ECONOMICS OF WATER DEVELOPMENT ON GOVERNMENT LANDS IN SOUTHERN AND SOUTHEASTERN ETHIOPIA

by

Gebrehiwet Zere

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After inspection of the final copy of the dissertation, the following members of the Final Examination Committee concur in its approval and recommend its acceptance:*

William N. Hall	May 23, 1973
Gilbert L. Jordan	May 24, 1973
David A. King	May 25, 1973
Drew D. McGinty	May 25, 1973

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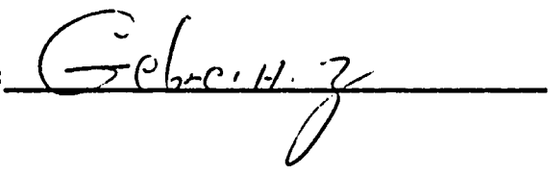
SIGNED: 

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ABSTRACT

A regional range development project has been established in southern and southeastern Ethiopia, and the planning area has been jointly studied by the Imperial Ethiopian Government and the United States Agency for International Development (USAID). I have been associated with both the feasibility studies and the actual implementation of the program from 1965 to 1969, and this experience with the project provided data for this dissertation.

The area is inhabited by different ethnic groups who are almost all nomadic and have a subsistence life based on production of various classes of livestock. They have great variability in customs, religions, social and cultural beliefs, and languages.

Excellent beef cattle are indigenous to the region, but there are many current cattle production and management problems in southern and southeastern Ethiopia. Among the most critical problems are diseases, poor nutrition, and lack of organized marketing.

Lack of water is also a limiting factor; it causes shortage of roughage, lack of proper nutrition, retarded reproduction, high mortality, especially among young individuals, lack of surplus animals for market, and no contribution to national revenue.

To solve some of the existing problems, the Imperial Ethiopian Government initiated a water development program in the early 1960's, but because of the type of planning, there was very little economic

benefit from the investment for range water development. There were no real defined objectives other than the provision of water to cattle with no management and maintenance once the initial construction was done.

Water development in combination with veterinary service to solve the water shortage and disease problems was analyzed in this dissertation. Objectives were: to describe the existing physical, social, and cultural conditions in southern and southeastern Ethiopia; to analyze the economics of veterinary services and water development with and without management; and to discuss management and social changes necessary to insure that water development accomplishes desirable economic and social changes.

Three development alternatives were considered and analyzed. The three alternatives were: mobile veterinary service, mobile veterinary service plus water development, and mobile veterinary service plus water development and management.

A rate-of-return analysis was used in evaluating the economics of the development alternatives. Each alternative was analyzed for four different grazing capacities and six different percentage increases in sales each 5 years in addition to the basic 3% annual sale that now exists. Thus, 72 different sets of rates of return data were obtained.

Under no circumstance should the planning rangeland be exploited and mismanaged through overgrazing and other improper management practices. With capital resources in short supply and long

planning periods, exploitation of available range resources was not considered as an appropriate alternative.

Rates of return greater than the 4% to meet the Government's return on investment would indicate the presence of net income to achieve social, cultural, and economic changes among producers in the planning area. At 4%, the Government will recover the money invested for development, but the producers may not gain from the investment.

Based on an economic analysis of each of the three development alternatives, the best alternative satisfying the objectives as outlined in this dissertation would be the development with management alternative. With 2560 animal units per year per management unit grazing capacity, and with a 4% increase in animal sales each 5 years, desired objectives would be met.

Based on the economic analyses made in this dissertation and if specific livestock sale goals are met in the early years of a project, a suitable annual payment scheme to recover development and maintenance costs while still providing economic incentives to producers could be formulated.

INTRODUCTION

The Imperial Ethiopian Government and the United States Agency for International Development (USAID) have jointly agreed to improve economic conditions in southern and southeastern Ethiopia. Improving livestock production and management is the first step in developing this area of Ethiopia, now dominated by nomadic people depending on livestock production for their livelihood, and adequate water supplies are essential to the development of the livestock industry. This dissertation deals with analyses of water development programs for improving livestock production in southern and southeastern Ethiopia.

Proper development of water will help to achieve full employment through optimum use of land, forage, livestock, and human resources, but developing countries also require social and cultural changes as well as economic growth. Qualitative transformations are required before technological processes can be put into practice. These qualitative changes are necessary to stimulate demand for better livestock production, better management, and proper utilization of range lands.

Following the development of water resources, the key to range management is the development of grazing systems and proper range utilization. Avoiding undue grazing pressure at any time or season of the year becomes extremely essential.

Because of limited financial and human resources, it is to the best interest of Ethiopia to devote time to considerable economic analyses prior to investment. A reasonable working plan must be carried out within the government's resources. The process of planning is especially difficult in developing countries because of a greater number of uncertainties, the absence of precedents, and the need for concurrent social and cultural changes. With these problems and difficulties in mind, the objectives of this dissertation are related to the planning process as a model procedure. Complete analysis of a project plan would be an important tool to establish policy and to guide decision makers in the allocation of resources.

Objectives

The objectives of this dissertation are to:

1. Describe existing physical and cultural conditions and management practices in southern and southeastern Ethiopia which influence economic and social growth and act as constraints to development programs.

2. Analyze water development with and without grazing management to determine economic implications.

3. Discuss management and social changes necessary to insure that water developments accomplish desirable economic and social changes.

Justifications

In most developing nations, almost all major development programs are carried out by the governments concerned. Usually governments have access to a large number of resources for effective development plans, but demands for financing exceed funds. Evaluation of returns expected for funds expended is necessary to make efficient use of available capital. Investment, however, need not always be justified on political, social, or humanitarian reasons, i.e., to attain certain social values. All of these elements play a great role in a nation's committed expenditure, and the provision of water development is no exception. The Ethiopian Government desires to make the best economical use of the vast rangeland in southern and southeastern Ethiopia and bring about social and structural changes.

Several important factors have led the Government to select this particular region of the Empire for livestock production rather than for other uses. These are:

1. Land resource is vast and in government ownership.

2. Livestock production has been the best alternative use of the range resource up to now, and the best beef animals are found in this region.

3. The capital required for development appears to be reasonable.

4. Most important of all is that the people in this region need economic and social development.

Southern and southeastern Ethiopia have most of the essential ingredients needed for range livestock production. Among the important and needed factors of production, about three-fourths are available locally.

An investment in water development will relieve pressure on existing overstocked range lands, will help to create a uniform livestock distribution for better range utilization, will reduce the time livestock spend traveling to water sites, and will increase grazing time to produce better conditioned beef animals for market.

BACKGROUND INFORMATION AND REVIEW OF LITERATURE

A preliminary study of conditions in southern and southeastern Ethiopia was conducted in 1957 (Church, Poppe, and Sandford 1957). Prior to this study, the livestock industry in the planning area had not been considered as a major contributor to the nation's economic growth and development. This preliminary study was highly favored by the Government and a considerable amount of money was allocated for a subsequent intensive study. An intensive livestock survey was carried on in 1961 and 1962 (Imperial Ethiopian Government Ministry of Agriculture 1962) which provided considerable information on critical problems needing immediate action. Some of the major obstacles to economic growth and development are the lack of water, animal diseases, poor nutrition, and marketing difficulties (Imperial Ethiopian Government Ministry of Agriculture 1964). In 1965, the Imperial Ethiopian Government and USAID initiated a range development project for southern and southeastern Ethiopia. The Imperial Ethiopian Government also has given priorities and allocated financial resources to improve commercial beef production through better production and management methods, disease control, and more efficient marketing systems (Imperial Ethiopian Government Ministry of Agriculture 1968).

The Imperial Ethiopian Government Ministry of Agriculture has established two livestock improvement centers about 190 kilometers south of Addis Abeba. These two farms are government owned, sponsored,

financed, and operated. One of the improvement centers is an experiment station dealing primarily with herd breeding and improvement by selection and upgrading. The 4,380-acre research center is completely fenced on the perimeter and cross fenced to form paddocks. All paddocks are provided with water from a nearby permanent lake. The aim is to test the performance of the Boran beef animals on rangeland to achieve the maximum performance without going into an expensive operation. The second farm is a commercial ranching enterprise on 10,600 acres of land. The objective is to test the Boran breed of beef animals, and the same general setup exists as for the previously discussed experiment station with respect to fencing, water supply systems, and paddocks but on a larger scale.

These two farms are provided with adequate water supplies and veterinary services. The water development systems used for these farms is "the hydram system," unique and expensive, but very dependable during drought periods. Salt and steamed bone meal are provided free choice to cattle. The improvements made from the investment on these two farms have served to encourage the government to invest more for range improvement and develop the livestock industry.

The results obtained from the two government farms were considered successful in the following aspects. (1) The range's carying capacity has improved from a low carrying capacity to a current 5 to 8 acres/animal unit/year. (2) Calf crop has increased from 60% to 80%. (3) Mortality rate has been reduced to less than 10%. (4) Improved beef quality is produced from the range. (5) Increased quantity of

animals produced on farms is available for market. (6) An improved price is received per animal sold because of the quality produced. These advantages have been achieved through proper range and livestock management.

But, unlike the range development plans discussed in this dissertation, these farms have considerable initial cost for perimeter and cross fencing and provision of water to each paddock through pipelines from a permanent lake and central reservoirs. The area developed under these two research centers is approximately 15,000 acres, and, in addition to the above mentioned costs, the government has provided minimum housing facilities to farm employees. Therefore, the total overhead cost of these farms is much higher than is planned for the rangeland.

In the general area just adjacent to the above discussed farms, a range development program was established in 1968 by the Imperial Ethiopian Ministry of Agriculture with exactly the same goals and purposes to be achieved as outlined in this dissertation. I worked with this project and comments here are based on my experience. The total range area developed is approximately 60,000 acres used by the public on government owned rangelands. The condition of the range prior to development was extremely variable, mostly poor. Extreme seasonal and annual fluctuations caused considerable production and management problems. A considerable amount of money was allocated to develop this rangeland in the Rift Valley with the major investment on water development and boundary clearance so that management could be efficient.

Because of heavy livestock concentration over the small rangeland area and because of the communal grazing system, there was much concern over a possible disease outbreak and economic losses. The increase in livestock within a short time following water development was due to the migration of cattle from the surrounding cultivated farm lands. Providing water for range livestock in this area has shown an immediate unfavorable effect on the range condition because the management organization was not ready to handle the situation. Within a year and a half, there was considerable range deterioration around the watering places; the pressure on the range area was obvious and building up.

I have also observed a high concentration of livestock accumulated near watering points in Borena during a critically dry period in 1967-1968. An estimated concentration of livestock watering from one huge pond was 8,000 to 10,000 animals for a period of approximately three months. There was a concern on the part of the government that a disease outbreak might erupt at that particular time, but fortunately the veterinary service was efficient and there was no serious disease problem.

In areas where the government is not in a position to manage developed rangelands adequately, the provision of water and veterinary services may have an unfavorable effect on rangelands. The people who are receiving the services and benefits must be educated and considered important in the planning and development phase of a project.

Planning Area

The planning area for range improvement in southern and southeastern Ethiopia is well defined by naturally formed drainages and international boundaries (Figure 1). The main boundaries for the planning area are:

Northeast - Genale River starting from the northern high encarpments flowing eastward.

West - Segen River within Rift Valley flowing to Lake Rudolf.

Southeast - An international boundary between Ethiopia and Somalia.

South - An international boundary between Ethiopia and Kenya.

North - An uneven boundary because some private lands are scattered among the Government owned and publicly used rangelands.

Within these boundaries lies one of Africa's best rangeland areas, with exceptionally high potential for livestock production.

An initial investment in water development in the area was made from 1962 to 1965, mainly on the southeastern part of the province of Sidamo (Figure 1). Loan money at that time was made available to the Imperial Ethiopian Government Ministry of Agriculture to develop the livestock industry through the provision of water. The idea was welcomed by the Ministry of Agriculture, but implementation was handicapped by lack of technically qualified personnel and well organized construction crews and equipment. The alternative was to pass the money and development responsibilities to another government agency. This was the Ministry of Public Works, Water Resources Department.

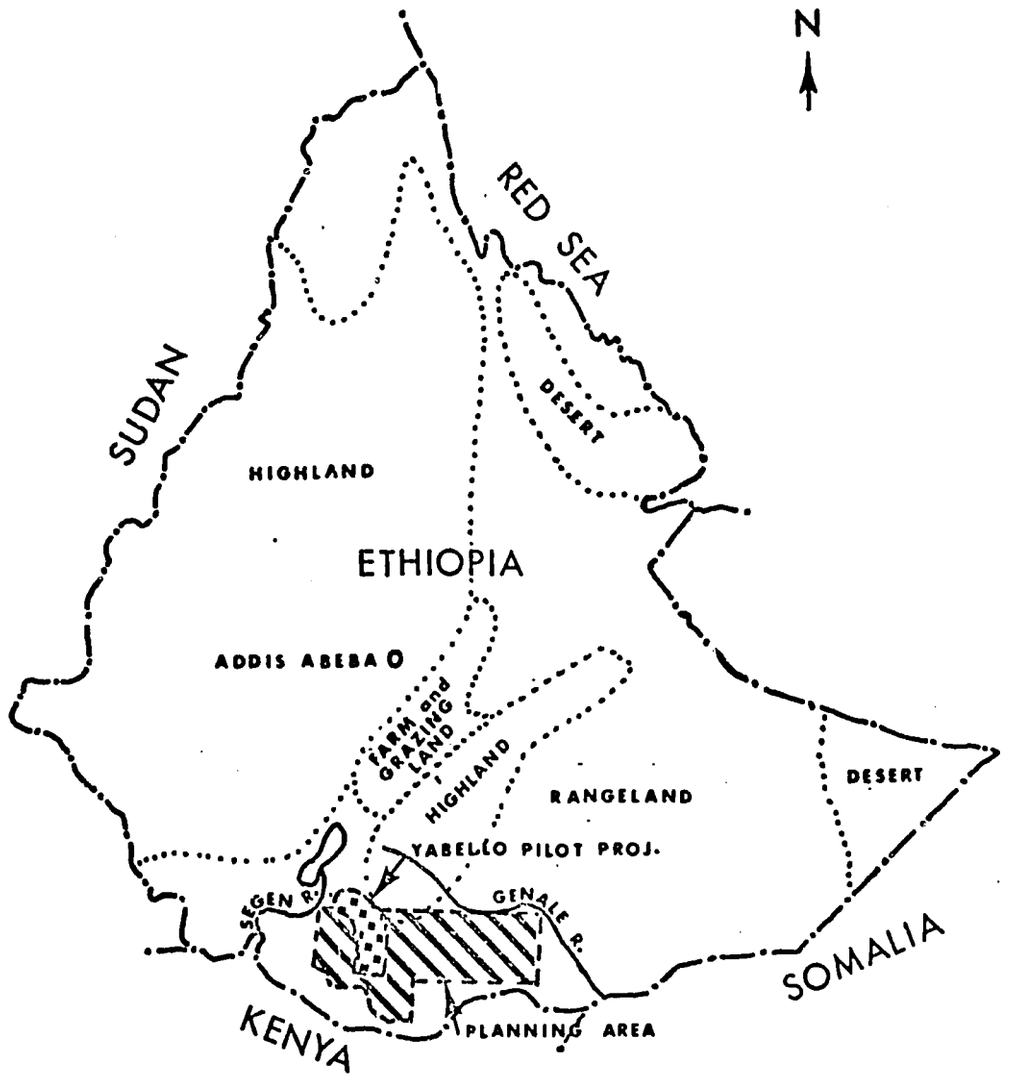

Figure 1. Rangelands and range improvement planning area locations in Ethiopia.

The Ministry of Agriculture had very little to do with the entire construction and development of the area during this period. Ponds were constructed here and there with no effective range development plan. As a matter of fact, there was no defined objective and goal other than the provision of water to nomadic people.

In 1965, the water development project was revised and two 800-square mile project areas were proposed for development as a joint effort between the USAID and the Ethiopian Government (Fischer 1968). Based on the experiences of the past, a new approach to range development was started. This time the Ministry of Agriculture was responsible for planning and financing the development and absorbed the Water Resources personnel and equipment. Planned pond development started, and pond sites were carefully planned and spaced to promote better livestock distribution and range utilization.

The combined effort between USAID technicians and the Ministry of Agriculture has resulted in successful range development plans for the area. Because of the limited capital resources made available, the development was limited to just one of the 800-square mile pilot project areas in Sidamo. This Sidamo project area is representative of much of the total range area in southern and southeastern Ethiopia, and the data used for analyses in this dissertation have originated from the author's and other's experiences with the Sidamo Pilot Project.

Physical Conditions

Land

The combination of potentially rich rangeland and the situation of complete government control of the development use of this land is considered to be a vital advantage in this large-scale development plan. These factors led the Ethiopian Government to believe that the area is unequaled as a potential resource that could be developed with reasonable amounts of capital and human resources.

The current income to the government from these lands is derived primarily from an annual tax paid by the inhabitants and based on the number and class of livestock maintained.

Climate

Climate determines the existence and potential productivity of both plants and animals and needs to be considered in planning range development. The mean annual precipitation varies from 600 to 1000 mm (24 to 40 inches) in most of the planning area. Intensive rainstorms at times cause very dangerous floods, creating large gullies and losses of soil by erosion. At other times, drought is common. Some rainfall information is available from small towns in the planning area (Table 1). These data are not complete and should not be considered as very reliable, but at the present time there are no better data.

Most of the planning area has relatively low humidity and high temperatures resulting in extremely high evaporation rates. This high rate of evaporation diminishes available soil moisture.

Table 1. Rainfall and temperature data at five major towns in southern and southeastern Ethiopia.

Months	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual total
						Adame Tulu							
Average monthly rainfall 1959-69 (mm)	2.8	118.2	35.6	64.6	58.9	49.9	128.9	117.6	109.1	48.7	18.1	9.4	661.8
						Shakiso Gold M.							
Average rainfall 1962-63 (mm)	20.1	21.0	83.5	214.0	134.6	41.9	31.2	49.9	59.6	519.8	78.4	24.9	919.2
Average min. temperature (C)	9.8	9.0	10.7	13.2	14.2	13.7	13.5	13.6	13.6	12.8	10.4	9.9	11.6
Average max. temperature (C)	28.4	29.4	29.0	27.3	26.3	25.4	23.6	23.9	25.9	26.3	26.3	25.8	26.1
						Negelle Borena							
Average monthly rainfall 1962-67 (mm)	5.4	7.9	45.8	186.5	130.7	10.4	7.9	5.8	28.8	152.4	45.6	18.1	645.3
Average min. temperature (C)	11.7	12.4	13.1	13.7	13.8	12.9	12.2	11.9	12.4	12.7	11.7	11.4	12.3
Average max. temperature (C)	28.4	28.1	28.9	26.2	24.4	23.9	23.2	24.1	25.7	24.4	25.3	26.4	25.9
						Moyale							
Average monthly rainfall 1964-67 (mm)	8.0	19.0	52.8	203.6	124.0	16.6	15.6	28.9	32.7	157.4	128.8	61.0	848.4
Average min. temperature (C)	17.5	19.3	18.6	17.7	16.6	16.0	16.1	16.7	17.4	17.6	19.2	17.3	17.6
Average max. temperature (C)	30.1	31.5	30.1	26.5	24.9	24.0	24.1	24.6	25.9	25.9	25.2	24.9	27.0
						Yavello							
Average rainfall 1957-67 (mm)	1.4	70.7	74.9	162.5	94.0	20.7	33.2	16.3	22.0	91.9	76.9	27.4	705.5
Average min. temp. 1953-67 (C)	-	12.5	13.3	13.8	12.7	11.3	11.6	12.3	18.9	13.7	12.5	11.2	13.1
Average max. temp. (C)	-	28.4	27.8	25.0	23.4	23.1	22.2	24.1	25.4	27.2	24.2	26.8	25.2

Source: Imperial Ethiopian Government Institute of Agricultural Research, 1969.

Soils

Murphy (1959, 1963) has classified the soils as well as the vegetation of the planning area to provide initial guidance for future investigation and development. The Imperial Ethiopian Government Institute of Agricultural Research (1969) has subsequently made a survey of soils and the major vegetation zones in southern and southeastern Ethiopia. This survey further emphasizes the potential of this area for economic and social development. Soil samples were taken from the planning area at 0 to 15 cm and 15 to 30 cm depths at different intervals and altitudes. Soils of the area were found to be mainly sandy and sandy loams, with adequate calcium and potassium, but phosphorus and nitrogen were found to be deficient throughout the sampled area.

Vegetation

The common vegetation communities are short to medium grasses associated with trees and scrub savannas of varying density, these dominated by small acacia trees. At the present time, the area is marked by extreme scarcity of palatable legume species, resulting in low protein intake at some seasons of the year. This low protein intake has a depressing effect on growth rate and weight gains of beef animals.

Some of the common grass genera found in this region are: Beckera, Brachiaria, Cenchrus, Chloris, Beckeropsis, Digitaria, Eragrostis, Hyparrhenia, Panicum, Sporobolus, and many others (Murphy 1959, Imperial Ethiopian Government Institute of Agricultural Research 1969, Tulley 1970). Many of the perennial grasses are good to

excellent in their nutrition or grazing values, and many of the annuals are poor. The room for range improvement is tremendous, and any contribution in this particular field would be appreciated and accepted by the livestock producers.

At the present time, burning of rangeland is very common in the nomadic area. This is done either deliberately or accidently. The indiscriminate annual burning is causing considerable economic losses and undesirable conditions on the vigor of and density of plants, resulting in tremendous soil erosion (Tulley 1970).

Tulley (1970) determined the livestock carrying capacity within the Sidamo project area. His report indicated that the average annual production per acre under existing range conditions was about 430 pounds, or 195.4 kg, of air dry forage. The present carrying capacity is estimated to be about 16 to 20 acres/animal unit/year. This study was done on a limited area within the region; therefore, additional data are needed.

The Ethnic Groups and Their Pattern of Life

Resource development and maintenance in the planning area is considered to be done on behalf of the local inhabitants, because the true core of development rests in the development of people. The Stanford Research Institute (1969) reported that the socioeconomic conditions and technological shortage are obstacles to changes in the lives of traditional livestock producers in Ethiopia. Their lives have not undergone much change in many years.

The ethnic groups in the planned area are strictly nomadic. They almost all lead a subsistence life based on some class of livestock. They raise and sell animals to buy other commodities such as food, clothing and luxury items, and to pay their annual livestock taxes.

Among the nomads, there is a great variability in customs, religion, social, and cultural beliefs, but they all have important factors in common. They depend on some form of livestock, are seasonal migrators, and have a closed society with a limited knowledge of the rest of the Empire. Livestock production is a way of life for both young as well as old, but it is a very primitive, traditional livestock system. Grazing lands are assigned to each ethnic group by traditional leaders and, therefore, as indicated below, extreme care should be taken if success is to take place from public expenditures.

There may be some problems arising from ethnic differences over some suitable traditional grazing rights, but finding a permanent solution becomes the responsibility of the government. Minimizing the existing conflicts among these nomadic people would enhance the economic growth of the area and the development of human resources.

Because of the different cultural and social backgrounds and values among the nomads, a sudden change in development may not be welcomed. They have enjoyed what they have inherited, and there is stability and continuity for the things they do. Their lives as nomadic, seasonal migrators follow certain patterns. These vital socioeconomic factors should not be ignored in the development program.

Any technical innovation in the livestock industry could be slowed and sometimes may not even be accepted by the nomads if the purposes and the objectives are to bring about sudden and immediate changes. On the other hand, progress and changes could be achieved if great consideration is given to customs, traditions, cultural, and social beliefs. It is absolutely vital that full respect for current social patterns be exercised so that objectives and goals can be reached. Working within their system will encourage producers to be guided toward commercially oriented beef production rather than the current subsistence level of production. Any traditional society tends to resist change unless challenged with problems that cannot be changed with traditional ways (Schultz 1964, Mellor 1969).

Livestock and Wildlife

Cattle

The planning region identified as southern and southeastern Ethiopia has been well known for having the best breed of cattle indigenous to the area. This particular type of zebu breed is known as Boran and has a similar body conformation and coloring as the Indian Brahman but smaller in size. The excellent ability of this breed to respond to better production management has been demonstrated on some government and private ranches both in Ethiopia and in other East African countries (Figures 2 and 3).

Of the estimated 113 million head of cattle in the continent of Africa, Ethiopia has about 25 million head of cattle or 22% of the total cattle population of the continent (Fischer 1969a). The Imperial

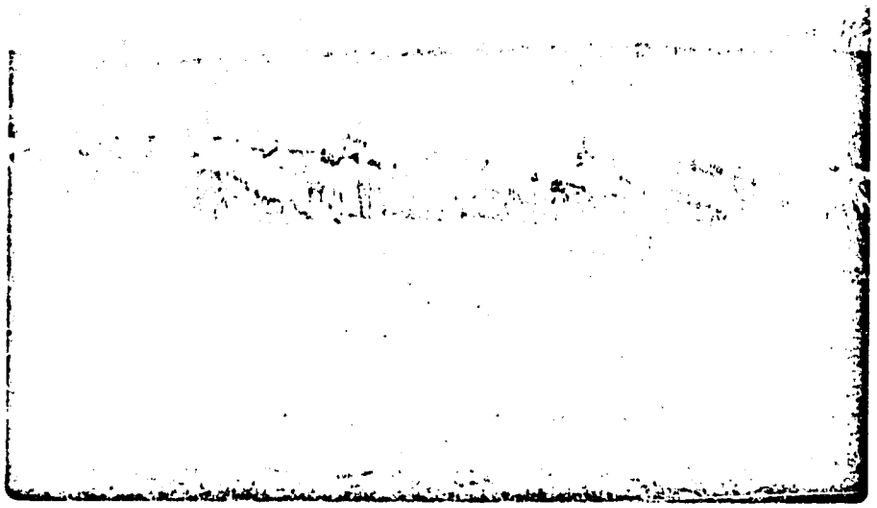

Figure 2. Boran cattle shown under nomadic production system on rangeland, Borena District, Sidamo Province, Ethiopia.

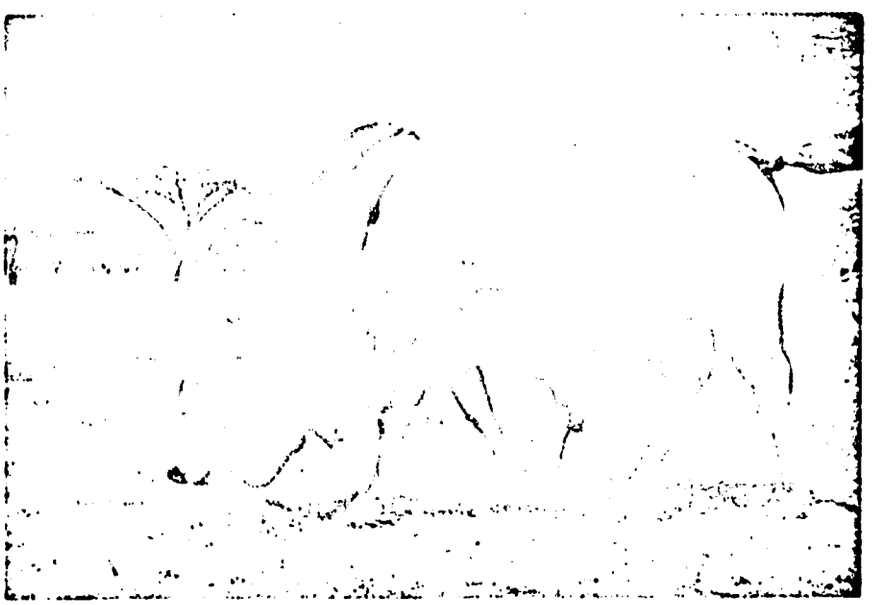

Figure 3. Boran bull shown under excellent management practice, on commercial ranch, 186-200 kilometers south of Addis Abeba, Ethiopia.

Ethiopian Government Ministry of Agriculture (1962) in its livestock survey of southern Ethiopia reported that about eight million cattle were estimated to be in the area surveyed and about three-fourths of these were estimated to be within the planning region. Due to considerable problems and obstacles faced by producers since the survey was made, the beef cattle population declined. Despite the existing production problems, Ethiopia has the largest cattle population of all countries in the continent of Africa.

Range improvement programs can be achieved by working with the nomad's own cattle. Beef cattle research should be done with the Boran breed, because this will serve as an important ingredient to the economic growth and development (Fischer 1968, 1969b; Peberdy 1967). Teaching of the cattle producers could be achieved by qualified extension personnel, and an increase in both quantity and quality of beef could be expected through proper management. Animals have always been regarded as an important resource among nomadic producers, and any effort to improve this potential resource is expected to be welcomed by the producing society. An increased revenue will be generated from increased production (Peberdy 1967).

Because of the tremendous shortage of technically qualified personnel in the field of range and livestock management and a lack of capital, the livestock industry has not attained its potential. With limited possibilities for stretching resources, it is important to allocate resources efficiently through effective planning (Pratt 1967). Pratt also considered that a land use survey and the training of

technically qualified personnel are prime requirements for successful range development and improvement of the livestock industry.

Fischer (1968) stated that although the development of the livestock industry is important from the nation's interest, such as earning foreign exchange, the impact on the people is of greater importance. People should be considered as vital and essential resources to be developed. The current nomadic and semi-nomadic production system provides an annual sale of 3 to 4% (Church et al. 1957, Imperial Ethiopian Government Ministry of Agriculture 1962, Fischer 1968).

The main reasons for the low annual sale of livestock from rangelands are due to the high mortality rate, poor nutrition, lack of water, and inefficient marketing systems (Fischer 1968, 1969a, 1969b). Because of these production problems, all females are kept for replacement unless proven nonproductive, and males are normally sold at 5 to 8 years of age. Church et al. (1957) and the Imperial Ethiopian Government Ministry of Agriculture (1962) reported the estimated calf crop to be 60% with 45% of the calves dying before reaching one year of age. A 10% per annum loss of the remaining animals die before reaching five years of age.

Because of these mentioned losses, the actual contribution of cattle to the nation's economic growth has been minimal. Fischer (1969a) stated that the veterinary service of the Ministry of Agriculture and the Livestock and Meat Board have been given nation-wide responsibility, so that they can assist in reducing the production and marketing problems. The plans to coordinate responsibilities and activities of these

agencies will no doubt create an atmosphere of confidence and encouragement among traders and producers, so that an orderly and continuous flow of surplus animals can reach consuming centers, thus reducing the seasonal fluctuation in number of cattle sold and market prices.

Other Animals

The economic analyses for this dissertation are made on beef cattle production, but total planning must take into consideration other classes of animals in the area. Other important animals are camels, sheep, goats, and wild game. Special economic consideration and emphasis must be given to camel production in certain areas. Camels play an important role in the livelihood of nomadic people. They have an important economic impact on certain ethnic groups, as they are used for the production of milk, meat, hides, and serve as beasts of burden.

Production of camels is feasible in certain areas, because of their adaptability and excellent performance under adverse conditions. Camels are browsers with a unique and different feeding habit than cattle. There is little direct competition for feed between camels and cattle. Areas covered with trees and brush are of marginal forage productivity for cattle but are good for camel production. The advantages of camel production under such circumstances are that rangelands will require less investment to develop and the removal of camels from the excellent rangelands will minimize the age-old misunderstandings and problems between cattle producers and camel herders.

Ethiopia, like many African countries, is the home of many varieties of big and small game, and especially so within the planning

area. Therefore, the development of this potential resource should be considered.

Many of the big game animals have suffered from destruction by irresponsible hunters. This critical problem has now been realized by the Ethiopian Government, and programs are being developed to protect the natural fauna. The Food and Agricultural Organization of the United Nations (1961) reported that game ranching would be an excellent means of providing additional meat and protein supply with limited financial expenditures.

The economic advantages of game ranching in the continent of Africa have been studied and reported by Dasmann (1961), Frankel (1961), Mossman (1961), Talbot (1961), Posselt (1963), Brown (1967), and Homar (1968). Dasmann (1961) and Mossman (1961) reported that areas of marginal to low productivity would be excellent for game production in the continent of Africa. Game production does not require expensive development cost compared to beef ranching or other domesticated animals.

Due to social, cultural, and other beliefs, there may be some resistance for game meat consumption, especially so in Ethiopia. Developing dependable markets must be given high priority if game ranching is to be successful. The values of wildlife for tourism should also be considered as an economic asset.

Like any other business enterprise, camel and wild game production should be studied to determine if they are socially accepted and profitable, and to assure that they are well adapted to specific environments unsuited to cattle production. The economics of camel and wild game ranching are beyond the scope of this dissertation.

Present Production and Grazing Problems

Lack of Organized Financial Institutions

Among the different tribes in the planning area, a cash economy is unknown and mistrusted. Modern financial institutions are not available, and livestock are used as a means of acquiring and storing wealth. Assets tied up in livestock make it relatively easy to avoid spending, and there are no other means of saving or investing. Also, the more cattle a person owns the more respected he is and the higher his status. Therefore, too many animals are kept per given unit of area, thus causing severe competition for available feed and water and also creating other production problems.

Diseases

The mild climate in southern and southeastern Ethiopia favors many parasites and epizootic diseases. The livestock of this area have suffered from various diseases for many years. The endemic diseases have played a major role in keeping the number of salable livestock low. This is one problem that the Ethiopian Government is trying to solve, so that the livestock industry can prosper within a reasonably short time.

At the present time, there is considerable information on diseases of livestock in Ethiopia (Stringer 1968a, 1968b, 1968c; Fischer 968, 1969a). Among the common epizootic diseases found in southern and southeastern Ethiopia, which have great economic importance, are foot and mouth disease, rinderpest, contagious bovine pleuropneumonia.

hemorrhagic septicemia, trypanosomiasis, anthrax, and black leg. The livestock disease situation has been well identified in the area (Imperial Ethiopian Government Ministry of Agriculture 1962). Stringer (1968a, 1968b, and 1968c) discussed important diseases caused by bacteria, virus, and tick-borne diseases commonly found in Ethiopia. He also stated that diseases caused by internal and external parasites have considerable economic importance.

Except for foot and mouth disease and trypanosomiasis, vaccine is produced locally and made available free of charge by the government to livestock producers. Some of the imported vaccines and drugs used to control diseases are too expensive for farmers, and the economic situation does not permit the government to cover all costs; therefore, to plan on a large-scale eradication program becomes economically unfeasible. Because of this economic situation, diseases will continue to cause considerable economic loss in the livestock industry.

Many of the indigenous cattle in the area have generally developed certain resistance to some diseases, but there is also a tremendous mortality rate among young individuals.

Water

In southern and southeastern Ethiopia, cattle production is often limited by inadequate energy intake. Because of the limited water supplies in many of the vast rangelands, cattle are unable to efficiently utilize ranges with abundant forage. As a result of this situation, there is usually improper livestock distribution and poor

range utilization (Church et al. 1957; Imperial Ethiopian Government 1962; Fischer 1968, 1969a).

Due to the occurrence of drought situations, cattle owners are often forced to move from excellent grazing ranges to areas with adequate water supplies but with less forage for their livestock. This condition has already created critical range problems that cannot be corrected easily, even with the best range management practices. Poor management practices are leading to the disappearance of perennial grasses, making conditions more suitable for shrubs and annuals of poor nutritional value. There is overgrazing of ranges near the watering points.

Graham (1969) summarized that the amount of available water determines the settlement and expansion of any industry in developing countries. Economic exploitation of many potentially productive areas and resources depend on availability of water. Bailey (1941) stated that water shortage has restricted the livestock industry from increasing in arid regions, causing a reduction in resources and retarded economic growth and development.

Drought is one of the unfavorable production problems which has an adverse effect on livestock distribution and range utilization. Church et al. (1969), Apane (1963), Bisschop (1964), and Maynard and Loosli (1969) mentioned that drought causes shortage of roughage, lack of proper nutrition, retarded reproduction, increased mortality, reduced surplus animals for markets, and reduced revenues from range livestock production.

Water shortage in the planning area has caused considerable economic pressure on the livestock industry, and large areas with excellent potential remain unused for most of the time (Imperial Ethiopian Government Ministry of Agriculture 1963). Phoenix (1966) also stated that because of water shortage in the planning area, the contribution of the livestock industry to the overall economic growth and development has not been significant. His evaluation was based on a 20,000 square kilometer aerial reconnaissance over the area. He concluded that development of water supplies is desirable and justified with certain degrees of risks involved.

Jones (1969) stated that properly sited sources of water are required for better livestock production and range management. He estimated the capacity of the ponds already in use in the Sidamo area to be approximately 47,000 cubic meters (12,750,000 gallons) each. Jones (1969) reported that the prospect for large-scale underground water development is poor and said that "as the number of fissures decreases in the basement complex, chances of encountering water bearing openings also decrease with depth" (p. 5).

Phoenix (1966) discussed dug wells as a common source of water supplies to both humans and livestock in the planning area (Figures 4 and 5). These wells are a fair source of underground water in the tufaceous lacustrine sediments and in the broad plain and along the sheer zone in metamorphic rocks and alluvium.

Dug wells are operated in a very unique way. Water is bailed from the source by a chain of humans using buckets made from giraffe

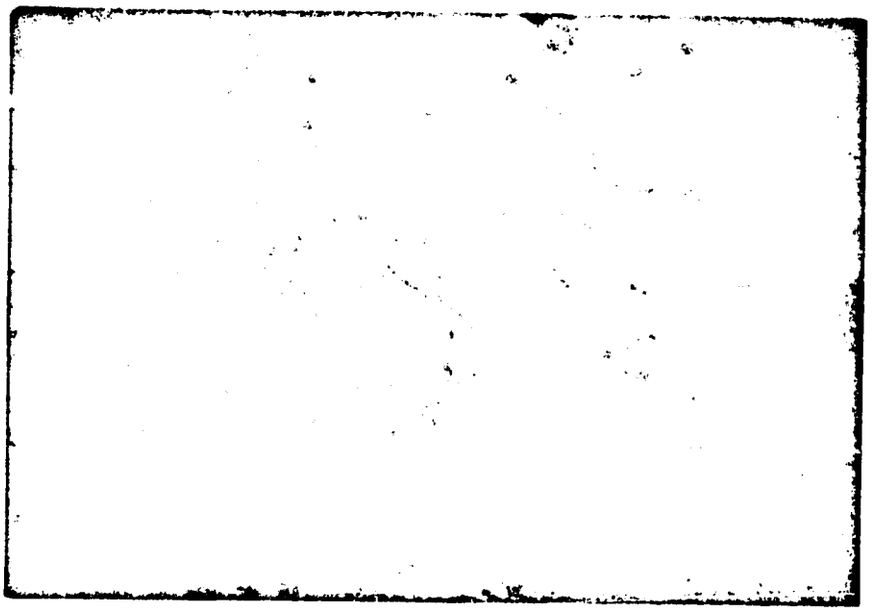

Figure 4. Aerial photograph showing the general shape of a dug well in southern Sidamo Province, Ethiopia.

Figure 5. Two-stage dug well, 80 feet total depth, showing the shaft and the water trough portion.

hide. A temporary water trough about 8 to 10 feet long is usually made from a mud wall and a low barrier of cribbed rocks (Figure 5). Phoenix (1966) and I measured the depth of many wells in the planning area. The total depth was found to be from 60 to 80 feet below the surface entrance. The shaft was from 6 to 8 feet in diameter, equipped with a wooden platform or stage-connected by ladders, so that water could be bailed and delivered to reach the water trough (Phoenix 1966). The number of people involved depends upon the depth of the well. A series of giraffe buckets are used in the process of bailing water. Phoenix (1966) estimated for an average well that from 20 to 30 gallons of water are hoisted per minute, watering about 1000 cattle per day. Phoenix (1966) believed that the potential of some of the dug wells is large, and some technical improvements should be considered if proper range management and utilization is to be maximized from rangeland.

Some springs are also available for stock watering but are less abundant than wells. Phoenix (1966) suggested that with limited investments these springs could be used to alleviate the existing water shortage if storage reservoirs were constructed where gravity flow could be used to reach remote water troughs. In many parts of Ethiopia, log water troughs are used and are considered to be durable and dependable. They could be reinforced with concrete or metal bindings.

On many rangelands, nomadic people use shallow ponds. These shallow ponds are useful only as long as there is rain or shortly after rain; they are being replaced by better and well-planned ponds (Imperial

Ethiopian Government Ministry of Agriculture 1962, Phoenix 1966, Fischer 1968, Jones 1969, Tulley 1970).

If there is no recharging, ponds dry up following drought periods. Therefore, under drought conditions, wells are more dependable than ponds if correct maintenance is practiced (Phoenix 1966).

Because of water shortages, large quantities of native vegetation are not used at the present time. The author has witnessed the burning of millions of acres annually with the destruction of vast quantities of usable forage. It is this condition that I would like to see changed into more productive resources rather than into ashes.

Nutrition

Inadequate nutrition is one of the most important causes of low productivity (Maynard and Loosli 1969). Nutritional requirement of animals must be satisfied if maximum efficiency is to be achieved from range livestock production. All classes of livestock have certain nutritional requirements varying with age, sex, rate of growth, work performance, fattening, and productivity (Cole 1966, Maynard and Loosli 1969). It is not at all uncommon to see animals kept at maintenance or survival level in southern Ethiopia; consequently productivity is extremely low. Energy, proteins, vitamin A and mineral supplements are not used to improve the quality and quantity of marketable animals from rangelands by the traditional society in the planning area. This is due to lack of knowledge and economic limitations. Much livestock feed supplement is currently wasted due to high cost and also due to lack of

knowledge on the part of the producers. It is not uncommon to see oilseed meals, mill wastes, and molasses poorly utilized.

The soils of the planning area are known to be low in phosphate (Murphy 1959), and forage produced in this area is often deficient in phosphorus. It is assumed that cattle raised under range conditions often suffer from phosphorus deficiency and exhibit low productivity if not supplemented.

It would be practically impossible to increase the calf crop, weaning weight, and to achieve production goals unless at least the minimum nutritional requirements are satisfied. With better production management and better feeding practices, the indigenous Boran breed in the area could offer a great potential for improving the meat industry.

Marketing

The marketing phase of the livestock industry in southern and southeastern Ethiopia has been confronted with many critical problems (Thomas H. Miner and Associates, Inc. 1964). Market prices have been unstable. Livestock mortality and losses in weight between production and consumption centers have always been great because it has been necessary to trail cattle a distance of 500 to 800 kilometers to reach final marketing centers. The incentives for increased annual sales of cattle have been poor, and the quantity of marketable cattle has been irregular.

Krutilla (1964) explained the problems and difficulties experienced in the development of the beef industry in the United States in the early 1800's. The movement and trailing of cattle to marketing

centers and all of the risks and uncertainties which occurred at that time are similar to the problems now existing in southern and southeastern Ethiopia.

Marketing is important to the success of range livestock production. Marousek et al. (1969) stated that cattle marketin involves the physical handling of livestock from producers to consumers and relaying marketing information back to producers. Production and marketing of beef animals must be planned so that one process does not lag too lar behind the other. A simultaneous development becomes more efficient and economically successful.

These marketing problems are now well identified (Miller et al. 1968; Fincher 1969a, 1969b; Marousek et al. 1969; International Bank for Reconstruction and Development 1970), and they are in the process of being solved. The remote production areas are no longer isolated but linked by all weather highways with the main consumption centers so that transport problems can be minimized. Development plans have been made to improve the livestock route leading to main consumption centers (Church et al. 1957). These development plans include the provision of water and feed along the route to market and a well-organized quarantine service so that disease is well controlled (Imperial Ethiopian Government Ministry of Agriculture 1962).

With the improvement of highways, transportation systems of handling marketable animals can be worked out based on economic feasibility (Love, Vrooman, and Smith 1969). An improved transportation system will ensure a regular flow of beef animals to market, thus

reducing the existing fluctuations. Among the possible alternatives needed to be studied and considered are trucking live animals to markets or taking small killing plants to the livestock area so that carcass and other usable products could be transported to consumers.

Because other forms of food products are not economically available, farmers in the planning area consume large amounts of milk and milk by-products. They milk every cow that is nursing a calf. The breed discussed in this dissertation is better-suited for beef purposes than for milk production. Therefore, the milking of this animal should be discouraged, so that calves could reach market-size earlier with better weaning weight. Weaning weight may be maximized if all of the milk produced by the cows is consumed by the nursing calves. This can only be achieved when enough food supplies are made available for human consumption at reasonable cost and convenient payment arrangements. This requires a united effort of interagency activities to be economically successful.

The total livestock development project will be successful only with adequate production incentives aimed to bring about economic, social, and cultural changes among producers.

Water Development Studies

Simpson (1971) discussed range conditions which resulted from investment for water development on the Papago Indian Reservation in Arizona. This problem occurred because, even though millions of dollars were invested to improve the range and the livestock situation with water development, little or no provision was made to improve the

education of the Papagos in proper range management techniques. The Papago area received a considerable amount of money from 1953 to 1958 through the Bureau of Indian Affairs to finance wind mills, dams, and storage tanks, but because of poor planning and poor range and livestock management practices, today, this area is very much deteriorated. It was overgrazed, as cattle were able to utilize the range more thoroughly than ever.

Goebel (1956) stated that the provision of water is the most important tool for range management, and it is the most crucial factor in securing the maximum efficiency of land use. An optimum forage yield can only be expected with reasonable annual precipitation and proper range and livestock management practices.

Bagley and Jeppsen (1964) have discussed the existing severe competition for water resources in the developed countries of the world. Clark (1967) stated that there must be a continuous supply of water if development is expected to be successful. Rapidly expanding livestock production and development is dependent on water availability. Lack of available water leads to nomadic life in developing nations of the world, and proper planning to conserve water at the right season requires financial investment.

Lauritzen (1960) reported that even when precipitation is limited, substantial amounts of water can be collected per acre, if the material used to collect the resource is water tight. Inexpensive, locally available collection materials requiring low maintenance service must be used. This could be an economical device to supply water

for range livestock and has special advantages in isolated areas where it is difficult to move heavy machinery and other construction equipment. Rain trapping would enhance rangeland and livestock development. Lauritzen and Thayer (1966) and Dedrick and Lauritzen (1969) have reported that rain trapping is a practical device to supply water for livestock and household uses. The distribution of livestock on rangelands with good forage utilization could be economically achieved through better water conservation.

Economic Analyses

Economic analysis of public investment projects should answer three questions: (1) Is the project worth undertaking? (2) How much should be spent? (3) How can this project be compared with others that may have equal claim to public funds? (See Gregory 1972.)

Benefit-cost analysis is the procedure most often used to answer these questions. In this procedure, project benefits and costs at various levels of investment are determined and discounted to the present. The ratio of benefits to costs is used as the criterion to answer the first question, is the project worthwhile. A benefit-cost ratio greater than one indicates the project is worthwhile. The optimum level of investment is determined by finding the level which maximizes present net benefits. Two feasible criteria for comparing projects are the benefit-cost ratio, calculated at optimum project size, and internal rate of return, if "costs" are defined as investments. If the internal rate of return is greater than the discount rate, the benefit-cost ratio is greater than one and the project is justified.

Heady (1952) and Harris (1962) discussed the present value of future payments or streams. Something a long distance away in time is not worth as much to us as if it were at hand. To bring this future payment to us or going to it costs something. The further away this future payment, the greater is the cost of getting to the future dollars, and hence the less their value now. We are willing to pay more for what we can have right away than for items which we could have some years away. The allowance for lower value obtained in the future is called discounting and is the opposite of compounding. Kelso (1964) and James and Lee (1971) have discussed discounting costs and returns to determine present net worths as a useful technique in economic analysis.

Singh and Shridhar (1965) reported the different discounting and evaluating methods for irrigation water development in India. Even though their major discussion was oriented toward analyzing benefit-cost analysis, they also mentioned that the present net worth method was also an important procedure to be considered in analysis of water development projects.

Gray (1965, 1968) and Simpson and Fretes (1972) have discussed and used the internal rate of return formula for both range and ranch improvements. They discussed costs of range and other improvements under different circumstances and environments. They used the internal rate of return formula to calculate annual returns to initial investment and maintenance costs of range improvement projects over the life of the improvements.

Three important elements to be considered for a successful economic analysis of returns of ranching enterprises and range developments are outlined by Gray (1968) and Simpson and Fretes (1972). First is the identification or determination of the length of the project's life, the number of years planned. Second is the amount of return or beef that can be produced during a fixed period from a given unit. The final and extremely essential economic ingredient to be considered in the economic evaluation system is the average price per unit of weight produced, so that a logical economic evaluation can be calculated systematically. The amount of feed produced must be converted into beef value in order to use present net worth or internal rate of return in the economic evaluation of the investment.

Nielsen (1967) discussed the interaction between use rates and resource flows over time and space on public range improvements, using several variable investments and varied productivities. He considered production of forage as resource flows and the utilization or removal as rate of use. He stated that the physical productivity of investment and the responsiveness of resource flows to prior use rates are particularly important.

Row (1963) used both present net worth and internal rates of return to choose among forest investments. He stated that it was more difficult to apply this system to forest return rates than in many other organizations; this was primarily due to the problems of discounting the money expenditures and returns to allow for the effect of

time. He developed a computer program to simplify the analysis, and it is his computer program which was used in this dissertation.

Gray, Stubblefield, and Roberts (1965) have discussed internal rate of return and considered it to b an important means of measuring economic evaluation and feasibility. They calculated internal rate of return based on actual returns and investments from three kinds of range improvements. These authors reported that stock water development resulted in an increased carrying capacity and greater rate of return than the other range improvements evaluated in Utah.

I have made estimates of annual cattle sales from the planning area based on several possible herd sizes and used the internal rate of return analysis to evaluate development alternatives. The interest rate at which the present net worth is zero is the internal rate of return for the set of costs and returns analyzed for the specified time period. Where capital is the most limiting factor of production, the internal rate of return is considered the relevant measure for choosing among alternatives.

METHODS AND ASSUMPTIONS

Rate of return analysis is one of the techniques normally used in economic evaluation of investments. As stated previously, the internal rate of return is that discount rate which drives present net worth to zero (Gittinger 1971). I have used internal rate of return as the decision criterion because capital is the limiting resource, and the alternatives are mutually exclusive and represent discrete levels of investment.

Rate of Return Analysis Procedure

The data considered in the analysis of project alternatives are costs involved during the entire lifetime of the projects, the number of animals sold annually, and the price of each animal sold.

The computer program for the analysis used in this dissertation was originally designed for computing rates of return from forest investments. Row (1963) stated that the program was written to calculate tables of present net worths calculated from discount rates of 3% to 30% for each timber management alternative. The computer program is applicable to range and livestock development investment analysis with no modification. Internal rate of return is found by finding the discount rate for which present net worth is zero.

This program was obtained along with a deck of Fortran cards from the U. S. Southern Forest Experiment Station and has operated accurately with practically no complications. The program was designed

to allow a rotation up to 99 years with as many as 50 yields. The program was written to process, simultaneously, six investment alternatives with common sets of price and cost assumption as described by Row (1963). This system was used to analyze forest product alternatives for the purpose of evaluating and ranking the alternatives.

The Imperial Ethiopian Government has used a 50-year planning period in evaluation, so this period was chosen for my analysis. Fifty annual returns were accommodated in the program, but the maximum number of different periodic costs that could be put into this format was 40. Many of the annual costs were not equal and had to be treated as periodic costs. Therefore, the tables showing the periodic costs include annual costs summed over two-year periods and reported as 25 periodic costs, so that they remain within the limitation of the program. These two-year, summed costs were read into the computer as being incurred at the end of the first year of each two-year period. This adjustment, to meet the dimensions of the computer program, causes a slight over estimation of the present worth of costs. The effect of this is to underestimate present net worths and internal rates of return. These errors are not considered to be of serious consequence, since the purpose here is to demonstrate an approach to range development planning; the errors are small and constant across all alternatives, not affecting the choice of alternatives.

I have made assumptions in estimating costs of development and maintenance and the surplus animals that could be marketed from the planning area based on experience with the pilot range development

scheme in Sidamo Province. The price per animal sold has been maintained constant at Ethiopian $80 throughout the planning period. The assumption here is that inflation in livestock value will parallel inflation in development and maintenance costs and the general price level therefore, inflation can be ignored in the analysis. There is an expected increase in quality of livestock which might result from improvement programs with a resulting increase in value of animals sold, but because of difficulty in arriving at a realistic estimate of this increased value per animal, I have held animal quality constant and accepted the fact that my estimates of returns will be conservative under good management programs.

Alternative Development Programs

Three alternative range livestock development programs for southern and southeastern Ethiopia are analyzed, each with its own annual costs, summed over each two years in this analysis. The three alternatives are: (1) a mobile veterinary service unit, (2) a mobile veterinary service plus pond construction and development, and (3) an alternative with permanent headquarters and management personnel, veterinary service, and pond development.

Annual Cattle Sales

Since the actual cattle numbers sold per year over the 50-year planning period for the three different development alternatives are not known, a series of annual cattle sale data were assumed and used to

test the influence of annual sales on the rate of return for the three development alternatives analyzed.

Annual cattle sale is a function of herd size and the percentage of the herd which is marketed each year. Herd size is determined by the grazing capacity of each management unit on the range. Grazing capacity is "the maximum stocking rate possible without inducing damage to vegetation or related resources" (Huss 1964, p. 16). Stocking rate is "actual number of animals, expressed in either animal units or animal months on a specific area at a specific time" (Huss 1964, p. 28). Carrying capacity is "in its true sense, the maximum number of individual animals that can survive the greatest period of stress each year on a given land area. It does not refer to sustained production. In range management the term has become erroneously synonymous with grazing capacity" (Huss 1964, p. 10).

The grazing capacity of the unimproved rangelands in the planning area has been estimated by Tulley (1970) to be approximately 16 acres per animal unit per year, but in the economic evaluation used here, I have been more conservative and used 20 acres per animal unit per year as the grazing capacity. Based on these data, the capacity of the rangelands of the planning areas per management unit, when fully stocked at 20 acres per animal unit per year and utilized uniformly over the area, would be 3200 animal units per management unit per year. Because of the critical water shortage for most of the year, a poor range utilization pattern, and other livestock production and management practices, the area has never been evenly utilized. It is estimated

that the area is utilized at only 40% of its potential grazing capacity under the current production and management system. This is a current stocking rate of 1280 animals per management unit.

Rates of return were calculated for each development alternative for four levels of grazing capacity. These levels are 1280, 1920, 2560, and 3200 animal units per management unit per year. Rates of return, therefore, were estimated for a variety of grazing capacities which might occur in the planning area over the planning period. Grazing capacities vary with range potential productivity, range condition, and utilization pattern. The development alternatives influence the grazing capacity of each range unit mainly by influencing livestock distribution and utilization patterns by water development and herd management. The four levels of grazing capacity have been analyzed in combination with different rates of increases of annual livestock sales every five years.

Church et al. (1957), the Imperial Ethiopian Government Ministry of Agriculture (1962), Fischer (1968), and Stanford Research Institute (1969) have reported that the current annual livestock sale from range livestock production is approximately 3% to 4% of the total livestock number maintained. This estimate of annual livestock sale is without taking into consideration the possibilities of improving the existing range and livestock situations. The only investment for this type of return would be the operational expenses for mobile veterinary service which is commonly in use and functional now to all parts of the Empire.

A 3% annual livestock sale was used as a current sale from the rangelands. In order to obtain estimates of sales which must be met to obtain given rates of return, six periodic increases in percentage livestock sales were evaluated. The six sets of sale increases were 0%, 1%, 2%, 3%, 4%, and 5% every five years using the 3% initial annual sale as the base. These six periodic increases in sales were evaluated with each of the four grazing capacities discussed above for each of the three range development alternatives. Thus, there are 72 different combinations of cost and return data analyzed.

Basic Assumptions Common to All Alternatives

Land Value

Because of the communal tenure system, I have not calculated the land value of the development area under consideration. Land is not owned by any individual or family but is owned by all in the community.

Land use is assigned to each tribe or ethnic group as agreed upon by local leaders among nomadic people. Under this communal system of tenure and land use, no land sales can take place nor can rent be collected by any person other than the government. Therefore, the whole land use system is based on tribal tenure arrangement. It is because of this unique nature of land use that I have decided not to consider the land value as a cost in the analysis of the development program.

In addition, there are no foreseeable alternative uses of the land; hence there are no opportunity costs involved in using the land for livestock production. The Government has already made its policies and decisions to develop this region for the benefit of the nomadic people through livestock production; thus, alternative land uses have not been taken into consideration, and no value has been assigned to the land input.

Development Costs

In the type of development project discussed in this dissertation, costs are borne by the government, and the return from the livestock sale goes to the cattle owners. In other words, the direct economic benefit goes to the cattle owners, not to the government. Yet, the government must realize a return on its investment in the form of taxes or other land use fees to justify the project.

As is usually common in developing countries, the Ethiopian Government is directly involved in many development programs and activities. Spontaneously created activities may be implemented, but in the final analysis they may have no great economic success unless carefully planned and continued to completion. It is, therefore, of vital importance to consider and fully analyze the entire financial expenditure required to develop a government-sponsored project. This becomes essential so that no grave mistakes will follow the initial investment. Government-sponsored or financed development projects must have a set of goals to be achieved with provisions for continuity of the project until goals are reached.

Management Unit

A management unit in this analysis is defined as an area which is 10 miles long by 10 miles wide, or a 100-square-mile area. This is the size of units designed for the Sidamo trial project area. This regional project calls for 4800 square miles to be developed within Sidamo Province if capital and human resources become available and also if the first 800-square-mile pilot range development project proves to be economically successful.

In the analyses here, an assumption has been made that average cost and production data per management unit in the Sidamo pilot project represent reasonable estimates for the total planning area in southern and southeastern Ethiopia.

Personnel

The personnel required for employment in all alternatives in the planned project area are assumed to serve for a maximum period of 25 years each. Any person is eligible for retirement after serving the government for 20 years; therefore, no more than 25 years of service is considered realistic. Employees replacing retired or fired individuals, however, are assumed to start with the salary of those persons who have been replaced. The salary of each position is then calculated for a period of 50 years, regardless of the changes expected to be made in employees.

Salary Increment

The procedure of calculating salary increment is designed so that no one person will receive a total increment of more than 50% of his initial salary during his entire working years. This is provided that his working period is limited to a maximum of 25 years. The salaries used in this analysis are considered to be very reasonable estimates under the local conditions.

Veterinary Service

Among the practices common to all alternatives is that a veterinary service is provided. In the first two alternatives, the provisions for housing, water supplies, and many of the other essential facilities and accommodations have not been considered and calculated as costs to the government. The reason for not considering these as costs is because a mobile type veterinary service is thought to be enough to provide the needed vaccination and other activities with no permanent headquarters established in the development project area.

This kind of service is commonly practiced not only in the project area but all over the Empire. Therefore, the analysis of government financial expenditures of this nature are of great importance and interest in planning and programming future development projects. Because of the high costs of controlling epizootic diseases in the project area, and because there is no charge for services rendered, it is vital to consider efficient means and ways of administering this operation. The mobile veterinary service is one cost discussed below.

The goal of the veterinary service is to have an effective control of the major epizootic cattle diseases in the area so that mortality rate is kept low and that the annual livestock sale from the rangeland is increased.

Market

One of the assumptions made in this analysis is that there will be no market outlet problem. The demand for quality meat is high, and the marketing system is improving. Because of limited financial and technical resources, the development of the livestock improvement project will be slow and salable livestock will not flood the market. It is assumed that demand for livestock will shift with shifts in livestock supply, and market outlets will be available for surplus animals.

Proportioning Returns

The initial cost of development and maintenance of the planning area is a capital investment totally made by the Government with no direct financial contribution by the producers. The rate of return must include a portion to cover the cost of capital used in the development of the area. I have made an assumption that the Ethiopian Government can get its development loan at 3% interest rate. To this rate I have added 1% more to cover the costs of administration risks and uncertainties that may occur during the planning period. Therefore, the Government should be satisfied with a 4% rate of return.

To improve the livestock industry in southern and southeastern Ethiopia, some additional investment by producers may be made over and

above the government's activities and responsibilities in developing the beef industry. Therefore, with this in mind, a positive present net worth, at a 4% discount rate, would be necessary to cover investment and other costs borne by the cattle producers and to provide an incentive for the cattle producers to practice better land management.

RESULTS AND DISCUSSION

Costs, cattle sales, and rates of return for each of three livestock development programs are presented and discussed in this chapter. Each alternative development program was evaluated using 24 different annual cattle sale estimates. All development costs and returns are expressed in Ethiopian dollars (Eth $2.50 = US $1.00).

Mobile Veterinary Service

Costs

Providing a mobile veterinary service to cattle owners is widely practiced at the present time. A mobile veterinary unit is usually assigned to cover a given area, and sometimes more than one unit may be assigned to an area, depending on the livestock population available for vaccination for a short time period. This is especially true if there is a disease outbreak. Any mobile unit which is not fully engaged in critical activities can be called upon to assist in controlling a serious situation.

The mobile veterinary unit does not have a permanent headquarters established within the project area to provide the service it is rendering. Therefore, no provisions for housing and other facilities are made in this analysis. The service offered in this manner is periodic and usually well timed with the suitable seasons of the year.

The essential costs considered in this alternative are for:

1. Salaries
   a. Chief veterinarian (Table 2)
   b. Animal health officer (Table 3)
   c. Two permanent vaccinators (Table 4)
2. Operational expenses (Table 5)
   a. Camping gear
   b. Equipment
   c. Fuel and oil
   d. Contingencies
3. Cost of vaccines (Table 5)
4. Transportation costs (vehicles), repair, and maintenance (Table 5)

The data for salaries are given in Tables 2, 3, and 4. Operational expenses, costs of vaccines, and vehicle costs are shown in Table 5 and total expenses by 2-year periods are shown in Table 6.

Salable Cattle

The number of cattle which could be marketed from each management unit with four different grazing capacity assumptions and six levels of 5-year rates of increase in sales are shown in Tables 7, 8, 9, and 10.

These cattle sale data were analyzed with each development alternative, so that rates of return data would be available for a wide range of salable cattle situations for each alternative. The decision

Table 2. Salary of chief veterinarian allocated as a cost per year per management unit for 50-year planning period.*

Year	Annual increment	Base salary plus annual increment	Salary each two years	Year	Annual increment	Base salary plus annual increment	Salary each two years
1	Eth $ 4	Eth $ 204.00	Eth $ 412.0	26	Eth $ 6	Eth $ 306.00	
2	8	208.0		27	12	312.00	Eth $ 630.0
3	12	212.00	428.0	28	18	318.00	
4	16	216.00		29	24	324.00	654.0
5	20	220.00	444.0	30	30	330.00	
6	24	224.00		31	36	336.00	678.0
7	28	228.00	460.0	32	42	342.00	
8	32	232.00		33	48	348.00	702.0
9	36	236.00	476.0	34	54	354.00	
10	40	240.00		35	60	360.00	726.0
11	44	244.00	492.0	36	66	366.00	
12	48	248.00		37	72	372.00	750.0
13	52	252.00	508.0	38	78	378.00	
14	56	256.00		39	84	384.00	774.0
15	60	260.00	524.0	40	90	390.00	
16	64	264.00		41	96	396.00	798.0
17	68	268.00	540.0	42	102	402.00	
18	72	272.00		43	108	408.00	822.0
19	76	276.00	556.0	44	114	414.00	
20	80	280.00		45	120	420.00	846.0
21	84	284.00	572.0	46	126	426.00	
22	88	288.00		47	132	432.00	870.0
23	92	292.00	588.0	48	138	438.00	
24	96	296.00		49	144	444.00	894.0
25	100	300.00	606.0	50	150	450.00	

*. Base salary at beginning is $9,600 per year for 48 management units or $200 per year per management unit. This salary scale was also used for project director and four caterpillar helper operators (each operator receives one-fourth of amount shown).

Table 3. Salary of animal health officer allocated as a cost per management unit for 50-year planning period.*

Year	Annual increment	Base salary plus annual increment	Added every 2 years	Year	Annual increment	Base salary plus annual increment	Added every 2 years
1	Eth $ 42.00	Eth $ 2142.00	Eth $ 4326.00	26	Eth $ 63.00	Eth $3213.00	
2	84.00	2184.00		27	126.00	3276.00	Eth $ 6615.00
3	126.00	2226.00	4494.00	28	189.00	3339.00	
4	168.00	2268.00		29	252.00	3402.00	6867.00
5	210.00	3310.00	4662.00	30	315.00	3465.00	
6	252.00	2352.00		31	378.00	3528.00	7119.00
7	294.00	2394.00	4830.00	32	441.00	3591.00	
8	336.00	2436.00		33	504.00	3654.00	7371.00
9	378.00	2478.00	4998.00	34	567.00	3717.00	
10	420.00	2520.00		35	630.00	3780.00	7623.00
11	462.00	2562.00	5166.00	36	693.00	3843.00	
12	504.00	2604.00		37	756.00	3906.00	7875.00
13	546.00	2646.00	5334.00	38	819.00	3969.00	
14	588.00	2688.00		39	882.00	4032.00	8127.00
15	630.00	2730.00	5502.00	40	945.00	4095.00	
16	672.00	2772.00		41	1008.00	4158.00	8379.00
17	714.00	2814.00	5670.00	42	1071.00	4221.00	
18	756.00	2856.00		43	1134.00	4284.00	8631.00
19	798.00	2898.00	5838.00	44	1197.00	4347.00	
20	840.00	2940.00		45	1260.00	4410.00	8883.00
21	882.00	2982.00	6006.00	46	1303.00	4473.00	
22	924.00	3024.00		47	1386.00	4536.00	9135.00
23	966.00	3066.00	6174.00	48	1449.00	4599.00	
24	1008.00	3108.00		49	1512.00	4662.00	9387.00
25	1050.00	3150.00	6363.00	50	1575.00	4725.00	

*. Base salary at beginning is $4200 per year per 2 management units or $2100 per year per management unit.

Table 4. Salary paid to two vaccinators allocated as a cost per management unit for 50-year planning period.*

Year	Annual increment	Base salary plus annual increment	Salary each two years	Year	Annual increment	Base salary plus annual increment	Salary each two years
1	Eth $ 43.20	Eth $ 2203.20	Eth $ 4449.4	26	Eth $ 64.80	Eth $ 3304.80	
2	86.40	2246.40		27	129.60	3369.60	Eth $ 6804.0
3	129.60	2289.60	4622.4	28	194.40	3434.40	
4	172.80	2332.80		29	259.20	3499.20	7063.2
5	216.00	2376.00	4795.2	30	324.00	3564.00	
6	259.20	2419.20		31	388.80	3628.80	7322.4
7	305.40	2465.40	4971.0	32	453.60	3693.60	
8	345.60	2505.60		33	518.40	3758.40	7581.6
9	388.80	2548.80	5140.8	34	583.20	3823.20	
10	432.00	2592.00		35	648.00	3888.00	7840.8
11	475.20	2632.20	5310.6	36	712.80	3952.80	
12	518.40	2678.40		37	777.60	4017.60	8100.0
13	561.60	2721.60	5486.4	38	842.40	4042.40	
14	604.80	2764.80		39	907.20	4147.20	8359.2
15	64 .00	2808.00	5659.2	40	972.00	4212.00	
16	691.20	2851.20		41	1036.80	4276.80	8618.4
17	734.40	2894.40	5832.0	42	1101.60	4341.60	
18	777.60	2937.60		43	1166.40	4406.40	8877.6
19	820.80	2980.80	6005.4	44	1231.20	4471.20	
20	864.60	3024.60		45	1296.00	4536.00	9136.8
21	907.20	3067.20	6177.6	46	1360.80	4600.80	
22	950.40	3110.40		47	1425.60	4665.60	9396.0
23	993.60	3153.60	6350.4	48	1490.40	4730.40	
24	1030.80	3196.80		49	1555.20	4795.20	9655.2
25	1080.00	3240.00	6544.8	50	1620.00	4860.00	

*. Base salary at beginning is $2160 per year per management unit.

Table 5. Veterinary service operational expenses allocated as a cost per management unit for 50-year planning period.

Year	Operational Expenses	Costs of vaccines	Transportation cost/5yrs	Added every 2 years	Year	Operational expenses	Costs of vaccines	Transportation cost/5yrs	Added every 2 years
1	Eth $1000	Eth$400.00	Eth$12000.0	Eth$14800.0	26	Eth$1000	Eth $400.00	Eth$12000.0	
2	1000	400.00			27	1000	400.00		Eth$2800.0
3	1000	400.00		2800.0	28	1000	400.00		
4	1000	400.00			29	1000	400.00		2800.0
5	1000	400.00		14800.0	30	1000	400.00		
6	1000	400.00	12000.0		31	1000	400.00	12000.0	14800.0
7	1000	400.00		2800.0	32	1000	400.00		
8	1000	400.00			33	1000	400.00		2800.0
9	1000	400.00		2800.0	34	1000	400.00		
10	1000	400.00			35	1000	400.00		14800.0
11	1000	400.00	12000.0	14800.0	36	1000	400.00	12000.0	
12	1000	400.00			37	1000	400.00		2800.0
13	1000	400.00		2800.0	38	1000	400.00		
14	1000	400.00			39	1000	400.00		2800.0
15	1000	400.00		14800.0	40	1000	400.00		
16	1000	400.00	12000.0		41	1000	400.00	12000.0	14800.0
17	1000	400.00		2800.0	42	1000	400.00		
18	1000	400.00			43	1000	400.00		2800.0
19	1000	400.00		2800.0	44	1000	400.00		
20	1000	400.00			45	1000	400.00		14800.0
21	1000	400.00	12000.0	14800.0	46	1000	400.00	12000.0	
22	1000	400.00			47	1000	400.00		2800.0
23	1000	400.00		2800.0	48	1000	400.00		
24	1000	400.00			49	1000	400.00		2800.0
25	1000	400.00		14800.0	50	1000	400.00		

Table C. Total veterinary expenses including salaries allocated as a cost per management unit for 50-year planning period.

Year	Operational expense costs of vaccines and transportation costs	Salaries			Total costs
		Chief veterinarian	Animal health officer	Two vaccinators	
1	Eth $ 14800.00	Eth $ 412.00	Eth $ 4326.00	Eth $ 4449.40	Eth $ 23987.40
3	2800.00	428.00	4494.00	4622.40	12344.40
5	14800.00	444.00	4662.00	4795.20	24701.20
7	2800.00	460.00	4830.00	4971.00	13061.00
9	2800.00	476.00	4998.00	5140.80	13414.00
11	14800.00	492.00	5166.00	5310.60	25768.60
13	2800.00	508.00	5334.00	5486.40	14128.40
15	14800.00	524.00	5502.00	5659.20	26485.20
17	2800.00	540.00	5670.00	5832.00	14842.00
19	2800.00	556.00	5838.00	6005.40	15199.40
21	14800.00	572.00	6006.00	6177.60	27555.60
23	2800.00	588.00	6174.00	6350.40	15912.40
25	14800.00	606.00	6363.00	6544.80	28313.80
27	2800.00	630.00	6615.00	6804.00	16849.00
29	2800.00	654.00	6867.00	7063.20	17384.20
31	14800.00	678.00	7119.00	7322.40	29919.40
33	2800.00	702.00	7371.00	7581.60	18454.60
35	14800.00	726.00	7623.00	7840.80	30989.80
37	2800.00	750.00	7875.00	8100.00	19525.00
39	2800.00	774.00	8127.00	8359.20	20060.20
41	14800.00	798.00	8379.00	8618.40	32595.40
43	2800.00	822.00	8631.00	8877.60	21130.60
45	14800.00	846.00	8883.00	9136.80	33665.80
47	2800.00	870.00	9135.00	9396.00	22201.00
49	2800.00	894.00	9387.00	9655.20	22736.20

Table 7. Cattle sale with a grazing capacity of 1280 animal units per year per management unit, beginning with 3% annual sale.

Years	Increase in percent sale each 5 years											
	0%		1%		2%		3%		4%		5%	
	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total
1-5	38	190	38	190	38	190	38	190	38	190	38	190
6-10	38	190	51	255	64	320	77	385	90	450	102	510
11-15	38	190	64	320	90	450	115	575	141	705	166	830
16-20	38	190	77	385	115	575	154	770	192	960	230	1150
21-25	38	190	90	450	141	705	192	960	243	1215	294	1470
26-30	38	190	102	510	166	830	230	1025	294	1470	358	1790
31-35	38	190	115	573	192	960	269	1215	346	1730	422	2110
36-40	38	190	128	640	218	1090	307	1360	397	1985	486	2430
41-45	38	190	141	700	243	1215	346	1600	448	2240	550	2750
46-50	38	190	154	770	269	1345	384	1790	499	2495	614	3070
Total/ 50 yrs	1900		4793		7680		9870		13440		16300	

Table 8. Cattle sale with a grazing capacity of 1920 animal units per year per management unit, beginning with 3% annual sale.

Years	Increase in percent sale each 5 years											
	0%		1%		2%		3%		4%		5%	
	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total
1-5	58	290	58	290	58	290	58	290	58	290	58	290
6-10	58	290	77	385	96	480	115	575	134	670	154	770
11-15	58	290	96	480	134	670	173	865	211	1055	250	1250
16-20	58	290	115	575	173	865	230	1150	288	288	346	1730
21-25	58	290	134	670	211	1055	288	1440	365	1825	442	2210
26-30	58	290	154	770	250	1250	346	1730	442	2210	558	2690
31-35	58	290	173	865	288	1440	403	2015	518	2590	634	3170
36-40	58	290	192	960	326	1630	461	2305	595	2975	730	3650
41-45	58	290	211	1055	365	1825	518	2590	672	3360	826	4130
46-50	58	290	230	1150	403	2015	576	2880	749	3745	922	4610
Total/ 50 yrs	2900		7200		11520		15840		20160		24500	

Table 9. Cattle sale with a grazing capacity of 2560 animal units per year per management unit, beginning with 3% annual sale.

Years	Increase in percent sale each 5 years											
	0%		1%		2%		3%		4%		5%	
	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total
1-5	77	385	77	385	77	385	77	385	77	385	77	385
6-10	77	385	102	510	128	640	154	770	179	895	205	1025
11-15	77	385	128	640	179	895	230	1150	282	1410	333	1665
16-20	77	385	154	770	230	1150	307	1535	384	1920	461	2305
21-25	77	385	179	895	282	1410	384	1920	486	2430	589	2945
26-30	77	385	205	1025	333	1665	461	2305	589	2945	717	3585
31-35	77	385	230	1150	384	1920	538	2690	691	3455	845	4225
36-40	77	385	256	1280	435	2175	614	3070	794	3745	973	4865
41-45	77	385	282	1410	486	2430	691	3455	896	4480	1101	5505
46-50	77	385	307	1535	538	2690	768	3840	998	4990	1229	6145
Total/ 50 yrs	3850		9600		15360		21120		26655		32650	

Table 10. Cattle sale with a grazing capacity of 3200 animal units per year per management unit, beginning with 3% annual sale.

Years	Increase in percent sale each 5 years											
	0%		1%		2%		3%		4%		5%	
	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total	Yearly	5 yrs total
1-5	96	480	96	480	96	480	96	480	96	480	96	480
6-10	96	480	128	640	160	800	192	960	224	1120	256	1280
11-15	96	480	160	800	224	1120	288	1440	352	1760	416	2080
16-20	96	480	192	960	288	1440	384	1920	480	2400	576	2880
21-25	96	480	224	1120	352	1760	480	2400	508	2540	736	3680
26-30	96	480	256	1280	416	2080	576	2875	736	3680	896	4480
31-25	96	480	288	1440	480	2400	672	3360	864	4320	1056	5280
36-40	96	480	320	1600	544	2720	768	3840	992	4960	1216	6080
41- 5	96	480	352	1760	608	3040	864	4320	1120	5600	1376	6880
46-50	96	480	384	1920	672	3360	960	4800	1248	6240	1536	7680
Total/ 50 yrs	4800		12000		19200		26395		33100		40800	

maker, then, given the attainable level of salable cattle for his particular management unit and the production system for each management alternative, may compare the rates of return from each of the alternatives.

A stocking rate, however, beyond the grazing capacity of a range causes depletion and high rates of sale increases cannot be obtained. In this case, an initially conservative number of livestock with a consistent improvement in sales percentage could yield greater livestock sales than large livestock numbers without increments in percentage sale. For instance, an initial stocking rate of 1280 animals and a 1% increase in percent sale each five years would result in a 12% yearly sale by the end of the 50 years, and 4793 animals would have been sold from the management unit in the 50-year planning period (Table 7). If on the other hand the management unit is utilized to obtain only a constant annual livestock sale at 3%, it would require an initial stocking of 3200 animals to result in 4800 animals sold over the 50-year planning period (Table 10).

Rates of Returns

For all four grazing capacities considered, an investment in mobile veterinary services would not be economically justified if the percentage of annual sales of cattle continues to be only 3% with no increase in cattle sales over the planning period (Tables 11, 12, 13, and 14).

To make returns from mobile veterinary service investment economically justifiable, there must be a resultant increase in the number

Table 11. Present net worths and rates of return for costs of mobile veterinary service with returns based on a livestock grazing capacity of 1280 animals per year per management unit with an initial sale of 3% and increases in animal sales of 0% to 5% each 5 years.

Discount rates	Increase in livestock sale each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-191038.74	-102094.52	-15159.43	72401.28	160017.32	246763.57
3.5	-173003.71	-96155.32	-21150.90	54435.33	130079.15	204925.73
4.0	-157482.73	-90815.20	-25844.28	39668.31	105239.81	170077.92
4.5	-144068.40	-86000.11	-29496.29	27512.27	84580.36	140971.47
5.0	-132425.42	-81646.10	-32312.30	17492.19	67356.30	116593.47
5.5	-122276.98	-77697.90	-34456.87	9223.43	52963.02	96120.23
6.0	-113393.94	-74107.68	-36062.02	2393.83	40908.32	78880.30
6.5	-105586.03	-70833.98	-37233.90	-3250.55	30790.55	64324.94
7.0	-98694.83	-67840.81	-38057.91	-7916.71	22281.16	52004.60
7.5	-92588.01	-65096.87	-38602.88	-11773.80	15110.75	41550.08
8.0	-87154.72	-62574.89	-38924.38	-14960.34	9057.86	32657.38
9.0	-77950.86	-58104.54	-39067.88	-19756.38	-393.54	18596.93
10.0	-70499.27	-54272.73	-38754.06	-22994.14	-7185.80	8289.14
11.0	-64380.35	-50958.38	-38157.16	-25143.87	-12085.14	673.42
12.0	-59288.88	-48067.35	-37391.61	-26529.23	-15624.32	-4990.98
13.0	-55000.10	-45525.83	-36532.57	-27374.83	-18177.40	-9226.69
14.0	-51346.43	-43275.40	-35629.18	-27837.84	-20009.55	-12006.18
15.0	-48201.47	-41269.48	-34713.39	-28029.12	-21310.50	-14797.57
16.0	-45468.67	-39470.57	-33805.66	-27654.49	-23221.13	-18947.43
18.0	-40957.73	-36377.58	-32060.51	-27654.49	-23221.13	-18947.43
20.0	-37389.89	-33812.80	-30444.63	-27006.36	-23544.73	-20219.31
22.0	-34496.69	-31649.88	-28969.86	-26234.35	-23478.95	-20940.47
24.0	-32101.35	-29799.47	-27631.38	-25419.18	-23190.07	-21061.89
26.0	-30083.36	-28196.74	-26417.93	-24603.92	-22775.54	-21034.72
28.0	-28358.03	-26793.64	-25316.49	-23811.14	-22293.60	-20852.33
30.0	-26864.19	-25553.80	-24314.27	-23052.07	-21779.53	-20573.69

Table 12. Present net worths and rates of return for costs of mobile veterinary service with returns based on a livestock grazing capacity of 1920 animals per year per management unit with an initial sale at 3% and increases in animal sales of 0% to 5% each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-149871.11	-18552.27	112051.88	243392.33	374677.43	506832.34
3.5	-135474.72	-22079.59	90601.91	203980.41	317301.31	431419.45
4.0	-123111.23	-24797.28	72810.97	171078.71	269287.54	368229.74
4.5	-112449.19	-26869.00	58018.57	143529.95	228981.80	315110.62
5.0	-103215.94	-28425.18	45689.83	120394.79	195040.12	270812.40
5.5	-95186.56	-29569.91	35390.55	100908.86	166367.88	232409.27
6.0	-88174.96	-30386.43	26767.36	84448.63	142071.26	200236.39
6.5	-82026.80	-30941.33	19512.04	70504.17	121418.56	172839.65
7.0	-76613.63	-31288.00	13448.88	58657.40	103808.24	149435.51
7.5	-71828.31	-31469.27	8324.66	48564.62	88749.11	129378.83
8.0	-67581.15	-31519.54	4000.61	39942.62	75830.47	112137.01
9.0	-60412.17	-31332.24	-2747.37	26215.03	55126.09	84409.52
10.0	-54635.57	-30888.57	-7592.37	16041.92	39627.79	63547.05
11.0	-49913.70	-30293.76	-11083.12	8430.47	27898.62	47666.95
12.0	-46001.68	-29615.91	-13601.05	2685.52	18929.56	35445.17
13.0	-42719.71	-28898.94	-15413.83	-1684.86	12004.41	25940.40
14.0	-39934.18	-28170.95	-16711.18	-5032.39	6609.44	18476.20
15.0	-37544.65	-27449.63	-17623.82	-7611.14	2372.19	12561.21
16.0	-35474.66	-26745.85	-18264.74	-9606.53	-980.19	7834.74
18.0	-32071.11	-25413.53	-18958.03	-12355.90	-5787.11	944.34
20.0	-29390.77	-24195.64	-19165.44	-14018.42	-8894.76	-3634.90
22.0	-27224.31	-23092.22	-19094.91	-15002.32	-10929.62	-6739.98
24.0	-25434.82	-22094.93	-18865.34	-15557.81	-12267.19	-8875.64
26.0	-23929.58	-21192.74	-18546.36	-15836.05	-13140.11	-10356.61
28.0	-22643.77	-20374.53	-18179.61	-15932.11	-13696.80	-11385.22
30.0	-21530.87	-19629.98	-17790.29	-15907.24	-14034.53	-12095.11

Table 13. Present net worths and rates of return for costs of mobile veterinary service with returns based on a livestock grazing capacity of 2560 animals per year per management unit with an initial sale of 3% and increases in animal sales at 0% to 5% each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-110761.87	64628.85	239076.91	414253.66	589366.25	764842.73
3.5	-99822.18	51614.46	202156.61	353386.66	504548.32	656036.71
4.0	-90458.31	40823.82	171258.90	302342.99	433355.39	564662.99
4.5	-82410.94	31854.39	145318.99	259395.64	373398.09	487668.82
5.0	-75466.94	24380.47	123472.04	223140.65	322733.16	422670.86
5.5	-69450.65	18137.87	105013.83	192433.72	279776.12	367343.79
6.0	-64216.93	12911.75	89369.44	166339.78	243231.64	320331.54
6.5	-59645.53	8527.02	76068.30	144092.75	212038.07	280176.41
7.0	-55636.50	4840.57	64724.27	125063.33	185322.91	245762.36
7.5	-52106.60	1735.18	55019.62	109733.25	162367.26	216169.59
8.0	-48986.25	-885.44	46692.25	94674.50	142577.17	190637.96
9.0	-43750.41	-4975.59	33339.20	72013.54	110608.87	149345.17
10.0	-39565.05	-7912.81	23335.73	54903.99	86394.27	118011.77
11.0	-36170.39	-10029.24	15758.30	1830.32	67825.75	93937.15
12.0	-33378.84	-11555.63	9958.36	31725.66	53418.01	75216.96
13.0	-31053.34	-12653.93	5475.53	23830.70	42112.74	60493.48
14.0	-29092.55	-13438.88	1979.49	17599.12	33147.60	48787.96
15.0	-27420.66	-13992.62	-769.34	12633.55	25967.37	39387.14
16.0	-25980.35	-14374.49	-2946.50	8641.89	20163.34	31765.52
18.0	-23628.81	-14784.24	-6073.10	2766.28	11543.13	20391.79
20.0	-21791.60	-14895.39	-8098.34	-1198.44	5643.35	12549.56
22.0	-20315.55	-14834.59	-9426.43	-3935.51	1501.64	6996.88
24.0	-19101.63	-14674.55	-10300.04	-5858.73	-1467.01	2977.29
26.0	-18083.43	-14458.11	-10869.81	-7227.42	-3630.65	13.81
28.0	-17215.22	-14211.02	-11232.06	-8209.17	-5228.17	-2203.82
30.0	-16464.22	-13949.01	-11450.06	-8915.32	-6418.97	-3883.20

Table 14. Present net worths and rates of return for mobile veterinary costs with returns based on a livestock grazing capacity of 3200 animals per year per management unit with an initial sale at 3% and increases in animal sales of 0% to 5% each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-71652.63	147929.47	366149.67	585050.82	776032.07	1022853.13
3.5	-64169.65	125434.48	313759.80	502724.53	667498.76	880653.97
4.0	-57805.39	106575.51	269755.26	433535.59	576281.63	761096.24
4.5	-52372.69	90711.52	232667.19	375187.13	499355.79	660227.01
5.0	-47717.93	77321.84	201300.97	325810.41	434259.12	574329.31
5.5	-43714.74	65982.43	174682.48	283881.09	378982.48	502278.31
6.0	-40258.91	56347.05	152015.33	248152.45	331882.16	440426.69
6.5	-37264.25	48132.25	132646.71	217602.19	291609.96	387513.16
7.0	-34659.36	41105.32	116040.07	191389.78	257057.13	342089.21
7.5	-32384.88	35074.73	101753.21	168822.26	227309.48	302960.35
8.0	-30391.36	29882.39	89420.75	149326.80	201611.22	269138.91
9.0	-27088.65	21511.42	69459.14	117733.03	159962.64	214380.82
10.0	-24494.53	15189.34	54293.88	93688.08	128258.20	172476.49
11.0	-22427.08	10357.32	42626.69	75153.58	103808.98	140207.34
12.0	-20756.01	6622.12	33541.89	60690.85	84717.93	114088.75
13.0	-19386.98	3703.89	26386.43	49273.14	69631.90	95046.55
14.0	-18250.91	1401.29	20689.35	40159.47	57575.00	79099.73
15.0	-17296.68	-432.20	16107.22	32809.17	47835.72	66213.07
16.0	-16486.03	-1904.34	12386.90	26823.37	39889.57	55696.30
18.0	-15186.52	-4065.08	6823.78	17828.93	27910.18	39839.23
20.0	-14192.44	-5513.68	2978.14	11563.43	19519.95	28734.02
22.0	-13406.79	-6503.29	249.43	7077.53	13474.17	20733.75
24.0	-12768.43	-7187.67	-1728.97	3790.76	9012.17	14830.21
26.0	-12237.38	-7663.49	-3188.74	1335.59	5652.22	10394.23
28.0	-11786.67	-7993.43	-4280.97	-528.12	3079.19	6077.58
30.0	-11397.56	-8219.29	-5107.05	-1961.80	1080.83	4328.71

of cattle sold. The percentage increases in animal sales each five years which would be necessary to yield a rate of return greater than 4% for lands with grazing capacities of 1280, 1920, 2560, and 3200 animal units per year per management unit would be 3%, 2%, 1%, and 1%, respectively (Tables 11, 12, 13, and 14). With these comparisons, the decision maker can determine the grazing capacity and livestock sales percentages feasible for his situation and determine if the mobile veterinary service would be an economically acceptable alternative.

Mobile Veterinary Service and Pond Construction

Costs

In this alternative, all of the services and costs associated with the mobile veterinary service (Table 6) are included plus water development. The system of water development evaluated is pond construction, as this is the type of development currently being used. Four ponds are needed per management unit. Ponds constructed in the planning area are illustrated in Figures 6, 7, 8, and 9. The plan in this analysis is directed to use range resources that have been economically used for the production of animals without causing serious problems and deterioration to rangelands because water is lacking.

In this alternative as in the previous alternative, it is anticipated that the full responsibility of managing the range and the entire livestock operations and to a certain extent the constructed ponds will be carried by the cattle owners. Advice and minimum supervision may be given mainly through the veterinary service employees and

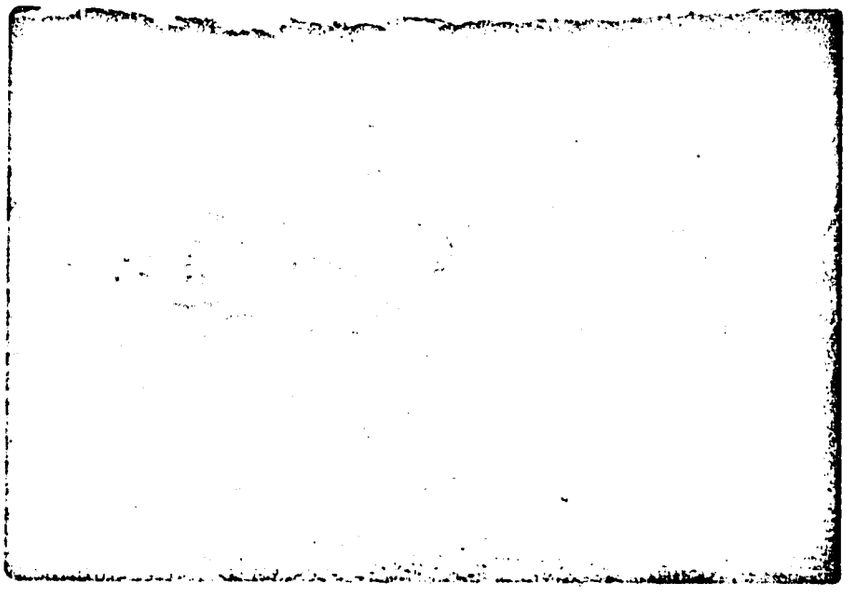

Figure 6. Heavy machinery constructing pond. -- Shown are four D7E caterpillars with scrapers and one with a bulldozer and a ripper attached.

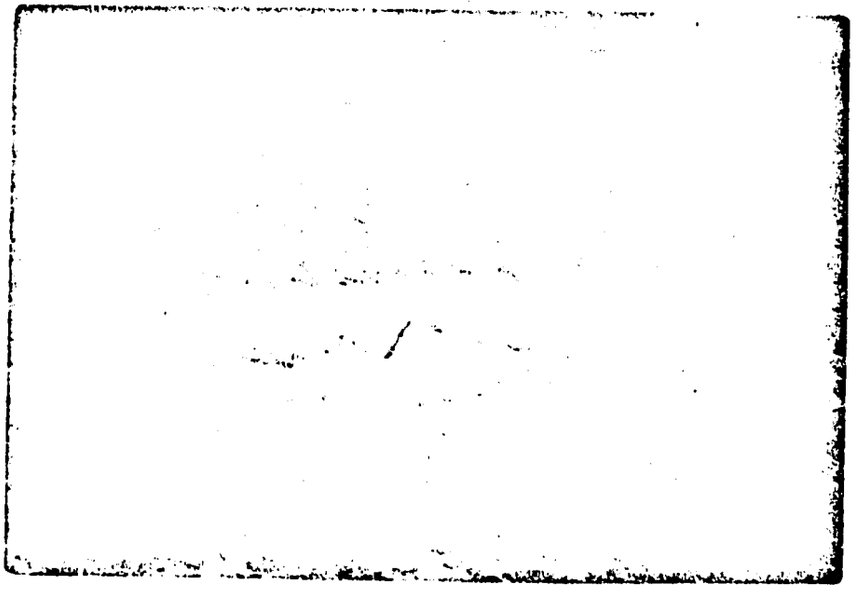

Figure 7. Design and general shape of a pond nearing completion.

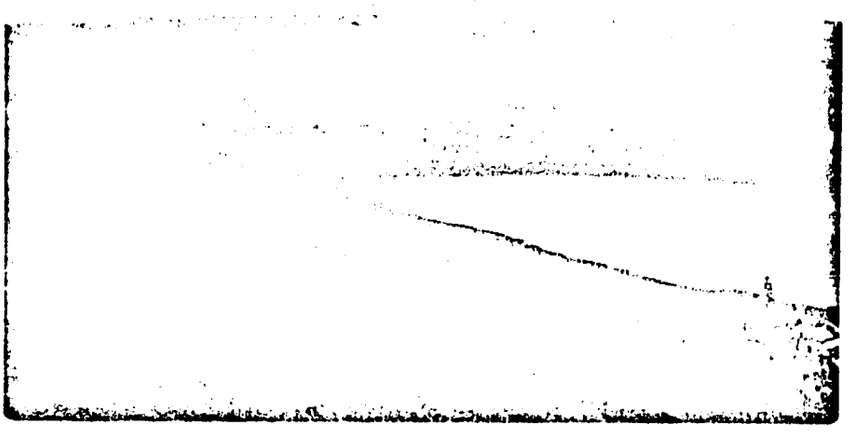

Figure 8. Portion of a pond in use. -- Location is about 23 kilometers north of Yabello, Sidamo Province, Ethiopia.

Figure 9. A brush fence in water between the cattle and the herders minimizes muddying of the water.

staff of the Ministry of Agriculture. The Ministry of Agriculture is not to take full management responsibility but make recommendations concerning proper management to the local elders and chiefs.

Marousek et al. (1969) reported that the cost of excavation in Ethiopia was $1.50 per cubic meter of earth removed. Jones (1969) estimated the average water-holding capacity of each pond already constructed by the Imperial Ethiopian Government Ministry of Agriculture and the United States Agency for International Development for the pilot range and livestock development project within the planning area was approximately 15,000 cubic meters, excluding the back-up water in the draw.

The initial financial expenditure for ponds was calculated by assuming the entire pond development operation is to be constructed by private contractors using current designs and specification of pond construction at current cost per cubic meter. The average pond capacity is estimated to be 15,000 cubic meters and the cost of excavation is $1.50 per cubic meter of earth removed. Thus, the initial construction cost per pond will be $22,500 or $90,000 per management unit (Table 15).

Maintenance and repair work are assumed to occur each 10 years. Because of this delayed service to ponds, we have allocated a large periodic cost, one-third of the initial construction cost, to be used every 10 years in maintenance and repair of ponds during the planning period. This periodic maintenance cost is shown in Table 15.

Table 15. Total cost per management unit for a mobile veterinary service and for four ponds with maintenance costs once every 10 years.

Years	Total veterinary expense	Initial cost of pond construction	Pond maintenance costs	Total costs
1	Eth $ 23987.40	Eth $ 90,000		Eth $ 113987.40
3	12344.40			12344.40
5	24701.20			24701.20
7	13061.00			13061.00
9	13414.00		Eth $ 30,000	43414.00
11	25768.60			25768.60
13	14128.40			14128.40
15	26485.20			26485.20
17	14842.00			14842.00
19	15199.00		30,000	45199.00
21	27555.60			27555.60
23	15912.40			15912.40
25	28313.80			28313.80
27	16849.00			16849.00
29	17384.20		30,000	47384.20
31	29919.40			29919.40
33	18454.60			18454.60
35	30989.80			30989.80
37	19525.00			19525.00
39	20060.20		30,000	50060.20
41	32595.40			32595.40
43	21130.60			21130.60
45	33665.80			33665.80
47	22201.00			22201.00
49	22736.20			22736.20

The purpose of this alternative is to provide data which can be used to evaluate economic returns when the responsibility for management is vested upon the users rather than the Ministry of Agriculture. What happens when water is provided but no government management is practiced? The total costs for this alternative summarized by 2-year periods are shown in Table 15.

Salable Cattle

Salable cattle data utilized to estimate returns for this alternative were the same as for the previous alternative and are shown in Tables 7, 8, 9, and 10. Because of the increased investment to develop water for range livestock production, the range is assumed to support a greater number of livestock than range without this water development. This is because use can be made of range resources previously unused due to water shortage.

Rates of Returns

Four levels of grazing capacity are also considered in this analysis (Tables 7, 8, 9, and 10). To obtain an economically justifiable return from the total financial allocation invested by the Government, there must be rates of return greater than 4%. The minimum 5-year increase in cattle sales necessary to satisfy development costs from the four levels of grazing capacity, 1280, 1920, 2560, and 3200 animal units per year per management unit would be 5%, 3%, 2%, and 2%, respectively (Tables 16, 17, 18, and 19). There is a wide gap in

Table 16. Present net worths and rates of return for costs of mobile veterinary service and water development with returns based on a livestock grazing capacity of 1280 animals per year per management unit with an initial sale of 3% and increases in animal sales of 0% to 5% each 5 years.

Discount rates	Increase in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-340721.46	-252458.19	-164842.15	-77281.44	10334.60	97082.13
3.5	-316481.65	-240272.66	-164628.84	-89042.61	-13398.79	61448.99
4.0	-295456.22	-229389.28	-163817.77	-98305.19	-32733.69	32105.54
4.5	-277139.41	-219635.39	-162567.29	-105558.74	-48490.64	7901.50
5.0	-261112.82	-210863.82	-160999.70	-111195.21	-61331.10	-12092.97
5.5	-247029.38	-202948.85	-159209.27	-115528.97	-71789.38	-28631.27
6.0	-234600.31	-195782.89	-157268.40	-118812.55	-80298.06	-42325.24
6.5	-223584.66	-189273.62	-155232.53	-121249.18	-87208.08	-53672.91
7.0	-213780.77	-183341.72	-153143.85	-123002.66	-92804.79	-63080.62
7.5	-205019.42	-177918.85	-151034.30	-124205.21	-97320.66	-70880.65
8.0	-197158.12	-172945.98	-148927.78	-124963.73	-100945.53	-77345.38
9.0	-183672.92	-164152.78	-144789.93	-125478.44	-106115.59	-87124.58
10.0	-172565.93	-156629.06	-140820.72	-125060.80	-109252.47	-93777.05
11.0	-163286.44	-150121.99	-137063.25	-124049.96	-110991.23	-98232.25
12.0	-155430.12	-144437.77	-133532.85	-122670.47	-111765.55	-101131.85
13.0	-148696.54	-139426.44	-130229.01	-121071.27	-111873.85	-102922.81
14.0	-142859.80	-134970.84	-127142.55	-119351.21	-111522.92	-103919.27
15.0	-137748.02	-130978.56	-124259.95	-117575.67	-110857.06	-104343.83
16.0	-133228.93	-127376.05	-121565.92	-115787.66	-109977.53	-104355.78
18.0	-125578.99	-121115.13	-116681.77	-112275.75	-107842.39	-103568.52
20.0	-119319.27	-115835.64	-112374.01	-108935.74	-105474.11	-102148.56
22.0	-114070.40	-111298.98	-108543.57	-105808.06	-103052.65	-100414.08
24.0	-109579.43	-107338.57	-105189.46	-102897.26	-100668.15	-98539.89
26.0	-105671.92	-103834.87	-102006.49	-100192.48	-98364.10	-96623.22
28.0	-102223.96	-100699.96	-99182.42	-97677.07	-96159.53	-94718.21
30.0	-99145.13	-97867.74	-96595.20	-95333.00	-94060.46	-92854.58

Table 17. Present net worths and rates of return for costs of mobile veterinary service and water development with returns based on a livestock grazing capacity of 1920 animals per year per management unit with an initial sale of 3% and increases in animal sales of 0% to 5% each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-299553.84	-168915.95	-37630.84	93709.61	224994.71	357150.90
3.5	-278952.67	-166196.93	-52876.03	60502.47	173823.37	287942.70
4.0	-261084.73	-163371.35	-65162.53	33105.21	131314.04	230257.36
4.5	-245520.20	-160504.28	-75052.43	10458.95	95910.80	182040.65
5.0	-231903.34	-157642.90	-82997.57	-8292.61	66352.72	141625.96
5.5	-219938.95	-154820.87	-89361.85	-23843.54	41615.48	107657.77
6.0	-209381.33	-152061.64	-94439.01	-36757.74	20864.89	79030.86
6.5	-200025.42	-149380.97	-98466.59	-47494.45	3419.93	54841.80
7.0	-191699.58	-146788.91	-101637.07	-56428.55	-11276.71	34350.29
7.5	-184259.72	-144291.24	-104106.75	-63866.79	-23682.30	16948.09
8.0	-177584.54	-141890.63	-106002.78	-70060.77	-34172.92	2134.25
9.0	-166134.23	-137380.47	-108469.42	-79507.02	-50595.97	-21311.99
10.0	-156702.23	-133244.90	-109659.03	-86024.75	-62438.88	-38519.14
11.0	-148819.79	-129457.36	-109989.22	-90475.62	-71007.47	-51233.72
12.0	-142142.92	-125986.32	-109742.28	-93455.72	-77211.68	-60695.70
13.0	-136416.15	-122799.55	-109110.27	-95381.31	-81692.03	-67755.72
14.0	-131447.55	-119866.38	-108224.55	-96545.76	-84903.92	-73036.89
15.0	-127091.20	-117158.71	-107175.37	-97157.70	-87174.36	-76985.10
16.0	-123234.92	-114651.33	-106024.99	-97366.79	-88740.45	-79925.30
18.0	-116692.36	-110151.08	-103579.29	-96980.16	-90408.37	-83676.75
20.0	-111320.15	-106218.48	-101094.82	-95947.80	-90824.14	-85564.14
22.0	-106798.02	-102741.32	-98668.62	-94576.03	-90503.32	-86313.59
24.0	-102912.90	-99634.03	-96343.42	-93035.88	-89745.27	-86353.64
26.0	-99518.14	-96830.87	-94134.92	-91424.61	-88728.67	-85945.11
28.0	-96509.70	-94280.84	-92045.33	-89798.03	-87562.72	-85251.09
30.0	-93811.80	-91943.93	-90071.22	-88188.17	-86315.46	-84376.01

Table 18. Present net worths and rates of return for costs of mobile veterinary service and for water development with returns based on a livestock grazing capacity of 2560 animals per year per management unit with an initial sale of 3% and increases in animal sales of 0% to 5% each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-260444.59	-85734.83	89394.18	264570.93	439683.53	615161.30
3.5	-243300.13	-92502.89	58678.67	209908.72	361070.38	512559.96
4.0	-228431.81	-97750.26	33285.41	164369.49	295381.90	426690.60
4.5	-215481.94	-101780.88	12247.99	126324.64	240327.09	354598.85
5.0	-204154.34	-104837.25	-5215.36	94453.25	194045.76	293884.42
5.5	-194203.05	-107113.09	-19738.57	67681.32	155023.72	242592.29
6.0	-185423.31	-108763.46	-31836.94	45133.40	122025.27	199126.00
6.5	-177644.15	-109912.62	-41930.33	26094.12	94039.44	162178.56
7.0	-170722.44	-110660.34	-50361.68	9977.39	70236.96	130677.14
7.5	-164538.01	-111086.79	-57411.79	-3698.16	49935.85	103738.85
8.0	-158989.64	-111256.53	-63311.14	-15328.89	32573.78	80635.19
9.0	-149472.47	-111023.82	-72382.86	-33708.52	4886.81	43623.66
10.0	-141631.71	-110269.14	-78730.94	-47162.68	-15672.39	15945.59
11.0	-135076.48	-109192.84	-83147.79	-57075.77	-31680.34	-4968.53
12.0	-129520.08	-107926.05	-86182.88	-64415.58	-42723.23	-20923.91
13.0	-124749.79	-106554.54	-88220.91	-69865.75	-51583.70	-33202.65
14.0	-120605.91	-105134.32	-89533.88	-73914.25	-58365.77	-42725.12
15.0	-116967.22	-103701.71	-90315.89	-76913.00	-63579.19	-50159.17
16.0	-113740.60	-102279.98	-90706.76	-79118.37	-67596.92	-55994.52
18.0	-108250.07	-00521.79	-90694.35	-81854.97	-73078.13	-64229.30
20.0	-103720.98	-96918.24	-90027.72	-83127.82	-76286.03	-69379.69
22.0	-99589.26	-94483.69	-89000.13	-83509.21	-78072.07	-72576.72
24.0	-96579.70	-92213.66	-87778.12	-83336.81	-78945.09	-74500.71
26.0	-93672.04	-90096.23	-86458.73	-82815.98	-79219.21	-75574.69
28.0	-91081.15	-88117.33	-85097.99	-82075.10	-79094.09	-76069.70
30.0	-88745.15	-86262.96	-83731.00	-81196.25	-78693.91	-76164.10

Table 19. Present net worths and rates of return for costs of mobile veterinary service and water development with returns based on a livestock grazing capacity of 3200 animals per year per management unit with an initial sale of 3% and increases in animal sales of 0% to 5% each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-221335.85	-2434.20	216466.95	435368.10	626349.35	873171.69
3.5	-207647.59	-18682.86	170281.86	359246.58	524020.82	737177.23
4.0	-195778.89	-31998.56	131781.76	295562.09	438308.14	623123.85
4.5	-185443.69	-42923.75	99596.19	242116.12	366284.79	527157.04
5.0	-176405.33	-51895.88	72613.57	197123.01	305571.72	446142.87
5.5	-168467.14	-59268.53	49930.08	159128.69	254230.08	377526.80
6.0	-161465.28	-65328.16	30808.96	126946.08	210675.79	319221.15
6.5	-155262.88	-70307.40	14648.09	99603.57	173611.34	269515.31
7.0	-149745.31	-74395.60	954.12	76303.83	141971.19	227003.99
7.5	-144816.29	-77747.25	-10678.20	56390.85	114878.07	190529.61
8.0	-140394.75	-80488.70	-20582.64	39323.41	91607.82	159136.14
9.0	-132810.71	-84536.81	-36262.92	12010.98	54240.58	108559.32
10.0	-126561.19	-87166.99	-47772.78	-8378.58	26191.54	70410.31
11.0	-121333.17	-88806.28	-56279.40	-23752.52	4902.89	41301.67
12.0	-116897.24	-89748.29	-62599.34	-35450.39	-11423.30	18847.87
13.0	-113083.42	-90196.72	-67310.01	-44423.31	-24064.55	1350.42
14.0	-109764.27	-90294.15	-70824.02	-51353.89	-33938.36	-12413.36
15.0	-106843.23	-90141.28	-73439.33	-56737.38	-41710.84	-23333.24
16.0	-104246.29	-89809.82	-75373.36	-60936.89	-47870.69	-32063.74
18.0	-99807.78	-88802.63	-77797.48	-66792.33	-56711.07	-44781.85
20.0	-96121.82	-87536.53	-78951.23	-70365.94	-62409.43	-53195.23
22.0	-92980.50	-86152.39	-79324.28	-72496.17	-66099.54	-58839.86
24.0	-90246.50	-84726.78	-79207.05	-73687.32	-68465.91	-62647.78
26.0	-87825.94	-83301.62	-78777.30	-74252.97	-69936.34	-65204.27
28.0	-85652.60	-81899.75	-78146.90	-74394.05	-70786.74	-66888.30
30.0	-83678.49	-80533.24	-77387.98	-74242.73	-71200.10	-67952.19

maximum rate of return, 4.5% versus 7.0%, at 2% sale increase between the last two levels of grazing capacities, 2560 and 3200.

Water Development with Permanent Headquarters for Veterinary Service, Management Personnel, and Maintenance Crews

Costs

This is a complete range planning and development program as far as management and organization is concerned. This alternative includes veterinary service and water development and, in addition, includes regular maintenance and a full management program.

Maximum supervision and management are provided with all the needed personnel employed. Unlike the previous alternatives, the management of the range and livestock as well as the use of water is not to be left to the producers but is supervised by the Ministry of Agriculture personnel. Thus, the water development program is expected to be followed with proper range management and livestock production systems.

Following the initial pond development or construction costs, periodic maintenance costs are assumed. These costs for pond construction and maintenance are covered in heavy machine costs and operations (Table 20). The assumption made in this alternative is that all of the ponds that are constructed will be usable during the entire life of the project.

This alternative has a considerable amount of financial requirement for salaries, housing, water development, transportation costs, veterinary services, and heavy machinery.

Table 20. Cost of heavy machines allocated per management unit.*

Year	Fuel and repairs	Initial cost plus maintenance	Added every 2 years	Year	Fuel and repairs	Initial cost plus maintenance	Added every 2 years
1	Eth $2083.30	Eth $22916.30	Eth $24999.60	26	Eth $4166.60	Eth $4166.60	
2	2083.30	2083.30		27	4166.60	4166.60	Eth $8333.20
3	2083.30	2083.30	4166.60	28	4166.60	4166.60	
4	2083.30	2083.30		29	4166.60	4166.60	8333.20
5	2083.30	2083.30	4166.60	30	4166.60	4166.60	
6	2083.30	2083.30		31	4166.60	4166.60	8333.20
7	2083.30	2083.30	6249.90	32	4166.60	4166.60	
8	4166.60	4166.60		33	2083.30	22916.30	24999.60
9	4166.60	4166.60	8333.20	34	2083.30	2083.30	
10	4166.60	4166.60		35	2083.30	2083.30	4166.60
11	4166.60	4166.60	8333.20	36	2083.30	2083.30	
12	4166.60	4166.60		37	2083.30	2083.30	4166.60
13	4166.60	4166.60	8333.20	38	2083.30	2083.30	
14	4166.60	4166.60		39	2083.30	2083.30	4166.60
15	4166.60	4166.60	8333.20	40	2083.30	2083.30	
16	4166.60	4166.60		41	4166.60	4166.60	8333.20
17	2083.30	22916.30	24999.60	42	4166.60	4166.60	
18	2083.30	2083.30		43	4166.60	4166.60	8333.20
19	2083.30	2083.30	4166.60	44	4166.60	4166.60	
20	2083.30	2083.30		45	4166.60	4166.60	8333.20
21	2083.30	2083.30	4166.60	46	4166.60	4166.60	
22	2083.30	2083.30		47	4166.60	4166.60	8333.20
23	2083.30	2083.30	6249.90	48	4166.60	4166.60	
24	4166.60	4166.60		49	4166.60	4166.60	8333.20
25	4166.60	4166.60	8333.20	50	4166.60	4166.60	

*. Total initial cost is Ethiopian $1,000,000/48 management units or $20,833/management unit with 10% maintenance cost for 1 to 7 years and 20% maintenance cost for 8 to 10 years. All replaced at 17 and 33 years.

Costs considered in this alternative and the tables where cost data are presented are as follows:

1. Salaries for project employees:
   a. Project director (Table 2)
   b. Project manager (Table 21)
   c. Project administrator (Table 21)
   d. Chief veterinarian (Table 2)
   e. Livestock marketing expert (Table 22)
   f. Extension supervisor (Table 22)
   g. Accountant (Table 22)
   h. Two mechanics (Table 23)
   i. Four mechanic helpers (Table 22)
   j. Animal health officer (Table 3)
   k. Two secretaries (Table 22)
   l. Three drivers (Table 22)
   m. Two vaccinators (Table 4)
   n. Four caterpillar operators (Table 24)
   o. Four assistant operators (Table 2)
2. Operational expenses for veterinary services (Table 5)
3. Costs of vaccines (Table 5)
4. Transportation costs (Table 25)
5. Water supplies for headquarters (Table 26)
6. Housing costs (Table 27)
7. Heavy machinery costs (Table 20)

The total costs for the third alternative are shown in Table 28.

Table 21. Salary of project manager allocated as a cost per year per management unit for 50-year planning period.*

Year	Annual increment	Base salary plus annual increment	Salary each two years	Year	Annual increment	Base salary plus annual increment	Salary each two years
1	Eth $ 3.50	Eth $ 178.50	Eth $ 360.50	26	Eth $ 5.25	Eth $ 267.75	
2	7.00	182.00		27	10.50	273.00	Eth $ 551.25
3	10.50	185.50	374.50	28	15.75	278.25	
4	14.00	189.00		29	21.00	283.50	572.25
5	17.50	192.50	388.50	30	26.25	288.75	
6	21.00	196.00		31	31.50	294.00	593.25
7	24.50	199.50	403.00	32	36.75	299.25	
8	28.50	203.50		33	42.00	304.50	614.25
9	31.50	206.50	416.50	34	47.25	307.25	
10	35.00	210.00		35	52.50	315.00	635.25
11	38.50	213.50	430.50	36	57.75	320.25	
12	42.00	217.00		37	63.00	325.50	656.25
13	45.50	220.50	444.50	38	68.25	330.75	
14	49.00	224.00		39	73.50	336.00	677.25
15	52.50	227.00	458.50	40	78.75	341.25	
16	56.00	231.00		41	84.00	346.50	698.25
17	59.50	234.00	472.50	42	89.25	351.75	
18	63.00	238.00		43	94.50	357.00	719.25
19	66.50	241.50	486.50	44	99.75	362.25	
20	70.00	245.00		45	105.00	367.50	740.25
21	73.50	248.50	500.50	46	110.25	372.75	
22	77.00	252.00		47	115.50	378.00	761.25
23	80.50	255.50	514.50	48	120.75	383.25	
24	84.00	259.00		49	126.00	388.50	782.25
25	87.50	262.50	530.25	50	131.25	393.75	

*. Base salary at beginning is $8400 per year for 48 management units or $175.00 per year per management unit. This salary scale was also used for project administrator.

Table 22. Salary of livestock marketing expert allocated as a cost per management unit for 50-year planning period.*

Year	Annual increment	Base salary plus annual increment	Added every 2 years	Year	Annual increment	Base salary plus annual increment	Added every 2 years
1	Eth $ 3.00	Eth $ 153.00	Eth $ 309.00	26	Eth $ 4.50	Eth $229.50	
2	6.00	156.00		27	9.00	234.00	Eth $ 472.50
3	9.00	159.00	321.00	28	13.50	238.50	
4	12.00	162.00		29	18.00	243.00	490.50
5	15.00	165.00	333.00	30	22.50	247.50	
6	18.00	168.00		31	27.00	252.00	508.50
7	21.00	171.00	345.00	32	31.50	256.50	
8	24.00	174.00		33	36.00	261.00	526.50
9	27.00	177.00	357.00	34	40.50	265.50	
10	30.00	180.00		35	45.00	270.00	544.50
11	33.00	183.00	369.00	36	49.50	274.50	
12	36.00	186.00		37	54.00	279.00	562.50
13	39.00	189.00	381.00	38	58.50	283.50	
14	42.00	192.00		39	63.00	288.00	580.50
15	45.00	195.00	393.00	40	67.50	292.50	
16	48.00	198.00		41	72.00	297.00	598.50
17	51.00	201.00	405.00	42	76.50	301.50	
18	54.00	204.00		43	81.00	306.00	616.50
19	57.00	207.00	417.00	44	85.50	310.50	
20	60.00	210.00		45	90.00	315.00	634.50
21	63.00	213.00	429.00	46	94.50	319.50	
22	66.00	216.00		47	99.00	324.00	652.50
23	69.00	219.00	441.00	48	103.50	328.50	
24	72.00	222.00		49	108.00	333.00	670.50
25	75.00	225.00	454.50	50	112.50	337.50	

*. Base salary at beginning is $7200 per year for 48 management units or $150 per year per management unit. This salary scale was used for extension supervisor, accountant, two secretaries, three all-purpose drivers, and four mechanic helpers.

Table 23. Salary of two head mechanics allocated as cost per management unit for 50-year planning period.*

Year	Annual increment	Base salary plus annual increment	Salary each two years	Year	Annual increment	Base salary plus annual increment	Salary each two years
1	Eth $ 7	Eth $ 357.00	Eth $ 721.0	26	Eth $ 10.50	Eth $ 535.50	
2	14	364.00		27	21.00	546.00	Eth $ 1102.5
3	21	371.00	749.0	28	31.50	556.50	
4	28	378.00		29	42.00	567.00	1144.5
5	35	385.00	777.0	30	52.50	577.50	
6	42	392.00		31	63.00	588.00	1186.5
7	49	399.00	805.0	32	73.50	598.50	
8	56	406.00		33	84.00	609.00	1228.5
9	63	413.00	833.0	34	94.50	619.50	
10	70	420.00		35	105.00	630.00	1270.5
11	77	427.00	861.0	36	115.50	640.50	
12	84	434.00		37	126.00	651.00	1312.5
13	91	441.00	889.0	38	136.50	661.50	
14	98	448.00		39	147.00	672.00	1354.5
15	105	455.00	917.0	40	157.50	682.50	
16	112	462.00		41	168.00	693.00	1395.5
17	119	469.00	945.0	42	178.50	703.50	
18	126	476.00		43	189.00	714.00	1438.5
19	133	483.00	973.00	44	199.50	724.50	
20	140	490.00		45	210.00	735.00	1480.5
21	147	497.00	1001.00	46	220.50	745.50	
22	154	504.00		47	231.00	756.00	1522.5
23	161	511.00	1029.00	48	241.50	766.50	
24	168	518.00		49	252.00	777.00	1564.5
25	175	525.00	1060.50	50	262.50	787.50	

*. Base salary at beginning is $16,800 / 2 men / 48 management units or $350.00 per year per management unit.

Table 24. Salary of four caterpillar operators allocated as a cost per year per management unit for 50-year planning period.*

Year	Annual increment	Base salary plus annual increment	Added every 2 years	Year	Annual increment	Base salary plus annual increment	Added every 2 years
1	Eth $ 6.00	Eth $ 306.00	Eth $ 618.00	26	Eth $ 9.00	Eth $ 459.00	
2	12.00	312.00		27	18.00	468.00	Eth $ 945.00
3	18.00	318.00	642.00	28	27.00	477.00	
4	24.00	324.00		29	36.00	486.00	981.00
5	30.00	330.00	666.00	30	45.00	495.00	
6	36.00	336.00		31	54.00	504.00	1017.00
7	42.00	342.00	690.00	32	63.00	513.00	
8	48.00	348.00		33	72.00	522.00	1053.00
9	54.00	354.00	714.00	34	81.00	531.00	
10	60.00	360.00		35	90.00	540.00	1089.00
11	66.00	366.00	738.00	36	99.00	549.00	
12	72.00	372.00		37	108.00	558.00	1125.00
13	78.00	378.00	762.00	38	117.00	567.00	
14	84.00	384.00		39	126.00	576.00	1161.00
15	90.00	390.00	786.00	40	135.00	585.00	
16	96.00	396.00		41	144.00	594.00	1197.00
17	102.00	402.00	810.00	42	153.00	603.00	
18	108.00	408.00		43	162.00	612.00	1233.00
19	114.00	414.00	834.00	44	171.00	621.00	
20	120.00	420.00		45	180.00	630.00	1269.00
21	126.00	426.00	858.00	46	189.00	639.00	
22	132.00	432.00		47	198.00	648.00	1305.00
23	138.00	438.00	882.00	48	207.00	657.00	
24	144.00	444.00		49	216.00	666.00	1341.00
25	150.00	450.00	909.00	50	225.00	675.00	

*. Base salary at beginning is $14,400 per year for 48 management units or $300 per year per management unit.

Table 25. Project vehicles costs allocated as costs per management unit for 50-year planning period.*

Year	Fuel & repair (3% of initial cost	Initial cost plus repair & fuel	Added every two years	Year	Fuel & repair (3% of initial cost	Initial cost plus repair & fuel	Added every two years
1	Eth $ 37.50	Eth $ 1287.50	Eth $ 1325.00	26	Eth $ 37.50	Eth $ 1287.50	
2	37.50	37.50		27	37.50	37.50	Eth $ 75.00
3	37.50	37.50	75.00	28	37.50	37.50	
4	37.50	37.50		29	37.50	37.50	75.00
5	37.50	37.50	1325.00	30	37.50	37.50	
6	37.50	1287.50		31	37.50	1287.50	1325.00
7	37.50	37.50	75.00	32	37.50	37.50	
8	37.50	37.50		33	37.50	37.50	75.00
9	37.50	37.50	75.00	34	37.50	37.50	
10	37.50	37.50		35	37.50	37.50	1325.00
11	37.50	1287.50	1325.00	36	37.50	1287.00	
12	37.50	37.50		37	37.50	37.50	75.00
13	37.50	37.50	75.00	38	37.50	37.50	
14	37.50	37.50		39	37.50	37.50	75.00
15	37.50	37.50	1325.00	40	37.50	37.50	
16	37.50	1287.50		41	37.50	1287.50	1325.00
17	37.50	37.50	75.00	42	37.50	37.50	
18	37.50	37.50		43	37.50	37.50	75.00
19	37.50	37.50	75.00	44	37.50	37.50	
20	37.50	37.50		45	37.50	37.50	1325.00
21	37.50	1287.50	1325.00	46	37.50	1287.50	
22	37.50	37.50		47	37.50	37.50	75.00
23	37.50	37.50	75.00	48	37.50	37.50	
24	37.50	37.50		49	37.50	37.50	75.00
25	37.50	37.50	1325.00	50	37.50	37.50	

*. Initial cost is $60,000 per 48 management units per 5 years or $1250/management unit per 5 years.

Table 26. Headquarters water supply expenses (well) allocated as a cost per management unit for 50-year planning period.*

Year	Maintenance (5% of orig. cost)	Initial cost plus maintenance	Added every two years	Year	Maintenance (10% of orig. cost)	Initial cost plus maintenance	Added every two years
1	Eth $ 38.54	Eth $ 809.32	Eth $847.86	26	Eth $ 77.08	Eth $ 77.08	
2	38.54	38.54		27	77.08	77.08	Eth $ 154.16
3	38.54	38.54	77.08	28	77.08	77.08	
4	38.54	38.54		29	77.08	77.08	154.16
5	38.54	38.54	77.08	30	77.08	77.08	
6	38.54	38.54		31	77.08	77.08	154.16
7	38.54	38.54	77.08	32	77.08	77.08	
8	38.54	38.54		33	77.08	77.08	154.16
9	38.54	38.54	77.08	34	77.08	77.08	
10	38.54	38.54		35	77.08	77.08	154.16
11	38.54	38.54	77.08	36	77.08	77.08	
12	38.54	38.54		37	77.08	77.08	154.16
13	38.54	38.54	77.08	38	77.08	77.08	
14	38.54	38.54		39	77.08	77.08	154.16
15	38.54	38.54	77.08	40	77.08	77.08	
16	38.54	38.54		41	77.08	77.08	154.16
17	38.54	38.54	77.08	42	77.08	77.08	
18	38.54	38.54		43	77.08	77.08	154.16
19	38.54	38.54	77.08	44	77.08	77.08	
20	38.54	38.54		45	77.08	77.08	154.16
21	38.54	38.54	77.08	46	77.08	77.08	
22	38.54	38.54		47	77.08	77.08	154.16
23	38.54	38.54	77.08	48	77.08	77.08	
24	38.54	38.54		49	77.08	77.08	154.16
25	38.54	38.54	115.62	50	77.08	77.08	

*. Initial cost of $770.80 and maintenance costs of $38.54 (5% for 1 to 25) and $77.08 (10% for 26 to 50 years).

Table 27. Housing expenses allocated as a cost per management unit for 50-year planning period.*

Year	Maintenance cost	Initial cost plus maintenance	Added every 2 years	Year	Maintenance cost	Initial cost plus maintenance	Added every 2 years
1	Eth. $ 270.80	Eth $13810.80	Eth $14080.80	26	Eth $ 406.20	Eth $ 406.20	
2	270.80	270.80		27	406.20	406.20	Eth $ 812.00
3	270.80	270.80	541.60	28	406.20	406.20	
4	270.80	270.80		29	406.20	406.20	812.00
5	270.80	270.80	541.60	30	406.20	406.20	
6	270.80	270.80		31	406.20	406.20	812.00
7	270.80	270.80	541.60	32	406.20	406.20	
8	270.80	270.80		33	406.20	406.20	812.00
9	270.80	270.80	541.60	34	406.20	406.20	
10	270.80	270.80		35	406.20	406.20	812.00
11	270.80	270.80	541.60	36	406.20	406.20	
12	270.80	270.80		37	406.20	406.20	812.00
13	270.80	270.80	541.60	38	406.20	406.20	
14	270.80	270.80		39	406.20	406.20	812.00
15	270.80	270.80	541.60	40	406.20	406.20	
16	270.80	270.80		41	406.20	406.20	812.00
17	270.80	270.80	541.60	42	406.20	406.20	
18	270.80	270.80		43	406.20	406.20	812.00
19	270.80	270.80	541.60	44	406.20	406.20	
20	270.80	270.80		45	406.20	406.20	812.00
21	270.80	270.80	541.60	46	406.20	406.20	
22	270.80	270.80		47	406.20	406.20	812.00
23	270.80	270.80	541.60	48	406.20	406.20	
24	270.80	270.80		49	406.20	406.20	812.00
25	270.80	270.80	3481.98	50	406.20	406.20	

*. Initial cost of $13540 and maintenance cost is $270.80 per year per management unit for the first 25 years and $406.20 for after 25 years.

Table 28. Total costs allocated for 50-year planning period for a mobile veterinary service, water development, and for a complete management and maintenance unit.

Years	Added years	Total
1	1-2	Eth $ 69979.00
3	3-4	22127.00
5	5-6	35918.00
7	7-8	25296.00
9	9-10	27915.00
11	11-12	41703.00
13	13-14	28997.00
15	15-16	42788.00
17	17-18	46745.00
19	19-20	26454.00
21	21-22	40244.00
23	23-24	29618.00
25	25-26	48539.00
27	27-29	33468.00
29	29-30	34280.00
31	31-32	48341.00
33	33-34	52568.00
35	35-36	45797.00
37	37-38	33358.00
39	39-40	34169.00
41	41-42	52397.00
43	43-44	39958.00
45	45-46	54019.00
47	47-48	41499.00
49	49-50	42392.00

In this analysis, the transportation and camping facilities for the mobile veterinary unit have also been included and considered essential; therefore, whatever resources have been allocated in the previous alternatives to operate an efficient mobile unit are also included here.

The construction and maintenance cost of ponds in this alternative are not to be done by private contractors, but instead a considerable amount of money is allocated for the purpose of purchasing heavy machinery, so the whole water development phase is to be done by the government. Therefore, instead of showing initial and maintenance cost of ponds, I have shown initial and maintenance costs of heavy machinery employed in water development.

This alternative has been provided with greater overhead cost than the previous two alternatives. I have included the management personnel, established headquarters, and allocated considerable amounts of capital for heavy machinery and transport vehicles, provision of water, and housing facilities. Many factors were considered in this alternative that were not included in the previous alternatives.

Functions of Management Personnel

A complete administrative and management system to improve range and livestock production in addition to the mobile veterinary service and water development should encourage economic growth and development of the planning areas. The rangeland with this kind of management and investment is expected to respond better and be more productive than under the previously discussed development alternatives.

With this system of range and livestock development, one of the most important contributions to the nation's economic growth and development could be achieved through the management's effort to develop the great potential human resource. This particular phase could be achieved through a well-planned and organized training program directed to bring about cultural and social changes. The training program could be geared to inform livestock producers on how to manage their available resources in order to achieve economic goals.

Success in economic development in this case may depend on how much and to what extent the human resource has been involved during the planning period. Responsibilities to develop should be equally shared by the producers; otherwise there will be no consistent economic growth or development.

The responsibilities to be given to the management unit, and the services provided, should lead the livestock industry of the planning area to move toward an efficient and economically sound production and management system. The investment considered in this analysis, therefore, should have greater possibilities in achieving the planned goals than the two previously discussed alternatives. The opportunity of achieving a higher grazing capacity and greater annual returns to the investment should be expected to be much higher than development without provisions for management and education.

Personnel employed for this development program should be fully utilized if economic benefit from the total investment is to be realized. The risks and economic losses that could occur from mismanaging the

available resources could be great if the management fails to handle the situation properly and also if the plan to be followed is programmed poorly at the beginning. This investment, therefore, requires considerable administrative and managerial ability and efficiency in order to avoid any economic failure that may occur as a result of the above weaknesses.

The project director, project manager, extension supervisor, and livestock marketing expert should have strong backgrounds in range and animal science. These personnel will have the responsibility to plan the financing and selecting of locations for water development and to execute the construction and maintenance of ponds. They must also supervise the maintenance of equipment used to maintain the ponds.

They are also expected to organize and conduct demonstrations, field days, and formal and informal discussions with producers to encourage better herd production through selection, management, and feeding, and to encourage marketing of surplus animals. They must conduct range analyses to determine grazing capacities and to enforce proper stocking rates. They also will coordinate effective veterinary service and other agricultural and interagency activities such as health and education.

Salable Cattle

The procedure used in establishing cattle sale returns in this alternative is the same as in the previous two alternatives discussed in detail earlier. Salable cattle data are shown in Tables 7, 8, 9, and 10. The main difference between this alternative and the

alternatives discussed prior to this one is that this section has included complete management costs, which are not allocated for the previous alternatives, and additional livestock sales are expected from these additional management and development costs.

Rates of Returns

Using the same four levels of grazing capacity (Tables 7, 8, 9, and 10) as analyzed and discussed in the previous two development alternatives and the total development and maintenance costs allocated for this alternative, it is not economically justifiable (provide a rate of return of 4% or more) if the percentage increase of cattle sale is less than 2% each five years for the lower grazing capacity levels.

From this analysis, the first three levels of grazing capacities have all shown negative rates of returns up to 2% increase in percentage sales each five years (Tables 29, 30, and 31). The only grazing level considered economically acceptable even with increases of animal sales of 2% each five years was the last grazing capacity with 3200 animal units per year per management unit (Table 32).

Because of the huge development and management costs involved during the planning period, this development alternative requires high cattle number with increased percentage sales from each management unit to be economically justifiable.

Table 29. Present net worths and rates of return for costs of mobile veterinary service, water development, and management units with returns based on a livestock grazing capacity of 1280 animals per year per management unit with an initial sale of 3% and increases of 0% to 5% in animal sales each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-431845.75	-343582.49	-255966.44	-168405.74	-80789.69	5956.55
3.5	-393705.25	-317496.26	-241852.44	-166266.21	-90622.39	-15775.80
4.0	-360787.01	-294720.07	-229148.57	-163635.98	-98064.48	-33226.36
4.5	-332253.64	-274749.62	-217681.52	-160672.97	-103604.87	-47213.76
5.0	-307414.93	-257165.92	-207301.81	-157497.32	-107633.20	-58396.03
5.5	-285700.36	-241619.83	-197880.24	-154199.94	-110460.35	-67303.14
6.0	-266636.89	-227819.47	-189304.98	-150849.13	-112334.64	-74362.65
6.5	-249831.17	-215520.13	-181479.04	-147495.69	-113454.59	-79920.20
7.0	-234955.06	-204516.02	-174318.14	-144176.95	-113979.08	-84255.63
7.5	-221734.05	-194633.48	-167748.93	-140919.84	-114035.29	-87595.96
8.0	-209937.72	-185725.59	-161707.38	-137743.34	-113725.13	-90125.62
9.0	-189873.41	-170353.27	-150990.42	-131678.93	-112316.08	-93325.62
10.0	-173542.54	-157605.66	-141797.33	-126037.40	-110229.07	-94754.13
11.0	-160065.10	-146900.64	-133841.91	-120828.62	-107769.89	-95011.33
12.0	-148798.13	-137805.77	-126900.86	-116038.48	-105133.56	-94500.22
13.0	-139265.99	-129995.88	-120798.46	-111640.72	-102443.29	-93492.58
14.0	-131112.47	-123223.51	-115395.22	-107603.88	-99775.59	-92172.21
15.0	-124067.58	-117298.13	-110579.51	-103895.24	-97176.62	-90663.68
16.0	-117924.28	-112071.40	-106261.27	-100483.01	-94672.88	-89051.35
18.0	-107734.63	-103270.77	-98837.41	-94431.39	-89998.03	-85724.33
20.0	-99625.72	-96142.10	-92680.47	-89242.20	-85780.57	-82455.14
22.0	-93011.75	-90240.34	-87484.93	-84749.42	-81994.01	-79355.54
24.0	-87504.52	-85263.66	-83034.55	-80822.35	-78593.24	-76465.06
26.0	-82838.05	-81000.99	-79172.62	-77358.61	-75530.23	-73789.40
28.0	-78824.68	-77300.68	-75783.14	-74277.79	-72760.25	-71318.98
30.0	-75328.53	-74051.15	-72778.61	-71516.41	-70243.86	-69038.02

Table 30. Present net worths and rates of return for costs of mobile veterinary service, water development, and management units with returns based on a livestock grazing capacity of 1920 animals per year per management unit with an initial sale of 3% and increases of 0% to 5% in animal sales each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-390678.13	-260040.24	-128755.14	2585.31	133870.42	266025.33
3.5	-356176.26	-243420.53	-130099.62	-16721.13	96599.78	210717.91
4.0	-326415.52	-228702.14	-130493.32	-32225.58	65983.25	164925.46
4.5	-300634.43	-215618.51	-130166.66	-44655.28	40796.57	126925.39
5.0	-278205.45	-203945.01	-129299.67	-54594.72	20050.62	95322.90
5.5	-258609.93	-193491.85	-128032.82	-62514.51	2944.51	68985.90
6.0	-241417.91	-184098.22	-126475.59	-68794.32	-11171.69	46993.44
6.5	-226271.93	-175627.48	-124713.10	-73740.96	-22826.58	28594.52
7.0	-212873.87	-167963.20	-122811.36	-77602.84	-32451.00	13175.27
7.5	-200974.35	-161005.88	-120821.38	-80581.42	-49396.93	232.79
8.0	-190364.15	-154670.23	-118782.38	-82840.38	-46952.53	-10645.99
9.0	-172334.72	-143580.96	-114669.91	-85707.51	-56796.46	-27513.03
10.0	-157678.83	-134221.50	-110635.63	-87001.35	-63415.48	-39496.22
11.0	-145598.45	-126236.02	-106767.87	-87254.27	-67786.13	-48017.80
12.0	-135510.93	-119354.33	-103110.29	-86823.73	-70579.69	-54064.08
13.0	-126985.60	-113369.00	-99679.72	-85950.75	-72261.47	-58325.49
14.0	-119700.22	-108119.05	-96477.21	-84798.42	-73156.59	-61289.83
15.0	-113410.76	-103478.27	-93494.94	-83477.26	-73493.92	-63304.91
16.0	-107930.27	-99346.68	-90720.34	-82062.14	-73435.80	-64620.87
18.0	-98848.00	-92306.72	-85734.93	-79135.80	-72564.01	-65832.55
20.0	-91626.60	-86524.94	-81401.28	-76254.26	-71130.60	-65870.73
22.0	-85739.38	-81682.68	-77609.98	-73517.38	-69444.68	-65255.05
24.0	-80838.00	-77559.12	-74268.51	-70960.98	-67670.36	-64278.81
26.0	-76684.26	-73997.00	-71301.05	-68590.74	-65894.79	-63111.29
28.0	-73110.42	-70881.57	-68646.26	-66398.75	-64163.44	-61851.86
30.0	-69995.21	-68127.34	-66254.63	-64371.53	-62498.87	-60559.45

Table 31. Present net worths and rates of return for costs of mobile veterinary service, water development, and management units with returns based on a livestock grazing capacity of 2560 animals per year per management unit with an initial sale of 3% and increases of 0% to 5% in animal sales each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-351568.89	-176859.12	-1730.11	173446.64	348559.23	524035.72
3.5	-320523.72	-169726.48	-18544.92	132685.13	283846.78	435335.17
4.0	-293762.60	-163081.05	-32045.38	99038.70	230051.11	361358.70
4.5	-270596.17	-156895.11	-42866.24	71210.41	185212.86	299483.58
5.0	-250456.44	-151139.35	-51517.46	48151.14	147743.66	247581.35
5.5	-232874.02	-145784.06	-58409.54	29010.35	116352.74	203920.42
6.0	-217459.89	-140800.04	-63373.52	13090.82	89988.69	167088.59
6.5	-203890.66	-136159.13	-68176.84	-152.39	67792.93	135931.27
7.0	-191896.74	-131834.63	-71535.97	-11196.90	49062.67	109502.12
7.5	-181252.64	-127801.43	-74126.43	-20412.79	33221.22	87023.54
8.0	-171769.25	-124036.13	-76090.75	-28108.50	19794.17	67854.96
9.0	-155672.96	-117224.31	-78583.35	-39909.01	-1313.68	37422.62
10.0	-142608.31	-111245.74	-79707.54	-48139.28	-16648.99	14968.50
11.0	-131855.14	-105971.50	-79926.45	-53854.43	-27859.00	-1747.60
12.0	-122888.09	-101294.05	-79550.89	-57783.59	-36091.24	-14292.29
13.0	-115319.23	-97123.98	-78790.36	-60435.19	-42153.15	-23772.41
14.0	-108858.58	-93386.98	-77786.55	-62166.92	-46618.44	-30978.07
15.0	-103286.78	-90021.27	-76635.45	-63232.56	-49898.75	-36478.98
16.0	-98435.95	-86975.33	-75402.11	-63813.72	-52292.26	-40690.08
18.0	-90405.71	-81677.43	-72849.99	-64010.61	-55233.77	-46385.11
20.0	-84027.44	-77224.69	-70334.18	-63434.27	-56592.48	-49686.28
22.0	-78830.62	-73425.05	-67941.49	-62450.57	-57013.42	-51518.18
24.0	-74504.80	-70138.75	-65703.21	-61261.90	-56870.18	-52425.88
26.0	-70838.16	-67262.36	-63624.50	-59982.11	-56385.34	-52740.87
28.0	-67681.87	-64718.05	-61698.71	-58675.82	-55694.81	-52670.47
30.0	-64928.55	-62446.36	-59914.40	-57379.66	-54883.31	-52347.54

Table 32. Present net worths and rates of return for costs of mobile veterinary service, water development, and management units with returns based on a livestock grazing capacity of 3200 animals per year per management unit with an initial sale of 3% and increases of 0% to 5% in animal sales each 5 years.

Discount rates	Increases in livestock sales each 5 years					
	0%	1%	2%	3%	4%	5%
3.0	-312459.65	-93558.49	125342.66	344243.81	535225.06	782046.11
3.5	-284871.18	-95906.46	93058.27	282022.99	446797.23	659952.44
4.0	-261109.68	-97329.35	66450.97	230231.30	372977.35	557791.95
4.5	-240557.92	-98037.98	44481.96	187001.89	311170.56	472041.77
5.0	-222707.43	-98197.99	26311.46	150820.91	259269.61	399839.80
5.5	-207138.11	-97939.50	11259.11	120457.72	215559.10	338854.94
6.0	-193501.86	-97364.74	-1227.62	94909.50	178639.21	287183.74
6.5	-181509.39	-96553.91	-11598.42	73357.06	147364.83	243268.02
7.0	-170919.60	-95569.89	-20220.17	55129.54	120796.90	205828.97
7.5	-161530.93	-94461.88	-27392.83	39676.21	98163.44	173814.30
8.0	-153174.35	-93268.30	-33362.25	26543.80	78828.22	146355.91
9.0	-139011.20	-90737.30	-42463.41	5810.49	48040.10	102358.28
10.0	-127537.80	-88143.59	-48749.39	-9355.18	25214.94	69433.23
11.0	-118111.83	-85584.94	-53058.06	-20531.17	8124.23	44522.59
12.0	-110265.25	-83116.30	-55967.35	-28818.40	-4791.31	25479.50
13.0	-103652.86	-80766.16	-57879.46	-34992.75	-14633.99	10780.66
14.0	-98016.94	-78546.81	-59076.69	-39606.56	-22191.03	-666.30
15.0	-93162.80	-76460.85	-59758.90	-43056.95	-28030.40	-9653.04
16.0	-88941.64	-74505.17	-60068.70	-45632.24	-32566.04	-16759.30
18.0	-81963.42	-70958.27	-59953.12	-48947.97	-38866.71	-26937.67
20.0	-76428.27	-67842.98	-59257.69	-50672.40	-42715.89	-33501.82
22.0	-71921.86	-65093.75	-58265.64	-51437.53	-45040.90	-37781.31
24.0	-68171.60	-62651.87	-57132.14	-51612.41	-46391.00	-40572.96
26.0	-64992.07	-60467.74	-55943.42	-51419.10	-47102.46	-42370.45
28.0	-62253.32	-58500.47	-54747.62	-50994.77	-47387.46	-43489.07
30.0	-59861.90	-46716.64	-53571.39	-50426.14	-47383.51	-44135.63

SUMMARY AND CONCLUSIONS

The planning area at the present time is inhabited mostly by pastorialists who depend for their livelihood on livestock and livestock by-products. Livestock production is on a subsistence level with practically no contribution to the nation's economic growth. The rangeland in the planning area has sufficient annual rainfall for good forage production with two rainy seasons annually and has excellent native vegetation, but these potential range resources are not efficiently utilized due to water shortage at certain times of the year.

Some areas show signs of overgrazing, especially near watering places, and other areas are not utilized efficiently and are burned annually, either accidentally or intentionally. Therefore, this rangeland is untapped and is undeveloped in almost all aspects but has great potential for economic exploitation.

Hirshleifer, Dehaven, and Milliman (1960) have analyzed the economic phase of water development financed by governments and concluded that any project covering the interest rate at which the government has borrowed would be considered financially feasible and any return above that is a profit.

In my analyses, I have made an assumption that the Ethiopian government would be able to get its development fund at a 3% interest rate and to this I have added 1% to cover overhead costs and uncertainties. Therefore, a project with a 4% rate of return to investment

should be considered economically acceptable by the Government, and return above this must be considered as profit to producers to bring about economic growth and development among the cattle producers.

Miller (1963) and McPherson (1968) have defined economic growth to be a rising real income per person or growth output per head of population determined by the quality and quantity of the physical resources and the efficiency with which the resources are utilized. Kuznets (1965) and Mellor (1969) have defined economic growth of a nation to be a sustained increase in its population and production per capita. It is, therefore, important to consider the association between population growth pattern and economic growth upon the whole social structure (Barlowe 1958, Chapman 1956, Heady 1962).

Rates of return greater than the 4% to meet the Government's return on investment would be income to achieve social, cultural, and economic changes among producers in the planning area. There may be no economic growth or development as defined by the references cited above if the rate of return does not exceed 4%. At 4% the Government will recover the money invested for development, but the producers may not gain from the investment. Therefore, in order to achieve the desired objectives and to develop the human resources, rates of return must be greater than 4% to provide economic incentive to producers.

In the analyses, I have not included land value as a cost to the Government nor have I considered land deterioration or rehabilitation. With capital resources in short supply and long planning periods,

it does not appear appropriate to consider exploitation of available range resources as an alternative.

It is important to consider proper range grazing capacity in all alternatives. Under no circumstance should the planning rangeland be exploited and mismanaged through overgrazing and other improper management practices. To achieve desired objectives and choose among alternatives, grazing capacity of the planning range for each management alternative should be determined by field technicians who are competent and knowledgeable in evaluating range productivity. Decisions on management alternatives thus are made within the constraints of grazing capacities under the proposed alternatives.

An economical return to development investments must come from livestock sales. The current average annual livestock sale in the planning area is estimated to be only 3%. Development alternatives would be expected to increase this percentage sale, and the changes in percentage sale increases would be expected to be different among alternative development programs. Thus, after grazing capacity is determined for an alternative, percentage livestock sale is the other major factor influencing the return to the development investment. Combinations of grazing capacities and percentage increases in cattle sales which might be feasible each 5 years were analyzed for three development alternatives to show the grazing capacities and percentage livestock sales which must exist or be developed to make development economically acceptable. The three alternatives were: mobile veterinary service,

mobile veterinary service plus water development, and mobile veterinary service plus water development and management.

With only mobile veterinary service and no increase in annual livestock above the 3% existing annual cattle sale from the rangeland, the Government would lose money continually. Based on my analyses, there is no opportunity to recover the money invested on mobile veterinary service by the Government if the existing condition persists, even for rangelands with grazing capacities of 3200 animal units per year per management unit.

The data of this dissertation are used in choosing among the three development alternatives by the procedure for the examples as follows. The estimated grazing capacity of the planning area, if uniformly utilized, is 3200 animal units per year per management unit and the current livestock sale is estimated to be 3%. Analyses of rangeland without water development may show that only 40% of the range area is actually used and, therefore, the grazing capacity would be 1280 animal units per year per management unit. With veterinary service, a possible 5-year increase in livestock sales of 2% may be feasible because of lowered mortality rate from diseases. The rate of return from this combination of grazing capacity and livestock sales for veterinary services is negative (Table 11).

When water development and veterinary service are combined, 60% of the range area may be utilized for a grazing capacity of 1920 animal units, but since extension activities and managements are not included, it is unlikely that livestock sales would increase more than 3% each

5 years and still maintain herds. The rate of return for this situation would be 4.5% (Table 17).

The grazing capacity under the third development alternative with mobile veterinary services, water development, and management may be determined to utilize as much as 80% or more of the planning area for a grazing capacity of 2560 animal units per year per management unit. With extension activities and management provided for this alternative, a 4% increase in sale of livestock each 5 years may be attainable. Thus, the rate of return in this situation would be 8% (Table 31). This alternative is economically the best and a return above the 4% necessary to cover the Government investment is available to producers to be realized above their current revenues from range cattle production. With this additional revenue, the development of human resource would be easily achieved.

Based on the economic analyses conducted and the results obtained under each of the three development alternatives, the best alternative satisfying the objectives as outlined in this dissertation would be the last development alternative. With 2560 animal units per year per management unit and with a 4% increase in animal sales each 5 years, desired objectives would be met.

A total and an indefinitely free service should not be practiced in any healthy society. Some sort of payment must be made to the Government within the lifetime of the project. A payment per head as an annual livestock tax could be imposed to cover the initial and periodic costs to be invested by the central Government. Annual payment

per animal unit should be designed so as to encourage better range management and livestock production practices. This will serve as a limiting factor from having surplus animals above the grazing capacity of the management unit and will serve as the best means of getting back the costs invested in developing the area. The analyses in this dissertation show that only by achieving specific annual livestock sale goals will there be enough capital return to livestock operators to satisfy a rate of return which can satisfy a tax to pay for the development and leave the livestock producers some return as incentives.

Since the process of formulating a system for payment for improvements based on annual grazing fees is complex, and because this plan is new and unique in its nature and has never been applied anywhere in Ethiopia, it is the author's personal belief that it would require considerable time to study and analyze it in detail if an economic success is to be achieved. Due to the sensitive nature of the subject, a complete analysis of how to set the payback procedures has not been worked out in this dissertation. Based on the economic analyses made in this dissertation and if specific livestock sale goals are met in the early years of a project, a suitable and acceptable annual payment could be formulated.

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