argue that the presence of ECF and the calf mortality which results from ECF are so high that the added risks and expense of an eradication program are justified for conventional herds. The primary vectors of the four major tick borne diseases are present throughout the zones of higher agronomic potential in Uganda in numbers sufficient to infect most communally grazed animals early in life. The 70-75 percent of the calves which survive the infections are naturally immunized against these diseases. Adults maintain their immunity by periodic re-exposure to infection. A disease eradication program could result in an adult population of animals highly susceptible to all four tick borne diseases. Should the program break down for any reason, death losses from three of the diseases--Anaplasmosis, Red Water and Heart Water--could be minimized by drug treatment and if necessary vaccination (see Fig II), but losses from ECF could be severe as neither specific drug treatment nor vaccine is available. Should a vaccine be developed for East Coast Fever there would be less danger of epizootics, provided the cost of the vaccine is not prohibitive for use with indigenous cattle.

Ranches in the tropics and semi-tropics where ECF does not occur or has been eliminated, practice partial tick control, spraying or dipping cattle at intervals to reduce tick numbers. Calves contract the tick borne diseases prevalent in the area when they are least susceptible (and least valuable); and adults through periodic challenge retain their immunity. Any new stock introductions are artificially immunized upon arrival by vaccination. Under the non-intensive cattle management practices on the ranches and by conventional husbandmen, the returns to disease eradication above the returns to tick control may be slight.

There is evidence that an effective tick control program can reduce calf mortality from ECF in indigenous herds to low levels (see Chapter VII).

Protagonists of a disease eradication program sometimes contend that partial tick control or a poorly executed control program will expose many ticks to applications of pesticide which are not lethal and thus speed the development of acaricide resistance in the tick population (see Appendix III). The weight of scientific evidence is that nearly perfect control, with only a very few ticks surviving, results in the greatest selection pressure for resistant ticks with the potential for the most rapid resistance build-up. Resistance to acaricides has appeared wherever acaricides have been used for a sufficient period of time. It should be noted that resistance to toxaphene, the acaricide of first choice, has already been reported in two areas of Uganda (see Appendix III). There is no evidence that a partial tick control program will result in the more rapid development of acaricide resistant ticks.

Protagonists of disease eradication also contend that ~~the eradi-~~cation of East Coast Fever is necessary to protect the exotic cattle which have been introduced by yeomen farmers on enclosed farms and ranches. The enclosed farms in Uganda are not continguous and are surrounded by grazing land under conventional land usage. Yeomen farmers must take precautions to prevent the invasion of disease infected ticks from communally grazed cattle. The bite of one <u>Rhipicephalus appendiculatus</u> tick infected with <u>Theileria parva</u> (East Coast Fever) is sufficient to kill 90 percent or more of exotic and 50 percent or more of crossbred exotic cattle. Some farmers, on the advice of the Veterinary Department, have resorted to double fencing boundaries, particularly if they adjoin communally grazed land or roadways used to move indigenous cattle on hoof to water, grazing or communal tick facilities.[1] In practice, double fencing is seldom necessary except to protect very valuable imported pedigree herds which have no immunity to any of the tick borne diseases. Almost all enclosed farms keeping exotic cattle do find it necessary to spray or dip their cattle twice weekly, as opposed to the once weekly which would suffice if all cattle were under strict tick control. The commonly used acaricides have sufficient residual toxicity to kill any ticks picked up between a three day spraying interval. Yeomen farmers who do not follow a rigorous schedule of twice weekly spraying do risk the occasional loss of animals to tick borne diseases. They must also

1. Yeomen farmers are advised to double fence their boundaries, leaving six to eight feet between. The strip between fences should be kept free of all vegetation, thus preventing the movement of ticks onto the farm and preventing any contact with outside cattle.

provide water and all necessary grazing so that cattle need never leave the farm.

The direct costs of tick control to yeomen farmers are at least two to three times greater than they would be if disease were to be eradicated generally. For this reason, yeomen farmers have strongly lobbied for compulsory disease eradication in order to protect against occasional (and avoidable) death loss and to reduce their control costs. However, particularly at current milk prices, the benefits derived from the eradication of disease on enclosed farms are far in excess of cost. It can be legitimately asked if the 97.5 percent of cattle owners who do not have enclosed land should be required to eradicate disease at considerable cost and at great risk to their own cattle in order to protect comparatively advantaged yeomen farmers. In fact some individuals have suggested that yeomen farmers, as well as conventional farmers, should pay a cattle tax to support general tick control in any disease eradication area (see p. 122).

Protagonists of disease eradication within the Veterinary Department have argued that once disease eradication is achieved, it will be possible to upgrade local cattle with exotic blood through an expanded artificial insemination service. Cattle in one parish of Kyagwe County are, if the owners request, inseminated with exotic semen. However, climatic data summarized in Chapter III clearly place most of Uganda in zones marginally suited for the introduction of temperate breeds of cattle without intensive management practices. It is felt by most authorities that upgrading with temperate breeds is not feasible <u>except</u> on enclosed farms and where improved grazing and water supplies and improved general health care can be provided. Without these complementary improvements, high mortality, poor reproductive performance and poor growth are expected to cancel out any gains from upgrading. In short, the eradication of East Coast Fever is a necessary step for the successful introduction of temperate breeds but it is not a sufficient one. Past project analyses have often assumed that upgrading communally grazed cattle will automatically be possible following tick control (see for example 202, p. 3). With the possible exception of a few favored areas this assumption is not a valid one.

Unfortunately, the improved breeds of Zebu cattle which might be introduced more widely are also highly susceptible to ECF. These include the Kenya Boran and the Asian Sihiwal (166). However, it has not been conclusively proven that under conventional husbandry these breeds are significantly more productive than the indigenous cattle. Nor has it been established that there are substantial benefits to local cattle owners from disease eradication in excess of the benefits of partial tick control. It is generally conceded that if the tick burden is reduced to the point where anemia, tick worry and tick toxicosis are no longer problems, no significant further improvement in productivity of African cattle will occur from disease eradication except a possible further minor reduction in calf mortality (see Chapter VII).

The Experience with Tick Control in Neighboring Countries

Perhaps the most compelling reason for opting for a program of partial tick control at the present time is the poor success record of other African disease eradication programs. It has been claimed that none of the many schemes, after which the Uganda Tick Control Project has been modelled, has been successful in eradicating disease permanently, and many have been abandoned completely (118, p. 70). As is too common, unsuccessful development projects are seldom evaluated unless they are spectacularly unsuccessful. No analysis apparently has been made of any of the unsuccessful projects nor was it possible to study any of them at first hand. Impressions gleaned from interviews in Uganda and from the Annual Veterinary Reports of Kenya, Tanzania, Zambia and Rhodesia suggest that a number of interrelated reasons were responsible for the failures (see also 16, pp. 343-356; 100, pp. 303-329; 147, pp. 206-214; 251, pp. 126-135).

The reason most often given for scheme failure is the lack of long term cooperation of conventional livestock owners with the program of disease eradication. Owners quickly observe the benefits of controlling ticks after the program is initiated. Cattle usually gain weight and their coat becomes less starred. Within months, calf mortality is sharply reduced. Cows increase in milk production and consequently calves also appear more thrifty. Cattlemen have long known the value of reducing tick numbers as a method of improving general herd health but apparently did not associate ticks directly with the diseases they transmit (200, passim).

The improvement in herd performance initially makes the dipping scheme popular with farmers and they may willingly pay part or all of the cost of scheme operation. However, problems tend to arise after the dips have been in use for several months. As tick numbers decline, the farmers begin to lose interest in bringing their cattle to the center weekly. Ticks so few in number as to escape detection on casual inspection are sufficient to maintain the races of ticks and to transmit disease. Also attendance is likely to be less regular when farmers are short of cash before the start of the harvest season and at peak labor requirement periods during the planting and harvesting of food and cash crops. Where herdsmen are employed or herding is the only enterprise of the men, herds tend to be brought more regularly. Small herds are less regular in attendance. In short, cattle are usually one of many enterprises and although the owners appreciate the value of partial tick control, there are not sufficient additional benefits for them to comply with a program of disease eradication.

Tick control schemes in African countries often have as a first objective the protection of settler or yeomen farmers and only secondarily the provision of disease control service for conventional African livestock owners. In most instances well defined areas are selected which are technically suited for disease eradication and have a natural barrier to prevent the immediate reintroduction of disease. Central government typically constructs all the facilities, including dipping tanks or spray races for acaricide application, laboratories for dip testing plus providing support equipment. It also trains and employs all the necessary staff for the scheme.

The philosophy of disease eradication schemes is to ~~provide a~~ "service" to the livestock owners. The approach to owners is paternalistic and little effort is made to involve cattle owners in the planning and operation of the local centers. The recurrent costs of the schemes are too great for the government to subsidize in their entirety and fees are a necessity. The usual practice is to subsidize service for an initial period with the intent of raising fees to cover the entire cost "once the value of tick control has been demonstrated."

A full economic charge for disease eradication schemes in Kenya is estimated to be in the range of 20-30 cents per head per week or only Shs. 10.50-16.00 per head of cattle per year ($1.50-$2.25 per year), (226). However, as most other veterinary services are provided free of charge or highly subsidized, owners are reluctant to pay for tick control on a recurrent basis. The enforced payment of fees is regarded as a tax on cattle.

In addition to the paternalistic attitude of the government and the apparent cattle tax, the profitability of tick control for the owners is assumed and little attention is given to the true costs to the owners in relation to improvements in his standard of living which can be directly attributed to tick control. Because the cash cost per head appears to be low, it is assumed that owners should willingly pay fees to achieve the presumed benefits of a major increase in income. Failure to support the program is therefore accepted as further proof of the perverse economic nature of cattle owners. However, the first consideration in most instances is to minimize the Government capital development and operating costs and insufficient attention is given to ~~minimizing the~~ non-cash costs of owners. For example, centers are widely spaced (up to 5 mile radius served), making it difficult for farmers to attend regularly and increasing the physiological costs of moving cattle long distances on foot.

Schemes have failed in the past because the Veterinary staff presented their program as a "service" without first considering the real cost to owners. The cattle owners do not understand the technical considerations which dictate that cattle be dipped regularly in disease eradication programs, nor could they understand why they should be compelled to participate at considerable cash cost and inconvenience to themselves. The attainment of disease eradication does not raise incomes substantially (see Chapter VII), nor does it initiate a chain reaction of general improvement in other husbandry practices sufficient to make tick control highly profitable for conventional owners. An unquantifiable cost of the schemes is the fact that the Veterinary staff to whom the owners are expected to turn for advice on other matters, are often the ones responsible for collecting fees and compelling attendance.[2]

Control Versus Eradication--A Summary View

The stated objective of the Uganda Tick Control Project is the eventual eradication of all tick borne diseases from Uganda. The imme-

2. The Iringa Scheme in Tanzania failed just prior to Independence because owners refused to bring cattle as a mark of political protest against the Colonial Government (251, p. 126).

diate and theoretically obtainable goal is the eradication of ~~the most~~ dangerous disease, East Coast Fever. For various technical and organizational reasons even this more modest objective may be impossible to achieve on a universal basis during the next decade and perhaps longer. There is little doubt, however, that given time and sufficient effort, ECF can be eliminated from many areas.

To achieve disease eradication in an area the compliance of all cattle owners is required for a considerable period of time. Government cannot afford to subsidize the entire capital and recurrent costs of either program on a national basis and owners would necessarily have to pay a regular subscription or fee. Experience has shown that compulsion is required to obtain the 100 percent compliance required in a disease eradication program and to collect fees. On the other hand, under a tick control program, participation need not be compulsory on a weekly basis and fees will be correspondingly less. Although compulsion was used extensively by the colonial administration to enforce many agricultural by-laws on such items as soil conservation practices, uprooting and burning cotton plants after harvest, cattle vaccination and the like; an independent Government has found it increasingly difficult to enforce unpopular laws for which the farmers do not understand the underlying reasons. In any society compulsion to achieve social or economic goals has a high cost. One thing is certain, compliance in either program will come more readily if most owners benefit substantially through an improved standard of living and cash income, or if they perceive that it would be improved in the near future. Conversely, the smaller the immediate return to owners, the smaller the share of the ~~cost of the~~ program they will be willing to shoulder themselves and the greater the burden on the government to subsidize the scheme. Every effort must be made to keep costs to owners low and to avoid compulsion. This will require careful attention to planning and implementation. Should widespread opposition to either program develop, the scheme would undoubtedly fail with potentially disastrous results.

A tick control program such as that proposed for Uganda and Tanzania, which has as its objective the eradication of East Coast Fever, has been described as "technically very feasible but practically very difficult" (118, p. 20). The technology is available to eradicate disease. The bottlenecks lie in financing the program, mobilizing the necessary support infrastructure and in obtaining the support of the livestock owners. The choice between a program of disease eradication or a program of partial tick control will depend in large part on the profitability of the two alternatives to the conventional husbandmen. Estimates of the direct benefits to owners and to the economy are developed in Chapters VIII; IX and X.

Prior Experience with Tick Control in Uganda

The Uganda Tick Control Project has evolved with a philosophy somewhat different than that of other countries. The previous chapter included a brief description of a short-lived program of "livestock improvement areas." It was indicated that through these areas it was hoped to introduce a package of husbandry improvements to the conventional livestock owner. Part of the improvement package was partial tick control. Owners were encouraged to hand spray their cattle, using inexpensive bucket pumps. The prevailing view at that time was that the conditions in Uganda were not favorable for a disease eradication program. With the hand spraying program the Veterinary Department hoped to reduce the severity of the tick problem but to avoid the capital and recurrent costs of disease eradication. Hand spraying to reduce tick numbers did catch on in a few limited areas, but after 20 years of promoting this program less than five percent of the national herd was under even periodic tick control (see Table 5.1). However, some hand spraying centers are still in operation.

The poor results of this program of partial control did not bode well for an expanded program of tick control, and indeed, this fact had been used by the Colonial Government as an excuse to limit activity in this area. To gain insight into the probable reasons for the general failure of this program, a more specific description of the program is required.

Hand Spraying Programs

A typical hand spraying cooperative society consists of ten to fifty owners, owning from 50-500 head of cattle. The society members are assisted in locating a site for a spray crush which is then cleared of trees and other vegetation. The crush, large enough to hold 5-10 cattle standing in line is constructed of green logs and poles cut from

TABLE 5.1. UGANDA TICK CONTROL PROJECT: CATTLE REGULARLY DIPPED OR SPRAYED, 1966-1969

Month	1966	1967	1968	1969
June	5.1	11,0	40.7	43.1
December	12.0	33.0	45.0	45.6

Source: Dept. of Vet. Ser. Animal Indus., Annual Report, various years. Includes all cattle reported to be participating in communal or private spraying or dipping programs.

the site or from the nearby bush. The life expectancy of crushes constructed with green poles set in the ground is 6 months to one year. Within this period, termites will rot the posts and the crush will need reconstruction. In order to make the crush strong enough to hold nervous cattle while their ears and undersides are sprayed, crushes are constructed with nearly solid sides, making it almost impossible to cover the animal thoroughly with spray material. The society is expected to collect funds periodically to purchase acaricides. Frequently, when funds are exhausted or the crush collapses, the society dissolves until they are encouraged by the Veterinary Assistant (or ordered by the local chief) to collect more funds and to construct a new crush.[3]

The evidence is that the rather cursory spraying carried out by a majority of these societies is not sufficient to reduce ticks or calf mortality to any extent. However, tick numbers may be reduced sufficiently to improve milk yield and the general condition of the cattle where tick burdens are particularly heavy. The two areas where hand spraying did catch on were areas of particularly heavy tick burdens--Ankole and southern Buganda. The promulgation of tick control rules in 1967 and 1968, which made it compulsory for all farmers to control ticks, resulted in a rapid expansion of hand spray crushes throughout the country. Cattle under some form of tick control is said to have increased from 5 percent in June 1966, to 41 percent in June 1968 (Table 5.1). There were an estimated 3,200 functional centers in July 1969 (see Table

3. Farmers are required by the Veterinary Department to build similar crushes at irregular intervals to facilitate vaccination campaigns.

XII). However, a Veterinary Department survey team reported that they were very poorly attended and that to avoid disciplinary action the junior staff exaggerated the numbers of cattle using the centers (204). Hand spraying under these conditions has been condemned by some research personnel because of the presumed hazards of such casual and intermittent control.

The hand spraying program has had only spotty success for the following reasons:

1. The spray crushes are not permanent and required almost continual maintenance.

2. Crushes are poorly constructed and in a manner that makes it nearly impossible to do a thorough job of spraying cattle.

3. Hand spraying is slow if more than a few cattle are involved and requires a great deal of hard physical labor. At many centers, water is not available on the site and must be carried to the center by porters.

4. Societies are transient and poorly organized and the large numbers of centers make effective supervision impossible.

5. In some areas hand spraying is not an economic practice for the farmers.

Despite the above criticism of hand spraying for a comprehensive program, it still finds application on small enclosed farms where not more than 10 or 12 cattle are involved. It may also have application where herds are small and travel is difficult such as in mountainous areas or in densely settled crop areas. Permanent crushes of treated timber and convenient permanent water supply would appear to be prerequisites for a successful local program.[4]

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4. The Veterinary Department might also encourage the spread of custom

Kyagwe County Pilot Disease Eradication Scheme[5]

For various reasons discussed in Chapter IV, the colonial administration of Uganda was unwilling to initiate any tick control program for African farmers where the objective was disease eradication. However in 1964 the newly independent Government, with the active assistance and encouragement of USAID, initiated a pilot disease eradication project.

The area chosen for the pilot project was Kyagwe County, lying 10 miles to the east of Kampala. It is a diamond shaped area of 1,124 square miles (720,000 acres) bound on the south by Lake Victoria, on the east by the Nile River and on the west and north by a series of papyrus swamps and forest preserves (County No. 44, Map 3). Lying wholly within the Fertile Crescent, it had a cattle population in 1966 of 55,000 head, indicating a rather dispersed population of one beast per 12 acres (53 per sq. mile). It was considered to be sufficiently well isolated to attempt disease eradication. Yeomen farmers had first successfully introduced exotic cattle into this area in 1958-59. For various reasons, including the rather large number of functioning hand spray crushes, owners in this area were considered to be more economically oriented

4. (cont'd.)
hand spraying observed in one area of Teso. School leavers, trained in hand spraying technique and provided with a pump, travel on a regular circuit of community centers by bicycle, spraying cattle for a fee. Hand spraying equipment is also being stockpiled for use when disease control quarantines require that communal facilities be closed.

5. For data included in this section I am particularly indebted to Dr. Andrew Antronian, USAID, Uganda, and the Veterinary Department staff in Kyagwe County.

(see also Chapter IV). This scheme is now considered to be a subproject of the greater Uganda Tick Control Project.

The choice of facilities was the first concern. The coffee/banana shamba/forest remanent vegetation with nearly contignuous cultivation on better soils make it difficult to move cattle. It was decided that 99 centers were required, or an average of about one center per 550 head of cattle.

The first 24 centers were 12 conventional spray races, constructed for communities with sizeable cattle populations, and 12 transportable motorized spray crushes, for use in communities with smaller populations. These two types of facilities are no longer being constructed because of high on site construction costs (Shs. 22,000 per center) and high recurrent costs. The remaining 74 centers were a modified spray race/dip tank construction known as the Kampala spray bath.[6] This facility could be constructed for about one-third the cost of the conventional spray race (Shs. 7,000), and it was hoped that the Kampala spray bath could be used throughout the coffee/banana zone (225, passim).

All three types have experienced high maintenance costs, frequent breakdown of the mechanical equipment and require a high degree of supervision because of the mechanical equipment. For these reasons, the Department has decided to use dipping tanks exclusively in the national control program.[7]

6. The Kampala spray bath combines a walk through dipping tank about 3 feet deep with a modified spray race. The spray nozzles, which are powered by a 2.5 H.P. engine, wet down only the animal's back and head. The engine and pump can also be used to fill the tank and spray reservoir. Its advantages are similar to the standard spray race but the spray bath is less costly to construct and maintain.

7. For a detailed description and a discussion of the advantages and dis-

The organization of this subproject was initially similar to those of other East-African countries. Plans were for central Government to construct and operate the facilities and provide a service for cattle owners.

In the early discussions of the scheme (1963-64), it was agreed that the cattle owners should pay a fee which would cover a major share of the cost of operating the scheme because:

1. "It was sound psychologically."
2. "It would develop a backlog of funds against the day when insecticide (provided under the USAID loan) was exhausted and the scheme would have to begin buying its own."

The proposed fee was Shs. 0.25 per head per week or Shs. 13.00 per year ($1.85) (226, passim).

Because agreement could not be reached quickly on either the size of the fee or the method of collection, free service was initiated. Once the precedent of free service was established, it proved very difficult to persuade owners to shoulder even part of the cost of operation. Central Government (Ministry of Finance), which had been assured before the scheme began that recurrent costs would be covered by scheme revenue, was unwilling to assume responsibility for recurrent cost on even a temporary basis. Consequently subsidies had to come largely from the operating budget of the Department of Veterinary Services and from loan funds.

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7. (cont'd.)
advantages of various types of tick control equipment and techniques used worldwide, see 15 and 140 and in Southern and Eastern Africa see 23, pp. 88-91; 61 and 117, pp. 93-101.

During the planning stage several alternative plans were suggested for financing recurrent costs. The first proposal was for central Government to meet the full recurrent cost of the scheme from regular revenue sources. It was argued that the presumed secondary benefits to the national economy from increased meat and milk production and from improved incomes would justify such support. It was noted that coffee and cotton production are promoted by subsidized fertilizer, pesticide, marketing facilities, planting material and tractor hire services. However, sales of cattle and meat, unlike cotton and coffee do not contribute directly to Government revenue through export taxes, except for a small export levy on hides and skins. The area of the pilot study was already economically advantaged, enjoying above average income from coffee sales and presumably was chosen because a major improvement to owner income would result from tick control.

It was then proposed that owners should pay a fee for the acaricide but that either central Government or local government should shoulder the costs of capital financing and the salaries of Veterinary personnel assigned to the scheme area. Those in charge of the program felt that compulsory compliance and manditory payment of the full cost of treatment were incompatible. This sizeable subsidy required initially could be reduced at a later date when owners were able to assume a greater share of the cost.

The problem then arose as to the most satisfactory method of collecting the farmers' share of the cost. Suggestions included the following:

1. General revenue of the local government, tapping the expected increase in local income tax revenue. Local councils in Kenya and Tanzania are in some instances subsidizing tick control schemes. However, the county government refused to undertake this added financial burden.

2. A special cattle tax payable on each head of cattle owned, including those on enclosed farms. It was argued that (a) all livestock owners would benefit from general tick control; (b) conventional owners taxed in advance for tick control would be more inclined to participate regularly to get their money's worth; and (c) it would simplify the problems of collection, finance and administration. This suggestion failed because of general opposition to a tax on cattle ownership.

3. The financing of local costs through the formation of voluntary cooperative societies. The coops would monopolize use of the Government financed communal facilities and only paid up members could participate. Individuals who did not want to participate would be allowed to treat their own cattle privately.

This last proposal has been adapted. Society members in Kyagwe are now paying fees sufficient to cover local costs. The positive features of this arrangement will be spelled out in more detail. The formation of the cooperative societies involves cattle owners in the planning and in the operation of the facility. In most instances, former hand spraying societies can be consolidated to form the new organizations. The societies give the Veterinary staff a point of entry for the extension of new practices and an opportunity to explain in detail the reasons for tick control. Community influence and sanctions can be mobilized to encourage voluntary compliance and if necessary to demand the enforcement of rules on cattle movement, sales and the like. Early hand spraying societies sponsored under the Livestock Improvement Area Program in Kyagwe County had persuaded local officials to make and enforce local regulations relevant to tick control--a very real reason for the successful early program in Kyagwe County (240).

Fees, once initiated, can be gradually increased, reducing the subsidy of central Government. Fees can vary to reflect local costs and services offered, and to some extent, operating costs can be reduced by community labor. It is envisioned that the local societies can be further organized into central unions which would be in a position to assume responsibility for ordering and supplying necessary commodities for the scheme. When and if conditions warrant it, unions can expand into other lines such as the supply of dairy equipment and feed, artificial insemination, product marketing and the like. As a first step in this direction, Kyagwe County is now organized into three subcounty unions through which fuel, acaricide and other supplies are furnished to local societies.

The capital development cost for Kyagwe County pilot project was approximately Shs. 1,580,000 or Shs. 32 per head, of which Shs. 900,000 ($115,000) was provided by USAID as equipment and acaricide.[8] The U.S. funds are part of a larger loan of roughly $2 million, most of which was assistance for the Ankole-Masaka ranching and for tsetse control equipment. The loan funds were in many respects only a minor part of the USAID contribution to the project. Much of the planning, budgeting and subsequent documentation, as well as project implementation, were provided by USAID technicians. The Kampala spray bath was designed and perfected by a USAID technician and assistance was provided in the testing of various acaricides.

8. One major distinction between USAID loans and loans from other sources is that implementation of the loan agreement is more closely supervised as a result of vigilant watchdogging by the U.S. Congress.

The development and estimated operating budgets for the scheme, excluding acaricide cost, are shown in Appendix Table XIII. Actual recurrent costs could not be estimated. They are somewhat below those shown because a full complement of staff and equipment has seldom been on hand. However, a partial subsidy of tickicide was still in effect in 1969. The estimated annual recurrent budget, excluding the tickicide cost, is estimated to be Shs. 307,000 for a target cattle population of 50,000 head, making the estimated subsidy Shs. 6.00 per year per head of cattle served. The estimated cost of the recommended concentrations of toxaphene, the acaricide in use in the scheme, adds an additional cost of Shs. 4.00 per head per year. Thus, the total cost of tick control in this scheme is estimated to be roughly Shs. 10.00 per head per year. It should be noted, however, that no amortization of the capital and development costs of the loan are included in the budget. The costs of a disease eradication program in Kyagwe County appear to be comparable or slightly below those experienced in Kenya, i.e., roughly Shs. 10-15 per head per year.

The Kyagwe County scheme is generally considered to be a successful project and its "success" has been cited as the reason for the expansion of the Tick Control Program to the rest of the country. It has been successful in that facilities for tick control have been made available to every owner in the county who supports the society.

Although highly subsidized, the scheme has not succeeded in achieving 100 percent weekly participation of all owners. It is claimed that 100 percent of all the cattle are sprayed during any month, but not all of the cattle are sprayed each week. Tick counts made at control center by Veterinary staff usually identify 2-5 nymphs and adult ticks per animal, with tick numbers rising rapidly following an equipment breakdown. Average weekly participation, based on a target adult cattle population of 45,000 head, ranges from 70-85 percent and is lowest in the pre-coffee harvest season when farmers lack funds. This level of compliance is sufficient to bring the tick population to a fraction of former levels, but is probably not sufficient to eradicate ECF.

Deaths attributed to ECF in calves or adults are rare and no local epidemics have occurred, suggesting that calves may still contract the disease, but, as expected, experience a much lower mortality (see Table 7.1). Although tick counts are being made on a systematic basis to assess the completeness of control, no research is being carried out to determine if the ultimate goal of disease eradication is being achieved.

In summary, the Kyagwe County scheme is not succeeding in eradicating ECF nor does it achieve 100 percent compliance of all livestock owners. The losses due to tick burden and calf mortality have been markedly reduced. It has succeeded as a partial tick control program. Perhaps the greatest achievement of the pilot project is the evolution of a rather different philosophy of approach to tick control which includes livestock owners more directly in scheme planning and operations. The self-help tick control project described in a later section has been built upon this new philosophy. It also provided evidence of necessary staffing levels and recurrent costs--evidence which was to be disregarded in planning an expansion of the program to other areas.

Chapter VI

FINANCING AND COSTING THE TICK CONTROL PROJECT

The second Five Year Development Plan, compiled in 1965 before tick control became a major program, allocated only Shs. 2.8 million for tick control during the entire plan period, 1965/66-1970/71. The development costs of the Kyagwe County pilot scheme made it increasingly obvious that if tick control was to be expanded quickly to cover large segments of the country, additional financial assistance would be required from local and international sources.

The principal consideration has been the rapid expansion of the Project rather than careful project implementation. Cost and benefit estimates have been prepared by the Ministry only when required for the purpose of loan or grant applications. As a result, program proposals often reflect the requirements of the potential donors rather than those of the Project, and the benefit projections, reviewed in the following chapter, are uniformly optimistic. For these reasons, it is necessary to review the various grant and loan applications and to develop independent program and cost estimates.

IBRD and FAO Project Proposals

Because both the World Bank and FAO were encouraging an expansion of the Tick Control Project, both were approached for assistance with the program (52, p. 99; 76, pp. 173-175). The Ministry of Animal Industry first prepared an extremely ambitious budget for a World Bank-International Development Association (IDA) loan (201). It called for the construction of 1800 dip centers (one for every 2,000 head) to be built over a period of five years. Because it was assumed that large loans and a project requiring a large import component would be more attractive to the Bank, centers were to be equipped with reinforced steel dip tanks, all necessary ancillary buildings and motorized boreholes. The proposed budget, which is included as Table XIV was for Shs. 180 million ($25 million). This was some sixty times the amount budgeted in the Development Plan. Development cost was projected at Shs. 100,000 per center or Shs. 50 per animal served. The projected capital cost per center was nearly four times that of the Kyagwe Scheme. On the other hand the budgeted recurrent supervision costs were only Shs. 1.00 per head per year, one sixth of the recurrent supervision cost of the pilot project in Kyagwe County and in Kenya. The recurrent budget did not include the operating costs of the mechanical equipment or the long term cost of financing the loan.[1]

1. In this first loan application prepared by the Ministry of Animal Industry, the import component of the project was deliberately kept high in order to minimize local development costs, and recurrent cost estimates were kept low in order to speed approval by the Ministries of Finance and Planning.

The loan request did not receive support from either the Bank or central Government. The Bank indicated that a more careful budgeting of a project of this size was required and suggested phasing the Project over a longer period of years with special attention given to training staff for the scheme (76, pp. 8-9). It also indicated a preference for projects with an internal capacity to directly repay the loan, as opposed to animal health oriented projects which would require repayment from Government revenue. It is more difficult to prepare a benefit/cost comparison of non-self supporting projects.

Roughly simultaneously, an application was made to the United Nations Special Fund (UNSF) for assistance in setting up two additional countywide pilot disease eradication areas, one in Kyoga County, Lango, the other in Serere County, Teso (County Numbers 60 and 81, Map 5). The former was chosen as being representative of the north Buganda and Northern Region ecology and husbandry, the latter as representative of southeastern Uganda. Both are peninsulas in Lake Kyoga and are semi-isolated as was Kyagwe County in Buganda. Their locations made them good sites for disease eradication trials. This subproject was to be part of a UNSF East African Regional tick borne disease research project with other subprojects in Kenya, Tanzania and Uganda. An ECF vaccine research project at Muguga, Kenya, is part of this project.

The Uganda subproject was to be mounted in cooperation with the Entebbe Veterinary Research Center with the UNSF providing specialist staff and roughly two-thirds of the capital and recurrent costs in a direct grant. Designed as disease eradication areas, plans called for the construction of 80 standard spray races and 60 dips for a cattle population of roughly 120,000 head, or one facility per 850 head of cattle. The capital cost was an estimated Shs. 26,600 per center--exclusive of water development costs--or Shs. 30 per head of cattle served. Although standard spray races were not being considered for the Project, they were included in the budget with the stated reason of comparing their efficiency with dipping tanks. However, as spray races require engines and hardware, they would also increase the import component of the budget which it was thought would make the grant more attractive to the UNSF. A budget summary is included as Table 6.1.

This proposed project was not approved, in part because of the long lag time between requests to the UNSF and project approval. During the negotiation period, the Ministry of Animal Industry had decided to push ahead with the Tick Control Project and that pilot schemes to evaluate the feasibility were no longer required. The research agenda included research on the morbidity and mortality from tick borne diseases and other causes, acaricide resistance in ticks, acaricide residues in products and the ecology of tick species. Greater knowledge of these subjects are vitally important to the success of the Project. Some data collected by the Veterinary Research Division in anticipation of the agreement with the UN have been used in various sections of this study.

Although plans for a UNSF sponsored research in Uganda are still in abeyance, preparations for this project were to inadvertently delay tick control in these two counties. Under the Project, facilities were to be constructed entirely with project funds and to insure compliance

TABLE 6.1. UGANDA TICK CONTROL PROJECT: PROPOSED BUDGET
UN SPECIAL FUND GRANT*

	Capital Costs Shs. '000's	Recurrent Cost Shs. '000's	Total Shs. '000's
Uganda Government	1,329	1,664	2,993
UNSF	2,400	2,177	4,577
Total	3,729	3,841	7,570

*Source: Uganda, Dept. Vet. Services and Anim. Ind., "Special Fund Tick Borne Disease Control Research Project Phase II: Field and Laboratory Investigations and Control of East Coast Fever in Uganda" (Application submitted by the Uganda Govt. to the U.N. Special Fund, Kampala, 1968, mimeo.).

and disease eradication, and cattle were to be dipped or sprayed free of charge for a period of three years. In anticipation that the grant would be forthcoming, owners were promised that all facilities were to be constructed without charge and service would be provided free for three years. One dip was constructed free in each county using Veterinary Research Division funds. Once this precedent was set, owners were most reluctant to collect funds to build dips or to assume recurrent costs under the present self-help dip building program.

The Growth of Self-help Tick Control Societies

The original intent of the Ministry of Animal Industry was to establish a national tick control service similar to that first planned for Kyagwe County with the cattle owners paying a fee for dipping. The inevitable delays between formal application and approval of loans from international sources contributed to bringing about a modification of the national Project. A decision was made to try and tap owner resources for at least part of the capital development costs as had been done in the past on a more limited scale. The first real breakthroughs occurred in those areas where hand spraying had been at least partially successful.

Under the active leadership and encouragement of the Veterinary staff, cattle owners in Ankole, Toro and some communities in Buganda were organized into societies for the purpose of raising contributions for the construction of communal "self-help" dip centers. Contrary to most expectations, many societies in Toro and Ankole succeeded in raising two-thirds of the on site costs of dip construction. The Department of Veterinary Services provided, free of charge, cement and pressure treated lumber and site survey. Private contractors were then hired to construct reinforced concrete dipping tanks under the supervision of the Department. Two tanks were built in 1966, 18 in 1967 and by mid-1969 there were 32 dips in Ankole and 27 in Toro (Table XII). Most dips were sited at or near communal watering points such as dams or streams, and thus a water supply did not need to be constructed. Cattle were grazed on their way to and from the centers, watered on arrival and consequently weekly dipping presented no particular added burden on time or labor. The water supply for the dip tank was provided with simple hand operated piston pumps at low cost. The average cost of constructing centers ranged between Shs. 13,000-15,000.

The case of the Ryanyamahembe Grazing Society in the savanna area north of Mbarara is typical of a self-help tick control center. Owners in a subcounty collected funds for a dip to service a cattle population of roughly 12,000 head. Because of the large numbers, dipping was scheduled for six days per week. Many members were bringing cattle 6-8 miles to the center. The leadership of the society voted to charge a fee of Shs. 0.30 per week or Shs. 15.60 per head per year, a figure well above the cost of acaricide. Surplus funds were placed in a fund for the construction of additional dips in order to reduce the distance cattle had to travel to dipping centers. The goal is to construct 5-6 centers or about one per 2,000 cattle.

The progress made in establishing "self-help" tick control societies in Toro and Ankcle demonstrates that livestock owners can be induced to support tick control where conditions warrant, even at comparatively high costs per head. The act of donating money for dip construction provides tangible proof that where owners recognize that tick control can improve their standard of living, they are willing to support tick control. Although the operating costs of these societies are low--Shs. 4-5 per head per year--the Department of Veterinary Services has elected to further encourage these societies by subsidizing the cost of acaricide, probably unnecessarily, by roughly 50 percent. The estimated budget of individual societies and the Government recurrent costs are discussed in a later section of this chapter.

Self-help financing of dip center construction has met with more spotty success in areas outside of the Western Region. As was the case with hand spraying centers, the response was greatest where the tick burden on cattle is high, where cattle are managed in large herds or by hired herdsmen, where commercial milk sales occur or where milk is an important diet item. The reasons which explain the less enthusiastic support for tick control in Eastern and Northern Uganda appear to include the provision of free service initially in Kyagwe County, the free construction of demonstration dipping or spraying centers at other scattered sites, the much smaller average herd size, the lesser tick burden characteristic of the Eastern and Northern Regions and the absence of milk markets.

Because the Department wished to get the self-help program going as fast as possible, it decided to further modify the aid formula. To encourage society formation, the financial contribution of the societies was reduced to somewhat less than half of the on site dip construction cost. The formula is varied slightly depending on the ability of the local society members to collect funds, the number of cattle to be served and local construction costs. Another significant change is that the Department has decided not to utilize private contractors but to train their own construction teams in an attempt to minimize construction costs.[2]

A breakdown of the items required in the construction of a full plunge dipping tank and the approximate cost of these items in south central Uganda are provided in Table XV. The objective of the program is to divide the on site development cost roughly 50:50 between the society and the Department. The breakdown in the items to be provided by each is as follows:

<u>Government Supplied</u>	<u>Society Supplied</u>
Cement and cement blocks	Building stone
Treated timber (boma and rails)	Sand
Transport Government items	Transport society items
Skilled artisans (carpenter and mason)	Unskilled labor
Site location and alignment	Building materials dip shelter
Water supply[3]	Reinforcing steel and wire
	Water installation

2. Construction teams were first recruited in an attempt to get away from the problems of contractor supervision and profits. However, services normally provided by the contractor, such as timely delivery of materials to the site, their protection from theft at the site, housing and transport for labor and materials and labor supervision

The rationale for the particular breakdown is that in some cases, stone, sand, water supplies and unskilled labor could be provided at low cost by the society members, reducing their share of the cost through cooperative action. In practice communal labor proved extremely difficult to organize and was unfamiliar with construction procedures. Also, stone and sand of construction quality are seldom available locally and their cost highly variable depending on transportation costs to the site. As a result, the on site cost of dip construction is also variable, ranging from about Shs. 7,000-13,000.

To level out the cost of construction between areas, the formula was further modified for the general Project. In a partial retreat from the self-help principal, society members are now required to collect Shs. 6,000 paid into a special account. All materials are now provided by the Department as well as all skilled and unskilled labor.

The typical centers in the eastern and northern sections of the country cater to not less than 1,500 head of cattle with some servicing 3,000-4,000 head. The owners' self-help contribution to construction costs is usually on the order of Shs. 3.00-5.00 for each head of cattle owned.

The Uganda self-help Tick Control Project differs from earlier projects in other African countries in several respects. First, the area approach has been abandoned. Centers are built only where sufficient

2. (cont'd.) have too often been lacking from the present program, adding an unquantifiable hidden development cost.

3. Water development policy and cost are discussed separately in a later section.

owner support can be generated. Self-help contributions are determined by the number of cattle served per center. No attempt is made to make facilities accessible to all owners in particular geographic areas. Thus, in the early stages of the Project, the goal of disease eradication has been set aside. It is now hoped that once facilities are available to all owners it will become possible to systematically enforce regular dipping and eradicate disease.

As a result of this policy, the early sites are in the most favored locations. Those that remain to be constructed are often in isolated areas with sparse cattle populations. Many sites will require the development of a water source. However, the Project has benefited from direct involvement of the society members in planning, financing and operating the centers. Members are providing roughly half of on site capital costs and somewhat more than half of local recurrent cost.

However, the Ministry of Animal Industry is committing itself to the considerable task of supervision of a large number of scattered centers and a sizeable recurrent cost for staff salaries, capital servicing and infrastructure, unless some method can be devised to transfer a larger share of recurrent cost to the societies. As of late 1969, the supervision of existing centers was the responsibility of regular Veterinary staff as an addition to their regular duties. A special tick control section with its own staff has been recommended but not yet established (82, p. 28). It must be noted that serious problems are being encountered at many centers because it is impossiblo for existing senior staff to give sufficient supervision. Very poor tick kills and widespread buildup in tick numbers are being reported in some areas of Ankole. As a result, owners are threatening to withdraw their support and to stop bringing cattle for regular dipping (200, p. 71).

Common problems reported are that dip attendants and frequently Veterinary assistants do not understand tank filling and topping up procedures. Foot baths are not kept clean and filled with running water. Tanks become so fouled that after a few weeks use the cattle are not getting an adequate coverage of acaricide. Because of the loose organization of the societies and large numbers of society members, certain tasks which are supposed to be provided communally on rotation, such as cleaning and refilling the dipping tank and foot bath and cleaning the collecting yard, do not get done.

Other common problems are in society financing for which there is no uniform pattern of operations. Only a few societies charge a regular fee either weekly or annually. Most societies assess members only if funds are required to purchase acaricide. Few if any societies have a budget to hire casual labor or to make repairs as they are needed. Collections are typically by a local chief or his clerk or by an officer of the society. With societies often handling Shs. 6,000-15,000 per year, there are the predictable problems of collection and audit. Because disease eradication has not yet been attempted, the rare closing of a dip center for lack of funds has not presented excessive problems of mortality.

There appear to be three underlying reasons for the problems observed.

First, the Ministry of Animal Industry has encouraged the rapid expansion of the Project without providing the necessary personnel to supervise the program. It has also failed to date to make a strong case with the Ministry of Finance for the necessary additional funding to support the recurrent costs of the Project. As a result there are too few special staff, too little staff training and shortages of transportation and travel funds for existing staff. Junior staff and dip attendants (usually school leavers) are particularly ill-prepared for their new, essentially extension roles in organizing and guiding cooperative societies. Second, society officers are not made sufficiently aware of the mechanics of their center's operations. Thirdly, many centers are catering to too many cattle and individual members, a problem which will be alleviated in part as more centers are constructed.

Experience with the self-help program to date shows that support by owners is in direct proportion to the convenience of regular attendance at the communal facility. Other things being equal, owners are more likely to bring their cattle to the centers if they are conveniently located and if easy access to the centers has been provided through food and cash crop fields. The location of the center in relation to water, grazing and rural markets is also important.

The type of center makes a great difference in popularity. Owners much prefer spray races or dipping tanks to the old style centers where cattle were sprayed by hand. Livestock owners are no different than other farmers in that they do place a value on their time and will only expend extra time and energy if they are rewarded by additional real income.

Assistance for the Self-help Program from International Agencies

In spite of the opportunities afforded by the Tick Control Project to increase meat and milk production, and the progress made in mobilizing owner resources, the Ministry of Animal Industry was unable to acquire additional capital development funds for the Project from central Government sources. Funds sufficient to complete the Project had not been included in the Development Plan, and the Ministry of Finance as well as the Ministry of Animal Industry anticipated additional international assistance. During 1968 and 1969, the Department of Veterinary Services utilized any surplus funds and a small vote specifically for subsidies for progressive farmers to expand the program. Assistance was also sought from all possible international sources. The Project was to be further modified to comply with requirements and specifications of the various organizations.

OXFAM Grant

The self-help aspects of the Project made it increasingly attractive to foreign donors. In the latter half of 1968 an approach was made to the Oxford Famine Relief Committee (OXFAM)[4] for a grant which would cover the half-subsidy provided by the Department. OXFAM considered this Project to be highly compatible with its objectives of assisting rural persons through self-help projects to raise their general levels of income and welfare. OXFAM made a preliminary grant of U.K. £13,125

4. OXFAM is a British philanthropic organization with interests and programs similar to the U.S. based CARE.

(Shs. 225,000; $36,750) which was sufficient to provide a Shs. 5,600 subsidy toward each of 40 centers within predesignated subproject areas (202, passim).

Those areas chosen were Dokolo County, Lango, and Kabermaido County, Teso, counties contiguous to the proposed UNSF subproject (County Nos. 58 and 78, Map 4). They were also respectively in the Eastern and Northern Regions which had not as yet received any special attention in regard to tick control. The two counties are in the cotton-ox-cultivation areas with a comparatively dense cattle population. Individual members of the OXFAM advisory council expressed grave concern that the Project would contribute to overgrazing in the area.

The most noteworthy aspect of this grant is that the Department of Veterinary Services was able to expand, without modification, its own program of self-help dip construction. The OXFAM grant was placed in a special account created to handle society members' contributions. The Department did agree to place special attention on society formation in the two counties and concentrate available construction crews in the area. In addition it was able to purchase all necessary materials, labor and transport from local (East African) sources, keeping total cost and foreign exchange cost to an absolute minimum.

United Kingdom-ODM Loan

In 1968, the Uganda Government negotiated a loan from the United Kingdom Overseas Development Ministry (UK-ODM) in the amount of U.K. £6.5 million (Shs. 111.4 million) for various development projects. The Ministry of Animal Industry requested financing for several development projects under this loan, two of which were approved by the ODM. One totalling U.K. Ł197,300 (Shs. 3,380,000) was to finance purchase of tsetse clearing equipment. The second, totalling U.K. Ł412,500 (Shs. 7,071,488), was to support the Uganda Tick Control Project. Loans to projects sponsored by the Ministry of Animal Industry represented only 10.7 percent of the total loan negotiated by the Uganda Government.

Provisions of the U.K. loan are quite liberal, calling for no interest payments and a graduated repayment schedule over a 40 year repayment period. The loan requires that funds be expended over a three year period and that not less than 51 percent of the entire loan package represent commodities imported from the U.K. Because other items in the loan package, such as road construction, require a high proportion of local costs, the Ministry of Animal Industry was under some pressure from the UK-ODM and the Ministry of Planning to keep the import component of the tick control subloan as high as possible.

The budget prepared for the UK-ODM is included as Table XVI and is summarized in Tables 6.2 and 6.3. The budget was to be sufficient to finance the construction of the 1,275 centers which were then seen as necessary to give complete coverage to the entire country (203, p. 2).

The budget prepared in support of the loan request and the accompanying statement of the economic benefits of the Project illustrate the comparative inexpertness of the Ministry of Animal Industry in preparing loan requests in a format acceptable to international agencies and the tendency to modify local programs to meet the specifications of the lending agency. Under the proposed budget, societies are expected to con-

TABLE 6.2. UGANDA TICK CONTROL PROJECT: SUMMARY, UNITED KINGDOM-ODM LOAN, ESTIMATED CAPITAL DEVELOPMENT AND RECURRENT COST OF PROJECT IMPLEMENTATION, 1968
(Shs. thousands)

	Year One	Year Two	Year Three	Total
		Capital Costs		
Local Contribution				
Livestock Owners @ 4322	1,830	1,821	1,812	5,464
Uganda Government	--	--	72[a]	72
Sub Total	1,830	1,821	1,884	5,536
British Loan	2,633	2,259	2,178	7,071
Total Capital Cost	4,463	4,081	4,062	12,606
		Recurrent (Local) Costs		
Uganda Government	737	817	898	2,452
Total Project Budget	5,200	4,898	4,960	15,058

Source of Data: Dept. Vet. Ser., Application for Assistance for the Uganda Tick Control Project, 1968. (See Appendix Table XVI.) Budget for construction of 1,275 reinforced steel dipping tanks.

a. Cost of 423 metal water storage tanks inadvertently omitted from the loan request.

TABLE 6.3. UGANDA TICK CONTROL PROJECT: CAPITAL DEVELOPMENT COSTS PER TICK CONTROL CENTER, USAID, UK-ODM LOAN AND STUDY ESTIMATES

Cost Items	Number Required per Center	Capital Cost per Center: USAID Loan[a] Shs.	UK-ODM Loan[b] Shs.	Study Estimate[c] Shs.
Support Facilities and Equipment				
Area Headquarters Office and Store	1:40	914[d]	N.B.	900
Regional Laboratores	1:50	N.B.	N.B.	700
Transport Vehicles	1:30	1,790[e]	527	700
House and Store Dip Attendant	1:3	8,746[f]	N.B.	2,000
Sub Total		11,450	527	4,300
Dip Center Construction				
Dip Tank, Boma and Shelter	1:1	14,280	8,575	12,000
Hardware and Tools	1:1	1,314	g	g
Sub Total		15,594	8,575	12,000
Water Development				
Water Storage Tank	1:1	785	171	250[h]
Hand Pump Valley Tank	1:1	393	223	225
Water Pipe 250' & Fittings	1:1	1,100	394	400
Installation Water Supply	1:1	1,071	N.B.	400
Sub Total		3,349	788	1,275
Digging Valley Tank	1:1	10,400[i]	N.B.	10,400[i]
Sub Total Center Construction and Water Development		29,343	9,363	24,675
Total All Items		40,793	9,890	27,975

N.B. Not budgeted.

a. Source of estimate Table XVII.

b. Source of estimate Table XVI.

c. Estimated from best available local and Dept. Vet. Ser. sources.

d. Imported prefabricated buildings.

e. Prorated from item 2, Table XVII.

f. Imported prefabricated two room residence and store, one per each center.

g. Included in cost of dip tank.

h. 500 gallon tank.

i. Source of estimate Table XVIII. Estimated capacity 80,000 cubic feet.

tribute roughly 43 percent of the on site capital costs, with the loan providing the remaining 57 percent. The Uganda Government is expected to provide local recurrent costs. The budget did not include provision for dip attendants, acaricide, dip testing, water source construction nor the operating expense of the vehicles provided for the transport of materials. To comply with the loan specifications, construction was initially scheduled for completion over a three year period, a construction rate well beyond the capacity of the Department to organize and implement. Unlike USAID, the UK-ODM does not generally provide assistance in budgeting and programming loans of this type. In spite of the deficiencies in the budgeting, the subloan was approved for financing by the UK-ODM because of the intrinsic merits of the Project.

Subsequent to the loan approval, the UK-ODM has negotiated a number of important modifications in the loan agreement. It has agreed to allow expenditures over a five year period to allow a more realistic implementation schedule. It has also agreed to finance the construction of reinforced concrete dipping tanks instead of welded steel tanks which would have had a higher import component. The UK-ODM loan gave the Ministry of Animal Industry sufficient funds to complete construction of a major part of the dips required in the Project. Financial bottlenecks remain in financing water development costs, in the provision of necessary support facilities and in providing annual recurrent costs.

USAID Subproject Extension

Also in 1968, the Uganda Government negotiated a loan with United States Agency of International Development (USAID) for a total of $4,700,000 (Shs. 33,558,000). The purpose of the loan, entirely earmarked for the Ministry of Animal Industry, is to assist in financing the foreign exchange and local costs of measures taken to increase the production of beef and dairy products in Uganda. Roughly 19 percent of the loan package (Shs. 6.3 million) is to assist in financing the expansion of the Kyagwe County pilot project area. This also is a 40 year loan, but it carries an interest rate of 2.5 percent after a 10 year grace period. The entire projected capital development budget of the subproject is to be financed by USAID contributions (Table XVIII). Staffing requirements and recurrent costs, which are not shown in the table, are assumed to be similar to those of the Kyagwe project area. The project has subsequently been revised slightly to conform with the new self-help policy and societies are expected to contribute roughly Shs. 6,000 toward the cost of construction.

The subproject area is an extension of the Kyagwe County project into several adjoining counties. It provides for the construction of 70 dips and 10 less expensive centers (Kampala spray baths or other mechanical spraying equipment) in Bugwere and Buruli counties which have 30,000 and 108,000 head of cattle respectively (County Numbers 40 and 42, Map 4). Except for a small area of southern Bugwere, this area lies within the Dry Hyparrhenia Land Resource Zone (Zone IVa). Two additional counties, Kyadondo and Busiro, which include the cities of Kampala and Entebbe and are in the heart of the Elephant Grass Zone, are also included. However, in these two counties, it was originally proposed that the roughly 2,050 individual cattle owners would be provided with hand spraying equipment in order to avoid the construction of communal centers in this area of intensive cultivation and dispersed cattle population.[5]

As with the Kyagwe pilot project, the planning of the subproject was assisted by USAID technicians and staff and thus it is budgeted in great detail. Construction of the 80 centers is scheduled over a three year period, 1968-71. In implementing the subproject in a Dry Hyparrhenia subzone, the need to develop water sources is recognized not only for dipping but for year round stock watering. Therefore the loan finances the importation of caterpillar tractors and earth moving equipment for valley tank construction, and the cost of valley tank construction is included in cost estimates. The budget also includes the importation of 20 U.S. made vehicles with spare parts (there is no local dealer) for the transportation of material as well as for the support of the Department's entire program. Thirdly, it includes the purchase of a sufficient amount of acaricide (toxaphene) to operate each center for roughly one year. The Department is selling the acaricide to societies at a subsidized rate, in order to encourage dipping and to provide income to help meet local and recurrent costs. Fourthly, the budget

5. See Appendix Table XVII, item 6. The problem of siting centers is discussed in a following section. As of December, 1970, a number of communal centers has been constructed in these two counties and the hand spraying component of the loan has been cancelled.

includes the purchase of various ancillary buildings for the scheme area, two offices and stores and a combined house and store for the dip attendant at each center. These are of prefabricated construction and imported from the United States. Finally, to further increase the import component of the loan and minimize the immediate capital cost to the Ministry of Animal Industry, small tools and hardware sufficient for the 80 centers are included. As a result of more complete budgeting and the high import component, the capital cost of individual tick control centers is estimated to be roughly Shs. 40,000 or some four times the estimate prepared for the UK-ODM loan.

Capital Costs of Tick Control Centers

The Ministry of Animal Industry requested financial assistance from a variety of international sources and from the self-help tick control societies in support of the Tick Control Project. In various project statements, prepared over a brief five year period, the estimated capital cost of individual tick control centers varied from less than Shs. 10,000 to a flat Shs. 100,000 per center:

	Cost per Center
UK-ODM Loan (Dept. Vet. Ser. Est.)	9,890
USAID Loan (USAID Est.)	40,793
IBRD-IDS Loan (Dept. Vet. Ser. Est.)	100,000
Revised Study Estimate	27, 975

Thus, in order to budget the development costs of the entire Tick Control Project, it is necessary to first establish a reasonable estimate of the cost of each center and the per center cost of the required support infrastructure. This can be done in most instances by bringing together in a revised budget the various cost items from earlier budgets (see footnotes Table 6.3). This revised estimate is compared with the per center budget costs prepared by USAID and for the UK-ODM Loan in Table 6.3. It is evident that many essential items were omitted from the UK-ODM budget prepared by the Ministry of Animal Industry. As a result the total capital cost of the Tick Control Project has been grossly underestimated by the Ministry. Major items omitted from the UK-ODM Loan include support facilities and water development costs.

The budget prepared by USAID exceeds the revised budget by almost Shs. 12,000 per center although it differs only slightly in content. The principal cause of this discrepancy in the importation of certain items from the United States, particularly prefabricated buildings at costs well above the local supply price. Centers provided by USAID will cost the Government more than Shs. 8,000 in foreign exchange costs, above that of locally purchased equivalents.

This revised per center estimate includes support facilities and equipment, regional and area stores and offices, and a local residence and store for dip attendants and also regional laboratories, an item omitted from all previous budgets. It provides for a reinforced concrete dipping tank with necessary runways and fencing and for a permanent water supply at each center. The total on site cost of each center is estimated to be approximately Shs. 23,675. An additional average cost of Shs. 4,300 is required for support facilities and equipment, bringing the total capital development cost per center to roughly Shs. 27,975.

Starting with a realistic capital budget for individual tick control centers, it is possible to project the capital development costs of the Project. Before doing so, attention must be given to the numbers of centers required, appropriate phasing of development and recurrent costs.

Total Capital and Recurrent Costs of the Tick Control Project

The scope of the Uganda Tick Control Project which began as a modest pilot scheme in 1964, has been expanded to cover the greatest share of the country. The intent of this study is to estimate the costs and benefits and the resources required to implement the Project. In the cost analysis which follows it is assumed that adequate financial support will be made available to provide the required staff and infrastructure necessary to make the Project successful. The rationing of these scarce resources between competing projects by any adjustment in the scope of this Project is more appropriately that of the Government of Uganda. The framework of the analysis has been built around the two remaining five year planning periods of the current 15 year perspective plan--1970/71-1980/81.

However, it is impossible to avoid making certain assumptions concerning the program for tick control where specific policy guidelines are absent. It is argued elsewhere that the stated goal of East Coast Fever eradication is not likely to be achieved except in unique local areas and that most of the benefits of disease eradication for conventional producers can be obtained from a more modest tick control program. For these reasons, the costs (and in the following chapter, the benefits) of a more modest partial tick control program are estimated. The modifications of the budgets which would be required to implement a disease eradication program are, however, noted. It is also necessary to make assumptions concerning the number of centers required, the proportion of centers which require water supplies, the services which will be provided by the Government and the appropriate charge for the capital invested in the Project.

Number of Tick Control Centers Required

In Chapter V the importance of making tick control centers easily accessible to all cattle owners was emphasized. However, in the blanket loan applications, prepared by the Ministry, the number of tick control centers required have been estimated by assuming that each center will cater to an average 2,000 head of cattle. This rule of thumb was chosen because it represents the optimum size of a center from the standpoint of minimizing acaricide and supervision costs.[6] However, given the rather sparse concentration of cattle over much of Uganda, some cattle would need to travel an unreasonable distance to reach centers if this rule were to be rigidly followed. With the intention of minimizing the cost of dipping to the individual owner, the following rules have been

6. It is usually recommended that dip wash be changed every six months or after dipping 50,000 head, whichever comes first. If 2,000 head were dipped weekly, dip wash would need changing at the end of six months exactly.

used to establish the number of centers likely to be required:

1. The maximum distance required to travel to any center in open grassland or savanna woodland, substantially free of cultivation, should not exceed 3 miles. This rule would apply to areas in Land Resource Zones IV, V and VII and would imply a maximum area served of roughly 27 square miles (see Tables 6.4 and 6.5).

2. The maximum distance required to travel to any center in crop/livestock areas with moderate to substantial amounts of cultivation should not exceed 2 miles. In some areas of intensive cultivation or difficult travel, the maximum distance may need to be reduced even further. This rule would apply to many areas in Land Resource Zones I, II, III and IVa. It is generally felt that Zebu cattle will suffer no appreciable decrease in weight or production if trecked weekly no more than two miles to a dipping center.

3. The maximum number of cattle served by any one center should not exceed 2,000 head of cattle. Where cattle densities exceed 128 per square mile in crop/livestock areas or 64 per square mile in grassland/savanna areas, the 2,000 head maximum will be exceeded within the 16 and 27 square mile service areas respectively (see Tables 6.4 and 6.5).[7]

4. In most instances, the minimum number of cattle served should not be less than 1,000 head. This final rule comes into play in areas with very low cattle population densities. Low densities occur extensively in Zone IV where cattle populations are expected to grow rapidly, but also in areas of intensive crop cultivation and forest remnants. For example, it will be necessary to construct 99 centers for 55,000 cattle in the Kyagwe County disease eradication area or one per 550 head of cattle, and it is proposed to construct one center per 850 head in the Kyoga-Serere County eradication area. In areas where cattle densities are light, it may be necessary to encourage the regular hand spraying of cattle. The Department of

7. Even where large herds occur, ownership within that herd may be by 2-4 or more households. Societies catering to 2,000 head could have 100 or more members. Where cattle are managed in small groups, it may be desirable to increase the number of societies in order to keep the size of the membership to manageable levels. This clearly would be desirable in a disease eradication scheme area.

TABLE 6.4. UGANDA TICK CONTROL PROJECT: DISTANCE TRAVELED AND SIZE OF AREA WHERE 2,000 HEAD OF CATTLE ARE SERVED PER CENTER, VARIABLE STOCKING DENSITY

Stocking Density Acres per Head	Cattle per Sq. Mile	Square Miles	Diameter of Block (Miles)	Radius Inscribed Circle (Miles)
1.0	640	3.13	1.77	.88
2.0	320	6.25	2.50	1.25
3.0	213	9.38	3.07	1.53
4.0	160	12.50	3.54	1.77
5.0	128	15.63	3.96	1.98
7.5	85	23.45	4.84	2.42
10.0	64	31.25	5.59	2.80
20.0	32	50.00	7.07	3.54

TABLE 6.5. UGANDA TICK CONTROL PROJECT: CATTLE PER SQUARE AREA, VARIABLE STOCKING DENSITY

Radius Inscribed Circle	Area Square Miles	Stocking Density Acres/Animal					
		1.0	1.5	2.0	2.5	5.0	10.0
		(Cattle per square mile, thousands)					
1.0	4.0	2.6	1.7	1.3	1.0	.5	.3
1.5	9.0	5.8	3.8	2.9	2.3	1.2	.6
2.0	16.0	10.2	6.8	5.3	4.1	2.1	1.0
2.5	25.0	16.0	10.8	8.2	6.4	3.2	1.6
3.0	36.0	23.0	15.4	11.9	9.2	4.6	2.3
4.0	64.0	41.0	27.3	20.5	16.4	8.2	4.1
5.0	100.0	64.0	42.7	32.0	25.6	12.8	6.4

> Veterinary Services now recognizes that one center per 1,000 head may be required for the Tick Control Project (200, p. 10).

In practice these guidelines will need to be modified on the ground in order to take into account suitable site locations and political boundaries. Centers usually serve one or more subparishes. Applying these four rules, the estimated number of centers required to complete the Project is shown for each county in Table III. This table is summarized by district in Table 6.6. The rule of one center per 2,000 head indicates that only 1,568 centers will be required to service the present cattle population; the revised estimate suggests that 2,154 centers is more realistic. Under the revised estimate the average center will serve roughly 1,650 head of cattle. If this ratio is maintained in the next decade--after taking into account the expected growth of the cattle population in each region--not less than 2,720 centers will be required to service the cattle population at the end of the Third Plan. A disease eradication program, limiting cattle at each center to 1,000 head, will require the construction of up to 4,500 centers.

The revised capital budget provides for the construction of only 215 centers per year, phasing the Project over the second and third plan period. This goal has been adopted by the Department of Veterinary Services (200, p. 42). At this rate it will be possible to complete the entire construction program by the end of the third plan period.[8]

8. For the purpose of projecting the impact of tick control, it has been assumed that all cattle will be included unter the program by 1978, midway in the third plan period. Construction post this date will be to reduce the numbers of cattle served per center. Additional centers will be required post 1981 to cater to any further expansion of cattle numbers.

Water Supply Development Costs

The largest expense item excluded from some previous budgets is the development of water supplies for the centers. The actual quantity of water required for dipping is rather small, at the most 50,000 gallons per center per year. Early dip sites were located on existing permanent lakes, swamps, streams, by motorized bore holes or next to the dams or valley tanks constructed specifically as water supplies for cattle by the Ministry of Lands and Surveys. The number of dams and tanks which had been built by mid-1967 totaled about 660 (see Table 6.6). They were constructed to create permanent year round water supplies for cattle in areas recently cleared of tsetse or subject to periodic droughts.

In Uganda, a common source of water for cattle are the many seasonal swamps, a factor contributing to the very high incidence of liver fluke in cattle. Watering points which dry up during the dry season are unsatisfactory as dip sites and, as the Project expands, it will be necessary to develop additional permanent water supplies. In most cases small to moderate size valley tanks are to be constructed at the head of catchment areas or at the margin of seasonal swamps. Valley tanks, if properly sited, have several advantages over dams in that they are much less expensive to construct, will not wash out in tropical flash floods and are slow to silt up. They can easily be dredged or enlarged at some future date using drag lines. Unlike mechanized bore holes, they require little mechanical equipment.

The core questions are to estimate the number of centers which will require water development and to make a decision as to what part

TABLE 6.6. UGANDA TICK CONTROL PROJECT: AVAILABLE DAMS AND VALLEY TANKS, 1967, AND ESTIMATED NUMBER OF TICK CONTROL CENTERS REQUIRED, 1968 AND 1981

District	Dams and Valley Tanks 1967[a]	Estimated Centers Required: Dept. Vet. Ser. 1968[b]	Study Estimate 1968[c]	Study Estimate[d] 1981
Northern Region				
Lango	136	190	256	--
Acholi	74	90	112	--
W. Nile	10	63	118	--
Madi	--	9	20	--
Total	220	352	506	660
Eastern Region				
Busoga	45	114	145	--
Teso	121	298	298	--
Bugisu	3	43	45	--
Sebei	2	19	18	--
Bukedi	40	83	98	--
Total	211	552	604	885
Karamoja	122[e]	45[f]	45[f]	45[f]
Eastern Region				
Ankole	139	67	233	--
Kigezi	--	49	75	--
Toro	11	34	60	--
Bunyoro	28	21	43	--
Total	178	271	411	635
Buganda				
W. Mengo	--	--	86	--
E. Mengo	68	--	228	--
Mubende	7	--	138	--
Masaka	66	--	136	--
Total	141	348	588	675
Total Uganda	661	1,568	2,154	2,855

a. Source of data: Ministry of Lands and Surveys, Water Development Division, Kampala. Includes all dams and valley tanks constructed for the use of cattle by the Water Development Division through 1967 and marked on 1:250,000 base maps.

TABLE 6.6. (cont'd.)

b. Source of Estimate: Dept. Vet. Ser., Application for Assistance for the Uganda Tick Control Project under the British Loan, Kampala, 1968. One center projected for 2,000 head.

c. Roughly one center per 1,600 cattle in the project (see Table III).

d. Assumes ratio of one center per 1,600 cattle will be continued and allows for growth of cattle population.

e. Includes all of Karamoja District.

f. Pian County only.

of the cost should be charged to tick control. Any allocation of costs is by necessity arbitrary without an extensive study to determine those sites which require water and the benefits of the new water supply to the cattle population. The water reservoirs will also serve as year round water supplies for cattle and in some instances the human population. They will also contribute to a better utilization of the available grazing and encourage the growth of the national herd in the underpopulated areas. For the purpose of budgeting the Project, it is assumed that 75 percent of the centers which remain to be constructed will require water supplies. or about 1,750 centers, and that one half of the capital cost of water development should be charged to the Tick Control Project. In costing the Project, a modest tank size has been used although in some areas it may be desirable to construct larger tanks (see Table XVIII for size and cost estimates).

Recurrent Costs

In projecting recurrent and total capital costs, it has been necessary to make assumptions about the future philosophy of the Project. It is assumed that the self-help tick control philosophy will be continued and that farmers will continue to contribute part of the on site development cost and will provide the local recurrent costs.

One frequent area of disagreement among those planning and evaluating the new programs is to decide which recurrent and capital cost items should be charged to the budget of the Project and which should be allocated to the normal budgetary expense of the department concerned. In the case of Tick Control, it was argued that there will be a continued expansion of Veterinary staff and support infrastructure and that over the next decade these, as a matter of course, will be assigned to Tick Control. However, the definition of "recurrent cost" proposed by the Ministry of Planning for the guidance of working parties for the Development Plans is more appropriate: "the more or less perpetual financial liabilities which could be avoided if the project were not undertaken" (213, p. 1). Following this definition, all staff principally assigned to tick control should be charged against the Project as recurrent cost.

A second area of disagreement is over which recurrent costs should be the responsibility of the owner societies and what would be an appropriate level of subsidy for the Project, if any. It has been noted that most societies do not have budgets, as such, nor regular fees. Funds are collected as required to purchase acaricide. It has been assumed here that societies will be responsible for all repair costs and for replacing equipment and fencing as required and also the salaries of the local dip attendant. Although the salaries of dip attendants are currently paid by Government, it is felt that they will be more responsive to the needs of the societies if paid by them and recruited locally. In addition, a levy of Shs. 0.10 per head is included for the support of a county cooperative union.

The major recurrent cost in the societies' budgets will be for acaricide. The precedent exists for Government subsidy on pesticides. However, animal products contribute only marginally to direct Government tax revenue and because of the major element of subsidy already in the scheme for staff, salaries, capital financing and support operations, it is felt strongly that owner societies should pay full price for acaricides. In fact, a surcharge in the cost of acaricides might be one source of revenue either for Government or cooperative unions. Never-the less, the Department has elected to grant a 50 percent subsidy on the price of acaricide to new societies during the first two years of their operations. Over a two year period, the value of this subsidy to most societies is roughly Shs. 3.50-4.00 per head of cattle. Coincidentally, this is roughly the contribution to capital development donated by society members. For this reason, the expense of this subsidy has been included as a capital development cost item. Expenditure on this subsidy must come almost exclusively from Uganda Government sources.

Following from these assumptions, the estimated annual recurrent cost for a tick control center servicing 2,000 head of cattle without an acaricide subsidy is outlined in Table 6.7. The costs per head for this size center and one servicing 1,000 head are as follows:

	Cost (Shs.) per Head per Year	
	2,000 Head	1,000 Head
Capital Costs		
(Depreciation)	0.67	1.34
Recurrent Cost		
Labor and Repairs	1.19	2.38
Acaricide and Dues	4.10	4.10
Total Recurrent Cost	5.29	6.48
Total Cost per Head	5.96	7.82

The recurrent annual budget for most societies (including depreciation of capital items) will fall between Shs. 6.00 and 8.00 per head per year or 12-15 cents per head per week. Based on past experience and reasonable estimates of added income to owners, this should not fall

TABLE 6.7. UGANDA TICK CONTROL PROJECT: CAPITAL INVESTMENT, ANNUAL FIXED AND RECURRENT LOCAL COST OF THE AVERAGE TICK CONTROL CENTER SERVING 2,000 CATTLE

Cost Item	Shs. Total Cost	Shs. Cost per Animal
Capital Investment[a]		
Dip Tank, Boma and Shelter	13,000	
Water Development (Equipment)	1,275	
Water Supply (Valley Tank)	10,400	
Total Cost	24,675	12.34
Fixed Cost Society		
Depreciation of Dip Tank Shs. 8,000 over 20 years	400	
Depreciation of Boma, Crush and Runway Shs. 4,000 over 5 years	800	
Depreciation of Water Development Components Shs. 1,275 over 10 years	130	
Total	1,330	.67
Recurrent Cost per Society		
Porter @ 480	480	
Dip Attendant @ 2,400 (1/3)	800	
Annual Repairs	700	
Misc. Society Expense	300	
Sub Total	2,380	1.19
Recurrent Cost per Head of Cattle		
Acaricide[b]	8,000	
Membership Fee Area Union @ 0.10	200	
Sub Total	8,200	4.10
Total Recurrent Costs	10,480	5.29
Total Fixed and Recurrent Cost	11,810	5.96

a. Source, Table 6.3.

b. Based on experience in Kyagwe County Scheme which suggests the cost of acaricide will be between Shs. 3.00 and 4.00 per head per year if cattle are dipped once per week in 1:300 concentration of toxaphene (see also Appendix III).

outside the willingness or ability of society members to pay on a regular basis (see Chapter VII).

The projected recurrent cost of societies and the average cost of service to members per head of cattle served over the perid 1969/70-1980/81 is summarized in Table XIX. The average cash cost per head served in the national Project is slightly less than that indicated in the above example because some centers will initially cater to more than 2,000 head. The average cost per head is expected to increase from a current Shs. 4.85 per head to 5.85 at the end of the third plan when acaricide subsidy will end and the average number of cattle served per center declines.

Turning to the recurrent costs of the Project to the Government, the estimated annual recurrent cost of support activities for each center in operation is summarized in Table 6.8. The various support activities are budgeted separately and their cost prorated on a per center basis. The estimated average recurrent cost per center for support activities is broken down into the following cost items:

Cost Item	Prorated Cost per Center Shs.
General Staff Units	348
Area Headquarter Units	1,773
Local Headquarter Units	381
Dip Testing Units	58
Chemicals and Supplies	50
Total Cost	2,610

TABLE 6.8. UGANDA TICK CONTROL PROJECT: ESTIMATED ANNUAL RECURRENT COST FOR GOVERNMENT SUPPORT ACTIVITIES PER TICK CONTROL CENTER

Support Units	No. of Items	Cost per Item	Total Cost of Item(s) (Shs.)	Fractional Units per Center	Prorated Cost Per Center (Shs.)
General Staff Units					
Veterinary Officer	(1)	32,300	32,400		
Clerk	(1)	8,040	8,040		
Secretary	(1)	8,040	8,040		
Personnel Overhead[a]		33%	15,998		
Sub Total			64,478		
Transport Units[b]	(1)	22,600	22,600		
Total Cost of Unit		77,540	87,078	1:250	348
Area Headquarters Units					
Animal Husbandry Officers	(2)	16,200	32,400		
Veterinary Assistants	(5)	7,000	35,000		
Statistician	(1)	8,040	8,040		
Clerk	(1)	8,040	8,040		
Porter	(2)	2,000	4,000		
Personnel Overhead[a]		33%	28,868		
Sub Total			116,348		
Transport Units[b]	(2)	22,600	43,200		
Total Cost of Unit			159,548	1:90	1,773
Local Headquarters Units					
Storekeeper	(1)	8,040	8,040		
Porter	(1)	2,000	8,040		
Personnel Overhead[a]		33%	1,388		
Sub Total			11,428	1:30	381

TABLE 6.8. (cont'd.)

Support Units	No. of Items	Cost per Item	Total Cost of Item(s) (Shs.)	Fractional Units per Center	Prorated Cost per Center (Shs.)
Dip Testing Units					
Officer (Entomology)	(1)	32,400	32,400		
Animal Husbandry Officer	(1)	16,200	16,200		
Vet. Assistant	(2)	7,000	14,000		
Clerk/Secretary	(2)	8,040	16,080		
Lab. Assistants	(3)	2,000	6,000		
Personnel Overhead[a]		33%	27,944		
Sub Total			112,624		
Transport Units[b]	(2)	22,600	45,200		
Total Cost of Unit			157,824	c	58
Chemicals and Supplies[d]	--	50	--	1:1	50
Total Support Activities	--	--	--	--	2,610

a. Includes fringe benefits and miscellaneous items of expense above wage costs.

b. Each transport unit includes both the operating expense and depreciation on a standard land rover.

c. One dip testing unit required per region or roughly one per 700 centers when project is completed.

d. Estimated cost of testing chemicals and supplies per center in operation.

The estimated annual recurrent cost subsidy per center is Shs. 2,610. The direct annual subsidy to farmers is estimated to be between Shs. 1.10-2.20 per head, depending on the number of cattle served per center. Should the Government elect to continue to pay the salary of dip attendants; the annual subsidy to each society would be increased by roughly Shs. 800, increasing the average subsidy to roughly Shs. 1.50-3.00 per head per year.

The projected budget for recurrent expense which reflects the phased growth of the Project is given in Appendix Table XX. This table also shows the estimated number of cattle served at each center and the average recurrent cost per head. The annual recurrent budget for the Project is expected to increase from an estimated Shs. 1.5 million in 1969 to just over Shs. 7.0 million at the end of the third plan. The average subsidy per animal is expected to increase as the scheme expands from about Shs. 1.05 in 1969 to Shs. 1.57 at the end of the third plan. This level of subsidy will not place an undue strain upon the budget of the Ministry of Animal Industry, particularly in light of the potential role of societies in extension education (see Chapter X). The number of full time officers and junior staff required to adequately implement the Project are indicated in Table XX.

Projected Capital Development Costs

The projected budget for capital expenditure and the accumulated value of the scheme are given in Table XXI. Including acaricide subsidy and one-half the cost of valley tank construction, the total capital required to complete the Project is Shs. 57 million, considerably above the Shs. 16.5 million expended or pledged by foreign assistance programs. The new capital required per year over the second and third plan will average about Shs. 5 million per year.

The question of an appropriate charge for capital used in the Project is a complex one. Early development funds came primarily from special activity funds and certain "surplus" funds of the Department of Veterinary Services and from donations of cattle owners and a philanthropic organization. A substantial part of past and future capital development is expected to be financed by long term foreign loans at nil or very low interest charges. The Ministry of Animal Industry has tended to view these funds, with some justification, as having a zero opportunity cost as it will be the responsibility of the Uganda Treasury to repay the loan funds, not the Ministry of Animal Industry.

However, the acceptance of foreign loans, regardless of terms, does have a direct bearing on the credit worthiness of the Uganda Government and the projects of the Ministry of Animal Industry. As a result, the opportunity cost of capital is considerably above the average cost of foreign loan capital used in the Project. Also, the probable useful life of the Project is expected to be much shorter than the average loan period of 40 years. Unless substantial additional soft loans for tick control are forthcoming, much of the remaining capital must come from local sources. For these reasons the capital invested in the Project, regardless of source, has been costed at roughly the marginal value of these funds in other uses, or 6 percent per annum, and all investment has been amortized at this rate over a 15 year period from the date of investment (Table XXII).

The recurrent capital cost of the Project and the cost of capital financing per animal served for the period 1970/71-1980/81 are summarized in Table XXII. From a current annual capital financing cost of roughly Shs. 0.50 per head of cattle served, this charge will increase over the second and third plan periods topping out at roughly Shs. 1.44 per head per year. The cost schedule for investments during the second and third plan periods will continue through 1996 but will decline as an annual cost item.

The projected recurrent costs per head to Government and owner societies, and the average cost of capital used in the scheme are combined in Table 6.9. The costs per head for representative years are as follows:

	Cost per Head		
	Recurrent Cost Society	Recurrent and Capital Cost Government Shs.	Total Project Cost
1971/72	5.05	1.67	6.88
1975/76	5.50	2.18	7.68
1979/80	5.80	2.69	8.43

The costs per head for tick control are compared with probable benefits in the next chapter.

The projected annual Project budget for each of the Plan periods is summarized in Table 6/10. Whether the Tick Control Project can be carried out as outlined will depend primarily on the willingness of Government to commit the requisite resources of manpower and funding to this Project in preference to other developmental requirements and on its ability to attract additional loan funds.

TABLE 6.9. UGANDA TICK CONTROL PROJECT: ESTIMATED RECURRENT AND CAPITAL COST PER HEAD PER ANNUM 1970/71-1980/81*

Year	Cost per Head				
	Recurrent Cost		Total Recurrent Cost Shs.	Capital Cost per Center	Total Capital and Recurrent Cost
	Society	Government			
1970/71	4.85	1.05	5.90	--	--
1971/72	5.05	1.13	6.34	.54	6.88
1972/73	5.20	1.17	6.37	.67	7.04
1973/74	5.30	1.19	6.49	.76	7.25
1974/75	5.40	1.24	6.64	.85	7.49
1975/76	5.50	1.27	6.77	.91	7.68
1976/77	5.65	1.32	6.87	.98	7.85
1977/78	5.70	1.36	7.06	1.03	8.09
1978/79	5.75	1.39	7.14	1.06	8.20
1979/80	5.80	1.48	7.28	1.15	8.43
1980/81	5.85	1.57	7.42	1.22	8.64

*Projected society recurrent cost summarized from Table XIX and those for Government from Table XX. Capital costs per center summarized from Table XXI.

TABLE 6.10. UGANDA TICK CONTROL PROJECT: SUMMARY OF PROJECTED PROJECT COST FIRST, SECOND AND THIRD PLAN PERIODS*
1965/66-1980/81

(Shillings, thousands)

Item	First Plan pre 1970/71	Second Plan 71/72-75/76	Third Plan 76/77-80/81	Total
Society Capital Contribution and Recurrent Cost Budget				
Capital Construction	3,420	6,450	6,450	16,320
Acaricide Cost	6,840	45,160	78,630	130,630
Other Recurrent Cost	4,659	25,222	41,264	71,145
Total Society Costs	11,499	70,382	119,894	201,775
Government Capital Development				
Direct Capital Investment	6,474	17,680	17,680	41,834
Acaricide Subsidy	3,000	7,760	4,730	15,490
Sub Total	9,474	25,440	22,410	57,324
Government Project Support Budget	--	15,855	29,885	45,740
Debt Repayment and Interest		10,149	22,768	32,917

*Society budget summarized from Table XIX. Government capital development budget from Table XXI, recurrent support budget from Table XX and debt repayment and interest budget from Table XXII.

Chapter VII

THE IMPACT OF TICK CONTROL ON PRODUCTIVITY FACTORS

Particularly difficult tasks in evaluating improvement projects are to establish accurate benchmark estimates of productivity in conventional farms and herds and to arrive at reasonable estimates of any improvements in productivity which can be expected to occur as the direct result of the specific project. Although data on the crop enterprises of African farmers can be surveyed over one crop season with some accuracy, livestock enterprises must be studied over a period of years before reliable estimates of productivity in typical herds can be obtained. Because of the expense and difficulties of surveys, particularly in pastoral areas, no long term studies of the cattle economy have been carried out in Uganda. The few short time studies and the impressions of owners and Government officers do provide valuable clues to existing productivity. In addition, the unusually detailed herd census data available for Uganda herds makes it possible to estimate productivity factors in the national herd with some precision. These in turn can be used to estimate farm and national income, the improvement in productivity which can be reasonably expected to occur as a result of tick control and the increase in the production of meat and milk.

Measures of Productivity in Dairy/Beef Herds

Cattle in Uganda are multipurpose animals but for the purposes of analysis, they may be assumed to be dairy/beef cattle. The important productivity factors in dairy/beef enterprises are the following:

1. Cow/calf herd
   a. Calving rate (calves born per cow per year)
   b. Calf mortality
   c. Effective weaning rate (calves weaned per cow per year)
   d. Milk production in excess of calf needs
   e. Weight at weaning
   f. Adult mortality

2. Immature and growing herds
   a. Weight for age at sale or maturity (males)
   b. Weight for age at sale or maturity (females)
   c. Age at first calf

3. General enterprise profitability
   a. Commercial extraction rate
   b. Milk sold (or consumed)
   c. Income per cow
   d. Income per acre (or hectare)

The herd productivity variables which are expected to be modified most by tick control are calf mortality and milk yield per cow. Thus estimates of these factors deserve particular attention.

Calf Mortality Pre and Post Control

The exact calf mortality in Uganda is unknown for conventional herds but it is believed to vary by (a) breed and strain of the animal, (b) general health of the calf, (c) the extent of the tick burden and (d) the types of diseases and disease strains present. Mortality may also vary between areas and between years. The most frequent estimate of calf mortality in conventional herds from all causes in East Coast Fever endemic areas is 30 percent but estimates range from 20-50 percent.

Data on calf mortality from several experimental and institutional herds and from field studies are available and these are summarized in Table 7.1. The data clearly illustrate the prohibitive mortality which occurs among exotic and exotic crosses which are highly susceptible to tick borne diseases. The data also indicate that in experimental and institutional herds, calf mortality following East Coast Fever eradication declines to less than 5 percent. For example, calf mortalities in the herds of the Ongino Leprosy Center and the Bunyoro Ranching Company which were 25.7 and 23.0 percent respectively prior to any tick control whatsoever, declined to less than 5 percent in both herds following the introduction of a vigorous tick control program.

Previous evaluations of the Tick Control Project have assumed similar post Project mortalities in conventionally managed herds. However, it is not realistic to assume that ECF can be eradicated in the short run nor is it reasonable to ~~expect~~ average mortality to decline from 30 percent to less than 5 percent in all herds.

Data to suggest the probable reduction in mortality under a regime of partial tick control are conflicting. During the first few years after partial tick control was initiated at the Serere Station (1947-1951), calf mortality was reduced to an average 7.7 percent for calves on free range with their dams, 11.1 percent for semi-ranged calves (dairy/beef combination) and 14.3 percent among calves bucket fed (167, pp. 250-255). However, during the years partial tick control was in effect (1947-1966), calf mortality in Zebu herds averaged 22 percent (171, p. 6). Mortality was only fractionally less than in the Ongino and

TABLE 7.1. EAST AFRICA: CALF MORTALITY PRE AND POST TICK CONTROL, GOVERNMENT AND INSTITUTIONAL HERDS AND FIELD SURVEYS

Area or Station	Year(s)	Mortality 0-12 mo. percent	Remarks	Source of Data
Land Resource, Zone II			Partial control by hand	
Kyagwe County, Buganda	1966	19.1	spraying	4
" " "	1966	9.2	Mechanized power spraying Kyagwe County subproject	
Entebbe Vet. Res. Sta.	1962	100.0	Guernsey males (5)	57 pp. 289-298
	1962	55.8	Jersey/Nganda crosses, (43)	
	1962	8.3	Nganda (12)	
Land Resource Zone III and IV			(All partial tick control)	
Serere Agr. Station	1947-51	7.7	Free range calves	167
	1947-51		Semi-ranged calves	pp. 250-255
	1952-56	19.1	" " "	
	1952-56	23.8	Bucket fed calves	
	1943-63	20.7	All cattle	
	1958-63	82.0	Pure Boran	171
	1958-63	40.0	Boran-Zebu crosses	
Ongino, Leprosy Center Farm, Teso	Pre-1963	25.7	Semi-ranged, no tick control)	
	Post-1963	3.3	Semi-ranged, full tick control)	48
Owner Opinion Poll, Serere and Kyoga Counties	1969	37.7	Average estimate, 14 farmers	47

TABLE 7.1. (cont'd.)

Area or Station	Year(s)	Mortality 0-12 mo. percent	Remarks	Source of Data
Bunyoro Ranching Co.	1964	23.0	Free range, no tick control	24 p. 71
Land Resource, Zone V Mbarara Stock Farm		42.0	Ankole and Ankole/Boran	197a, p. 24
Ankole Land Use Unit	early 1960's	21.1	Female calves only)	240 pp.178-181
		46.3	Male calves only)	
		33.8	Average, both sexes)	
Kenya, Nyanza Province Lela area	mid 1950's	28.6	Pre tick control)	16, pp. 343,357
Bungoma area	"	29.0	)	
Lela	"	7.4	2.5 yrs. post tick control)	
Bungoma	"	8.8	Bi-weekly dipping)	

Bunyoro herds which practiced no tick control. Calf mortality at the Mbarara Stock Farm under partial tick control continued to average an incredible 42 percent among both Ankole and Ankole/Boran crosses (197a, p. 24). Extrapolating from the experience on these stations, the Department of Veterinary Services concluded that the only solution was to press for a disease eradication program.[1] In doing so, they ignored evidence of the value of partial tick control had had in early years at Serere and evidence that partial tick control can effectively reduce mortality in conventional herds.

In one of the few careful field studies of its kind, biweekly dipping reduced calf mortality in two areas of Kenya with very similar climate to eastern Uganda, from around 29 percent to less than 10 percent (16, pp. 343-357). Also, less than complete disease eradication in Kyagwe County is allegedly to have reduced mortality from more than 20 percent to less than 10 percent. Provided calves are included in the program, partial tick control can reduce calf mortality substantially among indigenous breeds. Hence, less costly partial tick control has been advocated in this study for the national Project.

One other inclusion in Table 7.1 deserves special mention. In the Ankole Land Use Unit where typical herds were kept under observation, calf mortality averaged only 21.1 percent for female calves, but was 46.8 percent of male calves with an average of 33.8 percent mortality for both sexes. Mortality differs between sexes because cattle owning

1. Partial tick control failed to reduce calf mortality at Serere and Mbarara apparently because not enough attention was given to reducing the tick burden on calves (120).

families in Ankolo starve or sacrifice male calves in order to increase the milk supply for home consumption or for sale. As there is no reason to presume this practice will end following tick control, it is necessary to anticipate a differential calf mortality by sex in the western management area.

To summarize, earlier analyses of tick control have assumed a reduction in calf mortality from an average 30 percent to 5 percent in all herds. Even if ECF were to be eradicated, it is unrealistic to assume that calf mortality on average will be reduced to this low level. There is evidence that an effective tick control program can reduce mortality substantially, possibly to less than 10 percent.

Milk Yields Pre and Post Control

There are only scattered records of the total milk yields of cattle in conventionally managed herds, or of the fraction of the total yield extracted by the farmer and that proportion left for the calf to suckle. Calves are usually housed and grazed separately from the herd and cows are milked with calf at foot. As a rule, the calf is allowed to nurse two quarters while the herdsman milks two. When daily milk yields drop to unrewarding levels, the calves may be allowed to run with their dam during the day and the dams are milk only in the morning. Calves are seldom forcibly weaned and may be observed to suckle until they are 8-12 months of age. Further complicating any estimate of annual yield is the fact that male calves may be starved or slaughtered in order to make more milk available for family consumption. In any event, it is believed that herdsmen extract less than half of total milk yield of the cows and that calves nurse somewhat more than half.

A generally accepted estimate of milk extracted by the farmer during each lactation is 600 pounds (272 liters). The very limited data on yields directly from farmers' herds suggests this estimate may be slightly high but not improbable (34, 132 and 231). If it is assumed that milk extracted by the herdsmen represents 45 percent of total yield, total yield would be expected to be on the order of 1,335 pounds (605 liters) per animal per lactation (Table 7.2, column A). This estimated yield would be 65-85 percent of average lactation yields obtained in experimental herds (see Tables 3.1, 3.2, 3.3 and 3.4).

A second variable which must be estimated is calving percentage, or the percentage of the cow population which begins a lactation in any one year.

Zebu cattle have been shown to be excellent breeders under improved grazing conditions. Calving intervals in institutional herds are short (average 12-14 months) and it is not uncommon for individual cattle to conceive regularly 8-10 lactations in succession (for example see Table 7.3).

Calving intervals have not been reported for conventional husbandry conditions in Eastern Africa where the data has been collected over a sufficient period to average out seasonal and annual variations. Estimates of the calving percentage fall between 40 and 90 percent depending upon grazing conditions (24, 33, 34, 126, 231). The estimate which has been used here is that 65 percent of the cows (including first

TABLE 7.2. UGANDA: EXPECTED IMPACT OF TICK CONTROL ON MILK YIELD AND VALUE OF MILK PRODUCTION PER COW

Productivity Factor	Pre-Tick Control[a]	Post-Tick Control[a]	Enclosed Farms[b]
Total Milk Production			
Milk yield to calf, lit.	332	399	455
Milk yield to owner, lit.	272	327	455
Total milk production, lit.	605	726	910
Calving percentage	65	68	90
Yield and Value of Milk			
Milk yield to farmer, lit.	177	222	410
Imputed value milk per lit., Shs.[c]	.60	.60	.60
Imputed value milk yield, Shs.	106	133	246
Percentage Increase in Yield	--	25	130

a. Presumes calf nurses 55 percent of milk and yield to farmer is 45 percent of total production.

b. Based on experience at Serere Agricultural Station. Calf and farmer each milk 50 percent of total production.

c. The imputed average value of milk yield to the owner per kilo, taken here to be Shs. 0.60 per kilo, is roughly the average price of milk in rural areas of the Eastern, Western and Northern Regions.

TABLE 7.3. KUMI-ONGINO LEPROSY CENTER: CALVING INTERVAL BY LACTATION, PRE AND POST TICK CONTROL, 1958-1968

Lactation Interval	Pre Tick Control		Post Tick Control		All Records	
	Calving Interval (days)	Lactations (no.)	Interval (days)	Lactations (no.)	Interval (days)	Lactations (no.)
1-2	499	39	421	33	436	72
2-3	416	29	408	45	411	74
3-4	390	24	379	49	382	73
4-5	378	27	369	38	373	65
5-6	377	19	381	33	379	52
6-7	407	15	373	24	386	39
7-8	414	8	366	25	378	33
8-9	413	4	389	16	394	20
9-10	405	2	381	12	384	14
10+	392	3	393	9	393	12
All Lactations	408	170	387	284	395	454

Source: Compiled from herd records of Kumi-Ongino Leprosy Center Farm, Teso District. Prior to April, 1963 no tick control of any kind was practiced on the farm. Post April 1963, a standard spray race has been used twice weekly. Records for Zebu cattle only.

calf heifers) begin lactations each year.[2] Although cattle in the more favored parts of the country may conceive more regularly than every 18 months, it is unlikely that the average exceeds this. First, cattle are concentrated in areas where cattle numbers exceed the carrying capacity and cows are retained to advanced ages. Second, this estimate is consistent with the observed ratio of calves to cows in the census data.

There is, unfortunately, little objective data on the impact of tick control on milk production. Tick control is expected to have a positive impact on milk yield through the following:

1. Improved general health and condition--increased milk production per lactation.

2. Improved conception rate and calving percentage--increased milk production per annum.

3. Increased size of first calf heifers--improved milk production potential.

4. Reduced calf mortality--longer average lactation period with calf milked at foot.

The informed average estimate of persons queried for this survey was that total milk production per lactation would increase roughly 20 percent following tick control. This would increase the average milk yield to the farmer from 600 pounds (272 liters) to 720 pounds (327 liters) (Table 7.2, column B).

It is, however, possible to infer the impact of tick control on the calving percentage from data on calving interval in the Ongino Leprosy Farm herd (Table 7.3). These records indicate that the calving

2. To simplify assumptions here and in later sections, a heifer is assumed to become a cow at age 3 years and 6 months, the average age at first calving among Zebu cattle in institutional herds.

interval declined by 15 days or roughly 5 percent after tick control was initiated. Consequently the average calving rate in conventional herds has been assumed to improve by 5 percent from a 65 percent to a 68 percent annual rate.

The combined influence of an improved yield per lactation and an improvement in the calving rate are summarized in Table 7.2, column B. The yield of milk surplus above the need of the calf should be expected to increase roughly 25 percent per cow-year. Milk production improves rapidly following tick control but the full impact would require several years to be realized.

Impact on Owner Income

Previous attempts to project the impact of tick control on farm and national income in Uganda have followed the format outlined in Table 7.4. The first step is to assume a calving percentage, a pre and post tick control calf mortality and to project the number of calves saved by the project. The sales value of the calves saved at maturity, combined with the value of increased milk production from the cow population is then assumed to represent the "benefit" of tick control to the farmer.

In the example the project area is assumed to have 100,000 cattle. Column A uses assumptions of productivity changes projected by the Department of Veterinary Services, column B those of a USAID project analysis and column C those of this study. The projected increases in income per cow and per head from Table 7.4 are as follows:

TABLE 7.4. UGANDA: PRE AND POST TICK CONTROL HERD PRODUCTIVITY AND IMPROVEMENT IN GROSS FARM INCOME IN A TYPICAL PROJECT AREA, VETERINARY DEPARTMENT, USAID AND STUDY ESTIMATES

Productivity Factor	Dept. of Veterinary Services	USAID Estimate	Study Estimate
Cattle Population, No.	100,000	100,000	100,000
Percent Cows, %	50	40	45
Cow Population, No.	50,000	40,000	45,000
Calving Percentage, %	90	70	65
Calves Born, No.	45,000	28,000	29,250
Pre Tick Control Situation			
Calf Mortality, %	30	30	30
Calves Dead, No.	13,500	8,400	8,775
Calves Surviving, No.	31,500	19,600	20,475
Effective Weaning Rate, %	63	49	46
Post Tick Control Situation			
Calf Mortality, %	5	5	10
Calves Dead, No.	2,250	1,400	3,060
Calves Surviving, No.	42,750	26,600	27,540
Effective Weaning Rate, %	85	67	61
Benefits of Tick Control			
Calves Saved by Project, No.	11,250	7,000	7,065
Value Each Animal Saved, Shs.	500[a]	485[b]	300[c]
Savings from Tick Control, Shs.	5,625,000	3,395,000	2,119,500
Increased Milk per Cow, Liters	72.50	72.50	49.00
Milk Price per Liter, Shs.	.85	.85	.60
Milk Saved per Cow, Shs.	61.60[d]	61.60[d]	27.60[e]
Value of Milk Saved, Shs.	3,080,000	2,464,000	1,242,000
Total Savings from Project, Shs.	8,705,000	5,915,000	3,361,000
Increased Income to Pay Tick Control Cost			
Increased Income per Cow, Shs.	175.50	147.80	74.70
Increased Income per Head, Shs.	87.10	59.20	33.60

*Department of Veterinary Services and USAID Projections taken from various project evaluation documents. Study estimate based on data in Tables XXIII and XXIV.

TABLE 7.4. (cont'd.)

a. Assumes a 227 kg. animal at 3.5 years dressing out at 113.4 kg. carcass weight, and values carcass at the retail price of Shs. 4.40 per kilo.

b. Stated value in project analysis. No basis of estimate given.

c. Assumes a 227 kg. animal at 3.5 years valued at the average live weight value of Shs. 1.43 per kilo (see Table XXVI).

d. Assumes that milk yield per cow will increase from 145 liters to 217.5 liters per year and values milk at Kampala delivered price of Shs. 0.85 per liter.

e. Assumes that milk yield per cow will increase from 177 kg. to 223 kg. per year (see Table 7.2) and values milk at national average price of roughly Shs. 0.60 per liter.

Increased Income to Pay for Tick Control Costs

Source	Income per Cow	Income per Head
	(Shillings)	
Department	175.5	87.1
USAID	147.8	59.2
Study	74.7	33.6

Assuming tick control costs no more than Shs. 8.00 per head (see Chapter VI), both the Department and USAID projections suggest extremely favorable "benefit to cost" ratios to result from tick control with satisfactory increased profit margins to meet the monetary costs of tick control. The study based estimate shows favorable but much more modest benefits because the increased production of beef is valued at the average farm gate price rather than urban center price (see footnotes, Table 7.4) and productivity factors are used which are more in line with available census data. Although tick control improves owner income in the study estimate by over Shs. 30 per head, this may not be sufficient to induce all owners, particularly those with small herds or living in areas where cattle and milk prices are below the national average, to support tick control.

To obtain a more realistic estimate of owner benefits, it is necessary to take a wider range of productivity factors into consideration. An estimate of the benefits to farmers from tick control in those areas of the country where ox-cultivation occurs and where there is less emphasis on milk for family consumption (eastern management area) is summarized in Table 7.5, while the situation relevant to the western management area of the country is summarized in Table 7.6. The factors

TABLE 7.5. EASTERN UGANDA: CATTLE SALES, HERD INCOME AND SELECTED PRODUCTIVITY FACTORS PRE AND POST TICK CONTROL*

	Pre Tick Control	Post Tick Control A	Post Tick Control B	Dairy/Beef Scheme
Cattle Available for Sale				
Males	32	39	40	46
Females	18	30	30	40
Total	50	69	70	86
Value Animals Sold				
Males, Shs.	12,256	14,937	15,320	22,080
Females, Shs.	5,940	9,900	9,900	17,600
Income Cattle Sales, Shs.	18,196	24,837	25,220	39,680
Imputed Value Surplus Milk Production				
Number of Cows	170	149	144	111
Value Milk per Cow, Shs.	106	134	134	197
Imputed Income Milk, Shs.	18,020	18,966	19,296	21,867
Estimated Total Income, Shs.	36,316	44,833	44,516	61,547
Herd Productivity Factors				
Income per Cow, Shs.	214	301	309	541
Income per Animal Unit, Shs.	91	112	111	154
Increased Income to Meet Added Costs, Shs.	---	21	20	63
Income per Acre, Shs.	91	112	111	154
Commercial Extraction Rate, %	10.8	14.8	15.2	19.8

*Data on beef production summarized from Table XXIII. Projections are consistent with the available census data and other secondary data for the pre and post tick control situation in the Eastern and Northern Regions. The value of milk produced per cow pre and post tick control summarized from Table 7.2.

TABLE 7.6. WESTERN UGANDA: CATTLE SALES, HERD INCOME AND SELECTED PRODUCTIVITY FACTORS, PRE AND POST TICK CONTROL*

	Pre Tick Control	Post Tick Control	Ankole Ranching Scheme
Cattle Available for Sale			
Males, no.	32	40	40
Females, no.	23	34	41
Total, no.	55	74	85
Value Animals Sold			
Males, Shs.	12,672	16,400	31,600
Females, Shs.	9,545	14,280	19,940
Income Cattle Sales, Shs.	22,217	30,680	51,540
Imputed Value Surplus Milk Production			
Cow Census, no.	204	167	--
Value Milk/Cow, Shs.	106	134	--
Imputed Income Milk, Shs.	21,624	22,378	--
Estimated Total Income, Shs.	43,841	53,058	51,540
Herd Productivity Factors			
Income per Cow, Shs.	215	318	396
Income per Animal Unit, Shs.	110	134	129
Increased Income to Meet Added Cost, Shs.	--	24	19
Income per Acre, Shs.	55	66	64
Commercial Extraction Rate, %	11.5	15.0	17.1

*Data of beef production summarized from Table XXIV. Projections are consistent with the available census data and other secondary data for the pre and post tick control situation in the Western and Buganda Regions. Value of milk produced per cow summarized from Table 7.2.

for each area are summarized from Tables XXIII and XXIV. It is assumed that each owner has a constant acreage of land which requires that the animal units be restricted to the available carrying capacity (or convenient herd size).[3]

In both Tables XXIII and 7.5, column A depicts the pre tick control situation in the eastern ox-cultivation area consistent with the cattle census data. Assumptions include a 65 percent calving rate and a 30 percent calf mortality. Columns B and C indicate changes in herd composition and productivity which should pertain following tick control, differing only in calf mortality assumptions of 15 and 10 percent respectively. They also allow for a decline in immature and adult mortality, a younger age to reach saleable weight and a 5 percent improvement in calving percentage as a result of better herd health. Column D indicates an enclosed dairy/beed operation with improved pasture but which continues to use indigenous cattle.

The assumptions and productivity factors summarized in Table 7.5 include annual cattle sales, an imputed value of surplus milk, total herd income and income per cow and per head. Because of the restriction on cattle numbers, the composition of the herd changes markedly as calf mortality declines. Herds contain fewer cows but larger numbers of immature stock. The more significant projections from Table 7.5 are the following:

3. Similar projections for tropical South America are contained in <u>102</u> and <u>103</u>.

	Eastern Ox-cultivation Area			
	Pre Control	Post Control		Enclosed Farm
	A	B	C	D
Animals available for sale	50	69	70	86
Commercial extraction rate	10.8	14.8	15.2	19.8
Income per cow Shs.	214	301	309	541
Income per animal unit Shs.	91	112	111	154
Increased income to meet costs of tick control and other inputs Shs.	--	21	20	63

Without enclosure income from the sale of meat increases about 31 percent as does the extraction rate, with important implications for the supply of meat. However because of the decline in the number of cows, income from milk production increases only slightly and the average income per cow increases 24 percent. Of major significance to the choice between a tick control and a disease eradication project, income per cow or per animal unit is not affected by a decline in calf mortality from 15 to 10 percent. Also, the estimated increased income to meet the cost of tick control per animal unit is only about Shs. 20 per head.

Productivity factors for the larger Ankole cattle and the western area of cattle management are shown in Tables XXIV and 7.6. A higher average calf mortality is assumed with differing rates for male and female calves of 10 percent and 25 percent respectively by choice of the owner (column B). This has a decided impact on post tick control herd composition. Projections for the Ankole Ranches are shown in column C. The significant factors from Tables XXIV and 7.6 are the following:

	Western Dairy Grazing Area		
	Pre Control A	Post Control B	Ankole Ranches C
Animals available for sale	55	74	85
Commercial extraction rate	11.5	15.0	17.1
Income per cow Shs.	215	318	396
Income per animal unit Shs.	110	134	129
Increased income to meet costs of tick control and other inputs Shs.	--	23	19

Because of a younger average age at sale, the extraction rate is as high in the western area as in the eastern area even with an assumed higher calf mortality. Income from the sale of meat increases, as does the extraction rate, by roughly 38 percent. However, because of the sharp decline in cow numbers, total milk production increases less than 5 percent. With continued pressure on the man/cattle ratio in the semi-pastoral areas, male calves reared to maturity may be less than that assumed in this projection. Once again, the increase in income per animal unit to meet the costs of tick control and other inputs is surprisingly low at Shs. 23 per head.

To summarize the impact of the Tick Control Project on the conventional dairy/beef enterprise in Uganda, the Project may be expected to have a positive impact on productivity, raising the extraction rate from around 11 to 15 percent and milk production per cow by an estimated 25 percent. Milk production per cow will improve rather quickly following the initiation of tick control but the increase in the extraction rate must be lagged 3-5 years for the impact of faster growth and maturity and lower calf mortality to take full effect. Projections of the benefits of the Project on future production must take these into account.

The lagged cash benefits will also influence the willingness and the ability of the owner to initially pay for tick control and may justify the higher early subsidy for the Project.

Because of the very low current productivity of indigenous cattle, statistically large increases in productivity result in small--in absolute terms--increases in income per cow and per animal unit. Tick control is estimated to increase owner income on the order of Shs. 20-30 per animal unit with the impact greatest where land or labor are not constrained and milk prices are higher. This may not be sufficient to induce all owners, particularly those with small herds or those in areas where milk has a lower value, to support tick control enthusiastically. It should be sufficient to gain their support if fees are reasonable and centers are convenient for owners to use.

Chapter VIII

EXPANSION OF BEEF PRODUCTION

The dairy and beef industries are at the beginning of what is hoped will be major changes in production due to Tick Control and a variety of other development projects. Projects undertaken simultaneously may be complementary if they create external economies or provide raw materials for each other, or they may be competitive if they vie for the same resources and markets. There are elements of both in most livestock development projects. Although meat and milk produced by conventional producers may be considered separate products from those produced on enclosed farms and ranches, they are nonetheless near substitutes and their prices are closely related. Product prices in large measure determine the financial success of projects and the rate at which producers can adopt new practices. In evaluating the Tick Control Project it is therefore necessary to consider both the increased production resulting from the Project and the prospects for expanding production in the modern sector.

In this chapter, the supply, demand and price levels of both modern and conventional beef production are reviewed and the increment in production due to the Project is estimated. Similar aspects of milk production are considered in Chapter IX. The value of the increments in production are compared with Project costs in Chapter X.

Beef Supply and Consumption

Beef Production on Ranching Schemes, 1967-1975

Large scale beef production units are a recent phenomenon in Uganda. European settlers had been almost entirely excluded from Uganda. The tsetse resurgence of the first half of the century left large areas of former range areas free of cattle in western and northern Uganda. It was felt that in order to justify the expense of clearing the tsetse fly, and to avoid the spread of traditional "uneconomic" forms of cattle husbandry, that at least part of these areas should be used for ranches. It was hoped that the ranches would create a new group of yeomen farmer-businessmen and that they would set an example and goal for others to follow (75, p. 115; 224).

As of 1969 there were about 120 enclosed beef ranches scattered through western and northern Uganda. The largest group of 70 ranches of roughly 3,000 acres each, is in the Ankole-Masaka Ranching Scheme, located in Nyabushozi County, Ankole and Kabula County, Masaka (County no. 14 and 68, Map 4). A second group of four ranches of roughly 45,000 acres each is owned by the Uganda Livestock Industries, a Uganda Development Corporation subsidiary. A third group includes independently owned and cooperative ranches as well as sponsored ranches. By 1975/76 the combined cattle population of the three groups should be on the order of 180,000 head or somewhat less than 4 percent of the total cattle population.

Expected ranching scheme off-take for Planning Years 1968/69, 1970/71 and 1975/76 from Ranching Schemes are given in Table 8.1.

TABLE 8.1. UGANDA: ESTIMATED CATTLE POPULATION AND OFF-TAKE, MAJOR RANCHING SCHEMES, 1968, 1970, 1975*

Planning	Ankole-Masaka[a]		U. Livestock, Ltd.[b]		Other[c]			
	Cattle Number	Market Surplus	Cattle Number	Market Surplus	Cattle Number	Market Surplus	Total Cattle	Market Surplus
1967/68	18	2.7	19	2.8	10	1.5	47	7.0
1970/71	40	6.0	50	11.0[d]	30	4.5	120	21.5
1975/76	45	6.7	63	11.6[e]	72	10.8	180	29.1

*Source of Table, Uganda: Min. of Anim. Ind. Game and Fish, The Marketing of Livestock, Meat, Fish and Their Products in Uganda (Entebbe, 1969).

a. Includes Ruhengere Field Station.

b. Includes the four ranches presently under development by Uganda Livestock Industries in Bunyoro, Acholi and Lango, but excludes Nariam Ranch in Teso.

c. Ranches other than those in Ankole-Masaka or owned by U.L.I. which will be assisted by I.D.A. Loans. Includes the Singo and Buruli Schemes and Bunyoro Cooperative Ranches and several other minor schemes and private ranches.

d. Composed of 5,700 cattle purchased as immatures, 2,800 ranch bred steers and 2,500 cull breeding stock.

e. Composed of 5,800 ranch bred steers and 5,800 cull heifers, cows and bulls.

Expected sales from the ranching schemes in the development phase will be around 15 percent of average cattle numbers and will be composed of two-thirds surplus males and one-third cull cows. After the development phase when ranches are fully stocked, the commercial extraction rate should increase to 20 percent.

As it must be presumed that a "second generation" of schemes will be started, the surplus cattle sales from schemes probably may not exceed 15 percent for many years.[1] Thus, ranching scheme off-take could grow to around 27,000 head by 1975/76. This would be about 4.5 percent of Uganda's cattle sales and at the most 7.0 percent of meat supplies, still a very small proportion of total supply. A somewhat speculative estimate of future cattle numbers, post 1975/76 on enclosed ranches is included in Table VI. It is not correct to consider all scheme output as a net addition to national supply in that many of the sales in early years will be cattle purchased as immatures or breeding stock from the national herd and some ranches will displace conventionally managed herds. However, it will significantly expand the supply of good quality meat needed to replace imports from Kenya and potentially to support an export trade. The development of an export market will be hampered by the small volume of quality meat produced and rising prices. Ranch development has been supported by USAID and the World Bank.

The cattle population projections for the ranches assume that sufficient breeding stock and immatures can be found to stock the ranches.

1. The Ministry of Animal Industry has included 120 additional 3,000 acre ranches in preliminary plans for the Second Five Year Plan.

Buyers from the ranches have experienced difficulties in finding breeding stock and immatures. Prices for immatures in Uganda have been increasing. This trend could be reversed by the Tick Control Project. During the development phase these schemes will require 20,000-30,000 head of additional breeding stock.

The projection for ranching scheme off-take also assumes that the ranches will be developed as breeding units. The contribution of the ranches to the meat supply might be greater if developed as growing out ranches, speeding up the marketing of range cattle at somewhat higher carcass weights. Because productivity factors in the ranching sector will be above the national average, this will result in a slight improvement in the national extraction rate and pounds of meat sold per animal as they grow in numbers.

Beef Imports and Exports

In most years Uganda is a net importer of beef, that is, the pounds of beef imported as canned beef, carcass meat and as live cattle, exceeds the exports of beef by the Uganda Meat Packers (UMP,Ltd.) in the form of carcass meat or boned meat.[2] The balance of beef imports and exports over the period 1962-1967 is given in Table XXI.

Historically, Uganda has imported 3,000-7,000 cattle of better grades for the high income urban trade and roughly 100 tons of carcass meat for the same purpose. The UMP, Ltd., which was unable to purchase

2. The Uganda Meat Packers, Ltd. is a parastatal company within the Uganda Development Corporation. Their history is sketched in 210.

sufficient cattle in Uganda for its meat export operations, has imported 5,000 to 10,000 cattle from Kenya and Tanzania annually. Uganda also imports roughly the equivalent of 2,500 head of cattle as corned beef.

After converting all imports and exports to beef (flesh) equivalent, for the years 1962-1966, between 500 and 1,700 cattle were imported annually (final column, Table XXV). Only in 1967, a year of low imports by UMP, Ltd. and large purchases by them in Karamoja, did exports exceed imports by roughly 1,300 head. If the meat equivalent of the edible offals of the cattle imported live is included, imports exceed exports in all years. The UMP did not import cattle in 1968 but their exports were also small.

Beef Availability, 1967

It is an uncontested fact that slaughter data for most areas of Uganda is incomplete because some slaughter occurs outside official slaughter places. It then becomes necessary to fall back on an estimated extraction rate for various areas, combined with records of beef imports and exports and the output of ranching schemes in order to arrive at an estimate of the beef supply for 1967/68.

The beef supply for any point in time can be estimated from estimates of the total cattle population, the extraction rate and the pounds of meat equivalent from each animal marketed[3] plus any meat imports or exports. Taking into account the imports and exports of meat and the

3. An estimate of the average yield of meat equivalent per carcass from conventional and enclosed herds is contained in Table XXVI.

interregional movement of cattle, an estimate of the current availability of beef by region is included in Table 8.2.

No apology is made for using rounded figures in compiling the table as present data does not allow a more exact tabulation. For example, only scattered evidence on carcass weights is presently available. Nevertheless, data suggest a per capita meat availability (meat consumption varies between sub-locations and income groups) of 11 pounds. Large variations between regions are evident with availability in Buganda above the national average at 15 pounds. This reflects the urban concentration in Buganda and the higher incomes of coffee farmers. This estimate of meat availability is considerably below that of the East African Livestock Survey which estimated per capita availability at 22 pounds for the country in 1964 (53, p. 132). The reasons for this difference are that they did not make a sufficient allowance for imported hides, the assumed weight of cattle was greater than appears justified, and per capita availability appears to have declined since 1964.

Gross beef equivalent availability for 1967/68 has been estimated at 97 million pounds. Again it must be stressed that this is an estimate subject to a considerable margin of error but one based on the best available data. The true total should fall between plus or minus 20 percent from this estimate. It should be noted that estimates are constructed using an adjusted "hide extraction rate" for each region and would include most meat salvaged at farm level. The meat actually entering the market trade and sold for cash would be somewhat less (see Chapter III).

TABLE 8.2 UGANDA: ESTIMATED PER CAPITA MEAT AVAILABILITY, 1967/68

Region	A	B	C	C	E	F	G	H	I
	Human Population 1967[a]	Cattle Population 1967	Hide Extraction Rate[b]	Cattle Available for Sale BXC	Regional Exports(-) Imports(+)	Cattle Available for Slaughter D-E	Meat Equivalent Each Animal[c]	Total Meat Equivalent FXG (Million lbs.)	Per Capita Availability H÷A
	Millions		(%)	(Thousands)			(lbs.)		(lbs.)
Northern	1.50	.70	12	84	-8	76	225	17.1	12
Eastern	2.42	1.11	12	135	-35	100	225	22.5	10
Karamoja	.25	.73	8	58	-25	33	200	6.6	17
Western	2.20	.54	10	55	-15	40	325	13.0	5
Buganda	2.50	.70	10	70	+82	152	250	37.8	15

a. Estimated population mid-1967 based on intercensus growth rate.

b. Assumed numbers of cattle slaughtered per 100 cattle including those slaughtered on the farms.

c. Meat equivalent includes the red meat equivalent of edible offals available from each carcass. Hence, pounds of meat equivalent for typical animals is 45-50 percent of liveweight.

d. The balance of cattle exported as meat exceeded live cattle imported from Kenya and Tanzania and the cattle equivalent of beef imports by roughly 1,300 head (see Table XXV).

Future Production from Conventional Herds and Total Production, 1967-1981

Earlier sections provide a basis for projecting the impact of the Tick Control Project on meat production. It was indicated that the marketed extraction rate could be expected to improve from roughly 11 to about 15 percent of cattle numbers. This improvement would be lagged 3-5 years following the initiation of tick control.

The estimated meat equivalent production from conventional herds over the period 1967/68-1980/81 which reflects the phased improvement in the extraction rate in the Tick Control Project area is shown in Table XXVII. The estimated meat equivalent production from enclosed dairy farms and ranches over the same period is shown in Table XXVIII.

Because of the uncertainties inherent in these projections, three alternate estimates of the future annual beef production in Uganda are contained in Table 8.3, which summarizes Tables XXVII and XXVIII. The first, a pessimistic projection, assumes that production continues to expand at the historical rate determined largely by the rate of growth of the cattle population in the recent past or about 2 percent per year. The second, or median projection which parallels the projections in Table XXVII and XXVIII, assumes that the Tick Control Project is having and will continue to have an impact on production and that the extraction rate will improve about one percent every four years. It also provides for increasing production from enclosed ranches and a faster cattle population growth rate. The third or optimistic projection also uses an improving extraction rate. It differs from the first and second projec-

TABLE 8.3. UGANDA: PROJECTED GROWTH IN DOMESTIC BEEF SUPPLY--PESSIMISTIC, MEDIAN AND OPTIMISTIC ASSUMPTIONS, 1967/68-1980/81

Planning Year	Projected Cattle Population (Thousands)	Marketed Extraction Rate (Percent)	Cattle Marketed (Thousands)	Meat Equivalent per Animal (Pounds)	Gross Meat Equivalent[a] (Million pounds)	Growth Index[b]
			Pessimistic Assumptions[c]			
1967/68	3,966	10.00	397	240	95.3	100
1970/71	4,228	10.00	423	240	101.5	106
1975/76	4,668	10.00	467	240	112.1	117
1980/81	5,154	10.00	515	240	123.6	130
			Median Assumptions[d]			
1967/68	3,966	10.15	403	245	98.9	104
1970/71	4,242	11.20	474	245	115.9	122
1975/76	4,823	12.35	595	250	148.6	156
1980/81	5,431	13.45	729	252	184.1	193
			Optimistic Assumptions[e]			
1967/68	4,145	10.50	416	245	101.9	107
1970/71	4,242	11.25	477	251	119.7	126
1975/76	4,823	12.50	603	261	157.4	165
1980/81	5,431	13.75	737	271	199.7	209

a. Meat equivalent includes both meat and the red meat equivalent of edible offals.

b. 1967/68 production of 97 million pounds = 100.

c. Cattle population growing 2.0 percent per year, no change in extraction rate, no change in meat equivalent per animal.

d. Cattle population growing 2.5 percent per year, extraction rate growing roughly 1.0 percent in four years, modest change in meat equivalent per animal (see Table XXVII).

e. Cattle population growing 2.5 percent per year, extraction rate improving 1.0 percent in four years, meat rquivalent increasing two pounds per year.

tions in that it allows for a slightly faster improvement in the extraction rate and in the pounds of meat equivalent available per animal. The median and optimistic projections assume a small improvement in production above the base-line estimate already has occurred because of the Tick Control Project. The alternate projections of gross meat equivalent production from Table 8.3 are as follows:

Year	Pessimistic Growth	Median	Optimistic Growth
		(Pounds, millions)	
1967/68	95.3	98.9	101.9
1970/71	101.5	115.9	119.7
1975/76	112.1	148.6	157.4
1980/81	123.6	184.1	197.7

The difference in production between the pessimistic projection and the median assumption represents primarily the impact of tick control. If the optimistic projection is reached, the additional production will be primarily the result of other development projects.

The overall outlook for expanded production is excellent because of the expected control of tick borne diseases over the next two plan periods, the stocking up of the ranching schemes and the expansion of cattle numbers. The median projection indicates an 84 percent increase in the beef supply by 1980/81 and if all development objectives are reached, a 96 percent increase in production could occur. The critical unknown for the optimistic projection is the future profitability of beef production as it must be assumed that the response to price is positive and not perverse for most, if not all, cattle owners.

The Future Demand for Beef and Price Trends

Ideally when projecting the future demand for a particular animal protein (beef), the analysis should include a simultaneous projection of the supply and price of all potential substitutes for that product (goat meat, mutton, pork, poultry, fish and dairy products). The supply and price of animal proteins are often closely interrelated as they compete for the same resources (pasture, feed grains and the like) and the same consumer's food budget. In addition, the potential export price and market for these products should be considered. Needless to say, data are not available for an analysis in detail.

The production of goat meat, mutton, pork, poultry and fish has been estimated for 1967 in the Report of the Committee on the Marketing of Livestock, Meat, Fish and Their Products in Uganda (210). This estimate is shown in Table 8.4. The total meat availability per capita, including that for beef was ~~only~~ 20 pounds per year, with beef supplying about two-thirds of the total. Fish production currently supplies roughly half of the nonmilk animal protein consumed in Uganda.

The Report includes the following predictions about the future supply of the substitutes for beef (210, pp. 22-30). They predict that the supply of goat meat and mutton, currently about one-third of the red meat supply, will grow no faster than the number of rural households. They noted that the supply of commercially produced pork and poultry are constrained by high feed grain prices but could grow rapidly. Of most significance to the future demand for beef, they noted that the supply of fish, which has grown rapidly in the recent past, is reach-

TABLE 8.4. UGANDA: ESTIMATED PER CAPITA MEAT AND FISH AVAILABILITY, 1967*

	Gross Availability Pounds (Millions)	Production per Capita[a] (Pounds)	Daily per Capita (Grams)
Beef	97	13.0	16.2
Goat/Mutton	32	4.3	5.3
Pork	2	.3	.4
Poultry[b]	22	3.0	3.7
Total Non Fish	153	20.6	25.6
Fish	191	25.0	31.1
Total Fish and Meat	344	45.6	56.7

*Source of Data: Uganda, Min. of Anim. Ind., Game and Fish, Report of the Committee on the Marketing of Livestock, Meat, Fish and Their Products in Uganda (Entebbe, 1969).

a. Population estimate mid-1967, 7.41 million.

b. Does not include eggs.

ing a plateau determined by the biological limit to the fresh water fish catch. As this limit is approached, the price of fish should increase, removing the depressing effect fish supply expansion has had on beef prices. In short, substitutes for beef taken as a group are not likely to increase sufficiently in supply in the near future or have a depressing influence on beef prices.

In order to illustrate the potentially explosive nature of demand in a low income country and to assess the probable trend in future beef prices, three alternate indices of the future domestic demand for beef have been constructed in Table 8.5. The major determinants of future domestic demand are the rate of population growth, projected at the natural rate of increase of 2.9 percent per year, the growth of per capita income and the rate of urbanization. The available data suggest that the income elasticity of demand for meat in Uganda is not less than E = 1.0. The low demand projection assumes a growth rate in per capita income of 2.5 percent per year, the median projection a growth rate of 3.5 percent (roughly the rate of growth in the recent past) and a growth rate of 4.73 percent in the high projection. The latter figure is the desired rate of growth during the present 15 year perspective plan.

Comparing the supply projections (from Table 8.3) and the demand projections, there is only a fair probability that the supply of beef will grow as fast as domestic demand. In fact, the high supply projection suggests only a parallel growth with the low demand projection. If per capita income continues to grow at the present rate, a gradual rise in the price of beef can be expected. This price rise could accelerate as the limit to the fish supply is reached.

TABLE 8.5. UGANDA: INDICES OF FUTURE SUPPLY AND DEMAND FOR BEEF, 1970/71-1980/81

Planning Year	Demand[a]			Supply[b]		
	Low	Median	High	Low	Median	High
1967/68	100	100	100	100	104	107
1970/71	118	121	125	106	122	126
1975/76	154	165	182	117	156	165
1980/81	202	227	264	130	193	209

a. Demand projections assume a population growth rate of 2.9 percent per year and that the income elasticity of demand for beef is E = 1.0. In the low assumption, income is assumed to be growing 2.5 percent per year, 3.5 percent per year in the median projection and 4.7 percent in the high projection.

b. For assumptions on future supply see Table 8.3.

The estimated beef production and per capita availability of beef at the end of each of the plan periods is given in Table 8.6. Even though in the median projection the beef supply will increase by roughly 4 percent per year, the expected increase in population will keep the increase in availability to less than two pounds per capita. It is improbable that the meat supply will expand at a rate which will justify meat exports.

To summarize, many factors combine to create a situation in Uganda such that the demand for all animal proteins will grow rapidly. It is almost certain that the domestic demand for beef will grow faster than supply. It is highly improbable that the price of beef will decline from present levels and almost certainly will continue to rise. Therefore, any development project which expands meat production (such as tick control) is unlikely to face falling meat prices. On the other hand, without the projected impact on tick control on meat supply, a substantial increase in consumer prices will quite likely occur.

TABLE 8.6. UGANDA: ESTIMATED TOTAL BEEF PRODUCTION AND PER CAPITA AVAILABILITY OF BEEF
1969/70 - 1970/71 - 1975/76 - 1980/81*

	Milk Production pounds (million)	Human Population (thousands)	Per Capita Beef Availability	
			pounds	kilo
1969/70	107.3	9.53	11.3	5.13
1970/71	112.2	9.80	11.4	5.18
1975/76	141.9	11.31	12.5	5.68
1980/81	174.5	13.50	12.9	5.86

*Production data from Appendix Table XXVII. Estimated population growth rate 2.9 percent per year.

Chapter IX

EXPANSION OF MILK PRODUCTION

Demand for fluid milk as a cash commodity is a recent development. In the eastern and northern parts of the country access to family herds was general and milk sales were uncommon. Even in the western and southern areas where cattle herders intermixed with cultivators, the sale or barter of milk or milk products, common in similar areas of Africa, did not develop. Herdsmen retained a preference for milk and meat in their diet over those things which could be purchased for cash. Some milk sales did occur near trading and administrative centers where Asian and European populations were concentrated. Milk production remains a subsistence or "conventional" enterprise for a great majority of those owners who continue to utilize communal grazing for their milking cattle. However, "commercial" milk production is expanding rapidly and will be described first.[1]

1. Any distinction made between "conventional" and "commercial" milk production is necessarily arbitrary and may be somewhat misleading as both can be sold. However, the term "conventional" milk production will be used to designate milk from African cattle kept under typical management practices and primarily dependent on communal grazing. "Commercial" milk production will refer to milk produced primarily from European breeds of cattle or their crosses on enclosed farms or under zero grazing where the primary intent is milk production for off-farm consumption

Commercial Milk Production

As was indicated in Chapter IV, commercial milk production is a development of the previous decade. Its roots go somewhat earlier with the first real impetus to develop commercial milk production dating from World War II and the subsequent rapid growth of the urban population. A further impetus was the remarkable growth of the coffee industry in the Fertile Crescent north of Lake Victoria accompanied by high export prices. The emergence of a sizeable group of prosperous farmers not only increased the demand for milk and meat, but many were able to accumulate sufficient capital to invest in enclosed farms and exotic cattle (72, passim; 73, passim).

By the end of World War II, a modest trade in milk had developed around Kampala and Jinja. Milk was retailed largely by owner-dealer or milk vendors. By necessity, milk sold still originated from Zebu cattle but the evolution toward commercial production had begun.

As demand grew milk prices doubled and later tripled.[2] The cost of milk production among conventional producers is low as it is produced on an extensive basis and as a co-product with beef. On the other hand, to attempt commercial milk production based on Zebu stock is costly because of the low milk yields per lactation. Although milk prices improved during the 1950's, Ugandan milk supply was not able to keep pace with demand. To meet the demand, fresh milk was imported from the

2. Milk prices to farmers per pint:
   1950 - 15 cents
   1946 - 25 cents
   1968 - 50-65 cents

European estates in Kenya over the East African Railways. Opportunities for milk production at very remunerative prices caused enterprising individuals to demand the introduction of exotic cattle. Subsequently, the desire to limit foreign exchange expenditures encouraged the new Ugandan administration to seek the most rapid methods of ending milk importations.

A general idea of the trend in fluid milk importations from Kenya and the growth of commercial milk supplies from within Uganda over the period 1961-1969, may be obtained from Table 9.1. Milk imports in 1961 were roughly 27,000 liters per day and were to peak out at roughly 55,000 liters per day in 1967. Importations continued at about the same level through 1968 but dropped off to about half that level in 1969. It was expected that imports could be phased out entirely sometime in 1970.

The growth of commercial milk production in Uganda, while small in absolute terms, is impressive when viewed in terms of rate of growth in output. From nil in 1958, the exotic dairy cattle population of all ages grew to an estimated 15,000-20,000 head in 1969 (126, p. 7). This estimate was based on the 1968 census returns (see Table 9.2). This should represent roughly 10,000 producing dairy cows of cross breed or pure exotic breeding. In addition there are more than 10,000 indigenous dairy cattle on the 1,120 enclosed farms, indicating that crossbred cattle numbers should continue to expand rapidly.

Although there was a supply deficit, milk marketing and handling capacity generally lagged behind the available milk supply. The first plant was constructed in Kampala by the Kenya Cooperative Creameries,

TABLE 9.1. UGANDA: FLUID MILK IMPORTS, COMMERCIAL MILK PRODUCTION AND MILK SUPPLY IN MAJOR URBAN AREAS, 1961-1969*

	Million Liters per Year			
	Milk Imports	Local Production	Total Milk Supply	Percent Supply (+) Increase (-) Decrease
1961	9.9	3.3	13.3	+18.8
1962	10.8	5.0	15.8	+15.8
1963	11.6	6.6	18.3	+27.3
1964	13.3	9.7	23.3	+14.3
1965	14.9	11.6	26.5	+12.5
1966	16.6	13.3	29.9	+ 5.6
1967	16.6	15.0	31.6	+ 5.3
1968	16.6	16.6	33.2	+ 5.0
1969	9.5[a]	19.9[b]	29.4	-10.0
1970	--	24.9[b]	--	--

Source of Data: H. S. K. Nsubuga, "The Development of Dairy Production in Uganda," IDEP/MISR Quarter Continent Conference, June 1968. The author entitles this table "Milk Production and Consumption for Greater Kampala Area." By implication in the text this includes Southern Mengo, Entebbe and Jinja. A small quantity of the imported milk would have been sold in other towns.

a. Uganda, Dept. Vet. Ser., Annual Report, 1969 (1970).

b. Personal estimate.

TABLE 9.2 UGANDA: ENCLOSED DAIRY FARMS AND DAIRY CATTLE
DECEMBER, 1968*

District	Fenced Farms Dairy 1968	Indigenous Stock	Exotic Cattle and Crosses
Northern Region			
Lango	19	2,171	52
Acholi	8	--	30
W. Nile/ Madi	13	725	2
Total	40	--	84
Eastern Region			
Busoga	140	2,815	793
Teso	2	--	47
Bugisu	50	81	146
Sebei	8	48	--
Bukedi	44	1,430	259
Total	244	--	1,245
Western Region			
Ankole	60	--	1,538
Kigezi	18	--	147
Toro	43	--	1,003
Bunyoro	48	--	1,542
Total	169	--	4,230
Buganda			
E. Mengo	310	1,358	3,667
W. Mengo	276	1,461	4,165
Mubende[a]	--	--	--
Masaka	79	606	704
Total	665	3,425	8,536
Total Uganda[a]	1,118	10,695	14,095

*Source of data: Dept. of Vet. Ser., unpublished District Veterinary Department Annual Reports for 1968. Some reports did not distinguish between exotic cattle and crosses and indigenous stock.

a. The Mubende Report did not enumerate dairy farms or cattle numbers but numbers would be small.

Ltd. (KCC), the official agent of the Kenya Dairy Board. The design capacity was for only 2,500 gallons per day (11,000 liters) of milk pasteurized and packed in polyethylene one pint bags. An expanded plant capable of packing 9,000 gallons (40,000 liters) per day in one pint "tetrapacks" was opened in 1967. This second plant was financed jointly by the KCC and the Uganda Development Corporation. The interest of both parties was taken over in 1967 by the newly formed Uganda Dairy Industry Corporation (UDIC). This plant also proved inadequate and new facilities capable of handling 30,000 gallons (136,000 liters) of fluid milk daily with limited capacity for powder, butter and ice cream manufacture, is scheduled for opening in 1970. This plant should prove adequate for the next six to eight years.

The local supply of commercial milk grew rapidly from 3.0 million liters in 1961 to an estimated 19.9 million liters in 1969. Part of this increase is illusionary in that it represents an increased share of the fluid milk sales passing through official marketing channels as opposed to being retailed privately. The Dairy Industry Corporation has the authority to designate the legal buyer and wholesaler of milk in each area. The agent is usually an authorized local cooperative or a facility operated directly by the UDIC.

In order to assist small farmers entering the market, a network of milk collection centers has been established not only throughout the Fertile Crescent areas but also as far afield as Western Ankole, Toro, Teso and Bukedi. These centers, which numbered about 35 in late 1969, buy milk at a set price, repack milk in polyethylene bags for sale locally and ship any surplus milk to the UDIC plant in Kampala.

The milk collection centers are supplied by both small enclosed farms and conventional producers. Undoubtedly they have resulted in the sale of some milk which formerly would have been consumed by calves or by the farm family. Milk arrives at the centers, usually by bicycle, in small quantities. One to four gallon containers are typical. Distances traveled are up to twenty miles without prior cooling of the milk. Consequently, quality is low and rejection of milk at the center is common.

Milk collection centers currently handle only a small share of the urban milk supply. Most marketed milk comes from small to large commercial dairy farms who deliver milk directly to the UDIC milk plant. The regular cash income from milk sales has helped to make the tick control programs attractive to owners in the areas where they are located.

The total milk supply from importations and local production and the percentage increase or decrease in the supply over time are included in Table 8.7. The availability of milk increased rapidly between 1961 and 1965 at nearly 20 percent per year, increased at the rate of roughly 5.0 percent in 1966 to 1968 and declined in 1969. The rapid growth in consumption made possible by rising levels of milk imports probably reflects both a shift in the demand curve and the elimination of a supply deficit at the fixed price. The decline in consumption in 1969 occurred because of restrictions in Kenyan milk importations and the teething problems of the UDIC. These included the poor quality of the product coming from milk collection centers, poor shelf life, flavor of the packaged product and inexperienced staff.

In estimating commercial production for the purposes of establishing consumption levels, two approaches are possible: multiplying the estimated number of cows times an assumed milk yield or a more straightforward one, the milk handled by the UDIC and its predecessors. The latter would be a somewhat low estimate as some commercial milk is retailed independently of the UDIC and associated farmer cooperatives. On the other hand, it contains some milk from conventional producers. It has, however, been used in estimating milk available for consumption (Tables 9.6 and 9.7).[3]

Price Policy and Cost of Production

The analysis of the future supply and demand for beef has indicated that even if the more optimistic projections of supply expansion are met, including the continued expansion of the modern ranching sector, producers could anticipate rising cattle and meat prices because demand is expected to grow at a rate faster than that of supply. This is not the situation facing the emergent dairy industry. There is good reason to anticipate a continued rapid expansion in commercial milk supplies. Therefore, it is important to review present dairy pricing policy in Uganda, probable future trends in demand and farm prices and the profitability of milk production as these will have an important bearing on the success of various development projects.

3. Multiplying average yields obtained from exotic cattle and African cattle on enclosed farms times estimated cow numbers would result in an estimate of about two-three million liters greater. Offsetting this would be conventional milk sold to the UDIC.

Milk Pricing Policy in Kenya and Uganda[4]

The present Ugandan dairy policy has been greatly influenced by the past policies of the Kenya Dairy Board. Kenya dairy policy was settler dominated and hence producer oriented. Modeled after developed nation pricing policies, it attempts to discriminate between three markets, fluid, domestic manufacturing and export, and to limit production for the first two markets through an elaborate system of quotas and price incentives in order to maintain high domestic prices (21; 53, Chap. XV). The Ugandan market, which at one point represented about 10 percent of KCC sales, was treated as an extension of the Kenya fluid milk market. Because of KCC control of milk buying and retailing facilities in Kampala prior to 1967, and because the Administration was convinced that Uganda could never produce its own milk supply, the KCC chose to wholesale milk in Uganda at the same levels as those of Nairobi, instead of selling milk to Uganda at the manufactured or export price. Consequently, the infant dairy industry in Uganda has been able to grow up under the class I price umbrella provided by the sales policy of the Kenya Dairy Board.

The Kenya milk pricing policy has had the following disadvantages for the economy. Although the income of existing producers may have been maximized, this has been at the expense of the incomes of consumers of milk, both present and potential. Second, new producers who are typically small farmers anxious to increase their low incomes are excluded

4. It is not the intent here to investigate the optimum pricing policy for milk in Uganda but rather to suggest at least the direction and probable magnitude of price changes as such changes will affect the profitability of various development projects and farm organization.

by the quota systems from the higher priced markets. Thirdly, the policy rests on the assumption that the price elasticity of demand for fluid milk is less elastic than those of milk products. It is quite probable that this assumption is not valid for the newly developed African urban centers where there are few middle and upper income persons in relation to the masses of low income persons. In these markets, it would be reasonable to expect a large price elasticity of demand because of the high income elasticity of demand among African urban wage earners (see Appendix IV). An examination of the economic history of Kenya indicates that their price policy is a legacy of the period when the small group of estate producers wielded a disproportionate political power in the affairs of the country. The prospects of Uganda adopting a similar inequitable and uneconomic policy in order to maintain high prices for the benefit of a small group of existing farmers is presumably remote (21, pp. 41, 42).

The newly created Uganda Dairy Industry Corporation has had an enviable simple milk pricing policy because of the deficit in milk supplies. Because all milk is used for fluid consumption, it has been possible to maintain producer prices at high levels year round, averaging out domestic supply fluctuations by regulating the level of milk imports from Kenya. Seasonal fluctuations in milk supplies are not extreme in Uganda because of the short dry season.

Future Uganda price policy will be, by necessity, considerably more complex. It is almost inevitable that supply surpluses will develop in the near future at current milk prices (see section which follows). The choice will be between one of several supply control policies designed to maintain farm prices at high levels favoring existing producers or a more progressive policy which recognizes the desirability of encouraging greater consumption and the entry of new producers into the market. The latter policy would not only be more equitable, it would also be considerably easier to implement. Even the manufacture of milk into cheese and butter for the local market could be deferred, except as an expedient to balance seasonal fluctuations in supply and demand, until the potential market for fluid milk at lower prices has been satisfied (21, p. 42). The choice will depend in part on the price elasticity of demand for milk among consumers.

The Cost of Milk Production

Several studies have been made to assess the cost of milk production on commercial farms in Uganda. The most extensive one involved a farm survey of 20 percent of the known dairy farms (in 1967) in the Fertile Crescent area of Uganda or 52 farms. Farms were divided into three size groups for the analysis with the following estimated cost of production per liter (127, p. 16).

No. of Farms	No. of Cows	Cost of Production, Shs. (Per Liter)	(Per Gallon)
37	3-10	.52	2/36
11	11-30	.51	2/32
5	30+	.46	2/09

It is interesting to note that the results do indicate some economies of size but the small producers do not appear to be severely handicapped under present conditions. The study did indicate, however, that the five largest producers were producing nearly 40 percent of the milk sold by the sample studied.

This study also indicated the following yield and income data for farms of the three size groups.

No. of Cows	Yield per Annum (Gallons)	(Liters)	Net Income per Cow, Shs.
3-10	344	1,560	507
11-30	349	1,584	624
31+	521	2,364	1,388

Farmers in the smaller groups had more mixed herds which often contained Nganda or Nganda X exotic crosses, hence yields were lower as were profits per cow. However, production levels per cow easily obtainable by cross-bred cattle are still decidedly profitable.

These cost and profitability estimates are supported by several smaller surveys conducted by Makerere students in 1969 (88; 253) and by a hypothetical budget projection for a 45 cow, 45 acre dairy farm for the Kampala area (144). The profitability of small holder two and three cow dairy stall feeding units with dairy as one enterprise combined with coffee and vegetables has also been demonstrated (63; 165). High stocking rates are possible, particularly if elephant grass is grown as a roughage. Net income per acre at the 1970 milk price of Shs. 0.85 per liter ranged between Shs. 600 and 2,000 per acre in these studies. No comparable figures are available on the profitability of other land uses.

The cost of production estimates of Shs. 0.50 per liter can be compared with the following price schedule for milk delivered to the UDIC or affiliated cooperatives:

	Milk Price to Farmer[5]		
	Per gallon Shs.	Per Liter Shs.	Per 100 lbs. U.S.$
Kampala	4.00	.85	5.41
Mbarara	3.10	.65	4.19
Fort Portal	3.10	.65	4.19
Serere	2.85	.60	3.85

Prices in outlying areas reflect the transportation costs to Kampala. Many small producers and farmer cooperatives in the Fertile Crescent and elsewhere are able to sell part or all of their milk locally at a mark up over the UDIC price, and the UDIC is the buyer of last resort while larger producers tend to sell their milk directly to the UDIC.

It can be said clearly that there are no serious financial constraints operating on existing milk producers in Uganda at the present time. It is true that the shortage of exotic breeding stock, lack of credit and in some areas problems of land tenure may restrict the entry of new producers. Development programs should be directed at removing these constants. Nevertheless, milk prices are so high both absolutely and relatively to the cost of production that no constraint is operative through the lack of sufficient profit incentive and indeed, production has been responding to the favorable cost/price relationship (21, p. 42).

5. In mid-1969 the unit of measure for payment to farmers was changed from gallons (10 lbs.) to liters. During the conversion the price of milk to farmers was reduced slightly. Price per liter and per 100 pounds are the new prices.

For many reasons including the favorable profit position, the growing number of enclosed farms, the potential for upgrading indigenous cattle on existing enclosed farms, the program of milk collection centers, and the like, it is quite reasonable to anticipate a continued rapid expansion of the marketed milk supply. The estimate which has been used in the next section calls for a growth rate of 20 percent per year in marketed milk over the next 6-8 years doubling supplies about every four years (see Table 9.3). This could probably be obtained from an expansion of production on enclosed farms alone, but because of the new milk collection centers it will include increased purchases from conventional producers as well. It is unlikely that demand at present prices will expand apace and milk prices should be expected to decline. Because of apparent high profit margins, farmers should be able to absorb sizeable reductions in farm price for milk without severe dislocations.

The Future Demand and Price Trends for Commercial Milk Supplies

The rapid growth of fluid milk availability in urban areas was documented in Table 9.1. Urban consumption increased at an annual rate of roughly 20 percent between 1961-1965 but at a much slower 5 percent annual rate between 1965 and 1968. Milk consumption dropped sharply in 1969 due to curtailed importations from Kenya and not because of a decline in demand.

TABLE 9.3. UGANDA: PROJECTED SUPPLY AND DEMAND FOR FLUID MILK AT CURRENT PRICES AND DAIRY COW POPULATION, 1969-1980*

Year	Fluid Milk Demand Liters (Millions)	Commercial Supply Liters (Millions)	-Deficit +Surplus Liters (Millions)	Dairy Cows Required to Supply Demand (Thous.)	Expected Dairy Cow Population (Thous.)
1969	33.2	20.0	-13.2	18.3	11.0
1970	34.9	24.5	-10.4	19.2	13.5
1971	36.6	28.6	- 8.0	20.2	15.8
1972	38.4	34.3	- 4.1	21.1	19.0
1973	40.3	41.2	+ 0.9	22.2	22.8
1974	42.4	49.5	+ 7.1	23.4	27.4
1975	44.5	59.3	+14.8	24.5	32.8
1976	46.7	70.7	+24.0	25.7	39.0
1977	49.0	81.6	+32.6	27.0	45.0
1978	51.4	92.6	+41.2	28.3	51.0
1979	54.1	101.6	+47.5	29.8	56.0
1980	56.9	112.5	+55.6	31.3	62.0

*Fluid milk demand estimated to grow 5 percent per year at the 1969 retail price of Shs. 1.40 per liter. Dairy cow numbers and supply estimated to grow at 20 percent per year, 1969-1975 and at a constant annual rate, 1975-1980. Milk production per cow 1,815 liters (400 gallons) per year.

In Uganda, fluid (commercial) milk consumption is concentrated among a small group of middle and upper income households. The 1969 retail price for homogenized, pasteurized milk was Shs. 0.70 per one-half liter tetrapack (18 cents per U.S. quart). At the 1969 minimum legal wage of Shs. 140.00 per month ($20.00), just under one hour of work is required to purchase one tetrapack of milk, placing milk well outside the budget of low income persons.

Because milk clearly is a luxury item for most persons, future growth in demand will be determined primarily by the rate of expansion of middle and upper income families unless prices decline.

The best indication of the annual shift in the demand curve for fluid milk at current prices is the growth in consumption of milk during the period 1965-1968 (see Table 9.1). In this period, imports of milk were for the most part unrestricted and the supply deficit had been overcome. During the period 1965-1968, consumption grew at an annual rate of roughly 5 percent per year.

Using a 5 percent rate of demand increase, the projected demand for fluid milk in urban areas for the period 1969-1979 is shown in Table 9.3. It also indicates the expected growth of commercial milk supplies, the deficit of surplus in domestic production and a projection of dairy cow numbers.

A comparison of projected commercial supply and demand indicates that the 1969 supply deficit of about 13 million liters per year should rapidly shrink with probable surpluses developing by 1974 (column 3, Table 9.3). If prices to producers are not reduced in order to slow supply expansion and spur consumption, surpluses could be a serious problem by the end of the next plan period.

The present very low level of per capita milk consumption has already been documented as has the high price of milk on relation to current income. Both facts indicate the potential to expand consumption if the price can be reduced. An analysis of the available Ugandan data would suggest that the own price elasticity of demand is indeed high, quite probably exceeding Edp = 1.5 (neglecting sign). The implication of this elasticity estimate is that for each one percent decline in milk prices, consumer expenditure on milk should increase roughly by 1.5 percent, not only increasing consumption levels but also increasing the gross value of retail milk sales.

The theoretical increase in demand for milk in units sold at various consumer prices and two elasticity assumptions, Edp = 1.2 and Edp = 1.5 and the resultant level of farm price and farm income are shown in Table 9.4.

Because the assumed elasticities are greater than one, a unit decline in the consumer price will result in a proportionately greater increase in unit sales and also gross marketing income (columns two and three). The current marketing margin between the price paid for milk delivered in Kampala and the consumer price is 55 cents per liter. This margin is not excessive either in terms of the absolute amount or as a percentage of the final sale price.[6] In fact, the UDIC is believed to

6. For a comparison of Uganda and United Kingdom marketing costs see Table XXIX. The cost of marketing milk in tropical countries is necessarily high. A greater volume of milk handled could, through

TABLE 9.4. UGANDA: THEORETICAL DEMAND FOR FLUID MILK, MARKETING COST AND FARM INCOME AT VARIOUS CONSUMER PRICES AND TWO ELASTICITY ASSUMPTIONS

Consumer Price Shs./lit.	Units Sold No.	Gross Sales Shs.	Marketing Margin per Unit Shs.	Marketing Costs Shs.	Farm Price per Lit. Shs.	Gross Farm Income Shs.
			Price Elasticity of Demand = 1.2			
1.40	100.0	140.0	.55	55.0	.85	85.0
1.30	112.9	146.8	.55	62.1	.75	84.6
1.20	127.6	153.1	.55	70.2	.65	82.9
1.10	144.3	158.7	.55	79.4	.55	79.4
1.00	163.4	163.4	.55	89.8	.45	73.5
.95	184.0	174.8	.55	101.2	.40	73.6
.90	233.0	209.7	.55	128.2	.35	81.6
			Price Elasticity of Demand = 1.5			
1.40	100.0	140.0	.55	55.0	.85	85.0
1.30	116.2	151.0	.55	63.9	.75	87.1
1.20	135.1	162.1	.55	74.3	.65	87.8
1.10	157.1	172.8	.55	86.4	.55	86.4
1.00	183.1	183.1	.55	100.7	.45	82.4
.95	212.0	201.4	.55	116.6	.40	84.8
.90	335.6	302.0	.55	184.6	.35	117.5

be subsidizing marketing costs, but the extent of this subsidy is not known. The importance of keeping marketing margins low and if possible reducing them will be obvious. It must be presumed that the Government will not choose to further subsidize the operations of the UDIC. Thus, the average cost of marketing milk has been assumed to remain unchanged. Any reduction in consumer price would then need to be passed on to farmers by a corresponding reduction in the average farm price. Consequently, farm prices will decline at a faster percentage rate than consumer prices. In this projection, gross farm income will decline for producers delivering milk to the Kampala plant if the elasticity of demand, with respect to retail price, is less than E = 1.5 (final column, Table 9.4). This is the familiar picture of elastic demand at retail translated to a unitary or negative demand at farm level because of a large inflexible marketing margin. Gross income of farmers delivering milk to up-country collection centers would decline under any conceivable elasticity assumption because of the greater marketing margin due to transport costs.

The projected levels of demand for fluid milk at lower retail prices is compared with projected supplies in Table 9.5. The projections reflect the fact that the demand curve can be expected to shift to the right over time, and that at lower prices, a movement along the demand curve will occur. Provided the admittedly optimistic supply projections hold, it may be necessary to begin to reduce milk prices as early as

6. (cont'd.)
more efficient handling, reduce per unit collection and distribution costs. This gain could be more than offset by the handling costs of the occasional surpluses which will result because of seasonal supply and demand fluctuations.

TABLE 9.5. UGANDA: PROJECTED DEMAND FOR FLUID MILK IN MILLIONS OF LITERS AT VARIOUS RETAIL PRICES AND PROJECTED FLUID MILK SUPPLY, 1969-1978*

(Millions of Liters)

Year	Retail Price Level, Shs. per Liter					Projected Commercial Supply
	1.40	1.30	1.20	1.10	1.00	
	Estimated Commercial Demand					
1969	36.5[a]	--	--	--	--	20.0
1970	38.4[a]	--	--	--	--	24.5
1971	40.3[a]	--	--	--	--	28.6
1972	42.2[a]	--	--	--	--	34.3
1973	44.3[a]	--	--	--	--	41.2
1974	46.7	54.4[a]	63.1	--	--	49.5
1975	49.0	56.9	66.2[a]	77.0	--	59.3
1976	51.4	59.7	69.4[a]	80.7	--	70.7
1977	53.9	62.6	72.8	84.7[a]	98.7	81.6
1978	56.5	65.7	86.3	88.8[a]	103.5	92.6

*Demand estimated by assuming a five percent annual increase in demand regardless of price level and, following from the assumption of a constant (E = 1.5) price elasticity of demand, a 1.5 percent increase in demand for each one percent decrease in price. Projected supply from Table 9.3.

a. Price level to clear market supply as fluid milk.

1973 and to reduce them by as much as Shs. 0.40 per liter by 1978 in order to market all milk domestically as fluid milk. If this in fact occurs, a price constraint on supply expansion could come into effect.

The dilemmas are obvious. Uganda has pursued a producer oriented policy designed to rapidly expand domestic production and eliminate fluid milk imports from Kenya. Under the umbrella of Kenya dairy policy, it has been able to pay producers very remunerative prices for milk but it will soon be necessary to drastically reduce farm prices, perhaps by as much as one third by the end of the next plan period (1975/76) and to one half of present levels in the longer run if manufacturing for an export market is to occur.[7] As the current supply deficit is reduced, a pricing policy will need to be evolved which will help to level out seasonal supply fluctuations and take into account the necessary diversion of some milk into manufactured uses. The cost of milk production should decline slightly as externalities reduce the cost of purchased inputs, particularly the cost of concentrate and cow replacements. The available data suggest that milk production would be at best marginally profitable at the manufactured price level. The implications are that: (1) it is not reasonable to expect milk products to become a major export item; (2) existing enclosed dairy farms may tend to rever to dairy/beef operations because of an expected increase in beef prices, and (3) enclosure for the purpose of dairy production will become less attractive in the near future.

7. In order for Uganda to seriously consider milk processing for an export market, prices would need to decline to perhaps half the current Kampala price or around Shs. 0.45 per liter.

Estimating Milk Production in Conventional Herds

Estimating the milk produced in Uganda from conventionally managed herds involves many of the same difficulties as experienced in estimating the beef supply. Once again it is necessary to resort to indirect methods of estimation.

Quite accurate estimates of the cattle population and the cow population are available. The first difficulty is in establishing the yield of milk available per cow per year. Starting from the admittedly crude estimates of annual yield contained in Table 7.2, it is possible to estimate milk produced by conventional producers in the following manner:

Estimated Conventional Milk Production, 1969

Number of cows (1968)	1,535,000
Calving percentage	x 65%
Number of lactations	1,000,000 (per lactation, per year)
Milk yield to the farmer[a]	
Per lactation	61.5 (gallons)
Per lactation	280 (liters)
Per annum	40.0 (gallons)
Per annum	182 (liters)
Estimated total annual production	
(gallons)	61,500,000 (gallons)
(liters)	280,000,000 (liters)

a. Reflects a small improvement in production resulting from tick control (see Table XXX).

This rough calculation would estimate conventional milk production in 1968 at about 62 million gallons or 280 million liters per year. As is the case with beef production, this estimate is well below the semiofficial estimate for 1964 which estimated national production at 77 million gallons. The semiofficial estimate assumed similar milk yields per lactation but a much higher (90 percent) calving percentage. As a result, annual milk yield was estimated to be 540 gallons (53, p. 199). An assumed calving percentage and an average yield of these magnitudes are unrealistic.

Projecting the future production from the conventional milk producers is primarily a matter of projecting the growth of the cow population and the improvement in yield per cow expected as a result of reducing the tick burden. This projection and a production index for the period 1967/68-1980/81 are given in Table XXX. Over this 12 year period, production can be expected to increase roughly 50 percent or roughly 3 percent per year in conventionally managed herds.

Milk Consumption and Future Milk Supply

An estimate of fluid milk available for consumption in 1968 by region which includes fluid milk imports and production from commercial and conventional herds is shown in Table 9.6. It suggests a total milk availability in 1968 of just under 70 million gallons or 310 million liters. There are sizeable inter-regional differences in availability from a low of 1.8 ounces per day in the Western Region to 19 ounces in Karamoja. The average availability for Uganda is less than one-third cup per day and if pastoral areas are excluded, availability would fall to about one-fourth cup per capita per day. These rather crude estimates do indicate the potential for increasing domestic milk consumption, particularly if price declines.

TABLE 9.6. UGANDA: ESTIMATED FLUID MILK AVAILABILITY BY REGION, 1968

Area	Conventional Milk Production[a] Liter	Commercial Milk Production[b] Liter	Total Milk Production Liter	Human Population[c] 1969	Annual Avail-ability per Capita Liters	Con-sumption per Day Grams	Con-sumption per Day Oz.
	(Millions)						
Northern	47.2	--*	47.2	1.64	28.8	79	2.8
Eastern	71.7	6.6	78.3	2.52	31.1	85	3.0
Western	44.4	1.6	46.0	2.42	19.0	52	1.8
Buganda	58.6	24.9	83.5	2.67	31.3	86	3.0
Sub Total	221.9	33.1	255.0	9.24	27.6	76	2.7
Karamoja	57.2	--	57.2	.28	204.3	559	19.7
Total Uganda	279.1	33.1	312.2	9.53	32.6	89	3.1

a. Estimated production from African cattle (see Table XXX).

b. Includes both fluid milk imported from Kenya and milk produced locally by exotic cattle and their crosses (see Table 9.1).

c. Population estimate from Table 1.2.

The combined projections of milk production from conventional and commercial producers are given in Table 9.7. A comparison of the two projections indicate that commercial production will represent a growing percentage of total production, but at the end of the ten-year period shown (1978/79), commercial production will represent roughly 20 percent of total milk production. The table also indicates that conventional production through 1975/76 will expand more each year than commercial production. The outlook is for total milk production to increase at an annual rate of nearly 4.8 percent per year.

The estimated annual milk production at the end of each plan period and the estimated per capita milk availability are given in Table 9.8. Over the period of the projection, per capita availability will increase only slightly. However, the expected rapid expansion of commercial milk supplies will, in all probability, bring about substantially reduced commercial milk prices. As this occurs, severe financial constraints will act to retard the expansion of enclosed dairy farms and will seriously cripple the economic viability of the milk collection centers, particularly in out-lying districts. The analysis of livestock development projects affecting milk production, including the Tick Control Project, must anticipate a period of declining milk prices.

TABLE 9.7. UGANDA: PROJECTED MILK PRODUCTION, CONVENTIONAL AND COMMERCIAL PRODUCERS, 1968/69-1978/79

Year	Conventional Milk Production[a] (Millions of Liters)	Commercial Milk Production[b] (Millions of Liters)	Total Milk Production (Millions of Liters)	Percent Commercial
1968/69	305	16	321	15
1969/70	318	20	338	16
1970/71	328	25	353	17
1971/72	343	29	372	8
1972/73	355	34	389	9
1973/74	368	41	409	10
1974/75	380	49	429	11
1975/76	392	59	451	13
1976/77	402	71	473	15
1977/78	413	72	495	17
1978/79	422	93	515	18

a. Source: Table XXX.

b. Source: Table 9.3.

TABLE 9.8. UGANDA: ESTIMATED TOTAL MILK PRODUCTION AND PER CAPITA AVAILABILITY OF MILK
1969/70 - 1970/71 - 1975/76 - 1980/81

	Milk Production liters (million)	Human Population (thousands)	Per Capita Milk Availability	
			gallons	liters
1969/70	338	9,526	7.82	35.5
1970/71	353	9,802	7.93	36.0
1975/76	451	11,310	8.79	39.9
1980/81	642	13,500	10.49	47.6

*Production estimates from Table 9.6. Estimated population growth rate 2.9 percent per year.

Chapter X

THE IMPACT ON INCOME AND ECONOMIC DEVELOPMENT

The successful implementation of any development project has numerous effects on the national economy. It influences the size of the national income and its structure, the size of personal incomes and profits, the actual and future state of the balance of payments and the like. Some of these effects and their magnitudes can be estimated with some precision. Others which reflect the secondary benefits of the project can only be estimated in very general terms. Consequently, no perfect ranking of alternative development projects is possible. The right choice between projects presupposes a thorough understanding of the national economy and the main bottlenecks to developing that economy to its fullest. It also presupposes a clearly defined socio-political strategy for development (43, p. 1).

The Tick Control Project attracts support not only because of the expected financial benefits but also because of the anticipated secondary benefits to the economy. The anticipated benefits include the removal of "the single greatest bottleneck to development"--the existence of East Coast Fever. Although no prior project analysis has included a projection of the impact on production and prices, the Ministry of Animal Industry has claimed that tick control will result in a substantial

~~expansion of production~~ and so improve profitability and production possibilities that farmers will invest more labor and capital in their livestock enterprises. If these claims are valid, the expected expansion in production could result in a significant level of import substitution, export earnings and agricultural diversification. The estimates of the increments in meat and milk production and price trends developed in Chapters VII, VIII and IX make it possible to place in better perspective the probable impact of the project and its role in improving incomes and development possibilities.

The Benefits of Tick Control in Perspective

It is evident from data presented in Chapter VII that the Ministry of Animal Industry has overestimated the probable Project-related improvements in productivity in conventional herds. For a substantial expansion in production per animal to occur, ~~the Project~~ must make it possible for farmers to enclose their lands, improve pastures and adopt the use of exotic breeds or their crosses. This expectation is not supported by either the historical facts or the economic realities. The necessary eradication of East Coast Fever is unlikely to occur from communal grazing lands except in isolated areas. The growth of enclosed dairy farms where disease eradiction is possible is occurring only in climatic zones particularly suited to temperate breeds. A few farmers in these areas have been able to take advantage of a period of unusually high milk prices. Unless the cost of establishing and operating specialized dairy farms can be reduced, the past rate of growth in enclosed farms will decline. Enclosure for beef production is taking place only where atypically large land holdings occur or where ranches are being sponsored by Government, thus creating artificially low land prices.

There is compelling evidence that enclosure has not been profitable for the typical conventional dairy/beef producer using Zebu cattle (85, pp. 116-119 and 134, pp. 167-171). Data summarized from Tables XXIV and XXV suggest the following incomes per hectare from meat and milk production pre and post tick control:

	Income per Hectare	
Ox-Cultivation Area	Shs.	U.S. Dollars
Pre Tick Control	91	12.75
Post Tick Control	112	15.70
Enclosed Farm	154	21.55
Western Grazing Area		
Pre Tick Control	55	5.50
Post Tick Control	66	9.25
Ankole Ranch	64	9.25

In ox-cultivated areas and on farms with better soils, tick control will raise productivity per animal about 25 percent and increase incomes from around Shs. 90 to Shs. 112 per hectare. However, income per hectare remains too low on communal grazing to justify enclosure.

The data are even more compelling for grazing areas where the stocking rate and income per hectare are less. Perhaps surprisingly, when a value is placed on milk consumed by the family, the income per hectare obtained by conventional owners in grazing areas is similar to that projected for the Ankole Ranches. Evaluations of ranching schemes usually ignore the value of milk for human consumption when claiming significant increases in real income, employment and welfare above those obtained by conventional producers.

There are other financial benefits usually mentioned in conjunction with the Project that require comment. The first concerns an anticipated improvement in the value of hides. The value of hides exported from Uganda in 1969, a year of near normal prices and export levels, was Shs. 8.2 million (200, p. 22). A generous guess would be that a 10 percent improvement in hide values will occur as a result of the Project.[1] This would be roughly 2-3 shillings per hide. At the national level an improvement of no more than Shs. 800,000 in export earnings could be expected--a figure small in relation to the added value of meat and milk production. A second and potentially more important area of benefits is in the reduced cost of ox-cultivation. However, it did not prove possible to estimate these benefits (see Chapter III).

Added financial cost to the livestock owner from Tick Control could result from the transmission of communicable diseases at the centers where cattle will be brought together under conditions nearly ideal for disease transmission. Experience to date suggests that this will

1. Because the wound is superficial, tick bites do not directly affect the value of hides. However, the wound may be the initial site of secondary infections which do reduce hide values. Controlling ticks has been shown to reduce the incidence of these infections (141; 153, pp. 1-20). Because there has been no study of the losses resulting from the various hide and skin infections, any estimate of the benefits of regular dipping or spraying on hide values is speculative.

not be a severe problem. Often cattle are already coming into regular contact at communal watering and grazing areas. However, hand spraying equipment is being stockpiled for use in emergency situations.

Two other areas of cost are the cost of labor required to move cattle weekly to the center and the physiological cost of moving cattle on hoof and in passing them through full plung dipping tanks. The latter was implicitly taken into account in estimating the improvement in production which will follow tick control. Provided attention is given to minimizing these costs, the increased income of Shs. 20-30 per head should be sufficient to assure at least the level of voluntary compliance necessary for a successful tick control program.

Controlling tick induced disease losses is a necessary step in improving animal production but it must not be considered a panacea for the complex problems retarding modernization of the industry. The income analysis, the experience with similar projects elsewhere and the early experience in Uganda indicate that tick control will not activate a backlog of existing innovations appropriate for the conventional husbandman. The danger in overselling the program is that it contributes to the illusion that the production of meat and milk can be increased substantially without sizeable expenditures on research and extension by the Ministry of Animal Industry.

Although Uganda is a net importer of beef and milk, the Project itself will not bring about important import savings. The total value of beef and milk importations have not exceeded Shs. 30 million per annum. Importations in 1967 represented less than 2.5 percent of the value of all imports and less than 7 percent of the value of beef and milk consumed in Uganda. Most imports are of better quality beef and milk for the elite urban market, products not produced by the conventional owner. They are largely from Kenya, a sister state in the East African Common Market. Kenya has an established ranching sector and enjoys a comparative advantage in commercial milk production (21, pp. 40-49). Although this Project will play only a minor role in increasing supplies of quality meat and milk, it will contribute to an expansion of production which should eliminate most importations by the mid 1970's and will restrain any major increase in the price of meat. The prospects for exportations in quantity are remote because of the low per capita availability and the opportunity which exists to expand domestic consumption.

Development projects, even when chosen because of their potential for import substitution or export generation, require expenditure of foreign exchange in their implementation. The Tick Control Project will be particularly costly in relation to the increment in production because of the need to import acaricide. The estimated annual cost of acaricide will increase to about Shs. 15-20 million when all cattle are included (see Appendix Table XIX). Because Uganda is a small market for pesticides and because of the need to periodically change the acaricide used, this will be a continuing and unavoidable foreign exchange cost (see Appendix III). Other exchange requirements will be for equipment, petrol, chemicals, interest on loans and the like, increasing the annual import cost by another Shs. 3-5 million. Every effort should be made to keep the import component as low as possible by the careful choice of acaricides and equipment and by using materials of East African origin.

The Impact on Farm and National Income

The major financial benefits consequent to the Project are the improvements in the yield and production of meat and milk. A projection of this increment in production which will occur as a direct result of tick control and estimates of the value at farm gate and at retail for the period 1969/70-1980/81 are contained in Table XXXI. The assumptions used in compiling the estimate are included in the footnote to the Table.

The estimated increase in farm and national income is shown in Table 10.1. Placing a value on the increased production presents many problems. *Ex ante* project analyses should take into account the impact increased production is expected to have on the farm price of the product. Although it is not possible to predict the exact magnitude of price changes, the supply and demand analysis suggests that beef prices will continue to increase regardless of an increase in production but that commercial milk prices will decline. However, the expected decline in commercial milk price is of little consequence to the success of the Tick Control Project because little conventional milk production is sold and in most rural areas supply will not grow faster than the human population. It does have implication for the success of disease eradication areas where the intent is to introduce exotic cattle and for programs dependent upon high milk prices for their viability. As the intent is to construct realistic but conservative estimates of the benefits of the Project, a constant price level for both meat and milk is assumed in Table 10.1.

TABLE 10.1. UGANDA TICK CONTROL PROJECT: GROWTH IN FARM AND NATIONAL INCOME IN RELATION TO PROJECT COSTS, 1969/70-1980/81*

(Millions of Shillings)

	Total Growth Farm Income	Total Growth National Income	Estimated Cost Project to Owners	Estimated Cost Project Government	Estimated Total Cost Project
1969/70	20.9	26.1	4.6		
1970/71	27.8	34.8	6.9	1.9	8.8
1971/72	36.3	42.3	9.2	3.0	12.2
1972/73	44.1	55.1	11.6	4.1	15.7
1973/74	51.6	64.5	14.1	5.2	19.3
1974/75	59.8	74.7	16.8	6.3	23.1
1975/76	67.1	83.9	18.6	7.4	26.0
1976/77	73.4	91.8	20.9	8.8	29.7
1977/78	79.9	99.8	22.3	9.5	31.8
1978/79	86.9	108.6	24.6	10.5	35.1
1979/80	93.6	117.0	25.6	11.6	37.2
1980/81	102.2	127.7	26.6	12.6	39.2

*Farm and national income from Table XXXI. Cost projections from Tables XIX, XX and XXI.

The estimated annual costs of the Project to both producers and the economy for the period 1970/71-1980/81 is also included in Table 10.1. The data suggest that for each shilling owners spend on tick control, they can expect roughly Shs. 4.00 in increased income from additional meat and milk production. The "simple rate of return" for the Project to the national economy, estimated as the ratio of increased national income over the total cost of the Project, should be at least 3.3:1 when the Project is completed, a highly attractive ratio. Of perhaps greater interest, each shilling of estimated expenditure by Government will result in a ten shilling increase in national income. Furthermore, because the estimated marginal tax rate in Uganda is 15 percent on personal incomes, tax revenue assessed on the added income should in the long run exceed the subsidy provided by Government. Provided the Project can be successfully implemented, the financial benefits of the Project should substantially exceed the financial costs.

Utilizing the estimates of national production, it is also possible to estimate the contribution of meat and milk production to National Income for 1969/70 and to project this estimate for 1970/71 and 1975/76 (Table 10.2). The combined value of meat and milk produced by both conventional and modern farms and ranches for 1969/70 is estimated to be Shs. 394 million. In projecting the value of production for 1975/76, meat prices are presumed to increase 2.0 percent per year, but the average milk price is presumed to decline slightly. The growth in the beef supply by 4.8 percent per year and the milk supply by 5.0 percent per year combined with a small improvement in meat prices should

TABLE 10.2. UGANDA: PROJECTED QUANTITY, PRICE AND GROSS VALUE OF BEEF AND MILK PRODUCTION, 1969/70, 1970/71 AND 1975/76

(Production and Total Value in Millions)

	1969/70	1970/71	1975/76	Growth Rate Percent	Percent Growth Plan Period
Meat Equivalent Production					
Meat Kilos	50.90	53.20	67.20	4.8	26.3
Ave. Price per Kilo Shs.	3.72	3.73	4.13	2.0	10.7
Total Value Meat Shs.	189.35	197.85	277.30	7.0	39.5
Milk Production					
Milk Liters	338.00	353.00	451.00	5.0	27.7
Ave. Price per Liter Shs.	0.61	0.61	0.61	--	--
Total Value Milk Shs.	206.20	215.70	275.10	5.0	26.9
Total Value Meat and Milk Shs.	393.55	413.55	552.40	6.5	32.9

*Projections of meat equivalent production from Appendix Table XXVIII, and projections of milk production from Table 9.8. Meat and milk prices are weighted averages of the value of conventional and modern production (see Table XXVI.

cause the value of production to increase roughly 6.5 percent per year during the next plan period. It can be anticipated that animal industry will contribute to the overall rate of growth of the national economy but it will not contribute in an important manner to agricultural diversification during the next two plan periods.

Planning for Integrated Agricultural Development

There is no contradiction in stating that the Tick Control Project has been oversold as a vehicle for initiating a dramatic expansion of beef and milk production with the assertion that the Project may provide the cornerstone for such development. However, a different emphasis from present development policy will be required.

Livestock development policy in Uganda and in most African countries has had a rather narrow focus and has too often been based on popular misconceptions. Policies have, for the most part, been consumer oriented with the Ministries measuring success in their programs on their ability to induce the marketing of greater numbers of cattle at low prices rather than on their contribution to rural development. Early programs concentrated on disease prevention and cattle marketing. With Independence the new objectives of supplying quality products to urban markets and minimizing product imports were added. Production research sponsored by Veterinary Departments is almost exclusively oriented to the problems of the small modern sector, and development programs are strongly weighted in favor of creating specialized dairy and beef units.

These policies in part dictated by the shortage of trained senior staff have previously been presumed to represent the quickest method of eliminating product imports and of expanding the marketed supply of meat and milk. This approach is encouraged by development agencies because of their emphasis on economic diversification and import savings and by the types of projects and research which they are willing to finance. Insufficient attention is given to the desirability of a more complete inte-integration of crops with livestock, even though most livestock owners, with the exception of those in very arid zones, are more properly described as crop farmers who also own livestock.

The general nature of the program of the Uganda Ministry of Animal Industry can be discerned from the estimates for recurrent expenditure for 1967/68 and 1968/69 (Table 10.3) and development expenditure for 1969/70 (Table 10.4). The recurrent expenditure budget for 1968/69, which totals Shs. 29.7 million, allocates only Shs. 2.6 million for extension activities and development scheme supervision. These items, which include acaricide subsidies, will need to be substantially increased in future budgets.

The capital development budget for 1969/70 totals Shs. 22.5 million, only slightly less than the recurrent budget. All of the major projects are assisted by foreign loan programs. In the budget, roughly 18 percent is allocated to disease control projects, including tick control, 18 percent to dairy development programs, 8 percent to ranching schemes and a surprising 37 percent for tsetse eradication. The remaining 18 percent is allocated to various other expenditures. Only a token

TABLE 10.3. UGANDA, MINISTRY OF ANIMAL INDUSTRY, GAME AND FISHERIES: ESTIMATE OF RECURRENT EXPENDITURE, 1967/68 AND 1968/69

(Shs. Thousands)

Item	1968/69[a]	1967/68
Office of the Minister and Veterinary Department		
Personal Emoluments	8,449	7,173
Travel and Transport	3,540	2,454
Miscellaneous Other Charges	3,192	1,747
Stores and General Maintenance	2,040	1,293
Operations and Maintenance of Departmental Units	3,641	1,634
Extension Activities and Development Schemes	2,618	666
Special Expenditure	990	243
Sub Total	24,470	15,210
Game Department	2,018	1,642
Fisheries Department	3,073	2,181
Miscellaneous Services	134	132
Sub Total	5,225	3,955
Budget Gross Total	29,695	19,165
Miscellaneous Revenue	-5,366	-2,158
Budget Net Total	24,329	17,007

Source of Data: Uganda, Estimates of Recurrent Expenditure, 1968/69 (Entebbe, 1968).

a. Estimate.

TABLE 10.4. UGANDA: MINISTRY OF ANIMAL INDUSTRY, GAME AND FISHERIES: ESTIMATE OF DEVELOPMENT EXPENDITURE, 1969/70

	Shs. Thousands	Agency Assisting
Veterinary Services and Livestock Industry		
Dairy Development Incentive Program	386	a
Expansion of Artificial Insemination	329	a
Dairy Industry Expansion Projects	3,395	a
Mobile Epidemic Disease Control Scheme	931	a
Joint Campaign Against Rinderpest	460	b
Tick Control Subproject	2,072	a
Uganda Tick Control Project	860	b
Planning Activities	1	-
Sub Total	8,434	
Beef Production Projects	1,681	c
Ankole/Masaka Ranching Scheme	134	a,b
Tsetse Reclamation Schemes	8,305	a,b
Other	1,423	-
Sub Total	11,543	
Fisheries Department	2,002	b
Livestock and Fisheries Equipment Subsidy Scheme	501	-
Total Expenditure	22,480	

Source: Uganda, Estimates of Development Expenditure 1969/70 (Entebbe, 1969).

a. Scheme partly financed by a loan from USAID.

b. Scheme partly financed by a loan from the British Government.

c. Project assisted by the UN Special Fund.

Shs. 1,000 is allocated to planning activities. Additional development expenditures included in the budgets of the Dairy Industry Corporation and the Uganda Development Corporation further weight the Government program toward specialized livestock farms.

A narrow view of livestock development is encouraged and perpetuated in most countries by the division of responsibility for agricultural development between two or more ministries or departments within the same ministry. In Uganda there are separate ministries for animal industry, agriculture and agricultural marketing.

In Uganda, the Ministry of Agriculture has a much larger establishment than that of the Ministry of Animal Industry and has had a much more extensive extension education program with conventional farmers. However, the development program has placed considerable emphasis on large farm units and farm mechanization. The group (cooperative) farm program and a tractor hire service were initiated in support of these objectives. Both programs have required large subsidies and are being curtailed for lack of funds for their continued operation (228 and 63).

But because of its mandated concern for all farmers who cultivate crops, it has taken a somewhat broader view of livestock development. It has had major programs to encourage ox-cultivation and research stations under its administration are conducting research on fodder crops, pasture/crop rotations and ox drawn equipment suited for the use of conventional husbandmen.[2] These are areas of research which have been largely neglected by the Ministry of Animal Industry.

2. See for examples: 29; 65; 66; 84; 161; 165; 168; 169 and 170.

The physical resources which make livestock development attractive--fertile soils, well distributed and reliable rainfall and the like--also make most zones suited for a wide range of tropical crops. If grazing is to survive as a land use--and crop yields maintained or improved--grazing must become an integral part of the farming operation. The International Coffee Agreement forced Uganda to curtail expansion of its largest and most profitable export crop, cotton production has failed to reach target goals and the Ministry of Agriculture has been unable to mount a successful development program. Nonetheless, Uganda must continue to emphasize export crop production if it is to achieve a major expansion of export earnings.

The key policy issues are these: (1) the balance between programs to expand crop production versus those designed primarily to expand livestock production; and (2) the division of expenditures between the development of specialized production units, and the creation of integrated farm units which combine crops with a livestock enterprise.

Resolution of these issues is complicated by the absence of common policy objectives. Numerous attempts have been made to define the scope of the extension and research responsibilities of the two Ministries; none have been successful (<u>85</u>, p. 116). Although separate Ministries have been in existence since 1962, there are no regular and formal procedures for coordinating development policy. The Ministry of Planning and Economic Development is understaffed, particularly in the area of agricultural planning and is unable to perform this function.

Two examples illustrate the lack of policy coordination. The Ministry of Agriculture initiated a major extension effort in 1969 under the general title of the "Extension Saturation Project." One parish in each county has been selected for a more intensive extension effort. Although a closer integration of livestock and crop production would appear to offer one of the most attractive opportunities for maintaining and improving crop yields and rural incomes, no effort has been made to involve Veterinary personnel in the planning or implementation of this program.

The second example concerns the use of land in the higher potential land resource zones following the elimination of savanna tsetse. Perhaps because tsetse eradication is the responsibility of the Ministry of Animal Industry, the usual presumption is that this land will be used for grazing even when more intensive forms of land use is possible and may be highly desirable as a method of relieving population density elsewhere.

Detailed analysis of the most likely and desirable directions of agriculture development and the proper balance which should be struck between livestock and crop development are beyond the scope of this essay.[3] The development experience suggests that wherever both cash cropping and grazing are possible, a prosperous crop based agriculture will facilitate the development of animal husbandry by creating a demand for meat and milk and plowing cattle and by providing the capital for investment in the livestock enterprise. Enclosure and pasture improve-

3. The probable direction of livestock development is discussed in relation to the land resource zones in Appendix I.

ment needed for the breakthrough in animal production will become practical for the conventional producer only when crop yields are sufficiently improved by rotations to justify their added expense.

What is being advocated is a return to the concept of the "Livestock Improvement Area," the now abandoned program which was in part responsible for the early success of tick control in Buganda and Ankole. It will be recalled that this was an early effort to combine the separate expertise of Agricultural and Veterinary Staffs and to formulate a practical package of innovations for the average livestock owner. This approach would be complementary to the extension saturation program of the Ministry of Agriculture. It will need to be accompanied by an expanded research program designed to seek out the package appropriate for farmers in the separate land resource zones of Uganda, and the one which will most rapidly expand agricultural exports. Ox-cultivation supporting cash production could provide this package in most land resource zones.

The resolution of the policy differences between the Ministries and the identification of areas which require further research can best be accomplished by the compilation of the master land use or area development plan first proposed by the Agricultural Productivity Committee (see Chapter II). The Plan should include the delineation of more refined land resource zones and should be based upon the reasonable expectation that the human population of Uganda will double in the next 25 years. Because of the particularly low rate of urban employment in Uganda, a large share of this increase must be absorbed in agriculture.

The compilation of a regional agricultural plan will require that better use be made of the wealth of data available on Uganda agriculture, the compilation of improved statistics where required and an increase in the number of agricultural planning personnel. In December 1969, the Ministry of Animal Industry contained neither a planning nor a data collection section and employed no economists trained in agriculture. Development project proposals and implementation were supervised by a one man special development section. The agricultural planning sections of both the Ministries of Planning and Agriculture were at a fraction of their allocated strength. For these reasons, there has been a minimum of economic analysis of development projects, particularly for those which require farm level evaluations. This has made it difficult for both the Ministry of Agriculture and the Ministry of Animal Industry to obtain and utilize their rightful share of domestic development funds, forcing them to rely on foreign assistance.

The Rôle of Tick Control Societies in Improving Production

The tick control societies represent a unique opportunity to bridge the gap between conventional and modern production methods in a step by step manner. By seeking to organize farmers around a subject of great mutual interest--the health and well-being of their cattle--it may become possible through research and extension education to create the necessary climate for further improvements in productivity.

There do appear to be a number of immediately practical subjects which can be promoted through the vehicle of the cooperative society. The most important are the education of owners as to the importance of regular attendance at centers and the mechanics of society operations. At a later date, they may provide legitimatization for the enforcement of disease eradication ordinances in specific areas. Other topics include simple genetics and selection criteria, propaganda or vaccinations, endoparasites and other health problems, ox-cultivation, pasture improvement, supplemental mineral feeding and cooperative measures to prevent cattle theft. In predominantly grazing areas (Zones V and VII), they may prove to be logical units around which to establish cooperative grazing societies. The format can and should be modified based on the needs of the individual societies. For example, after the enclosure movement becomes more established, they may lobby for land registration and supervise the stocking of the remaining communal grazing areas. They could also serve an important role in extending credit for livestock development. The bottlenecks may prove not to be the conservative attitudes of the owners but the provision of the support infrastructure and the re-education of the field staff of the Ministry for their new roles in society organization and extension education. Should a new division be created within the Department of Veterinary Services to supervise the Tick Control Project, it should also have primary responsibility for extension activities.

In the recent past, emphasis in the literature of agricultural development has shifted from the best methods of motivating "peasant" farmers to accept change, to the provision of the institutional arrangements, technical knowledge and the inputs which will make change possible and profitable for the conventional husbandmen.

The word "development" means transformation of the existing order rather than creation <u>ex novo</u> of a new order (<u>14</u>, p. 24). The Uganda Tick Control Project contains the ingredients which could create the external economies and the economic milieu necessary for a step by step transformation of animal husbandry in Uganda, leading to the development of a broad segment of the agricultural community.

APPENDIX

Appendix I

LAND RESOURCE ZONES: DETAILS AND PROSPECTS FOR LIVESTOCK DEVELOPMENT

The following is a detailed description of the land resource zones discussed in Chapter II and illustrated in Map II. The characteristics of the parent range resource zones, their ecological zone origins and land use within each zone are summarized in Figure I.1 and I.2 at the close of this appendix.

Zone I, Mountain Grassland

Mountain grassland is a grouping of four ecological zones (see Figure I.1). They extend from around 5,500 feet to the highest elevations of Mount Elgon and the Ruwenzories. This Zone covers roughly 2,100 square miles or less than 3.0 percent of the total land area (see Table 3.1). Areas above 8,000 feet are seldom used for agriculture but those at lower elevations support very high population densities.

The Mount Elgon subzone enjoys a fairly prosperous peasant agriculture based on Arabica coffee, grown on volcanic soils. There are relatively few cattle (see Table 3.1) because of the dense human population--in excess of 1,000 per square mile in places--which leaves little natural grazing. Cattle are usually tethered and provided with cut fodder (usually elephant grass) and are fed banana peels and stems and other farm wastes.

The Kigezi subzone is the largest subzone and has a cattle population of about 50,000. The area is a highly dissected plateau. The district of which it is a part has the lowest per capita income in Uganda. The steep hillsides are terraced for subsistence cropping. The narrow papyrus swamp valley bottoms are gradually being drained for dry season vegetable production. Fallowed cropland and the tops of the higher formations are grazed by village herds. The several owners tend the cattle in rotation. There is now only 1.5 cattle per ten persons in Kigezi District. With increasing pressure on the land, the possibility of expanding cattle production in Kigezi is not great.

The Ruwenzori subzone contains very little agricultural land except for a very narrow belt of land along the steep lower slopes of the mountain range. There are few cattle in this subzone. Because a high human population competes for what agricultural land there is, this subzone cannot be expected to become an important livestock area, even though the climate and forage potential must be considered high.

To summarize, competition for land use, location and topography makes a major livestock expansion in Zone I unlikely. If an expansion of production occurs, it is likely to take the form of one and two cow farms with the cattle tethered and fed forage crops and farm residues.

Zone II, Elephant Grass

Zone II is based on five ecological zones within the medium altitude deciduous and semi-deciduous forest zones, 3,000-5,500 feet. It occurs on fertile soils that are typically deep, well drained, red clay loams. Rainfall is well distributed and exceeds 45 inches per year. The land supports the most productive agriculture in Uganda and occupies roughly 13,900 square miles or 19 percent of the total land area. It includes most of the perennial crop areas. The principal crops are Robusta coffee, sugar and tea and the staple food is matoke banana.

This land resource zone occurs as two subzones. The first and most important is usually referred to as the Fertile Crescent and includes a belt about 30 miles in width north and west of Lake Victoria from Masaka through Mengo and Busoga Districts. This 7,000 square mile subzone is the principal Robusta coffee growing region. It has a fairly high uniform human population density of about 400 per square mile. It is the only area in Uganda where most of the land is under private land title. There is still a surprisingly low percentage of the land under cultivation. Because of the high forage production potential of this area and its closeness to the major urban markets, a large share of the infant dairy industry is in this subzone. It should continue to expand as a dairy area.

The Toro-Bunyoro subzone is the largest underdeveloped area in the country. There is a small area of intensive cultivation around Fort Portal where tea and coffee are the principal cash crops. A small yeomen dairy industry is developing. However, the human and cattle population densities of this subzone rank with the lowest in the country. Over the last ten years, 1959-1969, the population of Bunyoro District doubled, reflecting the influx of settlers into this underdeveloped area (see Table 1.2). Most of the Toro-Bunyoro subzone was invaded by the tsetse fly during the past century and much remains infected (Map 3). Thus the presence of trypanosomiasis will locally retard the growth of the cattle production. But this subzone has a good potential for dairy production, either on small family units or specialized dairy farms.

Zone III, Moist Hyparrhenia

Zone III contains roughly 11,200 square miles or 15 percent of the land area of Uganda. It occurs between elevations of 3,400 and 5,500 feet on generally fertile, well drained soils under rainfalls of 40-65 inches. The dry season extends 2-4 months. It is based on five ecological zones where the climax vegetation would be either semi-deciduous forest or savanna woodlands. It supports a tall grass savanna after clearing.

Three major subzones occur. The Bukedi Plain of southeastern Uganda includes the District of Bukedi, two adjoining counties in Busoga, the lower elevations of neighboring Bugisu, and also Serere County of Teso District. This area is one of the most densely populated and intensely cultivated areas of Uganda with over half the land under cultivation (see Table III). Both coffee and cotton are grown. It also has a major concentration of cattle with a high cattle stocking rate and ox-cultivation is common. Due to competition for land the cattle population is declining (see Chapter III). Without a closer integration of crops and cattle, the importance of livestock in this subzone could decline.

The Central Ridge subzone occupies the northern portion of a ridge at somewhat higher elevation and rainfall running from Mount Elgon to Gulu in Acholi District. It includes Kaberamaido County of Teso District, most of Lango District and the south central portion of Acholi District. This subzone has a very much lower average human and cattle density than the Bukedi Plain. This area lost many cattle during the tsetse expansion of the 1930's. Ox-cultivation is locally important and the principal cash crop is cotton. There is a very real potential to further expand cattle numbers in many areas in this comparatively under-populated area.

The third subzone, the Ankole Uplands, occupies the hilly areas of western Ankole District and several adjoining counties at the lower elevations of Kigezi District. There is a dense human population and surprising density of cattle. The rainfall is bi-modal and well distributed with tea the principal cash crop. Because of the favorable climate and elevation, there are a few enclosed small dairy farms in the Bushenyi area. Small family dairy units should be encouraged to expand in this area of moderate temperatures and favorable rainfall. Distance to market places this area at a slight comparative disadvantage.

In summary, the Moist Hyparrhenia Land Resource Zone enjoys fertile soils, abundant rainfall and short dry period. Forage crops such as Elephant grass can be readily grown. This Zone could become an important dairy area if prices are sufficiently attractive. The comparative advantage of this Zone is most likely in dairy/beef or beef/ox-cultivation type operations.

Zone IV, Dry Hyparrhenia

The Dry Hyparrhenia Zone is roughly 27,700 square miles or 37 percent of the total land area of Uganda (see Table 3.1). As the name implies, is an extension of Zone III but occurs in areas of less rainfall and usually poorer soils. Grass species are medium to short in height. It is based on three ecological zones which would probably remain orchard savanna even if protected. Large areas in Teso and West Nile have been denuded of most trees by cultivation and cutting for firewood. The elevation of this Zone is 2,000 to 5,000 feet. Rainfall is 30-35 inches with higher rainfalls associated with poorer soils. The dry season is two to five months in duration.

There are four subzones of this land resource. The West Teso subzone is agriculturally the most important and is composed of six of the eight counties of Teso and Moroto County, Lango. It is the heart of the cotton, ox-cultivation area of Uganda. With the exception of subzone IIIa, it has the greatest density of cattle of any area of Uganda. However, the cattle population of several counties within this subzone is declining. It can be expected that beef/ox-cultivation type of livestock development will continue in this subzone.

The North Buganda subzone includes the drier areas of northern Buganda, eastern Bunyoro with an extension into the drier lowland areas of Toro. Much of the Toro section is still under savanna tsetse invasion. The area is quite heavily wooded and is sparsely populated. As a consequence the cattle density is quite low. Most cattle are owned by Bahima herdsmen or by crop farmers from the coffee zone who employ herdsmen. There are three ranching schemes in this subzone. There is little or no ox-cultivation.

The North Acholi subzone is comprised of the drier counties of Acholi. It also has a low human and cattle population density and has some areas of remaining tsetse invasion. Ox-cultivation is expanding fairly rapidly and cotton and tobacco are the cash crops. Because of the greater distance to markets and a four month dry period, it will most probably develop as an ox-cultivation/beef producing area with medium size farms.

The West Nile-Madi subzone includes the Districts of West Nile and Madi, the rift valley section of Acholi and a narrow belt of dry land along Lake Albert in Bunyoro. It includes a small, but important, strip of higher potential land along the Congo border in West Nile which does have a dense human and cattle population (see Map 4). But because of its isolated location, this area was generalized in with a lower class. Most of the subzone is tsetse infested and thus it has a very low human and cattle population density. As tsetse is eliminated, this area should develop an agriculture similar to the previous two subzones.

To summarize, the agricultural potential of the Dry Hyparrhenia Land Resource Zone is lower than that of the previous zones because of lighter soils and lower, more seasonal rainfall. Consequently it has a lower forage and pasture potential. Zone IV should be expected to remain an annual crop/ox-cultivation farming area.

Zone V, Ankole/Masaka Grassland (Themeda Triandra)

Themeda grasslands are the most productive natural rangelands in East Africa. In Uganda they comprise roughly 6,900 square miles or 9.4 percent of the land area concentrated in Ankole and Masaka Districts. It is the most well defined land resource zone. Most of the area is of rolling topography with skeletal, shallow soils on hill slopes. Valley bottoms have soils but may be seasonally flooded. The range of rainfall is 30-45 inches, falling in a bi-modal pattern. The arable cropping potential is very low although tea is being grown at higher elevations and at higher rainfalls. Matoke bananas are grown as a staple along areas of drainage on hill slopes.

The best use of this Zone will continue to be as an extensive grazing area. The Ankole-Masaka Ranching Scheme occurs in this Zone. The development challenge of this Zone is to evolve a system of communal grazing which will minimize overgrazing and overpopulation.

Zone VI, Loudetia Kagerensis

The Loudetia Kagerensis Zone is the smallest Zone described, having less than one percent of the total land area. It is an area of seasonal swamp-forest, occurring in southern Masaka District and on the Sese Islands in Lake Victoria. It is generally of very low agronomic potential. Scattered matoke bananas and coffee production occur and some areas are used for extensive grazing. It has been suggested that this area be considered as part of the Moist Hyparrhenia range resource zone (118, passim). It was kept separate in this analysis because of its low potential and the location.

Zone VII, Karamoja

Four of the ten range resources on the dry end of the vegetative scale are represented in Karamoja District. It contains 12,200 square miles or 17.5 percent of the land area. This Zone can be envisaged as a plain which is tilted slightly upward towards the eastern boundary with Kenya. The lower elevation of 3,400 feet occurs along the eastern boundary. Average elevation reaches about 5,000 feet along the Kenya border which is marked by a sharp escarpment downward to the Turkana Plains. Several hills and massifs of volcanic origin rise to 9,000 feet.

The rainfall decreases from 35-40 inches a year along the Teso-Lango-Acholi border to 20 inches along the Kenya border. The quantity of rainfall is unpredictable as to total annual amount and the season in which it falls. This makes food and cash crop production very unreliable.

The population is concentrated along a belt through the center of the district which has better soils and a water table sufficiently high enough to provide year round water supplies. In permanent settlement areas, sorghum and millet are grown as food crops. They provide over half the caloric intake. A portion of the family herds of cattle, sheep and goats is maintained permanently near the settlement or manyatta. The rest are moved in a transhumance pattern toward the dry areas in the wet seasons and toward the lower lying seasonally water logged soils along the Taso-Lango border in the dry season. Because of the low agrinomic potential of this zone, it will remain an extensive grazing area. As in Zone V, the development challenge is to evolve a system of communal grazing and population control.

FIGURE I.1. UGANDA: ECOLOGICAL ZONE ORIGINS OF RANGE RESOURCES AND COMPETING LAND USES*

Range Resource	Ecological Zone Origins	Competing Land Uses
I. Mountain Grassland	1. High Altitude Moorland and Heath 2. Rapanea Moist Montane Forest 3. Montane Bamboo 4. Pygeum Moist Montane Forest 5. Juniperus-Podocarpus Dry Montane Forest	Forest reserves; intensive cultivation of annual and perennial crops at lower elevations. Frequent tethering of cattle, tops of higher features grazed in Kigezi, small stock very important.
II. Pennisetum Purpurem	6. Parinari Evergreen Forest 7. Celtis Piptadeniastrum Evergreen Forest 9. Western Semi-deciduous Forest 10. Celtis-Chrysophyllum Semi-deciduous Forest 11. Albizia-Chlorophora Semi-deciduous Forest	Mixed agriculture with perennial crops predominant (banana, coffee, tea, sugar); scattered grazing; major areas of tsetse in Western Region.
III. Moist Hyparrhenia	6. Parinari Evergreen Forest 9. Western Semi-deciduous Forest 11. Albizia-Chlorophora Semi-deciduous Forest 12. Sapium Woodland 13. Terminalia Woodland	Mixed agriculture with both annual (cotton, millet) and perennial (banana, coffee) crops. Grazing important locally but cattle density low in lightly populated areas. Minor areas of tsetse in Western and Northern Regions.
IV. Dry Hyparrhenia	14a. Potential Moist Thicket-Combretum Savanna 15. Butyrospermum Savanna 16. Combretum Savanna	Mixed agriculture with annual crops (cotton and millet). Grazing intensity high in Teso but low elsewhere. Major areas of tsetse remain in Northern Region.
V. Themeda Triandra	14b. Potential Moist Thicket-Acacia Savanna 18. Grass Savanna	Grazing with scattered cultivation of annual and perennial crops.

FIGURE I.1 (cont'd.)

Range Resource	Ecological Zone Origins	Competing Land Uses
VI. Setaria Incrassata	17. Acacia Savanna	Grazing only, clay soils seasonally waterlogged.
VII. Loudetia Kagerensis	8. Seasonal Swamp Forest	Grazing with scattered cultivation of annual crops.
VIII. Chrysopogon steppe	19. Tree and Shrub Steppe 10. Grass Steppe	Grazing with scattered cultivation of annual crops.
IX. Bushland and Thicket	16. Combretum Savanna 19. Tree and Shrub Steppe 21. Dry Thicket	Grazing with scattered cultivation of annual crops.
X. Valley Grassland	20. Communities on impeded drainage	Grazing only, clay soils seasonally waterlogged. Includes areas of permanent swamp.

*Source of data: I. Langdale-Brown, H. A. Osmaston and J. G. Wilson, The Vegetation of Uganda and Its Bearing on Land-Use (Entebbe Govt. Printer, 1964). Numbering of the ecological zones follows those of the data source.

FIGURE I.2. UGANDA: CHARACTERISTICS OF THE RANGE RESOURCE ZONES

	Mountain Grasslands	Pennisetum purpureum (Elephant grass zone)	Hyparrhenia (Tall grass savanna)
Elevation Ft.	6,000-10,000	3,000-6,000	3,500-5,500
Rainfall (inches)	40-70 (variable by altitude and latitude)	45-70 (1-2 mo. dry season)	40-60 (2-4 mo. dry season)
Original Vegetation	Moist montane forest	Evergreen and deciduous forest	Deciduous forest and woodland
Soils	Varies, usually high in humus but elevation and topography severely limiting	Mainly red colored sandy or sandy clay loam of moderate to high fertility	Mainly deep, medium textured soils with good water-holding capacities and good fertility
Present Land Use	Intensive subsistence food cropping of millet and matoke banana in suitable locations. Arabica coffee on Mount Elgon.	Perennial crop zone. Food crop, matoke banana; cash crops: Robusta coffee, tea and sugar	Transition perennial/annual crop zone: Food crops: matoke banana and millet; cash crop, cotton and in some locations, coffee and tea. Some ox-cultivation in Eastern Region, Lango and Acholi.
Grazing and Forage Potential	Variable, highest in areas formally moist forest	Potentially high due to fertile soils and year-round rainfall	Moderate to high following clearing and improvement
Special Grazing Problems	Inaccessible to markets and limiting topography. Better soils have high population density	Competing for land use with more intensive uses, especially coffee	Competing for land use with more intensive uses, especially cotton. Bush regeneration when cleared and used for pasture only

FIGURE I.2 (cont'd.)

	Mountain Grassland	Pennisetum purpureum (Elephant grass zone)	Hyparrhenia (Tall grass savanna)
Principal Areas	Kigezi District, Ruwenzori Mts. and Mount Elgon	Southern Buganda Region and Busoga (the Fertile Crescent) Central Toro and Bunyoro	Bukedi District through south central Acholi (central Uganda ridge); Western Ankole; numerous small inclusions
	Hyparrhenia filipendula, H. dissoluta (Medium grass savanna)	**Themeda triandra (Medium grass savanna)**	**Setaria incrassata**
Elevation Ft.	2,000-5,000	4,000-6,000	3,500-5,000
Rainfall (inches)	27-59 (2-5 mo. dry season)	29-45 (bi-modal rainfall)	30-40 (4-6 mo. dry season)
Original Vegetation	Savanna woodland	Probably savanna woodland	Savanna resulting from impeded drainage
Soils	Tend to be shallow sandy loams with some locally heavier soils. Low to moderate fertility.	Tend to be shallow light textured soils of low arable cropping potential	Clay plain, seasonally waterlogged
Present Land Use	Annual crop zone. Food crop millet; cash crops cotton and in W. Nile tobacco. Considerable ox-cultivation in Teso and Lango Districts.	Almost exclusively grazing. Matoke banana and millet grown in suitable locations.	Seasonal grazing

FIGURE I.2 (cont'd.)

	Hyparrhenia filipendula, H. dissoluta (medium grass savanna)	Themeda triandra (Medium grass savanna)	Setaria incrassata
Grazing and Forage Potential	Low to moderate following clearing and improvement	Low to moderate following clearing and improvement	Seasonal grazing for drier areas
Special Grazing Problems	Bush regeneration when used for grazing only. Higher rainfall often associated with skeletal* soils. Lower rainfall often unpredictable.	Invasion of Cymbopogon afronardus, thought to be the first step in secondary succession to thicket. Regeneration of Acacia Sp.	Sticky clay soil wet in rainy season. Limited dry season water supply.
Principal Areas	Northern Buganda Region and Northern Busoga District, Eastern Teso and Lango; W. Nile, Madi, Acholi and N.W. Karamoja Districts.	Ankole District and Western part of Masaka District	Southwestern Karamoja adjoining districts.

FIGURE I.2 (cont'd.)

	Loudetia kagerensis	Chrysopogon steppe (Perennial grass savanna)	Bushland and Thicket
Elevation Ft.	a) 3,800-4,000 b) 5,000-7,500	3,500-5,000	4,000-6,500
Rainfall (inches)	a) 38-59 b) 34-65	18-36 (6 mo. dry season)	12-35 (6 mo. plus dry season)
Original Vegetation	Evergreen forest and swamp	Savanna grassland	Savanna grassland
Soils	a) Excessively drained old lacustrine sands b) Skeletal soils on upper slopes	Black cotton soils.	Shallow skeletal soils.
Present Land Use	Scattered grazing, low agricultural potential	Grazing and subsistence sorghum production	Grazing and subsistence sorghum production
Grazing and Forage Potential	Very low	Modest if properly managed	Modest if properly managed
Special Grazing Problems	Low soil fertility	Invasion of bushland and thicket following overgrazing and dry season water supplies	Invasion of heavily armed bushes and shrubs following overgrazing and dry season water supplies.
Principal Areas	Southern Masaka and Sese Islands	North Central Karamoja District	Central and Eastern Karamoja District and a narrow belt along Lake Albert in Bunyoro District

Source of Data: I. Langdale-Brown, *et al.*, *The Vegetation of Uganda and Its Bearing on Land Use*, (Entebbe, 1964).

Appendix II

TICK BORNE DISEASES IN UGANDA[1]

The climate of Uganda is nearly ideal for the persistence and transmission of a large variety of animal diseases and disease vectors. The now optimistic outlook for livestock development can be traced directly to the development of effective pesticides for use in vector control.

The four tick species of greatest concern to the cattle industry in Uganda are *Rhipicephalus appendiculatus*, *Amblyomma variegatum*, *Boophilus decoloratus*, and *Rhipicephalus evertsi*. Their distribution and important characteristics are described in Figure II.1. The diseases transmitted include East Coast Fever (*Theileria parva*), Red Water (*Babesia bigemina*), Anaplasmosis (*Anaplasma marginale*), Heart Water (*Rickettsia ruminantium*) and several other related diseases. The four diseases are described in Figure II.2. Ticks and tick bites are also implicated in the spread of spirochaetosis and streptotricosis which affect the value of hides (141, passim; 153, pp. 1-20). Also, ticks above a few in number can result in tick worry, anemia and a toxicosis from injected toxins. Where tick populations are high, relief from these debilitating factors may be as important in improving herd

1. For a more complete discussion of cattle ticks and tick borne disease in East Africa, see 38, 61, 120, 230 and 252.

productivity as the elimination of the diseases which they carry (37, p. 33). A brief description of the epidemiology of the four principal diseases follows.

Epidemiology

East Coast Fever: The tick of primary economic importance in eastern Africa is the three host brown ear tick, *Rhipicephalus appendiculatus*. In areas of high agronomic potential, it is usually the tick found in greatest numbers and it is the only vector of East Coast Fever under field conditions. *R. appendiculatus* is found only in southern and eastern Africa from the Sudan and Ethiopia south to Cape Province in the Union of South Africa. It occurs commonly at elevations between 2,000 and 6,500 feet and between rainfall levels of less than 20 to more than 75 inches where vegetation and length of dry season are suited for its survival. In Uganda it has not been found where the dry period exceeds 4 months and hence is absent from much of Karamoja. It is generally absent from elevations over 6,000 feet. However, the Fertile Crescent, Ankole and Toro represent nearly ideal conditions for the maintenance and rapid build up of *R. appendiculatus* and it is widely distributed elsewhere in Uganda (121, passim).

The causal agent of East Coast Fever is *Theileria parva*, a haemo protozoal infection in cattle.[2] Calf mortality in East Coast Fever

2. Two other *Theileria*--*T. mutans* and *T. lawrencei*--also occur in Uganda. The first is considered nonpathogenic. The latter, an infection of buffalo, can cause pathologic reactions in cattle in Rhodesia where

endemic areas is usually estimated to be between 20 and 50 percent from all causes. Reducing the number of ticks reduces the severity of the disease and calf mortality may decline to less than 10 percent (see Table 7.1). However, the bite of a single infected Rhipicephalus appendiculatus tick is sufficient to kill at least 95 percent of susceptible exotic stock. Consequently, unless ECF is eliminated, it is not possible to introduce exotic stock because there is no vaccine against the infection nor effective drug treatment once the animal contracts the disease. Animals which survive are often stunted and are slower to reach maturity.

A number of peculiarities of the disease have led to hopes of its eventual eradication. First, in its only vector, Rhipicephalus appendiculatus, the disease is not transovarian. Hence, an infective female tick cannot pass the disease through the ovary to the next generation of larva. Second, in endemic areas, calves contract the disease during the first year of life and if they survive, acquire a long lasting immunity. It is now believed that periodic exposure to Theileria parva is required to maintain immunity. However, a carrier state is not thought to exist. Although the vector may become infective during either the larval or nymphal stage, it can only do so by feeding on animals at a certain stage in the course of an active case of the disease, reducing the probability that individual ticks are infective.

Because the disease is not transovarian and because there is no

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2. (cont'd.)
it is known as Corridor Disease. Its relation to T. parva is in dispute (17, pp. 361-408; 117, pp. 93-101).

carrier state, it is possible to break the disease cycle and to eradicate the disease without eradicating the tick by reducing the tick population to low numbers for a sufficient period of time. Yeomen farmers in endemic areas have been able to eradicate infective ticks by grazing adult immune animals on the land for 6-9 months while systematically spraying or dipping with a suitable acaricide on a twice weekly interval. Following this "tick mop up" procedure, exotic cattle can be introduced to the farm without mortality. East Coast Fever also has been eradicated from Rhodesia and South Africa by enforced dipping with sodium arsenite (see Appendix III).

The hazard of attempting East Coast Fever eradication particularly in areas where rapid build up of tick numbers can occur is that animals which do not contract the disease as calves remain susceptible as adults. Reintroduction of ECF after several generations of control could result in an epizootic of ECF with mortality rates of 50 percent or more in cattle of all ages because no protective vaccines or drug treatments are available.

Red Water and Anaplasmosis: Red Water and Anaplasmosis have important similarities in East African epizootiology and will be discussed together. Calves contract the diseases early in life, usually within the first six weeks. Usually reactions are mild in healthy animals of all breeds with only a low rate of mortality. After the disease has run its course, a state of premunity results, during which cattle are carriers of diseases and potential reservoirs of infection. Morbidity may reoccur when animals are under stress, as during marketing. Animals which escape infection as calves are highly susceptible as adults. Because most cattle are premune and both diseases are transovarian in the primary vector, Boophilus decoloratus, a high proportion of this species are infective and only a few ticks need survive to perpetuate the diseases. Disease eradication can only be achieved by eradication of the tick vectors, an impossibility under Ugandan conditions. The disease chain may be reinitiated if a clean adult female tick feeds upon any animal that is a carrier of the disease as resultant larva will be infective.

The vectors of both Red Water and Anaplasmosis occur in all ecological zones of Uganda except those at high elevations. The presence of these diseases alone would not, in most instances, be a sufficient reason to initiate a tick control program for indigenous cattle as calf mortality is slight. An exception would be areas with high tick numbers. For these reasons the Tick Control Project will not be extended into the drier areas of Karamoja except where Rhipicephalus appendiculatus occurs. Also, there is real advantage of allowing calves of indigenous breeds to develop acquired immunity, avoiding the necessity of a comparatively expensive artificial immunization through vaccination. The important distinctions between these two diseases are included in Figure II.2.

Heart Water: The incidence of Heart Water in East Africa is not known. In Southern Africa it is considered to be one of the most dangerous and lethal of all diseases of cattle (68, p. 828). However, it has never been adequately studied in East Africa. The principal vector in most of Uganda is Amblyomma variegatum. A. lepidum is the vector in Karamoja. Both are three host ticks. These ticks or related species are present throughout Uganda except at the highest elevations. A. variegatum is usually associated with Rhipicephalus appendiculatus. The original hosts are thought to be the larger wild ungulates. The role of game as vector hosts and disease carriers requires further study (120). Because the disease is not transovarian, eradication may be possible but not likely.

Tick Control in Karamoja District

The question of an appropriate tick control program in Karamoja District is a complex one. Rhipicephalus appendiculatus is absent from most of eastern, central and northern Karamoja where climatic conditions are not suited for its survival. Consequently, a general communal dip constructed program will not be carried out in this District. However, periodic epizootics of East Coast Fever do occur among Karamojong herds when they are forced to graze their cattle in the higher rainfall areas of the western and southern parts of the District during the dry season.

The incidence of East Coast Fever is one reason why these areas are poorly utilized for grazing. Other reasons are the coarse grass species and the poorly drained soils. Before entering the area, herdsmen burn the savanna because they believe that this will reduce the probability of their cattle contracting East Coast Fever. Burning also removes the coarse vegetation and stimulates a regrowth of more palatable young grass.

As part of the national program, it has been proposed that 45 dips should be constructed in Pian County which borders on Sebei, Bugisu and the southern part of Teso District. Surveys indicate that R. appendiculatus is also found in areas bordering the northern part of Teso, Lango and Acuoli Districts. In 1965 the first six dips were constructed in Pian County by the Department of Veterinary Services and a free service of dipping provided. The objective of the program is to eliminate East Coast Fever from the area in order to protect adjoining districts as they become disease free and second, to enable cattle to graze the entire county with less fear of mortality.

Support for the free service has been sporadic and confined to periods when epizootic deaths are occurring from East Coast Fever. Among other things, owners are afraid to bring cattle for dipping on a regular schedule for fear that cattle raiders will anticipate herd movement and drive off herds on route to the center. An expanded program of dip construction in Karamoja is out of the question until security can be guaranteed. A second requirement is a research program to pinpoint the source of infection for the periodic epizootics of East Coast Fever (118). However, in projecting the capital development costs of the Tick Control Project, plans for a 45 dip construction program in Pian County have been retained.

General Problems of Control

To summarize, any attempt to eradicate all tick borne diseases from Uganda is faced with insurmountable difficulties. There are four principal and several minor tick vectors. There are also four important and several minor tick borne diseases. Their separate roles in mortality and morbidity are unknown. The higher potential agricultural zones in Uganda are in the optimum climatic ranges for the principal vectors. In addition, there are many alternative hosts among the other domestic livestock and game population for the vectors. For these reasons alone, the probability of completely eradicating any of the tick species from Uganda must be considered remote. It might be theoretically possible to do so but only through a tick control program well beyond the resources of the present Government. The eradication of disease through the eradication of particular tick species has occurred, with few exceptions, only in areas marginally suited to a particular tick and only where 100 percent compliance with eradication programs could be assured.

However, it may be possible to eliminate East Coast Fever from limited areas by a rigorous program of tick control. A successful program would require that all cattle be sprayed or dipped at least once and possibly twice weekly for an indefinite period. Special applications of tick grease on ears and other predilection sites would be desirable. Such a program would be costly and require that attention be given to the control of ticks on other domestic animals, particularly sheep and goats, and that all cattle entering the area must be free of ticks. It would require that efficient acaricides be available at reasonable cost and also that the necessary equipment be available for their application. Efficient acaricides are currently available but there is no guarantee this will always be the case as ticks could develop resistance to all practical acaricides (see Appendix III).

A disease eradication program requires an informed and educated citizenry. This implies that all concerned parties (including elected and appointed officials) understand the objectives of the program and be willing to support the program. Even if disease eradication is achieved, the Tick Control Project will need to be continued for the indefinite future in order to prevent reintroduction of disease. An efficient monitoring service would also be required to detect any outbreak and prevent the spread of disease.

The successful operation of a national program requires highly motivated Veterinary Staff, back stopped with the necessary support infrastructure, in sufficient numbers to supervise and implement the scheme. For these reasons, most advisors recommend a phased program, concentrating first on those areas where tick control will have the greatest payoff, expanding the program only as staff numbers and support facilities can be developed.

Lastly and in the opinion of this writer the most important condition for a successful disease eradication program is that the program must result in a substantial improvement in the real income of conventional husbandmen. Compulsion will be required to achieve 100 percent compliance of all cattle owners. The level of benefits from eradication will determine the difficulty in achieving compliance and the willingness of individuals and the local community to support and demand eradication.

FIGURE II.1. UGANDA: DISTRIBUTION AND CHARACTERISTICS OF FOUR PRINCIPAL CATTLE TICKS*

Name	*Rhipicephalus appendiculatus* (Brown Ear Tick)	*Amblyomma variegatum* (Bonte Tick)	*Boophilus decoloratus* (Blue Tick)	*Rhipicephalus evertsi* (Red Legged Tick)
Number of Hosts	Three hosts	Three hosts	One host	Two hosts
Diseases of Cattle Transmitted	East Coast Fever, Corridor Disease Anaplasmosis, Red Water	Heart Water	Red Water, Anaplasmosis, Spirochaetosis	Red Water, Anaplasmosis, Spirochaetosis
Distribution	All Uganda except in the long dry season areas of Karamoja District and the higher altitudes of the mountains.	Widely distributed in Uganda, absent from higher elevations and is less abundant in drier areas of Karamoja where it gives way to a related species, *A. lipidum*	Collected in all districts of Uganda	A widely distributed tick, probably present in all areas of Uganda except higher elevations. Was not found in southwestern Kigezi.
Physiography: Elevation (feet)a	2,000 to 6,500	2,000 to 6,000	2,000 to 7,500 (most abundant at intermediate elevations)	2,000 to 6,000
Rainfall	20"-75" with not over five months continual dry period.	25"-75" found in areas with zero to 6-7 months continuous dry season.	25"-85" found in all rainfall subregions.	25"-75" found in all rainfall subregions.

FIGURE II.1. (cont'd.)

Ecological Zones[b]	All medium elevation forest, woodland and savanna zones (Zones 6-18).	All medium elevation forest, woodland and savanna zones (Zones 6-20).	Probably in all zones except those at high elevations (Zones 4-21).	Probably in all zones except those at high elevations (Zones 4-21).
Associations and Remarks	Usually associated with the occurrence of <u>Amblyomma variegatum</u>. Principally a tick of cattle. Uncommon where cattle are absent.	Usually associated with the occurrence of <u>R. appendiculatus</u> except at higher elevations. Original hosts the larger wild ungulates, particularly buffalo. Severe bite which can lead to hide and udder damage.	Domestic cattle are by far the most important host of this tick. Occurs only irregularly on wild hosts. Has rapidly developed tolerance to acaricides in countries. Most important vector of both Red Water and Anaplasmosis.	Occurs on many wild and domestic herbivores. Usually present only in small numbers on cattle. Immatures attach deep in ears and difficult to control by sprays or dips. Important to horses and donkeys as a disease vector.

*Source of data: J. G. Matthysse and M. H. Colbo, The Ixodid Ticks of Uganda, Uganda Govt. Printer (forthcoming).

a. The lowest elevation in Uganda is roughly 2,000 feet.

b. For a listing of the ecological zones, see Figure I.1.

FIGURE II.2. UGANDA: COMMON TICK BORNE DISEASES OF CATTLE*

Disease	East Coast Fever	Anaplasmosis	Red Water (Texas Fever)	Heart Water
Causal Organism	Theileria parva	Anaplasma marginale	Babesia bigemia	Rickettsia ruminatium
Known Vectors	Rhipicephalus appendiculatus	Boophilus decoloratus biting insects	Boophilus decoloratus Rhipicephalus appendiculatus R. evertsi Tabanids and other biting flies	Amblyomma variegatum and other Amblyomma spp.
Mortality and Natural Immunization	Mortality in calves 10-95% and in adult 50-100% depending on breed and year.	Calves very low mortality all breeds. Mortality adults 50% all breeds if no treatment. State of premunition occurs.	Calves very low mortality. Adults high mortality if no treatment. State of premunition occurs.	Infection in calves or adults may result in substantial mortality, but strong immunity.
Vaccination	None[1]	1-10 cc blood infected animal	1-10 cc blood infected animal. Mild strain 3-15 mo. age.	Blood infected animal.
Treatment	None. Symtomatic treatment may be helpful.	Specific drugs	Specific drugs	Antibiotics
Period Infective to Ticks	10-21 days (no carrier state)	Indefinite period	Indefinite period	3-4 months

FIGURE II.2. (cont'd.)

Control of Disease	Tick control or eradication.	Tick eradication and vaccination	Tick eradication and vaccination.	Tick control or eradication and vaccination.
Remarks	Not transovarian. Reducing number of ticks reduces severity of infection. Disease eradication possible. Buffalo possible reservoirs.	Transovarian. Reducing number of ticks reduces severity of infection. Disease eradication unlikely.	Transovarian in <u>Boophilus</u> spp. Disease eradication unlikely.	Not transovarian. Disease eradication possible but unlikely. Game may act as reservoir.

Appendix III

THE USE OF ACARICIDES IN TROPICAL AFRICA

The first acaricide to come into general worldwide use was sodium arsenite.[1] First introduced to Southern Africa about 1900, its use was eventually made compulsory (235, p. 56). Arsenic compounds present many problems in use because of their toxicity to man and animals which require that they be very carefully handled, particularly the disposal of waste and dirty dip wash. In East Africa they were never seriously considered for general use in programs for African farmers except on a trial basis. Arsenic compounds did, nevertheless, gain wide acceptance on European estates and farms where their usage can be carefully controlled because of their low cost and simple tankside assay. They are still used where tick resistance has not developed to arseniates. They are also very stable compounds which do not break down in dirty dipping tanks. They have been used sparingly in humid tropical areas because severe scalding of the skin can result when cattle do not dry quickly after dipping. They also give only a short residual protection. Members of the genus Boophilus have developed resistance to arsenic in many countries, but because they never have been used in Uganda, they could be used in drier areas, provided strict supervision is available.

1. For a listing of some of the more commonly used chemicals and proprietary names, see 15, 38, 110 and 234.

The first of the organic pesticides were developed just prior to World War II. The chlorinated hydrocarbons comprise the best known group and include DDT, Dieldrin, BHC, Toxaphene and many others. A drawback in the use of organic compounds is that they are not soluble in water but form emulsions or suspensions which may result in the preferential removal or stripping of the active ingredients from spray races and dipping tanks. They also tend to lose effectiveness through bacterial decomposition in dirty dip wash. Mechanical spray races with smaller reserve tanks which can be changed more often were developed to take advantage of this new class of products.

DDT, the first of the chlorinated hydrocarbons to be developed, never has been widely used as an acaricide because of a rather limited range of effectiveness and rapid resistance build up in Boophilus sp. A BHC formulation, sold under the trade name Gamatox, came into general usage in tropical East Africa, starting about 1948. With the wider use of chlorinated hydrocarbons it became possible to introduce exotic cattle into the moist humid tropics. After World War II, temperate breeds of cattle or their crosses spread almost universally to settler farms in Eastern Africa. Gamatox was used in Uganda during the late 1940's in the hand spraying program in the livestock improvement areas and by the early yeomen farmers (see Chapter IV).

In this family of compounds toxaphene is currently the most efficient and widely used acaricide in eastern and southern Africa. It came into general usage about 1956 after its price declined to economic levels. Toxaphene adheres to the hair of dipped or sprayed cattle, resulting in preferential removal, but contributing to a prolonged residual effect of 3-4 days. Its residual properties make it particularly effective against the two and three host ticks which remain on cattle for brief periods. Consequently it is ideal for use in the control of *Rhipicephalus appendiculatus*, a three host tick. It also is a comparatively stable compound, retaining its efficiency even in rather dirty dip washes. It is equally effective in spray races, provided care is taken to compensate for preferential removal. It was not until the price of toxaphene reached economic levels that an East Coast Fever eradication program became a possibility for eastern Africa.

A third group of pesticides is the organo-phosphorus compounds of which there are many formulations sold under various proprietory names. They are in general more expensive than the chlorinated hydrocarbons. They are being used as acaricides where ticks have become resistant to less expensive compounds. Some are suited for use in general dipping programs. A fourth family of insecticides, the carbamates, has recently been developed (see footnote 1).

The Development of Acaricide Resistance in Ticks

"Resistance to insecticides is the development of an ability in a strain of insects to tolerate doses of toxicants which would prove lethal to the majority of individuals in normal population" (235, p. 54). Continued exposure to toxic substances is believed to result in the gradual selection of preadaptive characteristics already present in the population. A particular compound remains useful as an acaricide only as long as concentrations required to kill ticks are not in themselves toxic to animals nor becomes too costly. The acaricidal mode of action is to disrupt vital enzyme functions. Past experience would suggest that resistant strains will emerge to any acaricide at levels of application which are not toxic to animals. Consequently it is necessary to constantly look for new acaricides, usually among existing insecticides (234, pp. 381-404). Ticks of the genus Boophilus in some areas of Queensland, Australia, are now resistant to all practical acaricides and new interest is developing in selecting tick resistant cattle.

Various factors appear to favor rapid development of resistance. Other things being equal, resistance will develop first in areas where the average generation interval of the tick population is short. The generation interval is particularly short in Uganda because there is no seasonal interruption in breeding and maturation cycles resulting from prolonged dry or cold periods or diapause.

A second factor governing resistance build up is the degree of selection pressure applied to the tick population. There is considerable controversy as to which tick control methods are most likely to result in rapid resistance build up and should be avoided. Some scientists argue that near perfect control, achieved by thorough and regular dipping or spraying will so limit the gene pool as to retard the development of resistance. They would also argue that ineffective or partial control, as for example the hand spraying attempted in Uganda, exposes large numbers of ticks to acaricide levels lethal to only a portion of the population, thus speeding the selection of resistant strains. The other school of thought argues that near perfect control results in the survival of only those ticks which exhibit some resistance while imperfect control would tend to dilute any strain of partially resistant ticks, delaying resistance build up (245, pp. 14-17). They point out that the single host ticks, such as Boophilus sp., which are almost certain to come in contact with acaricide during their attachment to cattle, have been first to develop resistance. Three host ticks such a Rhipicephalus appendiculatus, have tended to be slower to develop resistance (9, p. 32). Both schools would agree that short of tick eradication, the development of strains resistant to particular pesticides is only a matter of time.

A third factor of great importance is the presence or absence of an untreated pool of ticks such as those on wild game, small animals, birds, other domestic stock which can serve to dilute any acaricidally selected population, slowing the development of resistance.

Although it is not possible to state categorically whether partial control or thorough control will result in more rapid build up of resistance, thorough control is necessary to eradicate disease. The Veterinary Department has made the decision to work toward the reduction of tick numbers to the lowest practical levels with the eventual goal of disease eradication.

The species of ticks known to have developed resistance to particular acaricides in South Africa which has a long history of tick control and therefore the greatest problem with resistance are shown in

Figure III.1. It also indicates the reported incidence of resistant species in Uganda. The choice of acaricides suitable for use in schemes such as those envisioned in Uganda and Tanzania is limited, and a very real threat exists that at some point in the future ticks of one or more species will become resistant to all practical acaricides. Within and among the four families of pesticides, cross resistance to the various acaricides has often been encountered. By initiating a disease eradication program, a nation is betting that efficient acaricides will be available for the indefinite future. There is great urgency in developing an effective vaccine against East Coast Fever to be used in the event of the absence of effective acaricides.

Making the Best Use of the Available Acaricides

The chemical technology which makes the Tick Control Project possible is borrowed entirely from the developed countries. The market for acaricides in East Africa is too small to justify commercial firms initiating research to develop new acaricides specifically for an East African market. Many of the large chemical companies are cutting back on pesticide research because of the recent unfavorable publicity on residue and environmental contamination with obvious implications for the future availability of efficient acaricides.

It is essential that the program be carefully managed in order to prolong the period that acaricides remain effective. Toxaphene resistant *Boophilus decoloratus* ticks have already been reported in one area

FIGURE III.1. UGANDA AND SOUTH AFRICA: REPORTED INCIDENCE OF RESISTANT TICKS TO COMMON ACARICIDES BY SPECIES AND LOCATION, 1970

Species	Acaricide	Location
	South Africa[a]	
Boophilus decoloratus B. microplus	Sodium arsenite BHC Toxaphene & Chlordane DDT Organophosphorus compounds	Scattered areas
Rhipicephalus evertsi	Toxaphene BHC Dieldren	Scattered areas
Rhipicephalus appendiculatus	Toxaphene	Scattered areas
	Uganda	
Boophilus decoloratus	Toxaphene[b]	Kyagwe County
Rhipicephalus evertsi	Toxaphene[b,c]	West Mengo (Namulonge)
Rhipicephalus appendiculatus	Toxaphene[b,c]	Ankole

a. Source of report: R. H. Wharton and W. J. Roulston, "Resistance of Ticks to Chemicals," Annual Review of Entomology, vol. 15, 1970, pp. 381-404.

b. Source of report: F. X. Kitaka, "Tick Resistance to Acaricide and Cross Resistance to Allied Acaricides Produced for Chemical Usage" (Animal Health Center, Entebbe, 1969, mimeo., pp. 1-5).

c. Source of report: Uganda, Dept. of Vet. Serv. and An. Ind., Annual Report, 1969 (draft report), p. 85.

of Kyagwe County and resistant Rhipicephalus appendiculatus ticks on one ranch in Ankole (see Figure III.1). These are the two areas where control has been practiced for the longest period using chlorinated hydrocarbons. As part of the program of general tick control, acaricides must be tested under practical dip and spray conditions in the field. Because of unique local conditions, acaricides cannot be borrowed from other countries without local experience as to their effectiveness.

As part of the program, procedures must be established to continually test R. appendiculatus, A. variegatum and B. decoloratus for susceptibility to the acaricide in use. Tick samples should be collected from herds selected according to the probability of resistance development in all high acaricide use areas. Resistant strains should be identified quickly in order to prevent their spread to adjacent areas. Also, indiscriminate use of a wide variety of tickicides should be avoided to delay the emergence of multiresistant ticks (247, pp. 507-512). Suspicious cases of poor tick control must be investigated and control practices improved (158, passim).

It should be noted that in North America and Europe the use of many of the most commonly used acaricides, including toxaphene are prohibited because of milk and meat residue. Should toxaphene or other chemicals come into general usage on most cattle on a weekly basis, real thought must be given to the hazards of residues and the disposal of waste and dip materials. To assure their safe usage, residue levels must be monitored in milk and meat supplies, particularly in semi-pastoral areas.

As of December 1969 no provision had been made in the various budgets of the Tick Control Project, nor in the program of the Department of Veterinary Services for the inclusion of the necessary laboratories, equipment, transport, supervisory and field hands to implement these essential aspects of the program. They have, however, been included in the estimated recurrent costs provided in Chapter VI.

Appendix IV

INCOME AND PRICE ELASTICITIES FOR MEAT AND MILK IN UGANDA

Very little is known about consumer consumption and expenditure patterns in Uganda. The very limited recent data comes from published urban consumer surveys (214; 215; 217), and one survey of coffee growers in Buganda (216). These surveys designed as base line studies for cost of living indices, sampled only a small number of households. No studies have been done on higher income groups or of the important Asian minority. Therefore, generalizations from the available surveys must be used with some caution.

An estimate of the income elasticity of demand for meat, milk and fish for unskilled African workers in Kampala, Jinja and Mbale, and for four coffee growing parishes in Buganda are shown in Figure IV.1. Although the estimates show large variations between survey areas--probably because of the small sample size and sampling and estimation error--they consistently show large and positive elasticity estimates for milk and meat. Those for Kampala and Jinja, which are the major urban markets, show an average income elasticity for milk of +2.00 and that for meat of +0.78. The average for the Buganda rural study were +1.26 for milk and +0.60 for meat. The income elasticity of demand for fish is also large and positive. The estimates are below those reported for

FIGURE IV.1. UGANDA: INCOME ELASTICITY OF DEMAND FOR MEAT, MILK AND FISH, URBAN AND COFFEE FARMER EXPENDITURE SURVEYS*

Location	Meat	Fresh Fish	Milk	All Food
		Urban Surveys		
Mbale 1967	4.03	2.47	6.16	1.50
Kampala 1964	.91	.15	2.05	-.11
Jinja 1965	.66	1.55	2.0	.38
		Buganda Coffee Growers		
Buddu	.45	.10	3.53	.19
Bulemezi	.75	.40	1.16	.43
Busiro	.21	.26	-.22	.21
Kyagwe	.99	.39	.58	.63
Average[a]	.60	.29	1.26	.37

*Compiled from Uganda, Min. of Planning and Econ. Dev., Statistics Dev., The Pattern of Income, Expenditure and Consumption of ~~African~~ Unskilled Workers in Kampala, February, 1964 (Entebbe, 1965); The Patterns of Income Expenditure and Consumption of African Unskilled Workers in Jinja 1965 (Entebbe, 1966); The Patterns of Income, Expenditure and Consumption of African Unskilled Workers in Mbale, June 1967 (Entebbe, 1968); The Patterns of Income and Expenditure of Coffee Growers in Buganda, 1962/63 (Entebbe, 1967). Extimates for the Mbale, Kampala and Jinja urban surveys estimated from percentage changes in per capita income and consumption, between low and medium income groups. Those for coffee growers from percentage changes in household income and consumption as data on household size by income group were not reported.

a. Simple average of the four areas.

other African countries with similar per capita incomes (51, p. 10; 54, p. 87). In neighboring Kenya, it has been estimated that the elasticity of demand for meat in rural areas to be not less than E = +1.0 and that for urban areas to be not less than E = +1.3 (2, pp. 25-65).

For the purposes of projecting the future demand for meat and milk in Uganda, conservative average income elasticities of E = +1.0 for meat and E = +1.5 for milk have been used (see Chapters VIII and IX).

In addition to the income elasticity, the question of the probable price elasticity for milk is of importance to this study because of the strong probability that the supply of fluid milk will grow faster than demand at present prices. The price elasticity of demand will determine the magnitude of the necessary price reductions required to market the anticipated supply.

When the income elasticity of a product is known, it is possible to suggest the magnitude of the price elasticity. Following from the Slutsky-Schultz relation or the homogeneity condition, a large income elasticity tends to imply a large (n absolute value) own-price elasticity. Also, a large number of substitutes or some very close substitutes also suggest a relatively large own-price elasticity for a commodity (180, p. 42). For these reasons, the magnitude of the income elasticity tends to set the lower limit of the own price elasticity (180, p. 44).

Because of the unique nature of milk and its very high price in urban markets, it can be assumed that there are no substitutes. Therefore, the income elasticity for milk (neglecting sign) may be a close estimate of the price elasticity. Thus, it would be expected that the price elasticity for milk to be equal to or greater than E = +1.2 in rural areas and may be as high as E = +2.00 in urban areas. An average price elasticity of E = +1.5 has been used in estimating the demand for commercial milk at lower price levels (see Table 9.4)

Beef priced comparatively much lower than milk has important substitutes in goat meat, mutton and fish (see Chapter VIII). For this reason, the price elasticity for beef would be expected to be somewhat larger in absolute terms than the income elasticity.

Appendix V

STATISTICAL APPENDIX

TABLE I. UGANDA: SUMMARY FOOD BALANCE SHEET, 1963*

Commodity	Production	Net Food Available	Calories Per Head Per Day	Protein Per Head Per Day
	(metric ton, thousands)			(grams)
Cereals				
Maize	162	108	150	3.9
Millet	335	210	269	5.3
Sorghum	154	77	102	3.0
Other	15	21	28	0.7
Subtotal	666	416	549	12.9
Roots, tubers, plantains				
Cassava	1,300	825	346	2.9
Sweet potatoes	571	571	213	2.4
Plantains	3,153	2,138	470	4.9
Other	25	21	6	0.2
Subtotal	5,049	3,555	1,035	10.4
Sugar	124	79	118	nil
Pulses, nuts, oilseeds				
Groundnuts	123	68	143	6.7
Beans	143	130	171	11.1
Other	551	40	62	3.4
Subtotal	317	238	376	21.2
Vegetables and fruits	150	142	19	0.6
Meat	126	114	83	6.5
Eggs and milk	186	101	34	2.4
Fish	70	60	28	4.0
Oils and fats	20	13	44	a/
Beer	--	--	80	n.a.
TOTAL	--	--	2,356	58.0

* Source: J. H. Cleave, "Food Consumption in Uganda," East African Journal of Rural Development, Vol. 1, No. 1, 1968, pp. 70-87.

a/ under 0.05 grams

TABLE II . UGANDA: RANGE AREA LIVESTOCK POPULATION ACRES PER HEAD AND ANIMAL UNIT, 1966*

Region	Total Area a/	Range Land a/	Cattle Census b/	Sheep and Goat Census b/	Acres per Head c/	Acres per Animal Unit d/
	(square miles)		(thousands)			
Northern Region						
Lango	4,464	3,183	327	170	6.23	5.92
Acholi	10,783	7,230	177	151	26.15	24.10
W. Nile	4,417	2,054	129	163	10.19	9.07
Madi	1,717	103	16	19	4.12	3.66
Total	21,111	12,570	649	504	12.41	11.51
Eastern Region						
Busoga	3,443	1,548	219	229	4.54	4.09
Teso	4,306	2,973	577	158	3.30	3.21
Bugisu	940	157	83	60	1.21	1.13
Sebei	671	347	46	20	4.83	4.63
Bukedi	1,575	711	169	148	2.69	2.48
Karamoja	9,115	7,115	742	540	6.14	5.72
Total	20,165	12,851	1,836	1,165	4.48	4.21
Western Region						
Ankole	5,929	3,296	334	393	6.32	5.66
Kigezi	1,902	850	97	174	5.68	5.66
Toro	4,745	990	70	145	9.05	7.54
Bunyoro	4,723	319	38	84	5.37	4.44
Total	17,298	3,455	539	977	6.48	5.48
Buganda Region						
All districts	16,138	12,965	658	218	12.60	12.20
TOTAL Uganda	74,712	43,841	3,682	2,684	7.62	7.10

* Source of table: D. S. Ferguson, "The Prospects of Expanding Beef Production in Uganda" R.D.R. Seminar Paper No. 64, Makerere University.

a/ Source: FAO East African Livestock Survey, Vol. 11 (Rome, 1967), Table XIII-6. To estimate land suitable for range use, the Survey made adjustments for forest reserves, parks, game reserves, townships, tsetse infested areas, and land under cultivation which were subtracted from total land area.

b/ Source: Uganda Dept. of Veterinary Service and Animal Industry, Annual Report, 1966 (Entebbe 1967), Appendix V.

c/ Acres of available range per head of cattle.

d/ Acres of available range per animal unit assuming one cattle equals ten sheep and goats.

TABLE III. UGANDA: AREA IN SQUARE MILES, CATTLE POPULATION, 1958 AND 1968 AND ACRES PER ANIMAL, 1968 BY COUNTY

County Number[a]	District County	Range Resource[b]	Total Land Area[c]	Cattle Population 1958[d]/	Cattle Population 1968[e]/	Cattle Density Acres per Animal [f]/	Land Cultivated 1958[g]/	Grazing Acres per Animal[h]/	Density Code[i]/	Minimum Dipping Centers Required[j]/
			(sq. miles)	(thousands)			(percent)			
	ACHOLI				'67					
1	Aswa	3	881	28	25	23.0	10.7	20.5	D	24
2	Agago	4	1,513	34	68	14.2	8.4	13.3	D	34
3	Chua	4	2,055	39	33	38.9	5.9	36.6	D	17
4	Kilak	3,4	2,760	12	16	108.6	5.5	103.1	D	9
5	Lamwo	4	2,077	13	20	67.3	4.1	64.6	D	10
6	Omoro	3	1,497	7	18	54.3	6.1	51.0	D	18
	Total	3,4	10,783	132	180	-	-	-	-	112
	LANGO				'68					
58	Dokolo	3	383	51	47	5.2	23.5	4.0	B	24
59	Erute	3	717	84	83	5.6	34.8	3.6	B	45
60	Kyoga	3	347	46	43	5.2	21.5	3.9	B	22
61	Kwania	3	486	28	38	8.2	17.3	6.8	B	30
62	Maruzi	3	570	6	11	33.3	10.8	30.0	D	26
63	Moroto	4	1,103	111	118	6.0	14.4	5.1	B	60
64	Oyam	3	858	45	49	11.1	20.2	8.9	D	49
	Total	3,4	4,464	353	388	-	-	-	-	256
					'68					
65, 66	MADI	4	1,717	20	19	-	-	-	D	-

(continued . . .)

TABLE III. UGANDA: AREA IN SQUARE MILES, CATTLE POPULATION, 1958 AND 1968 AND ACRES PER ANIMAL, 1968 BY COUNTY (continued)

	WEST NILE									
96	Aringa	4	916	8	8	69.2	8.3	63.4	D	9
97	Ayivu	3	163	15	21	5.0	51.6	2.4	B	11
98	Jonam	4	336	1	4	55.6	10.3	49.9	D	4
99	Koboko	3	298	11	12	15.9	9.9	14.5	D	12
100	Madi	4	742	2	6	75.7	9.2	69.5	D	6
101	Maracha	4	178	25	30	3.9	48.4	2.0	C	30
102	Okoro	4	770	23	16	30.5	16.9	25.4	D	16
103	Terego	4	442	15	20	14.2	13.0	12.3	A	20
104	Vurra	3	302	6	10	20.0	13.0	17.4	D	10
	Total	3,4	2,654	106	140	-	-	-	-	118
	BUSOGA				'68					
32	Bugabula	2,4	1,024		81	6.5	32.6	5.4	B	41
33	Bugweri	2	156		13	7.9	57.9	3.3	B	10
34	Bukoli	2	571		19	18.8	14.9	16.0	D	20
35	Bulamogi	3	258		32	5.2	34.2	3.4	B	16
36	Budiki	3	262		22	7.7	46.3	4.1	B	16
37	Butembe Bunge	2	683		11	40.1	30.8	27.8	D	11
38	Kigula	2	241		24	6.3	62.0	2.4	B	15
39	Luuka	2	248		23	6.9	66.5	2.3	B	16
	Total	2,3,4	3,443		225	9.8	36.1	6.3		145
	TESO			'57	'67					
76	Amunia	4	982	141	116	5.4	15.7	3.7	B	58
77	Bukedea	4	367	61	50	4.7	54.9	2.1	C	25
78	Kabermaido	3	508	87	83	3.9	25.6	2.8	C	42
79	Kumi	4	365	76	52	4.5	48.9	1.6	C	26

(continued . . .)

TABLE III. UGANDA: AREA IN SQUARE MILES, CATTLE POPULATION, 1958 AND 1968 AND ACRES PER ANIMAL, 1968 BY COUNTY (continued)

80	Ngoro	4	200	51	41	3.1	48.5	1.3	C	22
81	Serere	3	497	84	80	4.0	31.0	2.6	C	40
82	Soroti	4	507	101	83	3.9	32.8	2.2	C	41
83	Usuku	4	880	99	88	6.4	13.4	4.9	B	44
	Total	3,4	4,306	701	587	4.7	-	2.8	-	298
	BUSIGU			'57	'67					
17	Central	1,2,3	171	33	21	5.6	71.3	1.5	B	11
18	North	1,2,4	390	38	38	6.6	61.4	2.5	B	19
19	South	1,2,3	362	52	28	11.0	66.4	2.8	B	15
	Total	1,2,3,4	923	123	871	-	-	-	-	45
75	SEBEI	1,3,4,6,7	715	62	34	13.3	8.7	12.2	B	-
	BUKEDI									
20	Budaka	3	309	-	22	9.2	54.4	4.2	B	19
21	Bunyole	3	205	-	32	4.2	61.6	1.6	C	16
22	Pallisa	3	329	-	36	5.8	62.9	2.1	B	20
23	Samia/Bugwe	3	282	-	16	11.0	49.5	5.5	B	9
24	Tororo	3	164	-	20	5.2	45.1	2.8	B	11
25	W. Budama	3	286	-	45	4.0	44.8	2.2	C	23
	Total	3	1,575	-	172	5.9	53.5	2.7	-	98
	ANKOLE			'59	'68					
7	Bahweju	3	348	7	8	29.4	4.1	28.2	D	7
8	Bunyaruguru	3	393	-	-	-	9.0	-	-	-
9	Igara	3	395	15	21	11.9	14.9	10.1	B	15
10	Isingiro	5	1,017	8	26	25.1	2.9	24.3	A	26

(continued . . .)

TABLE III. UGANDA: AREA IN SQUARE MILES, CATTLE POPULATION, 1958 AND 1968 AND ACRES PER ANIMAL, 1968 BY COUNTY (continued)

11	Kajara	5	355	74	75	3.0	15.1	2.6	C	40
12	Kashari	5	401	28	47	5.5	7.7	5.1	C	24
13	Mitoma	5	668	9	22	19.8	5.6	18.7	A	22
14	Nyabushozi	5	1,423	10	104	9.0	.6	9.0	C	53
15	Rwampara	5	608	50	53	7.4	21.2	5.8	C	26
16	Shema	3	320	23	25	8.8	20.8	6.4	B	20
	Total	3,5	5,928	238	380	10.0	-	-	-	233
	KIGEZI			'59	'68					
52	Bufumbira	1	268	13	25	6.9	28.0	5.0	B	17
53	Kinkizi	3	525	3	4	87.2	18.9	70.7	C	4
54	Ndorwa	1	208	16	16	8.5	52.9	4.0	B	14
55	Rubanda	1	183	12	17	7.0	52.9	3.3	B	12
56	Ruzhumbura	3	440	24	14	20.2	30.4	14.1	D	14
57	Rukiga	1	277	24	23	7.6	26.7	5.5	B	14
	Total	1,3	1,901	92	98	12.3	-	-	-	75
	TORO									
84	Bunyangabu	1,2,5	475	-	7	41.6	14.4	35.7	D	8
85	Burahya	2,4	639	-	31	13.2	7.6	12.2	D	16
86	Busongora	1,4	798	-	1	-	23.9	293.1	D	2
87	Bwamba	1,2,4	588	-	1	-	7.7	267.2	D	1
88	Kibale	4	792	-	99	58.5	1.4	57.7	D	9
89	Kyaka	2,4	611	-	9	41.9	5.3	39.7	D	9
90	Mwenga	2	842	-	16	53.6	6.0	50.3	D	15
	Total	2,4,5	4,745	-	74	41.0	-	-	-	60

(continued . . .)

TABLE III. UGANDA: AREA IN SQUARE MILES, CATTLE POPULATION, 1958 AND 1968 AND ACRES PER ANIMAL, 1968 BY COUNTY (continued)

	BUNYORO									
26	Bugahya	2	1,366	-	5	194.1	8.3	178.0	D	5
27	Bugangazi	2,4	627	-	2	258.4	5.5	244.2	D	2
28	Bujenje	2,6	862	-	13	43.5	4.9	41.3	D	14
29	Buruli	4	892	-	26	21.8	5.6	20.6	D	14
30	Buyaga	2	1,005	-	3	192.8	8.3	176.1	D	4
31	Kibanda	3	797	-	2	260.2	4.7	248.0	D	4
	Park	-	806	-	-	-	-	-	-	-
	Total	2,3,4,6	6,355	-	50	81.0	4.7	248,0	D	4
	WEST MENGO			'66	'68					
91	Busiro	2	458	18	19	15.4	34.0	10.2	D	20
92	Butambala	2	139	11	9	10.3	28.4	7.4	D	8
93	Gomba	2,5	596	52	52	7.3	13.0	6.4	A	25
94	Kyadondo	2	276	12	13	13.9	56.7	6.1	D	13
95	Mawokota	2	365	18	20	12.0	28.4	8.6	D	20
	Total	2,5	1,844	-	112	-	-	-	-	86
	EAST MENGO									
40	Bugerere	2,4	525	29	30	11.3	10.7	8.8	B	26
41	Bulemezi	2,4	2,134	120	108	12.6	10.9	10.0	A	79
42	Buruli	4	1,197	103	118	6.5	2.9	6.3	C	60
43	Buvuma	2	121	2	3	29.7	2.5	28.5	D	3
44	Kyagwe	2	1,124	55	60	12.1	35.1	7.8	D	60
	Total	2,4	5,101	-	319	10.2	-	-	-	228

(continued . . .)

TABLE III. UGANDA: AREA IN SQUARE MILES, CATTLE POPULATION, 1958 AND 1968 AND ACRES PER ANIMAL, 1968 BY COUNTY (continued)

	MUBENDE									
72	Busuja	2	162	10	10	10.4	20.8	8.2	D	10
73	Buwekula	2	1,036	22	33	20.0	3.3	19.4	D	33
74	Singo	2,4	2,582	67	95	17.4	9.9	16.4	D	95
	Total	2,4	3,780	-	138	-	-	-	-	138
	MASAKA									
67	Buddu	2,5,6	1,786	70	73	15.7	24.3	11.9	D	73
68	Kabula	5	324	17	13	16.3	5.4	15.4	D	13
69	Koki	5	567	15	16	23.2	5.2	22.0	D	16
70	Mawagola	5	920	35	47	12.6	5.9	11.9	A	34
71	Sese	6	174	2	2	55.8	2.7	54.3	-	-
	Total	2,5,6	3,781	-	152	14.6	-	-	-	136

a/ Counties numbered after Map of Population Density in Uganda Atlas, 1963.

b/ For range resource designations see Figure I.2.

c/ Total land area as recorded for Map of Population Density in Uganda Atlas, 1963.

d/ Data source, D. J. Parson, Memoirs of the Research Division (Series III, Kampala, 1963).

e/ Data source, Uganda, Dept. of Vet. Ser. and An. Ind., District Reports, various years.

f/ Gross acreage per head of cattle.

g/ Cultivated acreage estimated from Map of Cultivated Land in Uganda Atlas, 1963.

h/ Net acreage per head of cattle.

i/ A, grazing areas; B, heavily cultivated or forested; C, both cultivation and grazing; D, sparse cattle population.

j/ Centers required based on density code (see pp. 150-154).

TABLE IV. UGANDA: ACRES OF POTENTIAL GRAZING, CATTLE POPULATION, 1969 AND POTENTIAL POPULATION BY DISTRICT

(Thousands)

	Acres of Grazing Land	Acres Required per Head	Cattle Population 1969	Potential Cattle Population[b]	Percent of Potential
Northern Region					
Lango	2,204	3.0	409	735	55
Acholi	5,683	3.0	219	1,894	12
W. Nile	2,187	3.0	130	730	18
Madi	977	3.0	21	326	6
Total	11,050	--	777	3,613	21
Eastern Region					
Busoga	1,540	2.0	232	770	30
Teso	1,774	2.5	636	710	90
Bugisu/Sebei	346	2.0	181	173	100
Bukedi	568	2.5	160	227	70
Total	4,230	--	1,210	1,880	65
Karamoja	4,051	5.0	690	810	85
Western Region					
Ankole	2,963	3.0	470	988	47
Kigezi	528	3.0	99	119	83
Toro	1,609	2.5	87	644	13
Bunyoro	1,757	2.5	63	703	9
Total	6,833	--	719	2,454	29
Buganda					
E. Mango	2,623	2.0	351	1,049	33
W. Mengo	785	2.5	108	392	28
Masaka	2,013	3.0	170	671	25
Mubende	2,092	3.0	119	697	17
Total	7,513	--	749	2,809	27
Total Uganda	33,677	--	4,145	11,566	36

a. Acres of potential grazing land after subtracting reserved land and cultivated acreages.

b. Potential cattle population in 1969 provided all areas suited for grazing were to be made available through bush removal and tsetse clearance.

TABLE V. UGANDA: CATTLE POPULATION, 1967 AND 1969 AND PROJECTED GROWTH RATE AND POPULATION, 1975 AND 1980 BY DISTRICT*

District	1967	1969	1975	1980	Estimated Growth Rate Percent
Northern Region					
Lango	380	409	488	566	3.0
Acholi	180	219	294	375	5.0
West Nile	126	130	138	145	1.0
Madi	18	21	28	40	5.0
Total	704	777	948	1,126	3.5
Eastern Region					
Busoga	229	232	246	259	1.0
Teso	587	636	675	710	1.0
Bugisu/Sebei	125	181	192	202	1.0
Bukedi	167	160	170	179	1.0
Total	1,108	1,210	1,283	1,350	1.0
Karamoja	729	690	732	770	1.0
Western Region					
Ankole	334	470	561	650	3.0
Kigezi	98	99	105	111	1.0
Toro	69	87	116	149	5.0
Bunyoro	43	63	100	147	8.0
Total	544	719	5,882	1,057	3.5
Buganda					
E. Mengo	332	351	419	485	3.0
W. Mengo	105	108	129	149	3.0
Masaka	133	170	228	290	5.0
Mubende	125	119	160	204	5.0
Total	696	749	930	1,128	3.8
Total Uganda	3,781	4,145	4,765	5,431	2.5

*Cattle census data from Uganda, Dept. Vet. Ser., Annual Report, 1967 and 1969. Estimated growth rate based on historical trend and subjective assessment of growth potential. Estimate includes cattle on enclosed farms and ranches.

TABLE VI. UGANDA: PROJECTED CONVENTIONALLY MANAGED CATTLE POPULATION, PROJECT AREA AND KARAMOJA AND THOSE ON ENCLOSED DAIRY FARMS AND RANCHES, 1968/69-1980/81*

Planning Year	Conventional Herds[a]			Dairy Farms[b]	Ranches[c]	Total Cattle Population[d]
	Project Area	Karamoja	Total			
	(Thousands)					
1967/68	3,318	600	3,918	13	35	3,966
1968/69	3,390	600	3,990	17	47	4,054
1969/70	3,465	600	4,065	22	58	4,145
1970/71	3,541	605	4,146	27	69	4,242
1971/72	3,619	610	4,229	32	86	4,347
1972/73	3,699	615	4,314	38	103	4,455
1973/74	3,780	620	4,400	46	124	4,570
1974/75	3,964	625	4,489	55	150	4,694
1975/76	3,948	630	4,578	65	180	4,823
1976/77	4,035	635	4,670	75	196	4,941
1977/78	4,124	640	4,764	85	212	5,061
1978/79	4,214	645	4,849	95	228	5,182
1979/80	4,307	650	4,907	105	244	5,306
1980/81	4,401	655	5,056	115	260	5,431

*Projections based on census data for calendar year, 1969.

a. Indigenous cattle population assumed to be growing 2.2 percent per year except in non tick control areas of Karamoja where the assumed rate of growth is 1.0 percent per year.

b. Enclosed dairy cattle population assumed to be growing 20 percent per year 1967/68-1975/76 and at a constant 6,000 per year 1975/76 to 1980/81.

c. Enclosed beef ranches assumed to be growing 23 percent per year 1968/69-1975/76 and at a constant 2,000 per year 1975/76-1980/81.

d. Total cattle population growing roughly 2.5 percent per year (see Table V).

TABLE VII. UGANDA: CATTLE, SHEEP AND GOAT POPULATION, CENSUS OF AGRICULTURE AND DEPARTMENT OF VETERINARY SERVICES, ESTIMATES FOR 1964*

(Thousands)

Area	Cattle		Sheep		Goats	
	Agr.	Vet. D.	Agr.	Vet. D.	Agr.	Vet. D.
Northern Region						
Lango	371	371	96	85	219	176
Acholi	135	137	93	43	116	78
W. Nile/Madi	143	134	64	45	252	151
Total	649	642	223	173	587	405
Eastern Region						
Busoga	195	223	33	22	294	241
Teso	660	584	48	31	221	133
Bugisu/Sebei	209	147	46	23	101	52
Bukedi	243	164	43	29	115	86
Karamoja	604	633	220	220	255	254
Total	1,911	1,752	390	325	986	766
Western Region						
Ankole	196	267	58	73	225	290
Kigezi	95	90	54	51	171	117
Toro	(73)[a]	79	(62)[a]	63	(98)[a]	98
Bunyoro	17	24	6	16	104	114
Total	351	480	180	203	598	619
Buganda						
Mengo	222	497	53	--	269	--
Mubende	18	39	5	--	50	--
Masaka	86	147	18	--	92	--
Total	326	643	76	51	411	220
Total Uganda	3,237[b]	3,497	869[b]	752	2,582[b]	2,010

Sources: Uganda, Ministry of Agric. and Coop., Report on Uganda Census of Agriculture, Vol. 1 (Entebbe, 1965); and, Uganda, Dept. of Veterinary Services and Animal Industry, Annual Report, 1964 (Entebbe, 1965.

a. Census did not include Toro. Average of Veterinary Reports for 1963 and 1964.

b. Includes Toro Estimate.

TABLE VIII. UGANDA: PERCENTAGE OF COWS, HEIFERS, CALVES AND BULLS IN THE CATTLE POPULATION AND RATIOS OF CALVES AND HEIFERS TO COWS, 1964*

	Calves	Heifers	Cows	Bulls	Calves Percent of Cows	Heifers Percent of Cows
	Percentage					
Northern Region						
Lango	14.6	17.5	36.1	12.9	40.3	48.5
Acholi	20.7	17.8	34.1	17.8	60.9	52.2
W. Nile Madi	25.2	17.5	37.8	11.8	66.7	46.3
Total	18.2	17.6	36.1	13.7	50.4	48.7
Eastern Region						
Busoga	26.7	21.0	37.4	8.7	71.2	56.2
Teso	17.1	16.4	32.6	10.6	52.6	50.2
Bugisu Sebei	22.5	20.6	34.0	11.5	66.2	60.6
Bukedi	21.0	18.9	32.9	12.8	63.8	57.5
Karamoja	25.8	11.4	45.6	8.9	56.7	25.1
Total	21.9	16.1	37.4	10.2	58.9	43.0
Western Region						
Ankole	18.4	24.0	42.3	10.2	43.4	56.6
Kegesi	23.1	21.5	43.1	9.2	53.6	50.6
Toro[a]	--	--	--	--	--	--
Bunyoro	23.5	23.5	35.3	11.8	66.7	66.7
Total	19.8	23.4	42.1	10.1	47.0	55.6
Buganda						
W. Mengo	27.8	18.5	40.7	9.3	68.2	45.5
E. Mengo	24.6	19.3	40.4	7.9	60.9	47.8
Mubende	27.8	16.7	38.9	16.6	71.4	42.9
Masaka	26.7	18.6	39.5	7.0	67.6	47.1
Total	26.4	18.7	40.2	8.6	56.6	46.6
Total Uganda	21.4	17.3	37.8	10.8	56.7	45.7

*Source: Uganda, Ministry of Agr. and Co-op., Report on Uganda Census of Agriculture, vol. I, Entebbe, 1965.

a. The census did not include the District of Toro.

TABLE IX. UGANDA: PERCENTAGE OF MALE CATTLE IN THE POPULATION BY DISTRICT, 1964 AND 1968*

Region	Cattle Population 1968	Male Cattle 1968	Male Cattle Percent 1968	Male Cattle Percent 1964
Northern Region				
Lango	388.4	118.1	30.4	31.9
Acholi	180.2	54.1	30.3	27.4
W. Nile	130.3	21.8	16.7	19.5
Madi	18.7	3.6	19.3	
Total	712.6	197.6	27.5	28.1
Eastern Region				
Busoga	227.3	49.1	21.6	14.9
Teso	591.4	185.7	31.4	23.9
Bugisu	86.6	15.4	17.8	22.9
Sebei	38.3	12.1	31.5	
Bukedi	171.7	48.6	38.3	27.2
Total	1,115.2	310.9	27.8	27.9
Karamoja	700.0	--	--	17.2
Western Region				
Ankole	380.0	65.7	17.3	15.7
Kigezi	98.5	15.7	15.9	12.3
Toro	74.1	11.7	15.7	--
Bunyoro	50.1	9.8	19.5	17.7
Total	602.7	102.9	17.0	14.7
Buganda Region				
W. Mengo	112.3	16.7	14.9	13.0
E. Mengo	319.3	68.0	21.3	15.7
Mubende	138.3	23.3	17.8	16.6
Masaka	151.9	24.2	15.9	15.2
Total	721.9	132.2	18.7	14.7
Total Uganda	3,857.5		23.1	23.5

*Source of Data for 1964: Uganda, Min. of Agr., Report on the Uganda Census of Agriculture, vol. II (Entebbe, 1965); and for 1968, Uganda, Dept. Vet. Serv., Annual Reports of the Various Districts for 1968, January 1969, unpublished.

TABLE X. UGANDA: AVERAGE RAINFALL AND RAINFALL INDEX SELECTED STATIONS BY MONTH*

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
					Rainfall Millimeters)								
Entebbe	93.8	95.6	167.9	281.1	257.4	98.1	64.4	84.2	82.7	111.8	157.0	122.4	1616.4
Fort Portal	35.5	73.0	136.6	189.9	142.8	80.9	58.7	118.2	187.6	218.3	166.0	80.8	1480.3
Gulu	13.4	42.5	90.1	175.0	196.6	150.5	167.5	228.9	177.2	165.4	97.7	46.6	1551.4
Kabale	61.3	91.2	114.1	138.4	91.1	26.0	19.4	54.9	95.4	97.5	108.2	92.3	989.8
Mbarara	44.3	63.5	95.9	123.9	80.5	23.9	20.4	62.6	96.2	104.7	116.3	76.7	908.9
Tororo	59.1	71.9	135.7	229.0	221.0	104.5	98.0	116.6	110.4	124.3	104.6	79.6	1444.7
					Rainfall Index								
Entebbe	69.6	71.0	126.1	208.7	191.1	72.8	47.8	62.5	61.4	83.0	116.5	90.9	100.0
Fort Portal	28.6	58.9	110.1	153.1	115.1	65.2	47.3	95.3	151.3	176.0	133.8	65.1	100.0
Gulu	10.4	32.9	69.7	135.4	152.1	116.4	129.6	177.1	137.1	127.9	75.6	36.0	100.0
Kabale	74.3	110.5	138.3	167.7	110.4	31.5	23.5	66.5	115.6	118.2	131.1	111.9	100.0
Mbarara	58.6	83.8	126.6	163.5	106.3	31.5	26.9	82.6	127.0	138.2	153.5	101.2	100.0
Tororo	49.0	59.6	112.5	189.9	183.3	86.7	81.3	96.7	91.6	103.1	86.7	66.0	100.0

*Source: Uganda: Ministry of Planning and Econ. Dev., Statistical Abstract 1968, 1969. Average of and unspecified number of years.

TABLE XI. UGANDA: MEAN MAXIMUM TEMPERATURE AND HUMIDITY AT 15:00 HOURS SELECTED STATIONS BY MONTH*

(Centigrade, Percent Humidity)

	Zone	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
Entebbe	IIa													
Temp.		26.8	26.8	26.7	25.9	25.5	25.3	24.9	25.1	25.9	26.2	26.2	26.1	25.9
Humidity		62	62	65	70	70	67	67	68	66	65	64	65	66
Fort Portal	IIb													
Temp.		26.3	26.8	26.4	25.6	25.0	24.8	24.5	24.6	24.8	24.8	25.0	25.2	25.3
Humidity		54	54	59	66	67	63	62	65	70	71	68	63	63
Gulu	IIIb													
Temp.		31.9	32.2	31.3	29.3	28.1	27.5	26.5	26.9	28.0	28.8	29.5	30.3	29.2
Humidity		33	35	42	55	61	60	63	63	58	53	47	40	51
Kabale	Ib													
Temp.		23.7	23.8	23.5	22.7	22.3	22.6	23.1	23.4	23.7	23.3	22.8	23.1	23.2
Humidity		57	58	63	68	68	60	52	51	57	61	65	63	60
Mbarara	V													
Temp.		27.0	27.3	26.8	26.0	25.6	26.2	26.6	26.7	26.3	26.0	25.7	25.6	26.3
Humidity		51	52	56	62	63	53	45	49	56	61	64	60	56
Tororo	IIIa													
Temp.		30.6	30.7	30.2	28.5	27.6	27.3	26.9	27.2	28.2	29.0	28.9	29.2	28.7
Humidity		40	42	46	57	61	58	57	56	54	52	50	48	52

Source: Uganda, Min. of Planning and Econ. Dev., Statistical Abstract 1968, 1969. Average of an unspecified number of years.

TABLE XII. UGANDA TICK CONTROL PROJECT: FACILITIES AVAILABLE FOR TICK CONTROL AND PERCENT CATTLE SPRAYED OR DIPPED BY DISTRICT, JULY 1969

District	Communal Spray/Dip	Private Spray/Dip[a]	Machakos Dip	Motorized Crushes	Functional Hand Spray Crushes	Cattle Spray/Dipped Percent
Northern Region						
Acholi	1	3	--	1	324	34
Lango	4	1	--	3	1,100	27
W. Nile/Madi	--	--			31	9
Total	5	4	--	4	1,455	--
Eastern Region						
Busoga	21	1	--	--	99	45
Teso	4	1	--	--	351	55
Bugisu/Sebei	3	--	2	2	56	--
Bukedi	4	1		--	102	36
Total	32	2	2	2	608	--
Western Region						
Ankole	32	9	2	--	528	73
Kigezi	--	1	5	--	96	48
Toro	27	3	1	--	106	82
Bunyoro	6	5	1	--	199	68
Total	65	18	9	--	929	75
Buganda						
W. Mengo	7	3	3	--	94	--
E. Mengo[b]	35	6	--	2	105	--
Mubende	6	2	--	--	--	--
Masaka	5	2	--	--	--	--
Total	53	13	3	2	199	--
Total Reported	155	37	14	8	3,191	--

Source: Uganda, Dept. of Vet. Ser., "Report of the National Tick Control Day Judging Team" (Kampala, July 1969).

[a]Excludes Ranching Schemes.

[b]Kyagwe County not included. It contained 75 Kampala Spray Baths, 12 motorized spray crushes, 12 standard spray races and an unknown number of private facilities.

TABLE XIII. KYAGWE PILOT TICK CONTROL PROJECT: PROJECTED BUDGET FOR RECURRENT ANNUAL COSTS

	Shs. per mo.	Shs. per annum
1. Personnel (Vet. Officer not included)[a]		
(a) Headquarters Staff		
1 A.H. Officer	1,695/-	
1 Statistician	500/-	
3 Vet. Assistants	500/-	
1 Clerk	671/-	
Subtotal	--	52,392/-
(b) Staff for Maintenance & Supply Work		
1 Senior Foreman	1,095/-	
1 Mason-Carpenter	270/40-	
1 Mechanical Assistant	192/40	
3 Drivers	244/40	
5 Porters	150/80	
Subtotal	--	36,540/-
(c) Staff for Spraying Centers		
50 Spray Attendants	150/80	90,480/-
Total Staff		179,412/-
2. Maintenance		
(a) Headquarters and Two Regional Stores This involves repairs to buildings and office equipment. At present these are new and require little maintenance	--	1,000/-
(b) Transport maintenance 4 Vehicles @ Sh. 5,000/-	--	20,000/-
(c) Spray Center Maintenance for 99 centers. Maintenance costs include: crushes and boma; spray unit--pump, engine, piping, nozzle, etc.; water supply unit--pump, piping, water tanks, etc.;	--	19,800/-
Total Maintenance		40,800/-

TABLE XIII. (cont'd.)

	Shs. per mo.	Shs. per annum
3. Supply		
(a) Office Supplies, Misc.	--	500/-
(b) Transport Supply Fuel and oil for four vehicles @ 5,000 and Motorcycle allowance, 3 V.A.'s @ 3,000/- per year	--	29,000
(c) Supplies for spraying centers including Fuel, oil, tools and clothing	--	57,500/-
Total Supplies		87,000/-
Grand Total Central Government Recurrent Expense		307,212/-

Source of Data: USAID, Uganda Mission, untitled material relating to the Kyagwe County Buganda Tick Borne Disease Control Project.

a. All salaries are computed using top step in the pay bracket, but housing, and other benefits excluded.

TABLE XIV. UGANDA TICK CONTROL PROJECT: WORLD BANK--IDA LOAN--ESTIMATED CAPITAL AND RECURRENT COST OF PROJECT IMPLEMENTATION, 1967*

Cost Item	Year One No.	Year One Shs. '000's	Year Two No.	Year Two Shs. '000's	Year Three No.	Year Three Shs. '000's	Year Four No.	Year Four Shs. '000's	Year Five No.	Year Five Shs. '000's
Capital Costs										
New Centers @ Shs. 100,000	360	36,000	360	36,000	360	36,000	360	36,000	360	36,000
Land Rovers @ Shs. 30,000	4	1,200	4	1,200	4	1,200	4	1,200		
Total Capital Cost		37,200		37,200		37,200		37,200		36,000
Recurrent Costs										
Veterinary Officers	4	82	4	86	4	90	4	94	4	98
Husbandry Officers	12	74	24	144	36	216	48	288	60	360
Dip Attendants	120	288	240	576	360	864	480	1,152	600	1,440
Relief Attendants	12	29	24	88	36	86	48	115	60	144
Mechanics	9	54	18	108	27	162	36	216	45	270
Drivers	4	16	8	32	12	48	16	64	16	64
Porters	12	24	24	48	36	72	48	96	60	120
Sub Total		565		1,052		1,539		2,026		2,496
Fuel & Maintenance @ 320 pa	360	115	720	230	1,080	346	1,440	461	1,800	576
Operation & Maintenance of Vehicles @ 10,000	4	40	8	80	12	120	16	160	16	160
Travel & Transport of Staff		78		148		138		168		198
Bicycle Allowance		22		43		65		86		108
Staff Privileges		1		5		7		10		12
Sub Total		257		506		676		885		1,054
Acaricide Cost @ 4.16 per Animal		2,995		5,990		8,986		11,981		14,976
Total Recurrent		3,817		7,548		11,200		12,866		16,030
Cattle Served ('000's)	720		1,440		2,160		2,880		3,600	
Total Cost per Animal, Shs.		5.30		5.24		5.18		5.17		5.15
Cost Less Acaricide		1.14		1.08		1.02		1.01		.99

*Source: Uganda, Dept. of Vet. Services, "Uganda Tick Eradication Scheme" (budget and supporting statement prepared for World Bank--IDA Loan, Kampala, 1967, mimeo.).

TABLE XV. UGANDA TICK CONTROL PROJECT: MATERIALS REQUIRED AND COST OF CONSTRUCTING FULL PLUNGE CATTLE DIPPING TANK, 1968*

Item and Description	Quantity Required	Cost
1. Cement Tororo	120x112 lb. bags @ 14/- ea.	1,680.00
2. Cement blocks 18"x9"x6"	700 blocks @ 1/20 ea.	840.00
3. Waterproof cement	2x5 lb. bags @ 32/- ea.	64.00
4. Weldmesh reinforcement	16 sheets 8'x4' @ 21/- ea.	336.00
5. Building sand	5x5-7 ton loads @ 75/- ea.	375.00
6. Quarry stones 1 1/2"	5x5-7 ton loads @ 175/- ea.	875.00
7. Roofing nails, wire	10 lbs. @ 1/50 lb.	15.00
nails, mixed sizes	10 lbs. @ 1/- lb.	10.00
8. C.I. sheets 6' 28G	48 sheets @ 1/85 ft.	532.80
Ridges 5'	10 pieces @ 10/- ea.	100.00
9. Hard core stones 6"	5x5-7 ton load @ 150/- ea.	750.00
10. Timber:		
70 pieces of 4"x4"x6' @ 1/50 per ft.	(420)	525.00
100 3"x2"x13' @ -/45	(1300 ft.)	585.00
12 4"x2"x8' @ -/60	(96 ft.)	57.60
12 6"x1"x8' @ -/80	(96 ft.)	76.80
12 3"x1"x6' @ -/35	(72 ft.)	25.20
11. Bolts:		
365 bolts 7" @ -/55 ea. bolt & nut		200.75
30 8" @ -/55 ea.		16.50
30 50 @ -/55 ea.		16.50
12. 4 pieces galvanized drain pipes 2" x 1 ft. equipped with one socket and plug to fit @ 6/- per piece		24.00
13. Labor:[a]		
a) Cost of 3 fundis at an average of Shs. 222/60 per fundi for al working days		667.80
b) Cost of 8 laborers @ Shs. 5.80 per day for 21 working days		974.00
	Total	8,747.35
		8,750.00
14. Additional allowance of 15% of the above total to cover miscellaneous expenses, i.e. transport costs, etc.		1,312.50
	Grand Total	10,062.50

Source: Uganda, Dept. of Vet. Services, Circular No. 179/160, June 20, 1968.

Estimates were compiled as a guide to staff and groups of farmers who wished to build cement cattle dips, and were the result of a close study of a number of dips constructed in Busoga under departmental supervision. The figures are for a 3,000 gallon capacity concrete tank, with a corrugated steel roof, a 30'x20' collecting boma, a 12' long footbath and a 90' draining race.

[a] The cost of labor is based on three skilled fundis (1 mason/carpenter, 1 mason and 1 carpenter) with an average salary of Shs. 10/60 per day; plus eight laborers engaged on Kampala/Jinja official rates of Shs. 5/80 per day, building and completing a dip in 21 working days. The cost of labor depends mainly on the efficient supply of building materials. If manual labor is provided by the farmers (as is expected in most cases) and materials like sand, blocks and stones were obtainable locally, the cost may be reduced. Water development costs not included.

TABLE XVI. UGANDA TICK CONTROL PROJECT: UNITED KINGDOM-ODM LOAN, ESTIMATED CAPITAL AND RECURRENT COST OF PROJECT IMPLEMENTATION, 1968

	Year One		Year Two		Year Three		Total		Cost per Center
	No.	Shs.	No.	Shs.	No.	Shs.	No.	Shs.	Shs.
Capital Development Cost									
New Centers @ Shs. 8,572	427	3,660	425	3,643	423	3,626	1,275	10,929	8,575
Land Rovers @ Shs. 20,512	6	123	5	183	5	103	16	329	258
Semi Rotary Pumps @ Shs. 223	427	95	425	95	423	94	1,275	284	223
Pipe per Center @ Shs. 394	427	168	425	167	423	167	1,275	502	394
200 Gallon Tank @ Shs. 171	427	73	425	73	423	72	1,275	218	171
Trucks 10 ton @ Shs. 85, 715	4	343					4	343	269
Total Capital		4,463		4,081		4,062		12,606	9,890
Recurrent Local Cost									
Staff:									
Veterinary Officers	4	103	4	107	4	111		321	252
A. Hus. Officers	16	188	16	197	16	205		590	463
Construction Teams @ Sh. 9,737	26	253	26	253	26	253		760	596
Drivers @ Shs. 343	6	21	11	38	16	55		113	89
Total Staff		565		595		624		1,784	1,400
Other:									
Vehicle Maintenance @ Shs. 10,286		62		113		165		339	
Travel of Staff		110		110		110		329	
Total Other		172		223		275		670	525
Total Recurrent		737		818		2,899		2,454	1,925
Total Capital and Recurrent Cost		5,200		4,899		4,961		15,069	11,793

Source of Data: Dept. Vet. Ser., Application for Assistance for the Uganda Tick Control Project under the British Loan (Kampala, 1968, mimeo.). It was assumed that farmers would provide half the capital cost of new centers, pay dip attendants and purchase acaricide without subsidy.

TABLE XVII. UGANDA TICK CONTROL SUB-PROJECT: USAID LOAN, ESTIMATED CAPITAL DEVELOPMENT COST OF TICK CONTROL IN BURULI, BUGWERE, KYADONDO AND BUSIRO COUNTIES, 1968

Item	No.	Import Cost	Local Cost	Total Cost	Total Cost Thousands	Cost per Center
		Dollars			Shillings	
1. Headquarters, Office and Store (prefab)	2	6,000	4,200	10,200	72.8	914
2. Vehicles and Spare Parts	20	97,980	2,300	100,280	715.9	
3. Machinery for Digging Valley Tanks		145,000	2,000	147,000	1,049.6	
4. Material for Tick Centers[a]						
a. Large centers complete[a]	70		140,000	140,000	999.6	14,280
b. Small centers	10	2,000	10,100	12,100	86.4	8,639
c. Water storage tanks	80	8,000	800	8,800	62.8	785
d. Hand pumps for valley tanks	80	4,000	400	4,400	31.4	393
e. Digging valley tanks	80U		80,000	80,000	571.2	7,140
f. Water pipe 250 ft. per center	80U	12,000	300	12,300	87.8	1,100
g. Installation water supply	80U		12,000	12,000	85.7	1,071
h. Prefab hut and store	80	80,000	18,000	98,000	699.7	8,746
i. Nails, bolts, hardware	80U	2,000		2,000	14.3	179
j. Tools and equipment	80U	12,400	300	12,700	90.7	1,135
Sub Total		120,400	261,900	382,300	2,729.6	34,828[a]
5. Acaricide		86,100	2,000	88,100	629.0	7,875
6. Tick Control Items for Individual Farmers[b]	2,055U	111,750	2,000	113,750	812.2	
7. Spare Parts for Item 4b,6		11,350	300	11,650	83.2	
8. Spare Parts for Item 3		30,000	5,000	35,000	249.9	
Grand Total		608,580	279,700	888,280	6,342.3	

Source of Data: USAID, Uganda Mission, unpublished project statements and reviews, Kampala, various years.

[a] Cost of full plunge dip. Kampala spray bath used, cost of center reduced to Shs. 29,188.

[b] Hand spraying equipment for use in Kyadondo and Busiro Counties.

TABLE XVIII. ANKOLE DISTRICT, UGANDA AND WEST LAKE, TANZANIA: ESTIMATED COST OF VALLEY TANK CONSTRUCTION BY SIZE OF TANK, 1969

No. Cattle	Cubic Feet Storage	Tank Size (Bottom)	Yards Dirt Moved[a]	Cost Excavation	Cost Fencing and Petrol Pump	Total Cost
				Shillings		
500	40,000	40/100x10	4,000	5,200	3,600	8,800
1,000	80,000	80x100x10	8,000	10,400	3,600	14,000
2,000	160,000	80x200x10	12,600	16,400	7,200	23,600
3,000	240,000	100x240x10	19,300	25,100	10,000	35,000
4,000	320,000	100x320x10	24,630	32,000	11,400	43,400

Source: USDA/USAID, Tsetse Fly Eradication and Livestock Development, Ankole, Uganda and West Lake, Tanzania (Kampala), 1969. Estimates based on construction costs in the Ankole/Masaka Ranching Scheme.

a. Yards dirt moved if 8 feet to impervious soil.

TABLE XIX. UGANDA TICK CONTROL PROJECT: RECURRENT COST TO SOCIETIES AND AVERAGE COST PER HEAD 1969/70-1980/81

	A	B	C	D	E	F	G	H	I	J
	Eligible Cattle Population[a]	Percent Cattle in Project	Cattle in Project[b]	Capital Contribution Owners[c]	Tickicide Cost of Project @ Shs. 4.00	Tickicide Subsidy[d]	Acaricide Cost to Societies[e]	Overhead Cost of Societies	Total Budget Societies	Average Cost per Head
	Shillings (thousands)		Shillings (thousands)							
1969/70	3,545	30	1,040	1,200	4,160	1,500	2,660	1,969	4,629	4.50
1970/71	3,625	40	1,415	1,290	5,680	1,500	4,180	2,690	6,870	4.85
1971/72	3,700	50	1,815	1,290	7,280	1,560	5,720	3,448	9,168	5.05
1972/73	3,780	60	2,230	1,290	8,920	1,600	7,320	4,315	11,635	5.20
1973/74	3,870	70	2,670	1,290	10,680	1,600	9,080	5,067	14,147	5.30
1974/75	3,950	78	3,020	1,290	12,480	1,600	10,880	5,928	16,808	5.40
1975/76	4,040	85	3,390	1,290	13,560	1,400	12,160	6,464	18,624	5.50
1976/77	4,120	90	3,680	1,290	14,720	1,200	13,520	7,362	20,882	5.65
1977/78	4,220	95	3,980	1,290	15,920	1,180	14,740	7,542	22,282	5.70
1978/79	4,310	100	4,310	1,290	17,160	1,160	16,000	8,580	24,580	5.75
1979/80	4,400	100	4,400	1,290	17,560	780	16,780	8,780	25,560	5.80
1980/81	4,500	100	4,500	1,290	18,000	410	17,590	9,000	26,590	5.85

Column A. Cattle potentially in the project. Excludes cattle in drier areas of Karamoja and cattle under private control. Population assumed to be growing.
Column B. Estimate share of cattle population in project. 2.2 percent per annum.
Column C. Average number of cattle served by the project.
Column D. Assumes 215 centers constructed per year with owners contributing Shs. 6,000 per center (see Table 6.6).
Column E. Assumes an average tickicide cost of Shs. 4 per animal in the project.
Column F. Presumes a 50 percent subsidy on tickicide for the first two years any animal unit is first served by the project.
Column G. Tickicide cost of project less subsidy.
Column H. Overhead cost of center operation reflecting average numbers of cattle served per center (see Column C).
Column I. Combined tickicide and overhead costs.
Column J. Average cost of tick control per animal served.

TABLE XX. UGANDA TICK CONTROL PROJECT: CENTERS IN OPERATION, CATTLE SERVED, STAFFING REQUIREMENTS AND GOVERNMENT RECURRENT BUDGET, TOTAL, AND PER HEAD, 1970/71-1980/81*

Year	Centers in Operation	Cattle Served ('000's)	Cattle per Center	Staff Required (est.)			Govt. Recurrent Budget	Cost per Head
				Vet. Officers	Hus. Officers	Vet. Assistants		
1970/71	570	1,415	2,490	2	13	28	1,488	1.05
1971/72	785	1,815	2,320	4	19	41	2,049	1.13
1972/73	1,000	2,230	2,230	5	23	52	2,610	1.17
1973/74	1,215	2,670	2,200	7	28	64	3,171	1.19
1974/75	1,430	3,020	2,110	8	34	76	3,732	1.24
1975/76	1,645	3,390	2,060	9	39	86	4,293	1.27
1976/77	1,860	3,680	1,980	11	44	98	4,855	1.32
1977/78	2,075	3,980	1,980	12	49	109	5,416	1.36
1978/79	2,290	4,310	1,870	14	54	121	5,977	1.39
1979/80	2,505	4,400	1,750	15	60	132	6,538	1.48
1980/81	2,720	4,500	1,650	16	64	144	7,099	1.57

*Centers in operation and cattle served from Table XIX. Staff requirements based on Table XIII. Government recurrent budget projected at an average cost of Shs. 2,610 per center in operation, Table 6.8. Cost per head estimated by dividing Government recurrent budget by cattle served.

TABLE XXII. UGANDA TICK CONTROL PROJECT: DEVELOPMENT CAPITAL REQUIREMENTS AND ACCUMULATED PROJECT VALUE, 1969/70-1980/81

	A	B	C	D	E	F	G	H	I	J
	Total Cattle Population	Centers Required	Centers in Operation	Capital Contribution Owners @ Shs. 6,000	Capital Cost to Govt. @ Shs. 13,575	Valley Tank Construction @ Shs. 5,200	Acaricide Subsidy	Total Development Budget	Accumulated Value of Scheme	Capital Required That Year
	Shillings (thousands)			Shillings (thousands)						
1968/69	3,345	2,200	144	--	--	--	--	(1,283)	(1,283)	--
1969/70	3,545	2,220	355	1,200	1,655	--	1,500	3,155	4,438	--
1970/71	3,625	2,270	570	1,280	2,704	832	1,500	5,036	9,474	5,868
1971/72	3,700	2,320	785	1,290	2,704	832	1,560	5,096	14,570	5,928
1972/73	3,780	2,370	1,000	1,290	2,704	832	1,600	5,136	19,706	5,968
1973/74	3,870	2,420	1,215	1,290	2,704	832	1,600	5,136	24,842	5,968
1974/75	3,950	2,470	1,430	1,290	2,704	832	1,600	5,136	29,978	5,968
1975/76	3,040	2,520	1,645	1,290	2,704	832	1,400	4,936	34,914	5,768
1976/77	4,120	2,580	1,860	1,290	2,704	832	1,200	4,736	39,650	5,568
1977/78	4,220	2,640	2,075	1,290	2,704	832	1,180	4,706	44,356	5,538
1978/79	4,310	2,690	2,290	1,290	2,704	832	1,160	4,686	49,042	5,518
1979/80	4,400	2,750	2,505	1,290	2,704	832	780	4,316	53,358	5,148
1980/81	4,500	2,810	2,720	1,290	2,704	832	410	3,946	57,304	4,778

Column A. Cattle potentially in project, excludes cattle in drier areas of Karamoja. Population assumed to be growing 2.2 percent per year.
Column B. Centers required estimated by assuming one center per 1,600 head of cattle.
Column C. Average number of centers in operation.
Column D. Assumes 215 centers constructed per year post 1969/70 and owner contribution to capital costs of each center, Shs. 6,000.
Column E. Assumes 215 centers constructed per year at an average Government contribution to capital cost per center of Shs. 13,575 including the cost of support facilities
Column F. Assumes that 75 percent of the centers constructed each year, or 160 centers, will require the construction of a water supply. Cost estimate assumes one-half of the cost of water supply development (one-half of Shs. 10,400) changeable to the Tick Control Project.
Column G. Assumes a 50 percent subsidy on tickicide for the first two years each animal unit is first served by the project.
Column H. Development budget includes capital expenditure, project share of water development costs and tickicide subsidy.
Column I. Accumulated value of development budget.
Column J. Development budget plus non-project share of water development costs.

TABLE XXII. UGANDA TICK CONTROL PROJECT: REQUIRED CAPITAL BUDGET AND CAPITAL REPAYMENT SCHEDULE PER ANNUM AND AVERAGE CAPITAL COST PER ANIMAL SERVED, 1970/71-1980/81

Year	Development Budget	Accumulated Value Project	Capital Servicing	Cost per Head Served
		Shillings (thousands)		
Pre-July 1970	4,438	4,438	132.1	--
1970/71	5,036	9,474	456.9	--
1971/72	5,096	14,570	975.4	.54
1972/73	5,136	19,706	1,500.1	.67
1973/74	5,136	24,842	2,028.9	.76
1974/75	5,136	29,978	2,557.7	.85
1975/76	4,936	34,914	3,086.5	.91
1976/77	4,736	39,650	3,594.7	.98
1977/78	4,706	44,356	4,082.3	1.03
1978/79	4,686	49,042	4,566.8	1.06
1979/80	4,316	53,358	5,049.3	1.15
1980/81	3,946	57,304	5,475.2	1.22
1981/82	--	57,304	5,881.4	1.44

*Capital development budget and accumulated project value from Table XXI. Capital cost of project estimated as the amortized cost of the capital invested in the project at 6 percent over a 15 year period from the time of investment. Cost per head served estimated by dividing the annual cost by the number of cattle in the project.

TABLE XXIII. EASTERN UGANDA: EXPECTED CHANGE IN HERD COMPOSITION AND PRODUCTIVITY FACTORS FOLLOWING TICK CONTROL IN DAIRY/BEEF HERDS* (CARRYING CAPACITY RESTRICTED TO 400 UNITS)

Inventory and Productivity Factors	Pre Tick Control	Post Tick Control		Dairy/Ranching Scheme
	A	B	C	D
Cows	170	149	144	111
Other Animals				
4+ Years	15	--	--	--
3-4 Years	49	59	60	69
2-3 Years	69	81	82	93
1-2 Years	72	83	84	94
8-12 Months	25	29	29	32
0-8 Months	62	63	62	65
Total Cattle, 8 mo. plus	400	400	400	400
Total Cattle, all ages	462	463	462	464
Productivity Factors				
Calves Born per Year	110	101	98	100
Calves Surviving One Year	76	85	87	95
Animals Reaching Maturity	64	79	80	92
Cow Replacements Required	14	10	10	6
Animals Available for Sale	50	69	70	86
Calving Percentage	65	68	68	90
Percent Calf Mortality	30	15	10	5
Effective Weaning Rate, %	45	57	60	85
Productivity Assumptions				
Immature Mortality, %	5.0	2.5	2.5	1.0
Adult Mortality, %	8.0	7.0	7.0	7.0
Ave. Age Sale, Males, yrs.	4.5	4.0	4.0	3.5
Ave. Age First Calf, yrs.	3.5	3.5	3.5	3.5
Ave. Weight Sale, Males, kg.	290	290	290	290
Ave. Weight Sale, Culls, kg.	250	250	250	270
Ave. Price of Hoof, per kg., Shs.	1.32	1.32	1.32	1.65
Hectares Required per Unit	1.0	1.0	1.0	1.0

*Data consistent with available census data and other secondary data for the pre and post tick control situation in the Eastern and Northern Regions. Herd size restricted to 400 animal units. Each animal over 8 months of age counted as one unit. Breeding bulls excluded from calculation.

TABLE XXIV. WESTERN UGANDA: EXPECTED CHANGE IN HER COMPOSITION AND PRODUCTIVITY FACTORS FOLLOWING TICK CONTROL IN DAIRY/BEEF HERDS* (RESTRICTED CARRYING CAPACITY--400 UNITS)

Inventory and Productivity Factors	Pre Tick Control			Post Tick Control			Ankole Ranching Scheme
	Males	Females	Total	Males	Females	Total	Total
Cattle Inventory							
Cows	--	204	204	--	167	167	130
3+ yrs.	)	19	)	)	23	)	88
2-3 yrs.	) 67	41	) 170	) 82	48	) 202	130
1-2 yrs.	)	43	)	)	49	)	91
8-12 mo.	11	15	26	14	17	31	) 97
0-8 mo.	34	37	71	32	36	68	)
Total Cattle, 8 mo. + yrs., no.	78	322	400	96	304	400	400
Total Cattle, All Ages, no.	112	359	471	128	340	468	497
Productivity Factors							
Calves Born per Year, no.	66	66	132	57	57	114	104
Calves Surviving One Year, no.	36	45	79	42	51	93	99
Animals Reaching Maturity or Age of Sale, no.	32	39	71	40	46	86	88
Cow Replacements Required, no.	--	16	16	--	12	12	3
Animals Available for Sale, no.	32	23	55	40	34	74	85
Commercial Extraction Rate, %	6.8	4.7	11.5	8.1	6.9	15.0	17.1
Effective Weaning Rate Ave., %	35.2	44.1	38.7	50.2	61.1	55.7	75

TABLE XXIV. (cont'd.)

Inventory and Productivity Factors	Pre Tick Control			Post Tick Control			Ankole Ranching Scheme
	Males	Females	Total	Males	Females	Total	Total
Productivity Assumptions							
Calving Percentage	--	65	--	--	68	--	80
Calf Mortality, %	45	30	38	25	10	18	5
Mortality, 8 mo. to Sale, %	5	5	5	3	3	3	5
Adult Mortality, %	--	8	--	--	7	--	2.5
Ave. Age Sale--Maturity, yr.	3	3.5	--	3	3.5	--	4.0
Ave. Weight Sale, kg.	300	315	--	310	320	--	360
Ave. Price on Hoof, kg.	1.32	1.32	1.32	1.32	1.32	1.32	1.43
Ave. Sale Price, Shs.	396	415	--	410	420	--	514

*Data consistent with available census data and other secondary data for the pre and post tick control situation in the Western and Buganda Regions. Herd size restricted to 400 animal units. Each animal over 8 months of age counted as one unit. Breeding bulls excluded from calculations.

TABLE XXV. UGANDA: BEEF EQUIVALENT OF CORNED BEEF, CARCASS MEAT AND LIVE CATTLE IMPORTATIONS COMPARED TO BEEF EXPORTATIONS BY UGANDA MEAT PACKERS, LTD.*

Year	Imports[a]			Flesh Equivalent of Imports[b]						
	Corned Beef Lbs.	Carcass Meat Lbs.	Live Cattle	Corned Beef Lbs.	Carcass Meat Lbs.	Live Cattle Lbs.	Total Imports Lbs.	Flesh Exports U.M.P. Ltd.	Net Flesh Imports(+) Exports(-)	Live Cattle Equivalent Imports(+) Exports(-)[c]
	(Thousands)									
1962	391	381	11.3	650	248	2,083	2,981	2,896	+85	+460
1963	110	439	13.7	183	286	2,263	2,732	1,359	+363	+1,950
1964	140	366	15.2	233	238	2,504	2,975	1,617	+358	+1,930
1965	301	357	11.7	502	232	1,923	2,657	2,207	+450	+2,400
1966	403	349	9.7	672	227	1,792	2,691	2,185	+506	+2,730
1967	370	238	10.1	617	155	1,662	2,434	2,675	-241	-1,300

* Source: Uganda, Min. Anim. Ind., Game and Fish, Report of the Committee on the Marketing of Livestock, Meat, Fish and Their Products in Uganda (Entebbe, 1969), Table 1-7.

[a] Source of data on corned beef and carcass meat imports, East African Community Customs and Excise, Annual Trade Report, 1962-1967.

[b] Flesh equivalent of corned beef estimated by multiplying corned beef imports by a factor of 1.67; of carcass meat by assuming a boning-out factor of 65 percent; and of live cattle, by assuming an average weight at import of 570 pounds, a K.O.P. of 50 percent and a boning-out factor of 65 percent.

[c] Flesh exports include boned-out meat and flesh exported in carcass form by the Uganda Meat Packers, Ltd.

TABLE XXVI. UGANDA: AVERAGE YIELD OF MEAT EQUIVALENT AND VALUE OF CARCASS AT FARM GATE AND RETAIL, 1969*

	Conventional Sector		Modern Sector	
	Pounds	Kilos	Pounds	Kilos
On Hoof Live Weight Values				
Average Live Weight (units)	550	250	617	280
Average Price per Unit on Hoof Shs.	.60	1.32	.65	1.43
Farm Gate Sales Value Shs.	330	330	400	400
Carcass Values				
Meat Equivalent per Carcass (units)	250	114	290	132
Value Meat per Unit Shs.	1.32	2.91	1.39	3.05
Farm Gate Value of Carcass Shs.	330	330	403	403
Marketing Margin				
Margin per Unit Shs.	.33	73	36	80
Average Price per Unit Shs.	1.65	3.64	1.75	3.85
Retail Value of Carcass Shs.	413	413	507	507

*Estimates based on best available evidence of average prices and slaughter weights. Modern sector includes both surplus dairy cattle and cattle from specialized beef ranches.

TABLE XXVII. UGANDA: ESTIMATED MEAT EQUIVALENT PRODUCED BY CONVENTIONAL HERDS 1967/68-1980/81*

Planning Year	Cattle Population Project Area (Thousands)	Extraction Rate (Percent)	Cattle Marketed Project Area	Cattle Population Non project Area	Cattle Marketed Non project Area	Total Cattle Marketed	Meat Equivalent Production (Pounds) (Millions)
			(Thousands)				
1967/68	3,318	10.25	340.1	600	60.0	400.1	96.0
1968/69	3,390	10.50	356.0	600	60.0	416.0	99.8
1969/70	3,465	10.75	372.5	600	60.0	432.5	103.8
1970/71	3,541	11.00	389.5	605	60.5	450.0	108.0
1971/72	3,619	11.25	407.1	610	61.0	468.1	112.3
1972/73	3,699	11.50	425.4	615	61.5	486.9	116.8
1973/74	3,780	11.75	444.2	620	62.0	506.2	121.5
1974/75	3,864	12.00	463.7	625	62.5	526.2	126.3
1975/76	3,948	12.25	483.6	630	63.0	546.6	131.2
1976/77	4,035	12.50	504.4	635	63.5	567.9	136.3
1977/78	4,124	12.75	525.8	640	64.0	589.8	141.6
1978/79	4,214	13.00	547.8	645	64.5	612.3	147.0
1979/80	4,307	13.25	570.7	650	65.0	635.7	152.6
1980/81	4,401	13.50	594.1	655	65.5	659.1	158.2

*Cattle population for the Tick Control Project area and for the dry areas of Karamoja from Table VI. Extraction rate in project area growing one percent in four years and remaining constant at 10 percent in Karamoja. Meat equivalent production estimated by assuming each carcass supplies 240 pounds of meat.

TABLE XXVIII. UGANDA: ESTIMATED MEAT EQUIVALENT PRODUCED BY ENCLOSED FARMS AND RANCHES, AND TOTAL NATIONAL PRODUCTION, 1967/68-1980/81

(Millions of Pounds and Kilo)

Planning Year	Modern Sector: Cattle Population (Thousands)	Modern Sector: Beef Production Pounds	Conventional Beef Production Pounds	Total Meat Production Pounds	Total Meat Production Kilo
1967/68	48	2.1	96.0	98.1	44.5
1968/69	64	2.8	99.8	102.6	46.6
1969/70	80	3.5	103.8	107.3	48.7
1970/71	96	4.2	108.0	112.2	50.9
1971/72	118	5.1	112.3	117.4	53.3
1972/73	141	6.1	116.8	122.9	55.8
1973/74	170	7.4	121.5	128.9	58.5
1974/75	202	8.8	126.3	135.1	61.3
1975/76	245	10.7	131.2	141.9	64.4
1976/77	271	11.8	136.3	148.1	67.2
1977/78	297	12.9	141.6	154.5	70.1
1978/79	323	14.1	147.0	161.1	73.1
1979/80	349	15.2	152.6	167.8	76.2
1980/81	375	16.3	158.2	174.5	79.2

*Cattle population enclosed farms and ranches from Appendix Table VI. Beef production from the modern sector estimated by assuming a 15 percent extraction rate and an average 290 pounds of meat equivalent per animal slaughtered. Conventional beef production estimate from Appendix Table XXVI.

TABLE XXIX. UNITED KINGDOM AND UGANDA: COST STRUCTURE OF MILK SOLD AT RETAIL, 1969

	England and Wales			Uganda
	Pence per gal.[a]	U.S.¢ per qt.	Uganda ¢ per lit.	Cents per lit.
Retail price paid by consumer for pasteurized milk	83.01	17.29	1.304	1.40
Cost of distribution:				
Retail margin	27.14	5.65	.426	.45[b]
Distribution allowance	3.32	.69	.052	.10[c]
Total distribution cost	30.46	6.34	.478	.55
Net return to board				
For sale of liquid milk	52.55	10.95	.825	1.30
For sale of manufactured milk	20.86	4.35	.328	--
Average return from both liquid and manufactured milk	42.33	8.82	.665	1.30
Excess return over boards entitlement under guaranteed price arrangement	.94	.20	.012	--
Price out of which the board make payments to producers (farmer's price)	41.39	8.62	.650	.85

a. Source: Federation of United Kingdom Milk Marketing Boards, Dairy Facts and Figures, 1969, 1970. Data for England and Wales.

b. Margin retained by Uganda Dairy Corporation to cover marketing and distribution costs. It is not known whether the Dairy Corporation makes a profit or is subsidized by the Government.

c. Retail marketing margin permitted to retail outlets.

TABLE XXX. UGANDA: ESTIMATED INCREASE IN MILK PRODUCTION CONVENTIONAL PRODUCERS, 1967/68-1980/81*

Planning Year	Indigenous Cow Population (Thousands)	Estimated Production per Cow (Liters)	Estimated Total Production Liters (Millions)	Estimated Total Production Gallons (Millions)	Production Index 1968 = 100
1967/68	1,631	179	293	65	100
1968/69	1,658	184	305	67	104
1969/70	1,687	189	318	70	109
1970/71	1,714	191	328	72	112
1971/72	1,743	197	343	76	117
1972/73	1,771	200	355	78	121
1973/74	1,800	204	368	81	126
1974/75	1,830	208	380	84	130
1975/76	1,860	210	392	86	134
1976/77	1,892	212	402	89	137
1977/78	1,926	214	413	91	141
1978/79	1,954	216	422	93	144
1979/80	1,987	217	431	95	147
1980/81	2,020	217	438	97	149

*Cow population growing 1.9 percent per year. Milk yield to farmer per cow per year assumed to increase from 390 gallons (177 liters), pre tick control to 490 gallons (223 liters) post control or 28.5 percent, reflecting an improvement in milk yield and calving percentage (see Table 7.2). Production per cow reflects share of cattle in scheme and lag in period to reach full production benefits from the project.

TABLE XXXI. UGANDA TICK CONTROL PROJECT: ESTIMATED INCREASE IN THE QUANTITY AND VALUE OF MEAT AND MILK PRODUCTION AS A RESULT OF THE PROJECT, 1968/70-1980/81*

(Millions of Liters and Shillings)

	Added Milk Production			Added Meat Production				
	Liters	Gross Farm Income Shs.	Gross Retail Value Shs.	Kilo.	Gross Farm Income Shs.	Gross Retail Value Shs.	Total Farm Income Shs.	Total National Income Shs.
1969/70	20	12.0	15.0	3.06	8.9	11.1	20.9	26.1
1970/71	25	15.0	18.7	4.43	12.9	16.1	27.8	34.8
1971/72	34	20.4	22.5	5.45	15.8	19.8	36.3	42.3
1972/73	41	24.6	30.8	6.70	19.5	24.3	44.1	55.1
1973/74	47	28.2	35.2	8.06	23.4	29.3	51.6	64.5
1974/75	54	32.4	40.5	9.42	27.4	34.2	59.8	74.7
1975/76	59	35.4	44.3	10.90	31.7	39.6	67.1	83.9
1976/77	63	37.8	47.2	12.26	35.6	44.6	73.4	91.8
1977/78	66	39.6	49.5	13.85	40.3	50.3	79.9	99.8
1978/79	70	42.0	52.5	15.44	44.9	56.1	86.9	108.6
1979/80	73	43.8	54.7	17.74	49.8	62.3	93.6	117.0
1980/81	74	44.4	55.5	19.86	57.8	72.2	102.2	127.7

*Additional milk production estimated as the difference between the expected yield of the cows under conventional husbandry practice before and after Tick Control Project completion. Additional meat production estimated as the difference between the numbers of cattle marketed before and after Project completion. Allowance in both projections made for differential rate of population growth after Tick Control. Value of milk at farm gate 60 cents per liter and 75 cents per liter at retail. Value of meat equivalent Shs. 2.91 per kilo farm gate and Shs. 3.64 at retail for 250 kilo animal.

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