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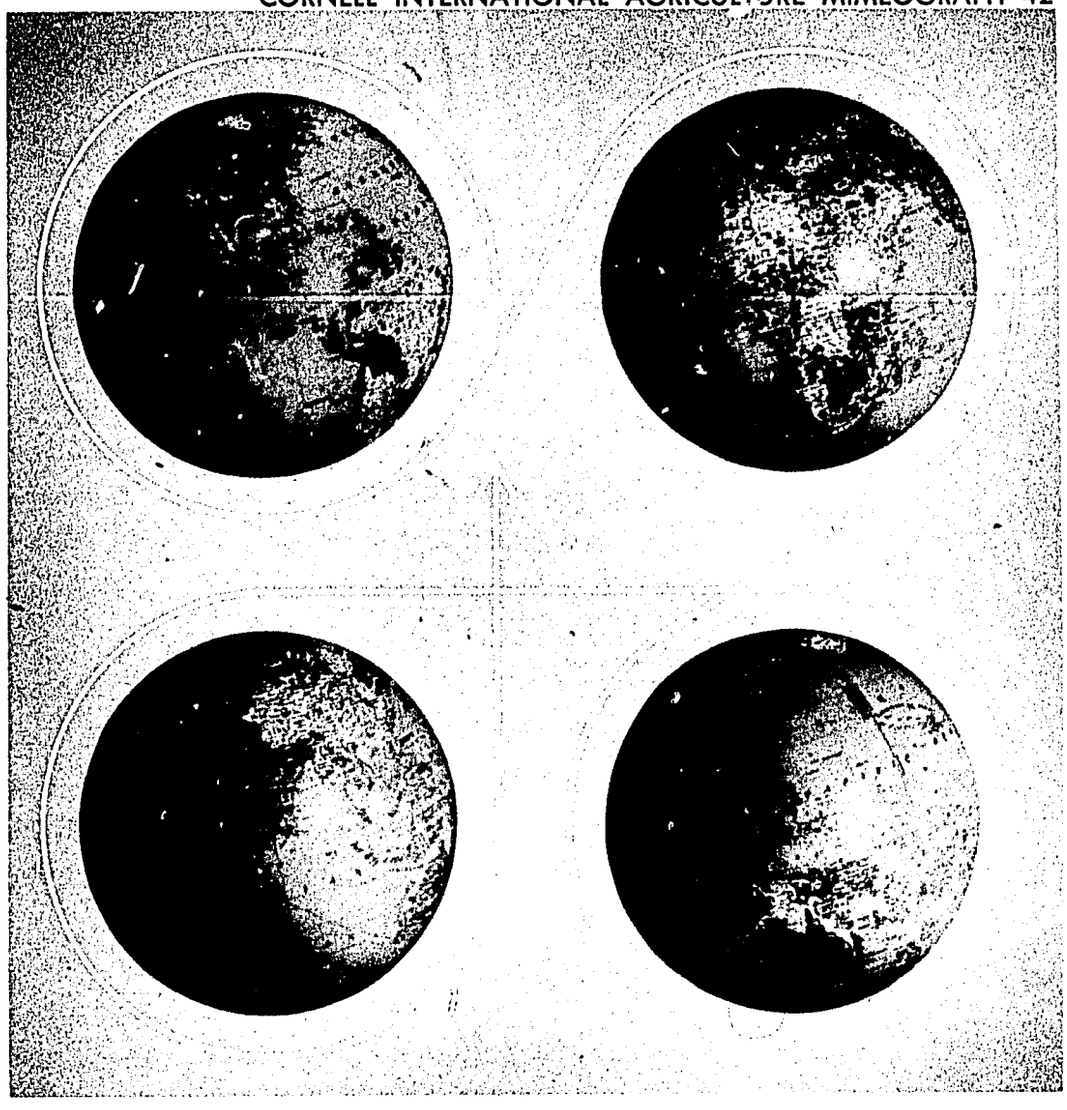

MODERNIZING AFRICAN ANIMAL PRODUCTION: THE UGANDA TICK CONTROL PROJECT

Donald S. Ferguson and Thomas T. Poleman

DEPARTMENT OF AGRICULTURAL ECONOMICS

New York State College of Agriculture and Life Sciences,
A Statutory College of the State University,
Cornell University, Ithaca, New York

July- 1973

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PREFACE

One of Africa's great underdeveloped resources is its grazing land. This resource has typically been neglected in national development plans in favor of export and calorie crops for two reasons: a widespread unawareness of the physical, economic, and social factors that have constrained past livestock development, and the complexity of the problems associated with expanding meat and milk production. Such expansion usually demands that progress be made simultaneously on many fronts, including disease control, introduction of improved breeds, modification of husbandry practices, enclosure of communal grazing lands, and establishment of an improved marketing infrastructure.

This paper sets forth a methodology for identifying, planning, implementing, and evaluating a livestock development program with the Uganda Tick Control Project taken as the case in point. Sponsored by the Ministry of Animal Industry, Game, and Fisheries of Uganda, the objectives of the project are the eradication of a tick-borne disease, East Coast Fever, and the amelioration of the debilitating effects of tick parasitism. The Ministry reckons that these will permit producers to adopt improved breeds of exotic stock, and through them substantially to increase milk and meat output. But between the target and the event, the study shows, are many slippages.

The paper, which so far as I am aware is unique in both subject matter and approach, is drawn from the dissertation submitted by Dr. Ferguson to the Cornell Graduate School in September 1971. As with all such condensations considerable material had to be left out. Some of this included the trappings thought essential to scholarship, some the tangential flights of a student immersed in his topic and reluctant to omit anything. But some, inevitably in a thesis of 355 pages, were ruled out by constraints of space alone. In this category were interesting historical sections dealing with the role of the tsetse fly and tribal inclinations on animal husbandry in Uganda, and appendices detailing the basis for the livestock zones of Uganda, the use of acaricides in tropical Africa, and the computation of demand elasticities. These are not unimportant points, but to learn more of them the reader will be reduced to squinting at what University Microfilms pretends are publications.[1]

Dr. Ferguson devoted over three years to the study, during two of which he was attached to the Institute of Social Research and the Department of Rural Economy and Extension at Makerere University. The assistance of his friends and colleagues at Makerere is gratefully acknowledged, especially that of D. G. R. Belshaw and Mrs. Beverly Brock.

Nor would the study have been possible without the cooperation of members of the Uganda Department of Veterinary Services and Animal Industry, both in Kampala and the areas of field study. Commissioner

1/ Donald S. Ferguson, "An Economic Appraisal of Tick Borne Disease Control in Tropical Africa: The Case of Uganda" (University Microfilms, Ann Arbor, Order No. 72-8849, 373 pp.).

H. S. K. Nsubuga and Deputy Commissioner S. L. H. Walshe were particularly helpful.

Thanks are also extended to the USAID Mission to Uganda for information on specific aspects of the tick control program.

Professor J. G. Matthysee of Cornell contributed immeasurably of his understanding of tick-borne diseases and the technical aspects of tick control. The maps and illustrations reflect the talent of Joseph K. Baldwin, also of Cornell.

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It is my personal pleasure to recognize the work of a good student.

T. T. P.

July 1973

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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. However, few major development projects for traditional livestock owners have experienced any lasting success (69, p. 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 (56) and delays the adoption of improved breeds. Most contagious diseases are now controlled at low cost by vaccination and quarantine. Those which remain to be controlled are often associated with poor husbandry practices. Their control requires the education and cooperation 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. 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 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 Great Britain. However the total area includes 16,400 square miles of open water and swamp, leaving 74,700 square miles of land (145, p. 1).

Uganda is part of the Central African plateau and is noted for great variability in climate and vegetation over short distances. Although

straddling the equator, the average elevation of 4,000 feet moderates the temperature to comfortable levels. The rainfall pattern in southern Uganda is bi-modal, while the northern half has a single rainy season. Rainfall levels decline from roughly 60 inches near Lake Victoria to less than 20 inches in parts of Karamoja. The climate and agriculture are described in greater detail in later sections.

The results of the 1969 Census place the population at 9.53 million, an increase of 45.7 percent in 10 years. A preliminary analysis indicates that the natural rate of growth is roughly 2.9 percent per year and the actual rate 3.5 percent, as the result of an influx of refugees from Congo, Sudan and Rwanda and by immigration from Kenya, Tanzania and Rwanda (116, 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. The 1969 Census gives the population of Kampala as 332 thousand, Jinja 47 thousand and Mbale 24 thousand. These 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 annum ($85).[1] The G.D.P. shows large annual fluctuations as the result of climatic conditions which affect export crop yields. In the 1962-1967 period, real per capita income increased an average rate of 3.5 percent per annum (143).

The contribution of animal industry to the G.D.P. is comparatively small. 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) from a cattle population of 4.1 million head. Per capita availability of animal protein is below recommended standards (20, passim) and a sizable "animal protein gap" exists between requirements and production (126, passim). Estimates of the current per capita availability of beef and milk by region are included in Tables 24 and 31.

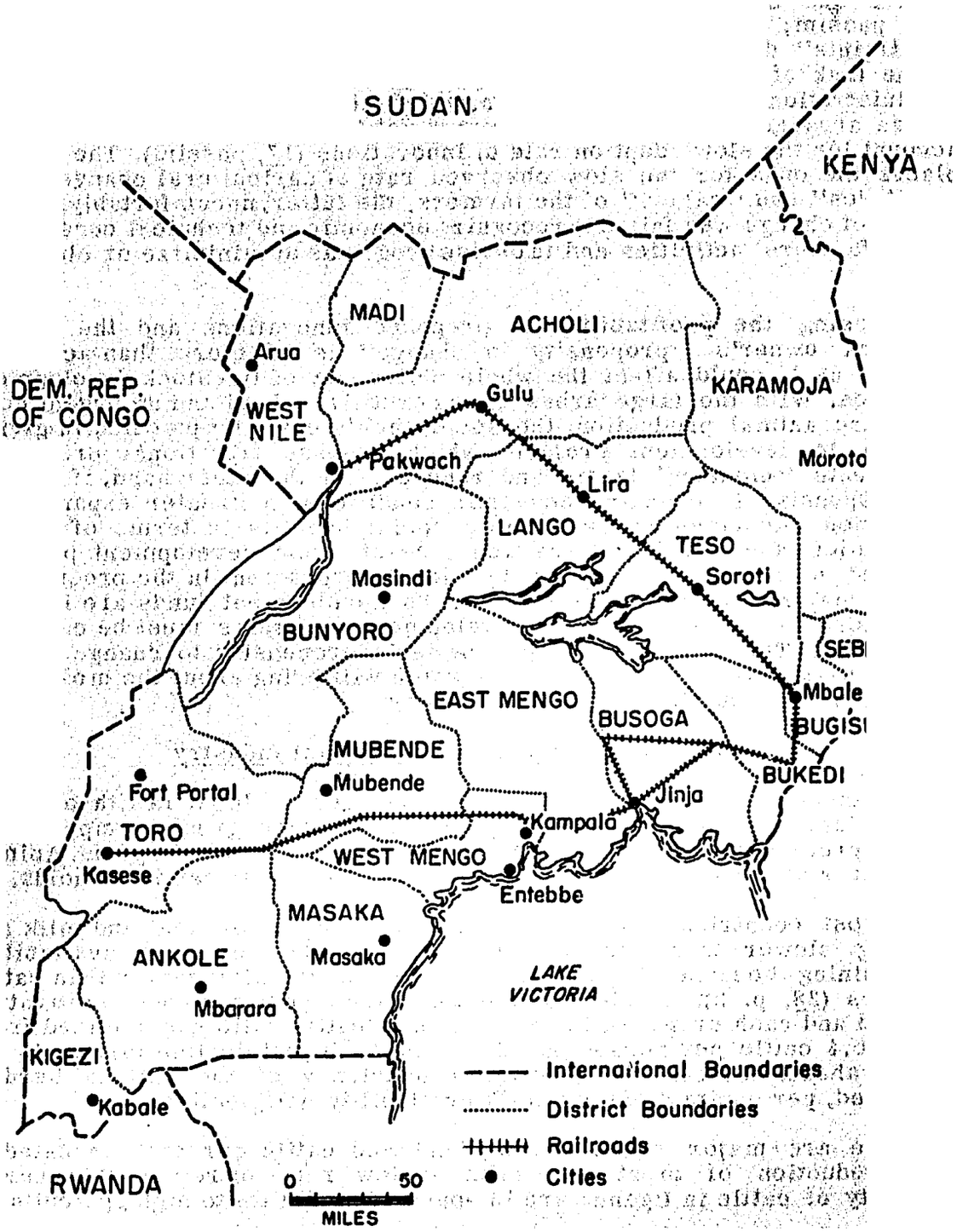
In summary, the growth of population, urbanization and income, combined with present low levels of consumption will result in a rapid growth in demand for all animal products, particularly if present price levels can be maintained.

Owner "Attitudes" and Economic Development

All too frequently, the lack of success of development programs designed for peasant farmers is attributed to their presumed conservative

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.

MAP I. UGANDA : DISTRICT BOUNDARIES AND MAJOR URBAN CENTERS



nature and to "social constraints" operating within the social system. Promoting innovation among African livestock owners is usually assumed to be particularly difficult. Only recently has the pastoralists and semi-pastoralists' economy been studied sympathetically (26, p. 55; 32, p. 71), and 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 (96, passim; 157, passim). Many authorities now feel that "social constraints" do not significantly retard development. They 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 the slow adoption rate of innovations (17, 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.

Assessing the profitability of proposed innovations and the typical livestock owner's "propensity to change" is of more than academic interest as it could affect the whole philosophy of livestock development in Africa. With the large areas of underutilized land and an urgent need to expand animal production, the Governments 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 owners are responsive to changing economic conditions, a greater expansion in production accompanied by greater social benefits in terms of income distribution and rural welfare would 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 must 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 production and of the economy.

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. Animal proteins are luxury food items in a majority of African households.

In most countries, as the world, the supplies of meat and milk are growing slower than demand, and in many the per capita availability is declining because the human population is growing faster than cattle numbers (38, p. 3). The best range lands are commonly under cultivation for food and cash crops. In Uganda, the man/cattle ratio has declined from 0.6 to 0.4 cattle per person and this ratio (RT) will decline further in the years ahead. Unless the average productivity of the national herd is improved, per capita meat and milk availability will decline.

There are major resources of land and cattle currently invested in the production of meat and milk at low rates of return. However, a majority of cattle in Uganda are in zones of moderate to high agricultural

potential. In these zones, 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. 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.

Development plans often emphasize the presumed need to diversify production in the agricultural sector and to expand export earnings. This is of particular concern in Uganda 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 (145, p. 19). An accelerated growth of livestock production would increase per capita income, expand employment opportunities, encourage import substitution and potentially expand export earnings.

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. All of the major development projects for animal production in Uganda have been assisted by one or more technical assistance or loan programs. These agencies have expressed interest in providing an even greater level of assistance provided suitable projects can be identified.

There are, however, distinct hazards in relying upon foreign assistance for a major part of capital development funds for any phase of agricultural development. 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.

To the credit of agencies, they have also supported a variety of improvement projects designed to raise the average productivity of many farm units but within the existing framework of methods and resources. In Uganda these 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 the poor record of success and the greater difficulty in evaluating and packaging the potential projects in formats acceptable to international agencies.

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 improvement projects to ministries of finance and planning or to international agencies, which

usually require that projects have a strong prospect of independent economic viability. Consequently programs are further biased in favor of transformation projects that can be more easily evaluated by traditional benefit/cost techniques and a greater share of their total cost can be financed by foreign loans.

Improvement projects can 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

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. 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 and by a severe shortage of development funds.

As late as 1964, 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.2/ The prospect of a major expansion of modern forms of livestock production in Uganda was considered to be remote. The decade of the 60's saw a remarkable reversal in the perceived prospects, and livestock production is now believed to represent a major development opportunity.

Since 1960, 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 mostly on Government ranching schemes. Some of the ranches also use exotic cattle.

Although the enclosed farms and ranches are making a growing con-

2/ 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.

tribution to total national production, this production remains a small fraction of the total meat and milk supply. Because of large numbers, it is possible to make a greater impact on total national production through modest improvements in yields and off-takes in the conventional herds than by a comparatively rapid growth in output from enclosed farms and ranches. The livestock development project in Uganda 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.

LAND AND HUMAN RESOURCES

The Land Resource Zones of Uganda

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 (149). 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.

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 (23;24).

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. The basis for defining land resource zones in Uganda was two research

memoir series published by the Ministry of Agriculture. The first series described the systems of agriculture practiced in Uganda (87; 88; 89; 90 and 91). The second described the vegetation and ecological zones (62).

Although ecological zone divisions are perhaps the best indication of land use and agricultural potential, the 22 ecological zones are often 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 are closely correlated with agricultural practices but must be generalized into zones of sufficient size to permit data summary and ease in planning.

A description of the range resources contained in the research memoir does provide a logical starting point in the process of defining land resource zones. The country is generalized into ten range resource zones. Range resource zones are composed of one of more ecological zones. 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. 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 livestock carrying capacity of the vegetation. The ten range resource zones are thus a useful index of physical resources and land use potential and are used as the basis 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, seven land resource zones were defined (Figure 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. When county boundaries approximate resource boundaries they are used as this is the smallest political unit for which planning 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 and on Mount Elgon, it is sometimes necessary to arbitrarily construct land resource boundaries along range resources boundaries and approximate the data for each zone.

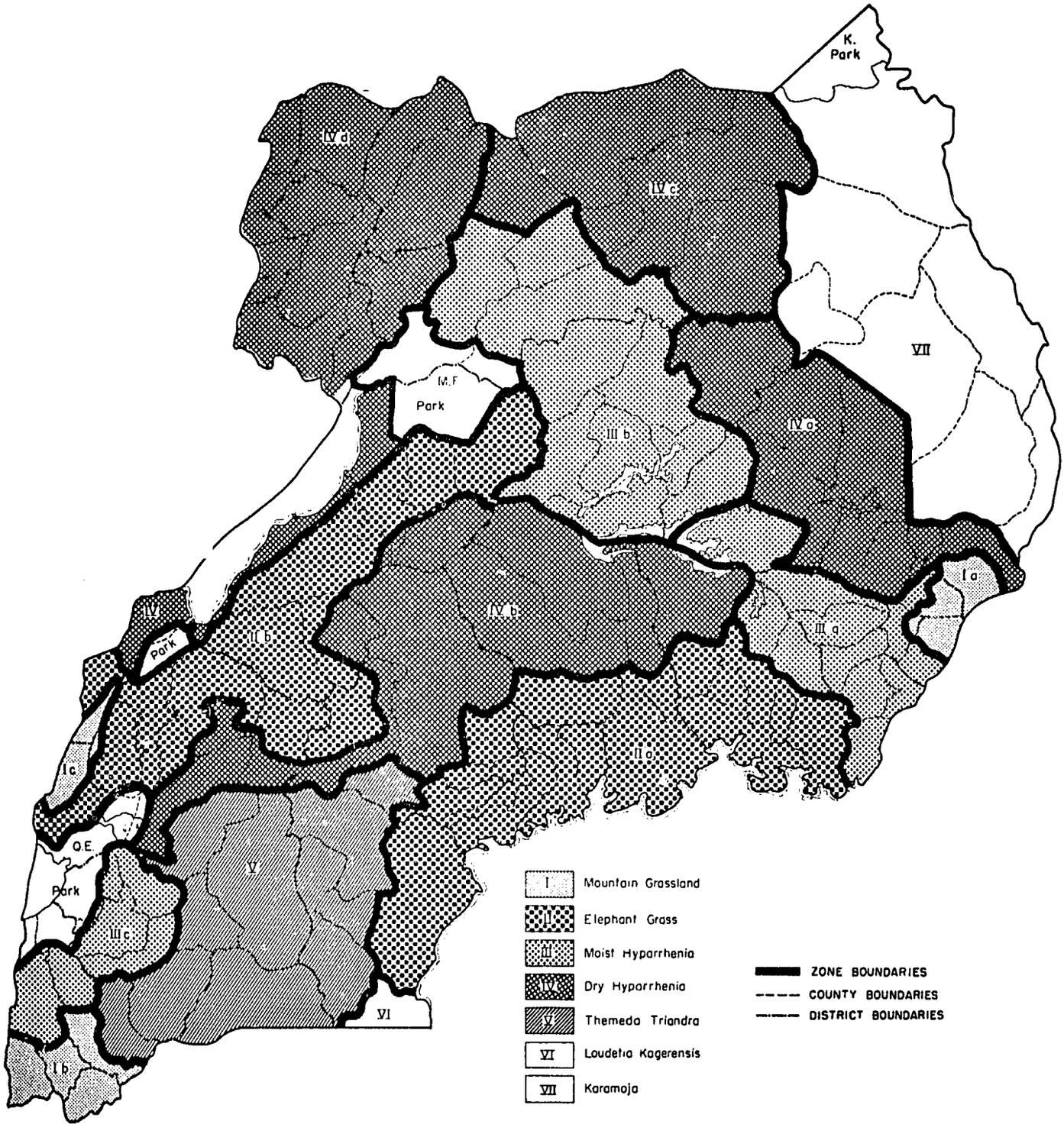
For ease of reference, five of the land resource zones are named after the range resource zones with which they closely coincide and two for the geographic areas where the zones occur. "Valley Grassland" range resource occurs as part of the vegetative catina within several zones and is generalized in 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 subzones, listed roughly in order of declining rainfall and agronomic potential in Figure 1, are described briefly.

FIGURE 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 [illegible]

MAP 2. UGANDA: LAND RESOURCE ZONES



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.

VI. Loudetia Kagerensis. 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.

VII. Karamoja. This Zone includes the entire District of Karamoja, roughly 12,200 square miles or 17.5 percent of the land area. Three range 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 in relation to the land resource 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. 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. Where not possible district or regional data are presented which suggest the general characteristics of each zone.

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. The Department compiles and publishes an annual report which contains only a fraction of the data collected by local staff. The unpublished data, if used with caution, do give valuable information on the livestock economy and land resource zones necessary for evaluating livestock development projects.

Cattle Numbers and Density

Veterinary scouts and assistants 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.

The annual census data collected by veterinary field staff and the results of a sample census of agriculture allow an examination of population density and ownership between areas and the growth of the population over time, by geographic area. The cattle population of each of the land resource zones is summarized for 1968 in Table 1. Roughly 70 percent of the cattle are in areas of moderate to high agronomic potential (Zones I-IV), 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 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 only 9.9 cattle per square mile (64 acres per animal) in the Toro-Bunyoro subzone (Table 1).

Substantive differences in husbandry and cattle ownership patterns occur between areas as a result of land resource differences and tribal history (31, pp. 31-45). In areas south and west of the Victoria Nile, cattle in grazing areas are owned by Bahima households which normally grow few crops. Those in perennial crop areas are often owned by crop farmers who employ herdsmen. 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). There is roughly one head for two persons in Ankole District where about 20 percent of the households own cattle, indicating that cattle are concentrated in fairly large herds (Table 3).

In the area east and north of the Nile, cattle ownership is more common as is the use of cattle for cultivation. In Teso, the most important cotton growing district, fully 50 percent of the households own cattle (Table 2). Most of the households which own cattle have one or more ox teams and nearly all cultivated land is ox plowed.

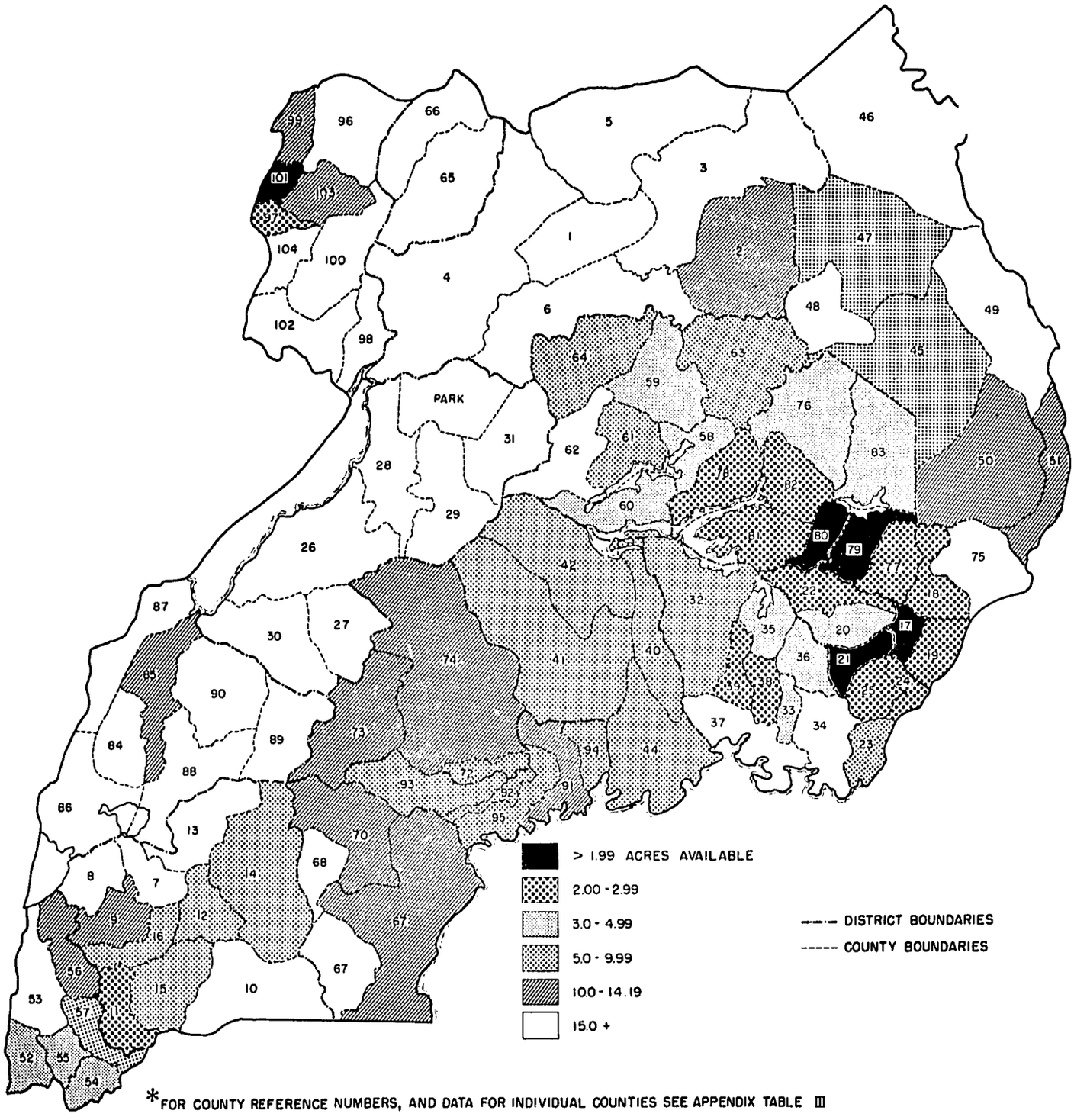
Only two districts, Teso and Karamoja, have more cattle than people; with the national average roughly 0.40 cattle per person. Thus there are some areas with a relative surplus of animal products and some with relative deficits, but beef and milk are produced (and consumed) in all districts. Few areas boast production in excess of dietary needs. 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. Something less than 20 percent of the roughly 1.2 million rural households own cattle or about 300,000 households.

Within each zone, sizeable areas are unavailable for grazing because of game parks and reserves, forest reserves, tsetse infestation and because of crop cultivation. Although data on the full range of land uses are not available, data on land under cultivation, by far the most important non-grazing land use, is available by county.

An estimate of the acres of available grazing per head of cattle by county are shown in Map 3. Map 3 illustrates the variability in stocking rates between areas and the concentration of cattle in the Eastern Region and in individual counties of Ankole, Kigezi and West Nile. It is of 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 (31, Table III). The reasons for the decline in cattle population are not known precisely, but they certainly include the growing pressure of cultivation in these counties.

The concern 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 presumes that cattle owners will retain additional cattle resulting in more severe overgrazing, a decline in average productivity, and ultimately an increase in mortality from

MAP 3. UGANDA : ACRES OF AVAILABLE GRAZING PER HEAD OF CATTLE BY COUNTY*



*FOR COUNTY REFERENCE NUMBERS, AND DATA FOR INDIVIDUAL COUNTIES SEE APPENDIX TABLE III

TABLE 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–Madi	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.

TABLE 2. UGANDA: TOTAL HOLDINGS, HOLDINGS WITH COMMUNAL GRAZING AND HOLDINGS WITH CATTLE, AGRICULTURAL CENSUS 1963/64

(Thousands)

District	Holdings[a]	Holdings with Communal Grazing[b]		Holdings with Cattle[b]	
	Number	Number	Percent	Number	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. Percentages of households which said they had access to communal grazing. Unpublished summaries suggest that roughly the same proportion owned cattle as reported access to grazing.

TABLE 3. 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.

starvation. While using this argument as an excuse to do nothing about disease losses is a "classical example of negative thinking" (3), it does raise important questions which cannot be ignored.

It is paradoxical that, provided bush regeneration is under control, controlled overgrazing for short periods appears to be a desirable management practice and the one which will maximize the production per unit area 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) (45, pp. 40-51; 115, p. 17). Intensive grazing also makes for easier ox-cultivation (57, passim).

In fact, increased cultivation and stocking density in undergrazed areas would 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. At the other extreme, continuous cultivation of food or perennial crops may prevent grazing or fodder production as land uses.

In most 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. For these reasons, in the more favored agricultural areas of Uganda, overstocking may be a serious problem but is seldom catastrophic.

The irreversible expansion of land under cultivation will continue to retard any general improvement in productivity and will increase the labor required to herd cattle and protect fields from trespass. But, 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; and, 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.

In the semi-pastoral areas where arable cash cropping is not a viable alternative to grazing as a land use (Zone V and VII), disease control may contribute to overgrazing and range deterioration. If the full benefits of production and productivity from tick control and tsetse clearance are to be realized in these zones, the cattle numbers must be limited to the carrying capacity of the range land. Reserving land for the exclusive use of "modern" ranching schemes will only repeat the mistake made so often in Africa of confining the conventional cattlemen to a restricted acreage. It is also imperative that ways be found to facilitate the resettlement of herds in overstocking areas to those with lower stocking densities, and where it is necessary to limit cattle numbers, provide households with alternative sources of food and income.

Although there are overstocked areas, 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 Table 4. 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 4. 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 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.

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 2). 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. Cattle numbers in 1960-61 declined as a result of unusual 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 5. 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.

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 ranches is shown in Table I. 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.

TABLE 4. UGANDA: ACRES OF POTENTIAL GRAZING, CATTLE POPULATION, 1969 AND POTENTIAL POPULATION BY DISTRICT

(Thousands)

	Acres of Grazing Land[a]	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. Mengo	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.

FIGURE 2. TREND IN CATTLE NUMBERS 1933-1969 AND PROJECTION TO 1980 (Semi Logarithmic Scale)

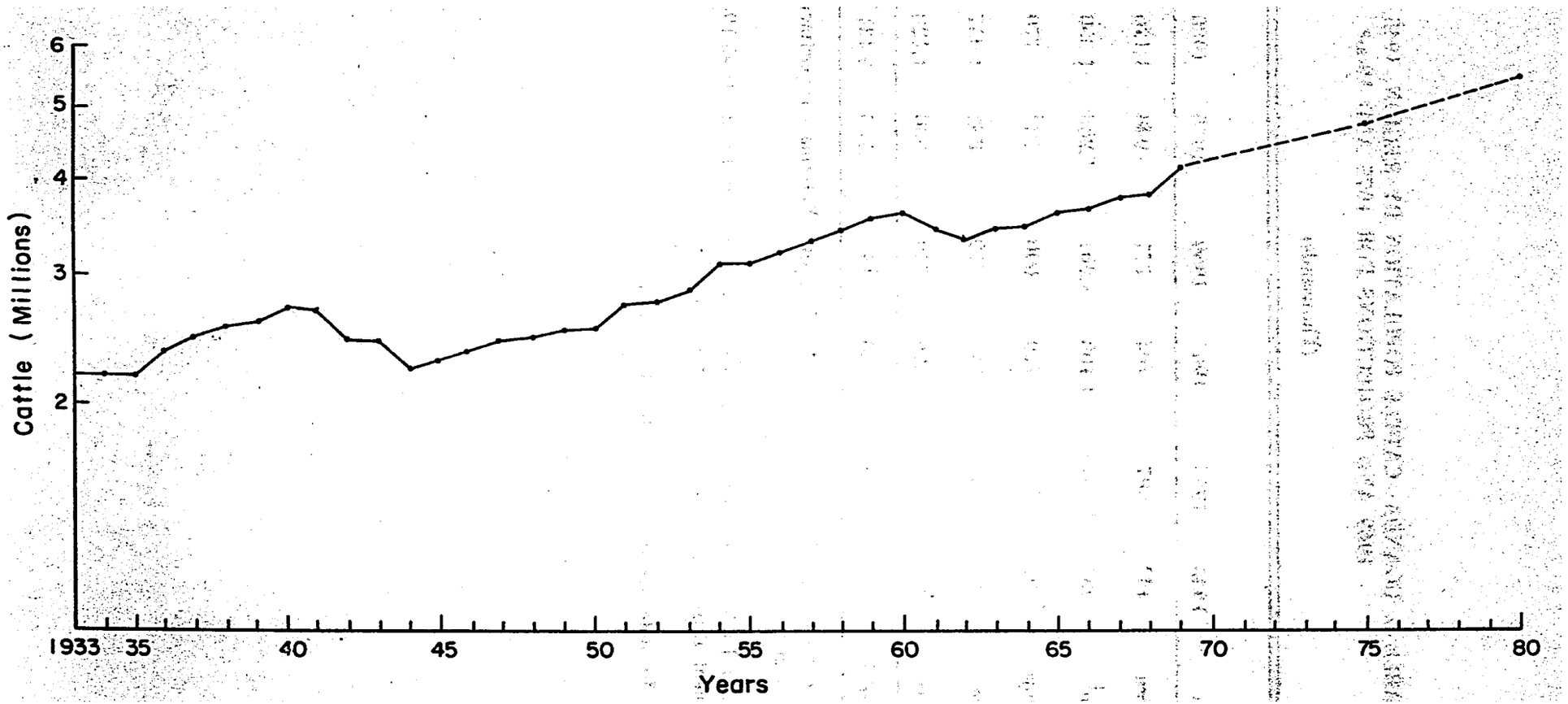


TABLE 5. UGANDA: CATTLE POPULATION BY REGION, 1945, 1955, 1967, 1969 AND PROJECTIONS FOR 1975 AND 1980*

(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.

The Age/Sex Structure in National Herd 3/

In addition to the annual census of cattle conducted by the Department of Veterinary Services, census data are also available from the 1963/64 sample Census of Agriculture compiled by the Ministry of Agriculture which enumerated herds by age and sex during each of three visits. These were compared with age/sex data compiled in either 1967 or 1968 by the staff of the Department of Veterinary Services.

There is substantial agreement between the two censuses as to the age/sex composition of the herds by district (compare Tables after making adjustment for difference in definitions). The estimated number of cattle in each category from the Veterinary Censuses for each region is given in Table 6, and the percentage in each category by district in Table 7.

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. Herds are oriented toward supplying milk for sale or family consumption 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 concentrating on commercial milk production rather than beef, a factor which will tend to curtail the growth of the meat supply.

Referring again to Table 6, the ratio of adult females to males is roughly 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.

Although the exact number of trained oxen is unknown, it is possible to estimate their numbers. The percentage of males in the population of the Eastern and Northern Region districts where ox plowing and cotton production occur 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.

The contribution of ox-cultivation to rural incomes is substantial. Uganda leads in the development of ox-cultivation in East Africa (12, p. 3) and there were an estimated 84,000 ox plows in 1960. 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 (41, p. 13). It can be conservatively estimated that oxen are cultivating upwards of

3/ 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.

TABLE 6. 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 7. 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 Sercre County Special Census conducted by the Research Division.

b. Excludes 20,000 cattle on ranching schemes.

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 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. Clearly, hide exports are an unsatisfactory index of herd productivity. In Uganda, sizable numbers of hides are imported from neighboring countries (141, Chapt. I). 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.

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.

In an area with a markedly growing cattle population, the marketed extraction rate would be expected to be below the national average.

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 of two percent may be salvaged and consumed on the farm.

The "marketed extraction rate" is low in comparison with European and North American figures where the extraction rates in the national herd 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 (101, 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. Present husbandry practices reflect the physical resources of each area, and, to this extent, cattle are integrated into the agriculture of each zone. Programs to modernize livestock production must consider many complex factors in devising programs to modernize annual production.

THE HISTORY OF GOVERNMENT PROGRAMS TO MODERNIZE ANIMAL INDUSTRY

The decade of the 1960's witnessed an important shift in Government policy toward the cattle industry. Prior to 1960, livestock development had a low development priority and was not thought to offer a significant development opportunity. 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. 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, developed in the temperate areas of Europe, are 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

"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 gradually 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 (58, p. 118). Because of early failures, veterinarians and animal scientists took the position that "climatic factors" made the probability of the successful introduction of temperate breeds of cattle remote (35, pp. 73-84; 98, pp. 523-535; 14, p. 79). These "climatic factors" appeared to include a mix of physical, herd management and social conditions.

Recent experiences in Uganda and in other tropical areas have indicated that it is 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.

As knowledge of forage production and disease control techniques improved, exotic cattle were successfully introduced into more tropical areas. For this reason the rules of thumb concerning the climatic conditions where temperate breeds of cattle can be successfully introduced have been 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 (67, p. 128). 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 four representative stations are shown in Figure 3. Figure 4 depicts histograms of monthly rainfall at these and seven other stations.

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. Zone I, II and IIIc also have above average soil fertility, permitting intensive pasture and fodder

FIGURE 3. ENTEBBE, MBARARA, GULU, KABALE : CLIMATOGRAPHS OF MEAN MONTHLY TEMPERATURE AND RELATIVE HUMIDITY

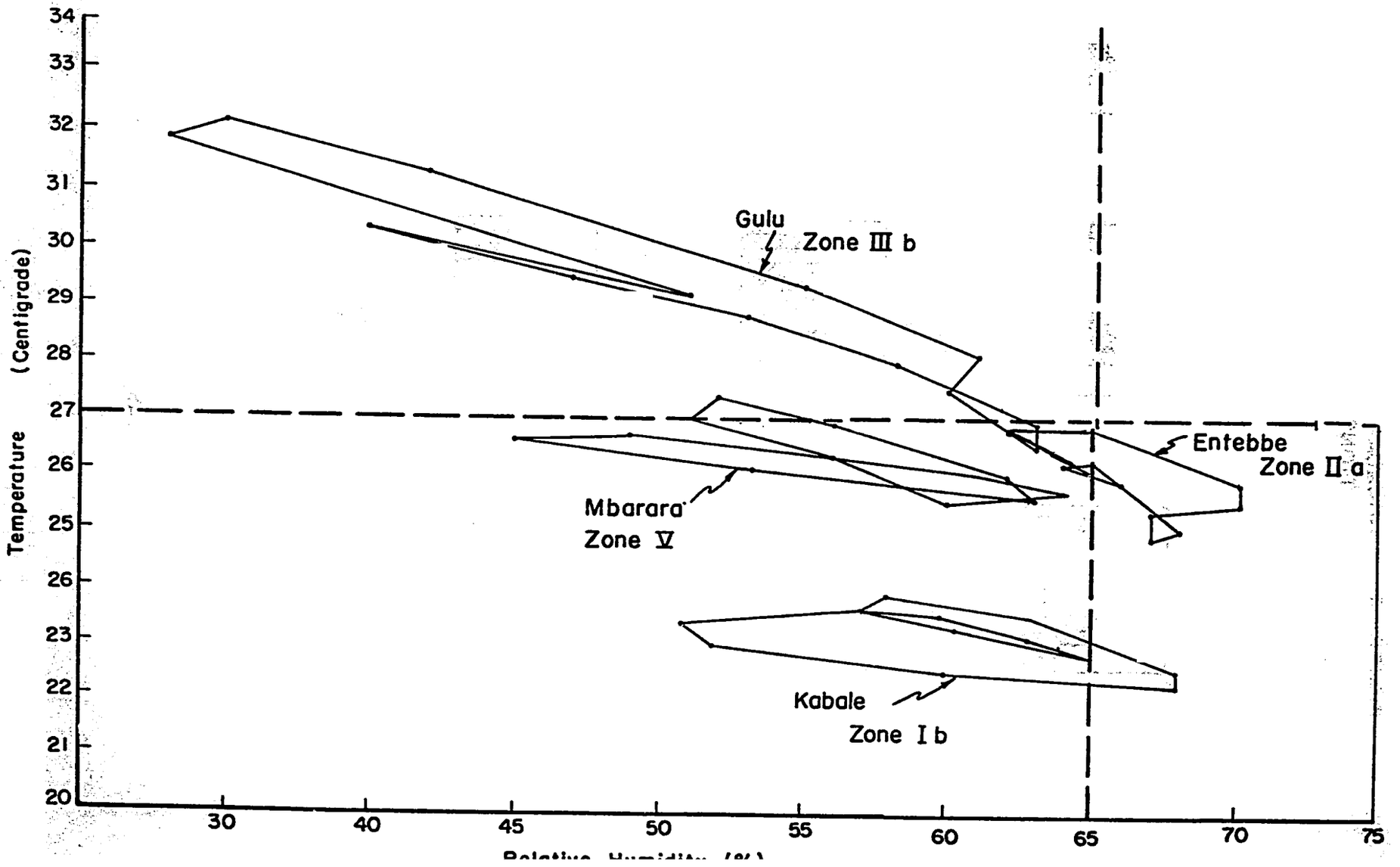
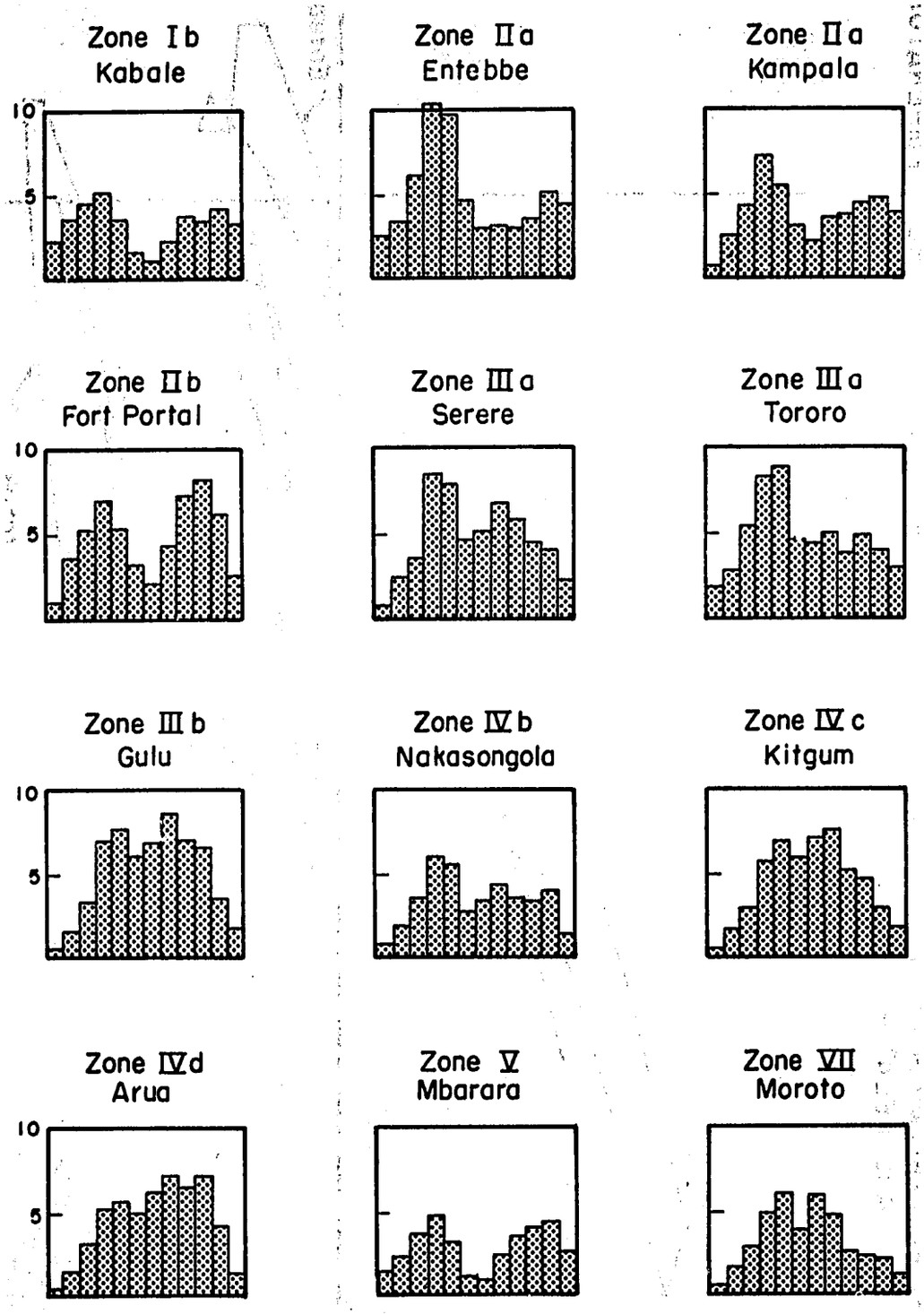


FIGURE 4 UGANDA: MEAN MONTHLY RAINFALL SELECTED STATIONS



SOURCE: UGANDA ATLAS, 1963

management. Almost all of the dairy farms of Uganda are located within these Zones or sub-zones. The 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 sub-marginal for the introduction of exotic cattle, except under superior management conditions. On the 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 crossbred Zebu/exotic cattle by yeomen farmers where enclosure has occurred, allowing pasture improvement. The stage is set for major changes in husbandry throughout Uganda with implications for other aspects of agriculture if a minimum level of husbandry can be achieved by farmers. The physical factor of climate can no longer be considered a barrier to improved husbandry. It now becomes a question of overcoming the secondary effects of climate by 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. The development policy was 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, 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 35, 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 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.[4] Of the productive traits, selection

4/ 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-thoracic 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 Buganda, Toro and Lango. They are about 20 percent of the population and are used for milk, meat and occasionally for tractive power (75, passim; 99, pp. 298-308).

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 (119). Selection was also attempted for resistance to the tick borne disease, East Coast Fever (ECF).

Research in Uganda and elsewhere has shown that there are 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. For this reason, a policy of partial tick control was initiated on experimental stations to reduce calf mortality and other deleterious effects of heavy tick burdens. Calves were allowed to contract ECF on the assumption that survivors would have a greater genetic resistance to disease and improved stock could be distributed to progressive farmers with less fear of mortality.

As part of the presumed package of available husbandry improvements, the Veterinary Department considered the 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, but the expense of constructing the requisite number of dips to deal with the entire cattle population was not felt to be an economic proposition. 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 (146, 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 (58, 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 it was hoped that new practices once introduced would spread to cattle owners on adjoining farms and in nearby areas. To test 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 (147, p. 12).

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" (22, 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" (148, p. 3; 117, 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 (22, 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 (127, p. 7).

Abruptly in 1958, the tone of the Annual Report began to change and it was concluded that, "the time will no doubt come when tick eradication areas can be scheduled" (128, p. 8). A number of private farmers observed that the regular use of insecticides had permitted farmers in climatically similar areas of Kenya to introduce temperate breeds of exotic cattle to their farms and ranches. However, the Veterinary Department, convinced of the inadvisability of introducing exotic cattle, refused to issue the health and

import permits needed for this importation. Finally in 1959, two farmers persuaded the Department that they had only their own money to lose. Both owned indigenous cattle and by systematically spraying their cattle were able to demonstrate that their enclosed farms were substantially free of ticks. Early importations were restricted to the Channel Island breeds because Jersey and Guernsey were presumed to be more heat tolerant (98, pp. 123-129). These two farmers were followed quickly by others. By 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 climate would quickly prove too extreme for pure-bred 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, selection of indigenous cattle for disease resistance continued until 1966.

By 1959, high grade and purebred exotic cattler were being successfully imported by small scale African farmers in Kyagwe County. The stage had been set 15 years earlier by the Livestock Improvement Area Project which introduced the improved husbandry techniques necessary for the successful introduction of temperate cattle. Farmer educational, self-help and tick control society demanded policy changes and lobbied for tick control legislation. The pressure for more progressive policies came from the bottom up and was prompted by the prospects for profitable milk sales to the newly prosperous coffee farmers and expanding urban population.

The example of yeomen farmers successfully maintaining exotic cattle and "insistent farmer demand for legislation to make tick eradication compulsory," won over even the most "conservative" Veterinarians. By 1960, farmers, principally in the area around Kampala and in parts of Ankole, Toro and Busoga were supporting 324 communal spray centers and an additional 329 individual farmers had private facilities (129, p. 5). But, it should be noted that the hand spraying program had reached less than five percent of the cattle population (see Table 5).

By 1961, the Veterinary Department asked for disease control 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 of 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 (130, 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. 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 (130, 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

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 and Mbarara Livestock Investigation Center, for Ankole, Zebu and Nganda cattle are summarized in Table 8. 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). Ugandan farmers are able to achieve herd averages of 3,500 to 6,400 pounds (1,000-2,960 kilo) per year with temperate breeds--some two to four times those obtained with indigenous breeds (21, p. 50 and Table 9).

The continued selection of local cattle for milk production for the conventional husbandman became to be seen as a "most futile and unrewarding occupation" (69, 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 (133, 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. 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. 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."

The first compulsory tick control area was initiated in Kyagwe County in 1964, about half of Uganda was gazetted for tick control 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 to comply more easily with the new ordinance.

Many factors will determine the eventual success of 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

TABLE 8. MBARARA AND ENTEBBE: MEANS OF PRODUCTIVE TRAITS – ANKOLE, EAST AFRICAN ZEBU AND NGANDA FEMALES

Trait	Ankole[a] (Mbarara)		E.A. Zebu[b] (Mbarara)		Nganda (Entebbe)
	First Lact.	Mature Lact.	First Lact.	Mature Lact.	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 9. 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.

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 sections which follow.

THE EVOLUTION OF THE TICK CONTROL PROJECT

The planning and evaluation of projects of the size and complexity of the Tick Control Project 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 on-going 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.

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.

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 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.

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 vector, 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, 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 I.

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 ticks and as a result, all tick borne disease, the probability of eradicating any species of ticks and any of the diseases except East Coast Fever is remote. The term, disease eradication is more appropriately used to mean solely the eradication of East Coast Fever.

The protagonists for disease eradication argue that the calf mortality resulting from ECF is so high that the added risks and expense of an eradication program are justified for conventional herds. The primary vectors of four major tick borne diseases are present throughout the zones of higher agronomic potential in numbers sufficient to infect most communally grazed animals early in life. The 70-75 percent of the calves which survive are naturally immunized against these diseases. Adults maintain their immunity by periodic re-exposure to infection. A tick eradication program which reduced ticks to low numbers could result in an adult population of animals highly susceptible to all four 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, but losses from ECF could be severe as neither specific drug treatment nor vaccine is available. Should current research to develop an ECF vaccine prove successful, 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 disease when they are least susceptible (and least valuable); and adults through periodic challenge retain their immunity. Any new stock introductions are artificially immunized by vaccination. Under the non-intensive cattle management practices on both ranches and in conventional herds, the returns to disease eradication above the returns to tick control may be slight.

Protagonists of disease eradication 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. 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, (59; 133; and 158). 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 eradication 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 Rhipicephalus appendiculatus tick infected with Theileria parva (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 bound-

aries, particularly if they adjoin communally grazed land or roadways. 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 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 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 favor 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.

Protagonists of disease eradication argue that once disease eradication is achieved, it will be possible to upgrade local cattle with exotic blood through an expanded artificial insemination service. However, climatic data 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 except 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 135, 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 are also highly susceptible to ECF. These include the Kenya Boran and the Asian Sihiwal (110). 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.

The Experience with Tick Control in Eastern Africa

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 (78, p. 70). 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 8, pp. 343-329; 97, pp. 206-214; 167, pp. 126-135).

The reason most often given for scheme failure is the lack of long term cooperation by conventional livestock owners with the program of disease eradication. Owners quickly observe the benefits of controlling ticks. Cattle usually gain weight, their coat becomes less starred and 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.

The improvement in herd performance initially makes the dipping scheme popular and farmers willingly pay part or all of the cost of scheme operation. Problems 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 regularly. Ticks so few in number as to escape detection on casual inspection are sufficient to maintain the races of ticks and to transmit disease. Attendance is less regular when farmers are short of cash before the start of the harvest season and at peak labor periods during the planting and harvesting of food and cash crops. Where herdsmen are employed or herding is the only activity 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 may not be 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 owners.

The approach to owners has been paternalistic and little effort is made to involve them in the planning and operation of the centers. 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), (152). However, as most other veterinary services are provided free compulsory fees are regarded as a tax on cattle.

In addition, 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 scheme development is to minimize the Government capital 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 the physiological and labor costs of moving cattle long distances on foot high.

Schemes failed 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 Tables 20 and 21), 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 (167, p. 126).

Prior Experience with Tick Control in Uganda

An earlier section 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; with part of the package, partial tick control. Owners were encouraged to spray their cattle, using inexpensive hand operated pumps. 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. After 20 years of promoting hand spraying less than five percent of the national herd was under even periodic tick control. However, some hand spraying centers are still in operation. 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 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.

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. There were an estimated 3,200 functional centers in July 1969. However, a Veterinary Department survey team reported that they were very poorly attended and that junior staff exaggerated the numbers of cattle using the centers (137).

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

Kyagwe County Pilot Disease Eradication Scheme 5/

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), with a cattle population in 1966 of 55,000 head, indicating a rather dispersed population of one animal per 12 acres (53 per sq. mile). It was considered to be sufficiently well isolated to attempt disease eradication. For various reasons, including the rather large number of functioning hand spray crushes, owners in this area were considered to be more economically oriented. 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 continuous cultivation on better soils make it difficult to move 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 (151, 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. In 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. The proposed fee was Shs. 0.25 per head per week or Shs. 13.00 per year ($1.85) (152, 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

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.

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. For a detailed description and discussion of the advantages and disadvantages of various types of tick control equipment and techniques used worldwide, see 7 and 92 and in Southern and Eastern Africa see 13, pp. 88-91; 40, and 76, pp. 93-101.

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.

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 (161).

Fees vary to reflect local costs and services offered, and to some extent, operating costs are reduced by community labor. The local societies are being grouped into central unions which are assuming 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.

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. 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.

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, exclusive of the amortization of the capital and development costs, is estimated to be roughly Shs. 10.00 per head per year. Costs in Kyagwe County are comparable or slightly below those experienced in Kenya, or 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 17). 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. 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.

Control Versus Eradication -- A Summary View

The long term objective of the Uganda Tick Control Project is the eradication of all tick borne diseases from Uganda. The immediate 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 during the next decade.

To achieve disease eradication, the compliance of all cattle owners is required for a considerable period of time 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. On the other hand, under a tick control program, weekly participation need not be compulsory and fees can be correspondingly less. 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 will improve in the near future. To keep costs to owners low and to avoid compulsion requires careful planning and implementation.

A tick control program which has as its objective the eradication of East Coast Fever, has been described as "technically very feasible but practically very difficult" (78, p. 20). 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 in the national project will depend in large part on the cost of the program in relation to profitability of the two alternatives to the conventional husbandmen.

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. Cost estimates for the purpose of loan or grant applications reflect the requirements of the potential donors rather than those of the Project, and the benefit projections were 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

Both the World Bank and FAO encouraged an expansion of the Tick Control Project, and were approached for assistance with the program. The Ministry of Animal Industry first prepared an extremely ambitious budget for a World

Bank-International Development Association (IDA) loan (134). It called for the construction of 1800 dip center (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, was Shs. 180 million ($25 million), or some sixty times the amount budgeted in the Development Plan. Development cost was projected at Shs. 100,000 per center (Shs. 50 per animal) or 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 the cost of the Kyagwe County project. The budget did not include the operating costs of the mechanical equipment of the long term cost of financing the loan. In this first loan application, 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 was not approved by the Bank or by the 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 (51, 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.

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 3). 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, making them good sites for disease eradication trials. The 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 Maguga, Kenya, is part of this project.

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. 26,000 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.

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.

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 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. 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 Ankole 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 later.

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.

The Department, wishing to encourage society formation, further modified the aid formula and reduced the financial contribution of societies 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. 7/

On site development costs were divided roughly 50:50 between the society and the Department. Items which in some areas could be provided by communal labor -- stone, sand, water supplies and unskilled labor -- were to be supplied by society members as a method of reducing costs through cooperative action. In practice communal labor proved extremely difficult to organize and was unfamiliar with construction prodcedures. Also, stone and sand of construction quality are seldom available locally and their cost highly variable depending on transportation costs to the work site. As a result, the total cost of dip construction varied between Shs. 7,000-13,000 (Table II).

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

7/ 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 have too often been lacking from the present program, adding an unquantifiable hidden development cost.

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 a minimum of 1,500 head of cattle with some servicing 3,000-4,000 head. The owners' contribution to construction costs is therefore 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 several respects. First, the area approach has been abandoned. Centers are built only where sufficient owner support can be generated. 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. The supervision of existing centers was originally the responsibility of regular Veterinary staff as an addition to their other duties. A special tick control section with its own staff is being established (55, p. 28). It must be noted that serious problems are being encountered at many centers because it is impossible 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 (133, 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, the Ministry of Animal Industry was unable to acquire funds from central Government to complete the Project. 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 international sources and 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 attractive to foreign donors. In the latter half of 1968 an approach was made to the Oxford Famine Relief Committee for a grant. OXFAM considered this Project to be highly compatible with its objectives of assisting rural persons through self-help projects to raise their levels of income and welfare. OXFAM made a preliminary grant of U. K. £13,125 (Shs. 225,000; $36,750) which was sufficient to provide a Shs. 5,600 construction subsidy for each of 40 centers within predesignated subproject areas (135).

Those areas chosen were Dokolo County, Lango, and Kabermaido County, Teso, counties contiguous to the proposed UNSF subproject (County Nos. 58 and 78, Map 3). 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. Two projects of the Ministry of Animal Industry were approved for financing under the loan. One totalling U. K. £197,300 (Shs. 3,380,000) was to finance purchase of tsetse clearing equipment. The second, totalling U. K. £ 412, 500 (Shs. 7,071,488), was to support the Uganda Tick Control Project. Loans to projects sponsored by the Mininstry 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 was thought 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 (136, p. 2).

The budget prepared in support of the loan request and accompanying statement of the economic benefits illustrate the comparative inexpertness of the Ministry of Animal Industry in preparing loan requests and the tendency to modify local programs to meet the specifications of the lending agency. Under the proposed budget, societies are expected to contribute roughly 43 percent of the on site capital costs, with the loan providing the remaining 57 percent. The Uganda Government was 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 (see Table 10). To comply with the loan specifications, construction was initially scheduled for completion over a three year period, a construction rate will be beyond the

capacity of the Department to organize and implement. 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 agreed to a more realistic implementation schedule of five years. It 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 loan gave the Ministry sufficient funds to complete construction of a major share of the required dip centers. Financial bottlenecks remained in financing water developments 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 $4,700,000 (Shs. 33,558,-000). The loan, entirely ear-marked for the Ministry of Animal Industry, is to assist in financing the foreign exchange and local costs of programs to increase the production of beef and dairy products in Uganda. Roughly 19 percent of the loan package (Shs. 6.3 million) was to finance the expansion of the Kyagwe County pilot project area. This 40 year loan, carries an interest rate of 2.5 percent after a 10 year grace period. The entire projected capital development budget of the subproject was to be financed by USAID contributions. Staffing requirements and recurrent costs, were 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 in the areas are expected to contribute roughly Shs. 6,000 toward the cost of construction.

The subproject area, an extension of the Kyagwe County disease eradication area, provides for the construction of 70 dips and 10 less expensive centers in the adjoining counties of Bugwere and Buruli (County Numbers 40 and 42, Map 3). 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 were later included.

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 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

In various project statements, prepared by or for the Ministry, 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, to budget development costs of the Project, it is first necessary to establish an estimate of the cost per center and pro-rated costs of the required support infrastructure. This was done for the most part by bringing together in a revised budget the various cost items from earlier budgets. This revised estimate is compared with the per center costs of the Kyagwe extension and from the UK-ODM Loan in Table 10.

Some essential items were omitted from the UK-OKM budget, including support facilities and water development costs resulting in a cost underestimate of roughly Shs. 18,000 per center.

The budget prepared by USAID exceeds the revised budget by almost Shs. 12,000 per center. The principal cause of this difference in the importation of certain items from the United States, particularly prefabricated buildings at costs well above the local supply price. Centers financed by USAID will cost the Government more than Shs. 8,000 in foreign exchange costs, above those constructed with 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.

Before projecting the capital development costs of the Project, attention must be given to the numbers of centers required, appropriate phasing of development and recurrent costs.

TABLE 10. 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 Laboratories	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 (152).
b. Source of estimate (136).
c. Estimated from best available local and Dept. Vet. Ser. sources.
d. Imported prefabricated buildings.
e. Prorated cost of vehicles imported.
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 cost estimate f. 80,000 cubic feet capacity valley tank, (153).

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. In the 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. Because the stated goal of East Coast Fever eradication is not likely to be achieved except in unique local areas and because most of the benefits of disease eradication for conventional producers can be obtained from a more modest tick control program, costs (and in the following section, 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 the blanket loan applications, 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.[8] 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 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 Table 11).

8/ 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.

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 trucked 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 Table 11).

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 Veterinary Services now recognizes that one center per 1,000 head may be required for the Tick Control Project (133, 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 was estimated for each county. Data are summarized by district in Table 12. The revised estimate suggests that 2,154 centers are required with the average center serving 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 or less will require the construction of not less than 4,500 centers.

The revised capital budget provides for the construction of only 215 cen-

TABLE 11. 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

ters per year, phasing the Project over the second and third plan period. This goal has been adopted by the Department of Veterinary Services (133, p. 42). At this rate it will be possible to complete the entire construction program by the end of the third plan period. 9/

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 12). 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 and streams, which are unsatisfactory as dip sites and, it will be necessary to develop additional permanent water supplies. In most cases small to moderate size valley tanks can 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. 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 of the cost should be charged to tick control. Any allocation of costs without an extensive study to determine those sites which require water and the benefits of the new water supply to the cattle population is by necessity arbitrary. 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 80,000 cubic foot tank size has been used although in some areas it may be desirable to construct larger tanks (see 153 for size and cost estimates).

Recurrent Costs

In projecting recurrent and total capital costs, it is assumed that the

9/ For the purpose of projecting the impact of tick control, it has been assumed that all cattle will be included under 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.

TABLE 12. 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.

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.

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" (144, 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 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. Nevertheless, 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 13. 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	1,000
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 outside the willingness or ability of society members to pay on a regular basis.

The projected recurrent cost of societies and the average cost of service to members per head of cattle served over the period 1969/70-1980/81 is summarized in Table III. 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 14. 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 (Laboratory)	50
Total Cost	2,610

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 Table IV. 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. The number of full time officers and junior staff required to adequately implement the Project are indicated in Table IV.

Projected Capital Development Costs

The projected budget for capital expenditure and the accumulated value of

TABLE 13. 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 year	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 10.

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.

TABLE 14. 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 14. (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 scheme are given in Table V. 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.

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 V. 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 capital repayment and interest costs for investments projected during the second and third plan periods will continue through 1996 but will decline as an annual cost item following 1980/81.

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 15. 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 16. 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.

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 purpose 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

TABLE 15. 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 III and those for Government from Table IV. Capital costs per center summarized from Table V.

TABLE 16. 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 III. Government capital development budget from Table V. Recurrent support budget from Table IV and debt repayment and interest budget from Table VI.

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 17. 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. 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 (111, pp. 250-255). However, during the years partial tick control was in effect (1947-1966), calf mortality in Zebu herds averaged 22 percent (115, p. 6). Mortality was only fractionally less than in the Ongino and 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 (131, p. 24). 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 (80). 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.

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 (8, 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.

TABLE 17. 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				
Kyagwe County, Buganda	1966	19.1	Partial control by hand spraying	2
" " "	1966	9.2	Mechanized power spraying Kyagwe County subproject	
Entebbe Vet. Res. Sta.	1962	100.0	Guernsey males (5)	39 pp. 289–298
	1962	55.8	Jersey/Nganda crosses (43)	
	1962	8.3	Nganda (12)	
Land Resource, Zone III and IV				
Serere Agr. Station	1947–51	7.7	(All partial tick control) Free range calves	111 pp. 250–255
	1947–51		Semi-ranged calves	
	1952–56	19.1	" " "	
	1952–56	23.8	Bucket fed calves	
	1943–63	20.7	All cattle	115
	1958–63	82.0	Pure Boran	
	1958–63	40.0	Boran–Zebu crosses	
Ongino, Leprosy Center Farm, Teso	Pre–1963	25.7	Semi-ranged, no tick control)	34
	Post–1963	3.3	Semi-ranged, full tick control)	
Owner Opinion Poll, Serere and Kyoga Counties	1969	37.7	Average estimate, 14 farmers	33

TABLE 17. (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	14 p. 71
Land Resource, Zone V. Mbarara Stock Farm		42.0	Ankole and Ankole/Boran	131 p. 24
Ankole Land Use Unit	early 1960's	21.1	Female calves only)	161 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)	8 pp. 343,357
Bungoma area	"	29.0	)	
Lela	"	7.4	2.5 yrs. post tick control)	
Bungoma	"	8.8	Bi-weekly dipping)	

One other inclusion in Table 17 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 families in Ankole 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 milked 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 (21, 84, and 155). 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 18, column A). This estimated yield would be 65-85 percent of average lactation yields obtained in experimental herds (see Table 3).

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.

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 (14, 20, 21, 82, 155). The estimate which has been used here is

that 65 percent of the cows (including first calf heifers) begin lactations each year.10/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 18, 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. These records indicate that the calving 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 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 18, 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 19. 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

10/ 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.

TABLE 18. 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.

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 19 are as follows:

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, 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, 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, a wider range of productivity factors must be taken into consideration.

The pre tick control situation in the eastern ox-cultivation area consistent with the cattle census data is given in Table 20 Column A. Assumptions include a 65 percent calving rate and a 30 percent calf mortality. It is also 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). 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/beef operation with improved pasture but which continues to use indigenous cattle.

The annual cattle sales, an imputed value of surplus milk, total herd income and income per cow and per head were estimated. Because of the restriction on cattle numbers, the composition of the herd changes markedly

TABLE 19. 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.

TABLE 19. (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 23).

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 18) and values milk at national average price of roughly Shs. 0.60 per liter.

TABLE 20. 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 31, 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 18.

as calf mortality declines. Herds contain fewer cows but larger numbers of immature stock. The more significant factors are the following:

	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 Table 21. 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 are the following:

	Western Dairy Grazing Area		
	Pre Control	Post Control	Ankole Ranches
	A	B	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 con-

TABLE 21. 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 31, 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.

tinued 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.

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 section 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.

Beef Supply and Consumption

Beef Production on Ranching Schemes, 1967-1975

Large scale beef production units are a recent phenomenon as European settlers had been almost entirely excluded from Uganda. However, 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 (50, p. 115; 150).

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 3). 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 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 22.

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 a "second generation" of schemes are planned, the surplus cattle sales from schemes probably may not exceed 15 percent for may years. 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 I. 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 and export trade.

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

TABLE 22. 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.

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 beef exports. 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 Uganda Meat Packers, Ltd. has imported as many as 10,000 cattle from Kenya and Tanzania for re-export.

After converting all imports and exports to beef (flesh) equivalent, for the years 1962-1966, between 500 and 1,700 cattle were imported annually. In 1967, exports exceeded 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 (141, Chapter I).

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 the modern sector in order to arrive at an estimate of the beef supply.

The beef supply for 1967/68 has been estimated from estimates of the total cattle population, the extraction rate and the pounds of meat equivalent from each animal marketed. An estimate of the average yield of meat equivalent per carcass from conventional and the modern sector is contained in Table 23. With adjustments for meat exports and the interregional movement of cattle, an estimate of the current availability of beef by region is included in Table 24.

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.

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 this estimate includes meat salvaged and consumed at farm level. The meat actually entering the market trade and sold for cash would be somewhat less.

Beef Production, 1967-1981

Earlier sections provide a basis for projecting the impact of the Tick

TABLE 23. 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 24. UGANDA: ESTIMATED PER CAPITA MEAT AVAILABILITY, 1967/68

Region	A	B	C	D	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	Per Capita Availability H+A
	Millions		%	(Thousands)			(lbs.)	(Million 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 (141, Chapter I).

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.

Three alternate estimates of the meat equivalent production from conventional herds over the period 1967/68-1980/81 which reflect the phased improvement in the extraction rate in the Tick Control Project and the estimated meat equivalent production from enclosed dairy farms and ranches are summarized in Table 25. 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, 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 differs from the second 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 meat production 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 overall outlook for expanded production is excellent because of the expected control of tick borne disease 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 realized, 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.

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.

TABLE 25. 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	247	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.

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

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 (141). This estimate is shown in Table 26. 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 Committee predicted 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 reaching 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.

Three alternate indices of the future domestic demand for beef are contained in Table 27. 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 and demand projections, 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 rise in the price of beef can be expected with the price rise accelerating as the limit to the fish supply is reached.

The estimated beef production and per capita availability of beef at the end of each of the plan periods is given in Table 28. In the median projection the beef supply will increase by roughly 4 percent per year, but 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, and the price of beef almost certainly will continue to rise. Therefore, any development project which expands meat production is unlikely to face falling meat prices. On the other hand, without the projected impact of tick control on meat supply, a substantial increase in consumer prices will quite likely occur.

TABLE 26. 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	6.2
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.

TABLE 27: 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 25.

TABLE 28. UGANDA: ESTIMATED TOTAL BEEF PRODUCTION AND PER CAPITA AVAILABILITY OF BEEF
1969/70 – 1970/71 – 1975/76 – 1980/81*

	Beef 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 Table 25. Estimated population growth rate 2.9 percent per year.

EXPANSION OF CONVENTIONAL AND COMMERCIAL MILK PRODUCTION 11/

Commercial Milk Production

The first real impetus to develop commercial milk production dates 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. 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 (47, passim; 48, passim).

As demand grew milk prices doubled and later tripled.12/ 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, 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 did not keep pace with demand and fresh milk was imported from the European estates in Kenya. 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 search for 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 29. 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 (82, p. 7). This represents roughly 10,000 producing dairy cows of cross breed or pure exotic breeding.

11/ 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.

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

TABLE 29. 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.

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.

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. 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 by the Uganda Dairy Industry Corporation (UDIC). 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 in small, one to four gallon containers. Milk is transported by bicycle up to twenty miles without prior cooling. Consequently, quality is low and rejection of milk at the center is common. 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 29. 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.

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 straight forward 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. 13/

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

13/ 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.

for the analysis with the following estimated cost of production per liter (83, 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

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 crossbred cattle are still decidedly profitable.

These cost and profitability estimates are supported by several smaller surveys conducted by Makerere students in 1969 (61; 169) and by a hypothetical budget projection for a 45 cow, 45 acre dairy farm for the Kampala area (95). 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 (42; 109). 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		
	Per gallon Shs.	Per Liter Shs.	Per 100 lbs. U.S. $
Kampala	4.00	.85	5.41
Mbarara	3.10	.65	4.19
Port Portal	3.10	.65	4.19
Serere	2.85	.60	3.85

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 (11, p. 42).

For many reasons including the favorable profit position, 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 30). 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 except in outlying areas.

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 (Table 29). In this period, when imports of milk were for the most part unrestricted and the supply deficit had been overcome, 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 30. 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). 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.

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 cow population are available. The 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 18, 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	x65%
Number of lactations	1,000,000 (per lactation, per year)
Milk yield to the farmer [a]	
Per lactation	61.5 (gallons), 280 (liters)
Per annum	40.0 (gallons), 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.

TABLE 30. 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.

This rough calculation would estimate conventional milk production in 1968 at about 62 million gallons (280 million liters) per year. 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, and an annual milk yield per cow of 540 gallons (37, 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 (Table 32).

Milk Consumption and Future Milk Supply to 1981

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 31. 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.

The combined projections of milk production from conventional and commercial producers are given in Table 32. 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.

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.

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

TABLE 31. 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 1969	Annual Availability per Capita Liters	Consumption per Day Grams	Consumption 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.

b. Includes both fluid milk imported from Kenya and milk produced locally by exotic cattle and their crosses (see Table 29).

TABLE 32. UGANDA: PROJECTED MILK PRODUCTION, CONVENTIONAL AND COMMERCIAL PRODUCERS, 1968/69–1978/79

Year	Millions of Liters			
	Conventional Milk Production	Commercial Milk Production	Total Milk Production	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

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 (29, 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. Only if these claims are valid can the expected expansion in production 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 earlier 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

If a substantial expansion in production per animal is to occur, the Project must make it possible for many more 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 eradication is possible is occurring only in climatic zones particularly suited to temperate breeds, where a few farmers have been able to take advantage of a period of high milk prices. 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 (58, pp. 116-119 and 86, pp. 167-171). Data 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 should 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.

Enclosure is even less profitable in 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 the Western area 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.

Two other financial benefits mentioned in conjunction with the Project require comment. The value of hides exported from Uganda in 1969, a year of average prices and export levels, was Shs. 8.2 million (133, p. 22). A generous guess would be that a 10 percent improvement in hide values will occur as a result of the Project.[14] 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 due to larger, more healthy cattle and the expansion of hectarage under cultivation. However, it did not prove possible to estimate these benefits.

Added financial cost to the livestock owner from Tick Control not directly included in the analysis 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 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 plunge 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 labor 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.

While the control of tick induced disease losses is a necessary step in improving animal production, 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 further expenditures on research and extension.

14/ 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 (93; 102, 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.

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 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 (11, pp. 40-49). Although this Project will play only a minor role in increasing supplies of quality meat and milk, it will help to reduce importations and will restrain any major increase in the price of meat. The prospects for exportations in quantity are remote.

Development projects, even when chosen for their potential for import substitution or export generation, require expenditures of foreign exchange in their implementation. The Tick Control Project will be 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 Table III). 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. Other import requirements will be 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 VII. The estimated increase in farm and national income is summarized in Table 33. Exante 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. 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 33.

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 33. 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.

TABLE 33. 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 VII. Cost projections from Tables III, IV and V.

TABLE 34. 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 Table 28, and projections of milk production from Table 32. Meat and milk prices are weighted averages of the value of conventional and modern production.

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 34). 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 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. Production research sponsored by Veterinary Departments is almost exclusively oriented toward 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 been presumed to represent the quickest method 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 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 Ministry of Animal Industry's recurrent expenditure budget for 1968/69, totalled Shs. 29.7 million but allocated only Shs. 2.6 million for extension activities and development scheme supervision. This item which includes acaricide subsidies, will need to be substantially increased in future budgets. 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 the role of livestock in development is encouraged by the division of responsibility for agricultural development between ministries for animal industry, agriculture and agricultural marketing. In Uganda, the Ministry of Agriculture with a much larger establishment

than the Ministry of Animal Industry, has had a substantial extensive extension education program for conventional farmers. Because of its mandated concern for all farmers who cultivate crops, it has taken a broader view of livestock development and has had programs to encourage ox-cultivation and research stations under its administration are conducting research on fodder crops, pasture/crop rotation and ox drawn equipment suited for the use of conventional husbandmen (see for examples: 18; 43; 44; 57; 106; 107; 112; 113; and 114). These are areas of research which have been largely neglected by the Ministry of Animal Industry.

The land resource which makes livestock development attractive--fertile soils, well distributed and reliable rainfall and the like--also makes most zones suited for a 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 systems. 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. 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.

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. 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 improvement 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. 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 of area development plan. This 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. 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 Role 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.

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 ex novo of a new order. 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 I

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 in the tropics 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. 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. Ticks and tick bites are also implicated in the spread of spirochaetosis and streptotricosis which affect the value of hides (93, passim; 102, 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 productivity as the elimination of the diseases which they carry (25, 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 (81, passim).

The causal agent of East Coast Fever is Theileria parva, a haemo protozoal infection in cattle.2/ Calf mortality in East Coast Fever 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 17). However, the bite of a single infected Rhipicephalus appendiculatus tick is sufficient to

1/ For a more complete discussion of cattle ticks and tick borne disease in East Africa, see 25, 40, 81, 154, and 168.

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 it is known as Corridor Disease. Its relation to T. parva is in dispute (9, pp. 361-408; 77, pp. 93-101).

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 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.

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 (46, 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 (80). 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 Acholi 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 (78). 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.

Appendix II

STATISTICAL APPENDIX

TABLE I. 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.

TABLE II. 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 5" @ –/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 all 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

TABLE II. (cont'd.)

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 III. 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 Contributi n 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 2.2 percent per annum.
Column B. Estimate share of cattle population in project.
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 IV. 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 III. Staff requirements based on experience in Kyagwe C. Government recurrent budget projected at an average cost of Shs. 2,610 per center in operation. Cost per head estimated by dividing Government recurrent budget by cattle served.

TABLE V. 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
	(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.

TABLE V. (cont'd.)

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 VI. 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 V. 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 VII. 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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