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TSETSE FLIES, BOVINE TRYPANOSOMIASIS AND THE DEVELOPMENT OF THE CATTLE INDUSTRY

- an examination of economic implications with special reference to Uganda -

"Outline of a Proposed Study"

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Tsetse Flies, Bovine Trypanosomiasis and the Development of the Cattle Industry - an examination of economic implications with special reference to Uganda.

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Introduction

Tsetse flies (Glossina species) occur in an area of about 10 million sq km of tropical Africa. Their immense practical importance is due to the fact that they transmit trypanosomiasis. Trypanosomiasis is a collective term given to a group of diseases of man and animals caused by one or more species of protozoan blood parasites of the genus Trypanosoma.

It is generally accepted that tsetse flies and bovine trypanosomiasis constitute a serious obstacle for the development of the cattle industry of tropical Africa. Considerable efforts have been made towards controlling the tsetse and the disease they transmit.

It is the aim of this study to examine critically the economic implications of tsetse flies and bovine trypanosomiasis for the development of the cattle industry.

The scope of the study is limited in several ways:

1) The study is basically not concerned with trypanosomiasis of non-bovine animals and of man (sleeping sickness). When considering specific areas this restriction will receive further justification and, in some cases, modification.

2) The study is only concerned with economic implications. While the concept of "economic implications" is kept very wide, no new ground is broken with respect to the biotechnical problems of the disease its control or with respect to general problems of cattle production.

3) The study concentrates on the problem in Uganda. This allows more detailed examination, promises greater comparability between different control schemes and - a major concern of this study - renders possible the viewing of single control schemes as part of a general policy adopted with regard to this disease.

   Uganda was selected for a number of reasons the more important of which are:

- the significance of the tsetse and trypanosomiasis problem
- the emphasis that is being put on the development of the cattle industry
- the considerable number of control operations that have been carried out in the past involving different techniques and areas of different natural and socio-economic conditions.
- the number of large-scale operations that are foreseen for the future
- the high standard of organization and documentation

It is, however, believed that the results of this study, and, even more so, the principles of the approach, are applicable to other countries confronted with tsetse and trypanosomiasis problems.

Section A : Exposition of the Problem

1) Bovine Trypanosomiasis, its transmission and control: a technical survey.*

Trypanosomes are unicellular organisms belonging to the Genus Trypanosoma. They live as parasites in many kinds of vertebrates - fish, birds and mammals - in many parts of the world. This study is only concerned with those African species pathogenic to cattle. These species are:

- T. vivax; depending on the strain, the disease in cattle may be virulent, especially in West Africa, or mild;
- T. congolense; due to its frequence, the severeness of the infection and due to the fact that it affects every kind of domestic animal it is probably the trypanosome of the greatest economic importance;
- T. brucei; this species seems to be of lesser importance for cattle, in fact some authors consider it to be completely non-pathogenic for bovines.

The disease they cause in cattle is called bovine trypanosomiasis or nagana, which are collective names given to infections with one or more of the above species.

Transmission of the trypanosomes is effected mainly by tsetse flies, which are only found in tropical Africa. They are biting insects belonging to the genus Glossina. This genus is sub-divided into the morsitans group, the palpalis group and the fusca group, the sub-divisions being based on taxonomic characters of the genital armature. All in all 22 species are recognized; in some sub-species are distinguished. Most of them are characterized by different habits and habitats. All of them can probably transmit those trypanosomes mentioned above.

The most important species for this study are:

- morsitans group: G. morsitans
  G. pallidipes
  they are usually referred to as woodland-savannah species
- palpalis group: G. fuscipes
  these species preferably occupy riverine and lake-shore vegetation
- fusca group: G. brevipalpis
  G. fusca
  G. fuscipleuris
  they are typically forest species.

A more detailed description of their characteristics will be given in the context of specific control operations.

The tsetse flies feed solely on blood and are always harmless when they hatch from the pupae. When they feed on a host in-

*In summarizing the various aspects I have drawn freely on Nash T. A. M. (1970), The Tsetse Fly: Africa's Bane.

fected with trypanosomes, however, they may themselves become infected. The trypanosomes then undergo a complicated development cycle in the fly. The metacyclical infective forms of the trypanosomes are transmitted the next time the flies suck blood. This type of transmission is termed cyclical and only occurs in tsetse flies.

Transmission of trypanosomes may also occur mechanically (acyclically). In this case the trypanosomes remain completely passive in the carrier, and do not pass through any stage of their life cycle. This type of transmission usually only occurs if carriers other than tsetse flies are involved (Stomoxys, Tabanids etc.). Mechanical transmission may assume local importance. Successive mechanical transmission tends to lower the virulence of the trypansomes.

The area in which the risk of trypanosomiasis prevails can be roughly taken to be identicial with the area infested by tsetse flies. This area comprises about 10 million sq. kilometres of Africa between latitude 14° North and a line drawn from Benguela to Durban which is indented by the Bihe Plateau in Angola and the Transvaal and the Southern Rhodesia high veld.

Severeness of the disease in cattle varies with the breed and the general condition of the animal, with the species and strain of trypanosome.

The disease may be acute or chronic, and is characterized by loss of condition, anaemia, oedema of dependent parts, progressive emaciation and intermittant fever; the eyes may be sunken and the coat staring. If the strain of trypanosome is highly pathogenic the animal may become exceedingly thin and die, particularly if subjected to adverse conditions such as cold weather, lack of food or over-work.

Bovine trypanosomiasis cannot be diagnosed with certainty by external appearances. To detect trypanosomes a blood film must be prepared. Although the trend of the disease is usually towards death, the animal may - especially under favourable conditions, with good grazing and no work - survive an acute phase of nagana and pass on into a chronic stage or even become premunized. Premunity refers to an equilibrium between the protozoon and the host organism the animal showing no clinical symptoms inspite of the presence of trypanosomes in the blood stream and being apparently immune against new infection with the same trypanosome species. This state of immunity is a labile one that can be lost through stress.

Table 1: METHODS TO CONTROL BOVINE TRYPANOSOMIASIS

Directed Against	Method	Principle	Application	Remarks
TRYPANOSOMES	avoidance	prevent cattle to get in contact with tsetse flies	Pull cattle out of infested areas	only feasible for small cattle numbers
			expand the cattle industry into naturally fly-free areas only	question of availability
	immunization	render the cattle immune against the action of tryp.	vaccination	no efficient polyvalent vaccine exists at the moment, considerable research activity
			induce an acquired immunity	experimental stage
	introduction of trypanotolerant breeds	use cattle breeds that are naturally tolerant	introduce a breeding stock and build up a tolerant population	done on large scale in CAR and Congo-Kinshasa; these breeds are of low productivity tolerance may break down under stress or heavy fly challenge
			introduce a breeding stock for cross breeding with indigenous stock	pilot project in CAR (Central Afr. Republic)
	application of trypanocidal drugs	administer chemicals to the cattle which kill the trypanosomes in the blood stream	treat cattle individually or in "blocks" with curative drugs as signs of trypanosomiasis occur protect herds with prophylactic drugs	very extensively used. Problems - particularly in prophylaxis-are: - doubtful effectiveness if fly challenge is very high - conscientious application necessary(organizational problem) - development of durg resistent strains of trypanosomes
Tsetse Flies	climination of game	eliminate the natural sources of food of the vector, and eliminate the trypanosome reservoir	destroy game in a certain area (shooting)	effectiveness and feasibility disputed but spectacular successes in Uganda. Game may constitute an economic asset
			keep game out of a certain area (controlled hunting, fences)	most attempts have been unsuccessful

Table 1 (cont'd):

Directed Against	Method	Principle	Application	Remarks
TSETSE FLIES	bush clearing	change the habitat of the vector so as to render it unsuitable for it (and possibly for game at the same time)	destroy those parts of the vegetation that are essential for the survival of the vector (selective, discriminative, sheer clearing)	discriminative and selective clearing has had varying success sheer clearing(mechanical or by hand) is most expensive and therefore only applied to barrier zones
	(Cultivation and settlement)	indirect application of game elimination and bush clearing	direct these socio-economic activities into tsetse areas	only possible and feasible for limited areas (barriers)
	application of insecticides	bring insecticides in contact with vector	apply insecticides to the vegetation(from the air or from the ground)	most widely used method now to control the vector
			apply insecticides to the cattle (spraying or dipping)	pilot project stage in CAR (combined tsetse and tick control)
	release of sterile males	interfere with the reproduction of the vector	introduce in regular intervals sterile males into a confined area the number of sterile males being in a predetermined proportion to the number of "normal"males	pilot projects planned in Central African Republic and Zambia
	catching by hand or traps collection of pupae			only suitable for surveys, scientific purposes and fly pickets
	bush fires			only to assist other methods like elimination, bush clearing, application of insecticides
	systemic poisons antosterilization promotion of nat. enemies of the vector			no indication of practical applicability for the near future

Premunity is however quite firm in West African Short-horn Cattle, and particularly prevalent in game animals. Through their ability to serve as a host for trypanosomes without being pathologically affected, game animals thus constitute a permanent source of infection (trypanosome reservoir) for the environment.

A range of methods exist to control the disease. Table I gives a synopsis of methods available. All have their merits, drawbacks and limitations which will receive closer consideration in Section C.

2) Bovine Trypanosomiasis, tsetse flies and their control in Uganda: a Historical Account.*

The study is to a considerable extent based on the tsetse situation and the control policies in Uganda. A historical account is therefore necessary.

Three periods can be distinguished: (1) the period extending from the beginning of organized concern for the cattle industry into the late thirties; comparatively little attention was paid to the disease and its vector, (2) the following years which were characterized by a dramatic advance of the tsetse towards the important cattle areas and a trypanosomiasis incidence assuming epidemic dimensions, (3) a period commencing with the creation of the Tsetse Control Department and reaching right into the present. This period is marked by massive tsetse control campaigns and also by large-scale systematic application of trypanocidal drugs.

From the point of view of disease control rinderpest and contagious bovine pleuro-pneumonia were of overriding importance in that first period. Little attention could be paid to the less conspicuous enzootic fly-borne and tick-borne diseases although it was realized that they were taking a continuous heavy toll of the stock. Tsetse-cattle contact was relatively infrequent. Owing to massive and uncontrollable stock movements mechanical transmission rendered trypanosomiasis wide-spread while virulence of the disease was comparatively low. A campaign to free the water supplies of Ankole from the tsetse by discriminative bush clearing failed in the early thirties.

In the second period the nation-wide spread of the tsetse first came under observation. In many cases this spread could be

*Main source: Vet. Dept. Annual Reports of the various years, Tsetse Control Division(Dept.)" " " "

attributed to man-induced ecological changes of an area. Incidence of trypanosomiasis soared and many regions were denuded of cattle. The situation was characterized by uncertainty concerning the future development of the tsetse threat, and the absence of drugs suitable for efficient protection of the existing cattle industry. It was this emergency situation which led to the creation of the Tsetse Control Department.(from 1962 on Tsetse Control Division of the Vet. Dept.)

The most recent period is characterized by tsetse control campaigns covering thousands of square miles and annual treatment of hundreds of thousands of cattle with trypanocidal drugs (see Tables 2, 3, 4, and 5).

It is possible to distinguish two phases. In a first phase up to about 1961 some 7000 sq. miles had been covered by game shooting and bush clearing operations, mostly with rather spectacular success. The basic policy was stated as one that aims at halting the tsetse advance and reclaiming land up to where a consolidation line along a narrow front was possible.

The second phase commenced as the last tsetse advance (that in Ankole) had been brought to a halt. Game destruction and application of insecticides were used as tsetse control methods over an area of about 4000 sq. miles, bush clearing being restricted to the establishment of consolidation lines. The objective of tsetse control has since been stated as the release of land for economic use. Furthermore it was stated that the development of the cattle industry depended to a considerable extent on more land being made available.

TABLE 2: TSETSE CONTROL SCHEMES IN UGANDA 1947 - 1960/61[1]

District Name of Area	Extent of scheme area km²	Species of Glossina	Period of control operation	Control Method	No. of game destroyed 7)	Area reclaimed km²	Purpose of the scheme	Remarks
Karamoja								
Labwor	1,700	mors.subm.	48-49	discriminative clearing by hand,[2]			Check southward advance of the fly though preventive reclamation	Cattle kept under traditional system were re-introduced. The cons. line could not be strengthened by settlement due to unsuitable soil and lack of population pressure. In 59/60 it was found that the fly had re-infested 1000 km² to the south of cons. line.
Kachiri H./ Lolelia	1,075	" "	47-51	near sheer-clearing in some parts	500[3]	3,350		
Sangaar	1,620	" "	50-52					
Natira/ Karenga	(360)[4]	" "	53-59	selective clearing by hand 2)			Consolidation line	
Acholi Lagile	4,870	fuscipes mors.subm.	47-51	game destruction (burning) 5)	10,518	4,870	Check southward advance of the fly though prev. reclamation	G. fuscipes still present - settlement efforts on cons. line unsuccessful (poor soil, lack of popul. pressure). Attiak - Palabek Road further north as more suitable cons.line proposed. Natural withdrawal of tsetse in the North
Gulu/ Kitgum	3	" "	55	Sheer clearing by hand, settlement, pickets			Consolidation line	
Aswa Valley	1,000	" "	58-60	discr. clearing by hand		~ 500	Reclaim land up to the more suitable Attiak-Palabek cons. line	25-mile fly-free barrier achieved but Attiak-Palabek Rd. not reached.

Table 2 (cont'd):

District Name of Area	Extent of scheme area km²	Species of Glossina	Period of control operation	Control Method	No. of game destroyed 7)	Area reclaimed km²	Purpose of the scheme	Remarks
Lango Kwania/ Maruzi	1,810	fuscipes pallidipes mors.subm.	53-60	Game destruction (insecticides, clearing, pickets) game exclusion[6] aerial spr.[6]	10,534	1,425	Eliminate the risk of spread into adjacent areas	385 km² in Muruzi still infested in 1960 Some cattle present. Ranching Scheme planned
Bunyoro SE - Bunyoro	2,230[8]	fusca pallidipes mors.subm.	51-60	Game destruction (settlement, burning)	15,675[3]		Eliminate the risk of spread into reclaimed areas of Mengo Consolidation line	In 56 Ranching Scheme started. Tsetse break through northern part of cons. line. Ntoma R. cons. also unsatisfactory. By 1960 emergency situation had arisen
Itoma Riv. Ikoba - Masindi - Atura Rd.		"	51-60	Mech. sheer clearing, insecticides, settlement				
Ankole Mitoma		pallidipes		Settlement (burning game destr. and exclusion)	4,562[3]		Check southward advance by the construction of a defence line	Successful settlement and cultivation
Centr. Ankole	675	mors.mors.	9) 51-57	Selective clearing by hand (mech. clearing, burning)			Reclamation of land and experimental testing of selective clearing	Completely unsuccessful; the fly spread to cover an area of 1580 km²

TABLE 2 (cont'd):

District Name of Area	Extent of scheme area km²	Species of Glossina	Period of control operation	Control Method	No. of game destroyed 7)	Area reclaimed km²	Purpose of the scheme	Remarks
Ankole/ Masaka	4,400	mors.mors.	58-60/61	Game destruction (cattle exclusion, insect).	28,193		Check the general advance and stabilize by extension of the control scheme	By 60/61 advance was stopped and the fly population reduced to very low levels.
Merama Hill	180	" "	50 9)	Sheer clearing by hand		180		Successful
Kigezi Bugangale		fuscipleuris pallidipes	49-51	Sheer clearing and undercutting by hand (pickets) 10)		20	Allow milk cows to be kept in resettlement area	Successful
Mengo Buruli/ Bulemezi	6,600	pallidipes mors.subm.	44-51/58 11)	Game destruction (discr. cl., burning, pickets)	14,388 11)	6,150	Check the southward advance and reclaim land for the cattle industry	Complete elimation only in 57 when source in Lango eliminated } re-introduction cattle commenced in 52
Bugerere/ Kagwya	1,360	brevipalpis pallidipes	48-52/59	Game destruction (discr. cl., insect, burning)	2,540	1,360	"	brevipalpis only eliminated in 59 by spraying }

Table 3: Tsetse Control Schemes in Uganda 1961 - 1970/71 (period of the first two Five-Year Plans)

District Name of Area	Extent of Scheme Area sq.km.	Species of Glossina	Period of control operation	Control Method	No.of game destroyed 7)	Area re-claimed sq.km.	Purpose of the Scheme	Remarks
Karamoja[12] Meriss/ Lomaler R.	300	mors.subm.	60-63	Sheer clearing by hand, insecticides (pickets)		300	Prevention of further southward spread by the construction of a temporary barrier	The tsetse population between these two barriers was to be eradicated in 1966
Narus/ Lokulas	240	" "	65			240	Construction of a final and permanent cons. line to stabilize position in Karamoja	Between 62/66 extension into Acholi sheer clearing west of Orom Mt. to prevent spread into Omoro - Oyare drainage system.
Lango Maruzi	385	fuscipes pallidipes mors.subm.	61-65	game destruction (insecticides, sheer clearing, burning, pickets)	2,548	385	Stabilize situation for the already reclaimed parts of Lango.	Fuscipes still present; protective measures still necessary; cattle present all along; ranching scheme started; incidence of sleeping sickness
Bunyoro[12] SE Bunyoro	1,550	fusca pallidies mors.subm.	61-64	game destruction insecticides (clearing)	13,869		Stabilized situation in the already treated area eliminate risk of spread	Complete elimination not achieved yet,
Itoma Riv. -Ikoba -Masindi -Atura Rd.	(400)	"	64-65-[14]	mech.sheer clearing settlement (pickets, insect)	13,869		Strengthening the existing cons. line	Cons. line not completed yet

Table 3 (cont'd):

District Name of Area	Extent of scheme area sq.km.	Species of Glossina	Period of control operation	Control Method	No. of game destroyed	Area re-claimed sq.km.	Purpose of the Scheme	Remarks
Ankole[12] Ankole/ Masaka	4,400	mors.mors.	61-64	game destruction, insecticides (burning, exp. spraying)	16,780	4,400	Having stopped the advance completion of the reclamation of the treated area	From 63 on land gradually opened up for cattle (by 64 52,000 heard)
Mbarara/ Lyantonde	(80)	"	63-64	mech. sheer clearing			temporary cons. line to the south	On the sprayed area consolidated to the south -Ranching Scheme started
12) Nakivale/ Ruhengere	200	mors.mors.	62-63	mech. sheer clearing (pickets)		200	make grazing available for cattle of refugees from Ruanda	cattle on area during control operations
Acholi/ Karamoja[13] N.Karamoja	290	mors.subm.	66	insecticides		290	as a follow-up measure to the establishment of the two cons. lines the tsetse population in between was eliminated	Mainknance still necessary

Table 3 (cont'd):

District Name of Area	Extent of scheme area sq.km.	Species of Glossina	Period of control operation	Control Method	No.of game destroyed	Area reclaimed sq.km.	Purpose of the Scheme	Remarks
Logelat V./ Acholi	100	mors.subm.	68	sheer clearing by hand, insecticides		100	reclamation of land and elimination of the risk of a southward spread	as in N. Karamoja low level of subsequent utilization for cattle
Aswa V.13) Acholi	1,800	mors.subm.	66-70/71	game destriction insecticides(check of game movement)	15) 6,740		protect the Ranching Dev. Scheme and permit further expansion	Ranch established on 240 Km²
Atiak-Palabek		"					consolidation line	Control scheme not finished by 1970/71
Bunyoro/ Lango 13)		fusca pallidipes		game destruction (insecticides)	15) 19,683	1,550	stabilize situation, make land available for ranching and eliminate risk of spread	in Lango only protective measures were necessary (No. of game shot included in the figure for SE Bunyoro).
SE Bunyoro	1,550	mors.subm.	66-70					
Itoma Riv. Ikoba-Masindi-Atura Rd.	(400)	"	-65-67	mech. sheer clearing settlement (pickets)			strengthening of the consolidation line	Maintenance of cons. line and protective measures still necessary. 700 km² avail. for ranching
Ankole Ankole Lakes 13)	2,590	mors.mors.	65-68	insecticides(experiment aerial spr., pickets, game excl.)		2,590	make land available for ranching	830 km² available for ranching
Ishingiro Hills		"	69-70/71	mech. sheer clearing			cons.line to protect all of the reclaimed area in Ankole Masaka	further work necessary

Table 3 (cont'd)

District Name of Area	Extent of scheme area sq.km.	Species of Glossina	Period of control operation	Control Method	No.of game destroyed	Area reclaimed sq.km.	Purpose of the Scheme	Remarks
Toro 13) Rwimi R.	?	fusciphleuris pallidipes	68-?	?			Permit cattle keeping on Prison Farm and introducing of cattle	Originally eradication of tsetse from 2075 km^2 of Kyaka/Kibale/Mwenge counties had been planned. Due to lack of funds this scheme had to be postponed.

Notes to Tables 2 and 3:

1) not including schemes in Lango, Bukedi, Busoga, Buvuma Islands,Teso and and West Nile which were primarily concerned with the elimination of the risk of human sleeping sickness.
2) the terms discriminative and selective are used differently in the Reports of the TCD. In this study the definitions used are those of WHO/FAO (1969) Tech. Rep. Ser. No. 434 p. 45.
3) figures incomplete
4) extent of the area of consolidation lines given in brackets means that the area is not additional to the area of the whole scheme but already therein included.
5) control methods given in brackets are additional methods intended to assist the main method(s) used.
6) control methods used on an experimental scale only.
7) No. of game shot does not include animals killed by hunting of the local population which in some cases has been considerable.
8) The core of the operation area was about 1,000 sq.km. Various extensions were however made.
9) This scheme was carried out by EATRO.

Notes to Tables 2 and 3 (cont'd):

10) undercutting refers to the clearing of the lower vegetation in double canopy vegetations

11) game shooting on a small scale was continued until 58. Until the end of 51 13,888 animals had been shot. Based on an estimate of roughly 200 animals annually shot in subsequent years a total of 1,500 has been added to the 51-figure.

12) schemes under the First Five-Year Plan

13) schemes under the Second Five-Year Plan

14) "64-65-" means that scheme is being carried on without interrruption

15) figures only cover the period up to the end of 68.

16) "Insecticides" if not otherwise stated refers to discriminative ground-spraying with knapsacks or to spraying with motorized mistblowers, in both cases using residual insecticides

17) "Mechanical sheer clearing" is always assisted by clearing by hand.

Sources:

1) Dept. of Vet. Services and Animal Ind.,
Annual Reports of the various years.

2) Tsetse Control Dept. (Division)
Annual Reports of the various years.

3) Wooff, W. R. (1968)
The Eradication of the Tsetse Glossina Morsitans Westw. and Glossina Pallidipes Aust. By Hunting.
12th Meeting of ISCTR, Bangui, 1968.

4) Dept. of Lands and Surveys, Uganda
Uganda Atlas Second Addition (1967)
Uganda Atlas First Addition (1962).

5) Uganda Government
First Five-Year Plan
Second Five-Year Plan

Table 5: NUMBER OF DOSES OF TRYPANOCIDAL DRUGS ADMINISTERED IN UGANDA, 1947-1968

YEARS	TRADENAME OF DRUG						
	CURATIVE				Total curative	PROPHYLACTIC	GRAND TOTAL
	Antrycide dimethyl sulphate	Berenil	Ethidium Bromide	Other curative drugs 1)		Antrycide prosalt	
47				68000	68000		68,000
48	3)	-	-	80000	80000	3)	80,000
49	5000	-	-	78000	83000	3)	83,000
50	102551	-	-	59921	162472	-	162,472
51	172706	-	-	11895	184601	-	184,601
52	298990	-	-	100	299090	-	299,090
53	216736	-	-	-	216736	-	216,736
54	137680	-	-	-	137680	4890	142,570
55	79950	-	-	-	79950	27420	107,370
56	163468	-	-	-	163468	35398	198,866
57	188447	-	-	-	188447	43149	231,596
58	255734	4729	-	-	260463	44361	304,824
59	179316	13040	-	-	192356	110546	302,902
60	233990	3292	-	-	237282	39203	276,485
61	210465	5199	1572	-	217236	35571	252,807
62	196060	10941	3853	-	210854	94119	304,973
63	221124	24314	-	-	245438	74202	339,640
64	204228	74262	-	-	278490	101633	380,123
65	120808	148204	-	-	269012	47480	316,492
66	130688	2)	-	-	130688	50188 4)	180,876
67	2)	2)	-	2)		2)	209,466
68	2)	2)	-	2)		2)	258,420

Notes to Table 5:

1) Up to 1952 Dimidium Bromide
2) No specification
3) Only on experimental scale
4) No. of doses issued by the Animal Health Research Centre

Sources:

Dept. of Veterinary Services and Animal Industry
Annual Report of the Various Years.

Table 6: Approximate[1] Expenditures for Tsetse Control in Uganda 1961/62 - 1970/71 (Shs. '000)

Development Expenditures[2] Tsetse Reclamation Scheme	61/62	62/63	63/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	61/62 - 70/71
1) Central Ankole	452	1,304	1,704	1,816	1,808						7,084[3]
2) Bunyoro	551	1,270	2,192	1,918	1,700						7,631
3) Nakivali/Ruhengeri			300								300
4) Karamoja				1,664	1,328						2,992
5) Aswa Valley						498	262	1,567	1,700	2,000	6,027
6) Ankole Lakes						2,600	2,253	1,705	1,750	1,700	10,008
7) Bunyoro/Lango						3,000	1,911	2,105	2,100	2,300	11,416
8) Acholi/Karamoja						160	212	690	710	800	2,572
9) Toro						20	113	2,015	2,045	2,250.	6,423
10) other schemes (not specified)				1,322	2,000						3,322
TOTAL	1,003	2,574	4,296	6,720	6,836	6,278	4,751	8,082	8,255	9,050	54,453
Vet.Services & Livestock Ind. (incl. tsetse reclamation)	?	6,161	9,086	15,059	16,058	9,866	7,341	16,292	19,977	39,932	-
Tsetse Reclamation in % of Vet. S. & Livestock Industry(incl.T.C)		42%	47%	45%	42%	64%	65%	50%	41%	23%	
Recurrent Expenditures Tsetse Control Division	1,844	1,734	1,935	3,798	880	913	1,219	1,272	-	-	-
Total Expenditure Tsetse Control	2,847	4,308	6,231	10,518	7,716	7,191	5,970	9,354	-	-	-

1) figures partly constitute estimated instead of actual expenditures, discrepancies between different sources exist
2) non-recurrent expenditures of the Central Government plus foreign aid including contributions to the recurrent budget
3) Cost of sheer clearing in past borne by the Ranching Development.

Sources: - The Government Accounts of Uganda, 1959/60 - 1964/65.
- Estimates of Development Expenditure, Various Years.
- Background to the Budget, Various Years.
- First and Second Five-Year Plan of Uganda incl. Supplement (all Government Publications).

3) The need for an economic appraisal

Tsetse and trypanosomiasis control schemes have been carried out on a large scale in Uganda. (See Tables 2 to 6). It has been the stated objective of these schemes to contribute to the development of the cattle industry by eliminating a forceful constraint.

Low income countries are inhibited by a large number of constraints and the range of development possibilities may be rather limited. It therefore seems particularly important that any development activity aim at eliminating the most forceful constraints and/or enhancing the most promising development possibilities in a rational way. Whether tsetse and trypanosomiasis control schemes fulfill these requirements cannot be answered in the affirmative without thorough examination. A number of questions can be raised such as:

- How does trypanosomiasis control contribute to the development of the cattle industry, and what other measures are available to achieve this objective?
- To what extent is trypanosomiasis a limiting factor?
- Is it not necessary to carry out land-use studies prior to embarking on tsetse eradication shemes?
- Is it feasible to destroy game in order to build up a cattle population where the possibility of economic game utilization exists?
- What are the real costs of control schemes to the economy?
- What are the benefits that result from these control schemes?
- What are the side-effects of the various control methods and how do they influence the relative desirability of the various methods?
- How is a long-term control policy affected by uncertainty with respect to the development of an efficient vaccine of better drugs and to changing needs of the economy etc.

It is therefore proposed to subject tsetse and trypanosomiasis control projects to a general economic examination in order to maintain their relevance with the development of the cattle industry and the objectives of the country.

This examination will be carried out under three headings:
- trypanosomiasis and the development of the cattle industry
- trypanosomiasis control and land use planning
- efficiency analysis of trypanosomiasis control (Section B)

followed by a number of case studies (Section C).

The findings will then be summarized in an evaluation of past control policies and in recommendations for the formulation of future policies (Section D).

Section B: Examination of Economic Implications

In this section it is attempted to outline and examine the economic implications of trypanosomiasis control. While the primary concern is the control of this disease in relation to the development of the cattle industry some implications have to be seen in a broader context.

The principles of this economic approach to the problem of trypanosomiasis and tsetse control are believed to be generally applicable. In this study, the examination of their relevance for Ugandan conditions is particularly emphasised.

4) Trypanosomiasis and the Development of the Cattle Industry

Uganda Government is planning the extensive expansion of its cattle industry. In this, it also has the support of international organizations that carried out economic studies in Uganda.(1) This priority is basically accepted in this study without further questioning. It is only to determine the probable stability of this objective and to define its meaning more accurately that a concise treatment of the rationale of the development of the cattle industry will be given.

a) The rationale of developing the cattle industry

The present low standard of the cattle industry when compared with the considerable natural potential of Uganda reveals the great development potential of this branch of the economy.[2)]

The "first spearhead" of Uganda's strategy of growth as stated in the Second Five-Year Plan is the development of the rural sector. At the same time the economy being heavily and dangerously dependent on a narrow range of agricultural crops diversification is sought. The livestock and in particular the cattle industry has for long been recognized as one of them most suitable branches on which diversification efforts should be concentrated.[3)]

The market prospects for livestock products, and in particular for beef, round up the argument which in the case of Uganda is strongly in favor of the development of the cattle industry.[4)] It is however note-worthy that not just an increase of beef production is called for, but simultanuously the inclusion of a large number of people into contributing or participating in the benefits of development.

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1)F.A.O., World Bank.

2)F.A.O. (1967) East African Livestock Survey. P. R. Baker (1969) Environment and the Supply and Production of Beef Cattle in Uganda . F.A.O./I.W.P. (1968). The Livestock Industry of Africa.

3)Uganda's First and Second Five-Year Plans. I.B.R.D.(1961) The Economic Development of Uganda.

4)F.A.O.(1967) op.cit.; Ferguson,D.S. (1968) The Prospects for Expanding Livestock Production in Uganda.

b) The principles of developing the cattle industry [1]

There exists no universally applicable recipe for the development of the cattle industry.
The development can be seen as a continuous process extending from traditional nomadism to scientific exploitation of rangeland and industrial fattening. The measures to induce and promote this development include general education, change of land tenure system provision of credit facilities, instruction of producers, disease control, establishment of permanent water supplies, animal health and production research, Government fiscal policies and others. Each stage in this development is characterized by a different set of predominant constraints requiring a specific set of measures to mitigate them. Table 7, taken from the East African Livestock Survey, F.A.O. (1967) tries to correlate characteristics and requirements of certain development stages.

When applying these principles of development at any one time to a country the problem of change over time becomes one of regional variation. Different areas have reached different stages of development depending on the socio-economic and natural conditions prevalent thus having different requirements with regard to development efforts. At the same time when there is a need for setting up co-operatives in the intensive areas of Buganda, provision of stock routes may be a more urgent and more promising exercise in Karamoja. Provision of permanent water supplies in areas where range land is fenced is likely to be more beneficial than in areas where grazing is uncontrolled and overstocking around the water holes may be the adverse result.

The conclusions from these considerations for this study are two-fold:

- control of a certain disease is only one of many measures available to develop the cattle industry (although tsetse control may be of prominent importance since the presence of tsetse is one of the few factors that may render cattle husbandry completely impossible), and must therefore be seen in relation to other parallel and subsequent requirements.
- effects of trypanosomiasis control are likely to be different in different areas according to development stage reached, and to natural and socio-economic conditions.

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1) see e.g.

F.A.O.(1967) East African Livestock Survey, Vol. I, Development Requirements.

de Wilde, T.C.(1967) Experiences with Agricultural Development in Tropical Africa, Vol. I and II.

Table 7: CHARACTERISTICS AND REQUIREMENTS OF DEVELOPMENT IN THE LIVESTOCK INDUSTRY

Development Status	Characteristics	Type of Need	Emphasis Required
A	Nomadic or semi-nomadic pastoralists whose economy is based on livestock. Shifting agriculturalists. Land held by communities according to tradition. Poor educational standards and low level of political understanding. Generally uncooperative with Government. Although may be potentially wealthy, the present living standards are low and seldom above subsistence.	General education. Prevention of stock theft. Appreciation of monetary values and the cultivation of an appetite for consumer goods and more varied diet. Control of epizootic disease. Specific measures to improve efficiency of animal production (e.g. grazing schemes, de-stocking campaigns) unlikely to succeed.	Schools and adult education facilities. Strong administration, police services, etc. Improved shops and demonstration units to publicise better nutrition, housing, child-care and animal production. Constructive political propagandists. Strict veterinary control. Efficient marketing organization with adequate stock routes and quarantine grounds. Soil conservation measures.
B	Settled communities who have a system of land tenure involving registration and legally recognized holdings on an individual or co-operatives basis. An economy based on money in which livestock are a recognized income earner. Quality in livestock appreciated as a factor of economic importance. Disease control measures accepted.	Disease control facilities e.g. dipping schemes. Opportunity to improve quality of stock by using superior bulls. Water facilities on each holding. Better grazing schemes to avoid erosion, reduce drought losses and increase offtake. Adequate and fair marketing system. Prevention of stock theft and illegal movement of animals.	Veterinary services collaborating closely with district administration. Bull camps or an artificial insemination service. Soil conservation and water development services. Farmers' training centers and extension services. Co-operative marketing system for milk, eggs, hides and skins. Milk distribution and treatment facilities. Credit facilities for capital improvements.
C	Individual or co-operatively run farms or ranches which are fenced, watered and serviced by adequate communications. Disease control	Agricultural information of all types, particularly relating to improved husbandry and problems of management. Organization for processing and marketing	Farmers' training centers and extension services including animal husbandry and farm management. Regional research and demonstration units. Agricultural societies and clubs, shows, etc. Better

Development Status	Characteristics	Type of Need	Emphasis Required
C	based on individual animals rather than on herds. A more highly developed marketing organization and co-operatives which assist with production as well as distribution and marketing. No longer entirely dependent on family labor.	products overseas as well as in East Africa.	credit organizations. Marketing Boards. Livestock improvement schemes (e.g. performance and progeny testing).
D	Modern economic units, well mechanized and with employed labor. Good quality stock including stud breeding. Close attention to health of individuals and production of high quality.	Advanced information on animal health, breeding and production. Security from stock theft can be critical. Long-term security to attract large-scale private investment.	Research stations and good extension service. Agricultural colleges. Private veterinary services and diagnostic centers. Radio and magazine information on farming.

It will therefore be tried to define the important characteristics of cattle regions where trypanosomiasis and tsetse control measures have been applied and to relate the economic success or failure of these measures explicity to these characteristics.

Development must not necessarily imply the continuous process as outlined above. Thus in some areas of very low natural potential a traditional form of nomadism may well be the most rational way of using the land for stock. This does not seem to apply to any greater extent to Uganda. More important however in Uganda is the short-cutting of the tedious development process by transformation schemes (ranching schemes).

In the process described before development efforts can be termed "improvement" measures, attempts to introduce development gradually into the existing systems of stockholding.[1] "Transformation", however "starts by ensuring that the development area is cleared of both local stock and local people. Transformation schemes are designed to produce a rapid increase in the pastoral productivity of an area through the unhindered application of scientific techniques, strong management and large amounts of capital. The supply of stock to the market is also rationalized and related to location and level of prevailing market prices, and quality requirements."[2] While problems of the physical and human environment have often checked the speed and thoroughness of ranch development in Uganda, the basically different approach to the development of the cattle industry through transformation schemes leads to some distinct consequences for the appraisal of trypanosomiasis control operations.

- The feasibility of control methods will have to be judged in a different light (the strong organization renders chemoprophylaxis more promising, limited hunting operations to drive game out of the ranching area (which is to be fenced) become more feasible)
- Ranching schemes are usually carried out in areas where present land use is not intensive enough to be an indicator for the most appropriate type of land use. Prior to embarking on tsetse control schemes to prepare the land for cattle alternative possibilities of land utilization would have to be considered (see Chapter 4)
- For the situation in Uganda it appears warranted to pay particular attention to the sequence of planning for tsetse control and of planning for ranching development. In general one might consider it more logical to start with the planning of ranching schemes and this would then determine time and place for tsetse control if necessary. In Uganda the sequence of events has often been the reverse. The reasons for this as well as the resulting effects will have to be examined.

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1) & 2) Baker, op.cit. p. 240.

There are many instances of geographical coincidence of tsetse control and ranching schemes in Uganda (Ankole/Masaka, Bunyoro, Maruzi, Acholi, Buruli etc.) and case studies will be carried out in some of these areas to examine more closely the implications indicated above.

This appears particularly important since emphasis seems to be shifting from tsetse control as a general "improvement measure" to tsetse control as a means of making land available for ranching schemes.

c) Trypanosomiasis control as a development activity

Having outlined some principles and problems of the development of the cattle industry it will be attempted to define more accurately the role of the bovine trypanosomiasis as a limiting factor and the role of trypanosomiasis control as a development activity.

Again it is necessary to take a rather differentiated view. While tsetse flies and trypanosomiasis have direct and indirect effects on the cattle industry over a considerable part of Uganda, these effects are by no means uniform.

Broadly the following "trypanosomiasis situations" can be distinguished:

- Areas of high tsetse density
  The tsetse flies because of trypanosomiasis they transmit may deny the land to cattle and thus be responsible for the lack of economic activity and production. This e.g. is claimed to be the case in Uganda for large areas of Toro, Bunyoro and Madi.[1] Causality is however not so unambiguous and it can well be argued that the tsetse flies are present because population density and consequently the intensity of land use is low in these areas (which may be attributed to factors other than trypanosomiasis).[2]
  In some of these areas the beneficial effect of the tsetse in preserving pastures from unwise overutilization at present until economic pressure will result in a rational development of these areas may be considerable.

  In the light of these considerations some attempts to estimate the losses attributable to trypanosomiasis seem rather naive. F.A.O., e.g. calculates that the potential capital value lost through permanent infestation of land by tsetse flies is in the order of 5 bio US.$. The arithmetics are simple: the tsetse occupy an area of 10 mio sq. kilometres. Allowing for a carrying capacity of 12.5 cattle per sq. km. a potential cattle population of 125 mio head is calculated.

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1) Baker, P. R. (1968) "The Distribution of Cattle in Uganda", East African Geographical Review, No. 6, pp. 63/75.

2) Ford, I. (1969) "The Distribution of the Vectors of African Pathogenic Trypanosomes." Bull. W.H.O. 1963, 28.

Multiplication with an average price of US $ 40 per head brings about the above figure.[1] It does not seem worthwhile to devote time and effort to criticising this computation.

- Areas of low tsetse density
  These areas may carry stock but incidence of trypanosomiasis may be a major factor responsible for high mortality and low productivity. Accurate quantification of the loss attributable to trypanosomiasis appears problematic if not impossible due to the interaction of different diseases and the presence of many other factors limiting production and productivity. A rough idea of the impact of the disease can however usually be obtained from figures of infection rates in examined herds and from comparison of mortality and productivity figures with those of similar areas that are trypanosomiasis-free.

- Tsetse-free areas

  Trypanosomiasis may effect the cattle industry in tsetse-free areas as well. Several cases which may be simultaniously present, can be distinguished:

  - occasional introduction of an infected animal into the herd combined with subsequent mechanical transmission may result in a trypanosomiasis problem similar to that of areas with low tsetse density (although the virulence of the disease is usually lower).
  - cattle are seasonally taken into adjacent infested areas for pasture and water. This will result in occasional total losses of animals and lowered production from animals that survive the infection, a price often paid knowingly for the sake of saving the majority of the herd from starvation. This situation is most conspicuous in tropical Africa west of Cameroon where a regular massive transhumance carries the cattle from the tsetse free north into infested regions in the south during the dry season, and back as the rains start. On a smaller scale this is also found in central and eastern Africa.
  - cattle raised in trypanosomiasis-free country have to be driven through fly-belts on their way to the market. The animals may contract trypanosomiasis resulting in loss of condition and mortality. The reduction of returns for the cattle producer is more readily assessible and can assume considerable dimensions in some areas.[2]
  - cattle in fly-free country may be under the risk of a tsetse spread from adjacent areas. While no actual losses are incurred, for almost 20 years "elimination of the risk of spread" has been the primary justification for the execution of large scale tsetse control projects in Uganda. It will be attempted to examine this argument more closely.

The above differentiation of "situations" serves two purposes:

1) The characterization of an area according to the trypanosomiasis situation can be carried out in conjunction with

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[1] F.A.O./W.H.O./O.I.E.
Animal Health Year Book, 1962, p. 297.

[2] W.H.O./F.A.O. Expert Committee (1969)
African Trypanosomiasis, W.H.O. Technical Report Series No. 434, p. 8.

a characterization according to development stage and development potential of the cattle industry in this area. If this is done for some areas in which trypanosomiasis control schemes have been executed or for which schemes are proposed an ex-post or ex-ante feasibility study of such schemes will be possible. In other words the role of trypanosomiasis control as a development activity in specific areas can be roughly assessed.

2) The classification of areas according to the "trypanosomiasis situation" allows a first feasibility study of the various control methods available.

It has been stated above that e.g. chemoprophylaxis is not feasible as a control method where the fly challenge is very high. Destruction of game would not be the method of choice in areas where the tsetse density is already very low or where the odd cases of trypanosomiasis can be traced back to mechanical transmission. Where cattle only get into contact with tsetse on their way to the market chemoprophylaxis is certainly preferable to ruthless sheer clearing along the trade routes.

While these examples are self-evident it is intended to establish more sensitive relationships. These should then be extended to account for development stage and development potential of an area as well as biotechnical conditions that influence the choice of a control method. For ex-post analysis these relationships may offer some explanation for economic success or failure of certain schemes. Regarding future policies of tsetse and trypanosomiasis control this will allow more specific recommendations down to the level of defined areas and of specific control methods.

5) Trypanosomiasis Control and Land Use Planning

Examination of economic implications of trypanosomiasis has so far been related to the development of the cattle industry. There are however implications that need be seen in a broader context.

a) The conflict between trypanosomiasis control and "optimal" land use

Tsetse and trypanosomiasis control schemes that are carried out in areas where the cattle industry is already firmly established and where it constitutes the predominant or exclusive type of land use consideration of alternative land uses may be of little immediate importance.

Control schemes - and in particular tsetse control schemes - are however often extended into areas where present land use is of negligeable proportions and does not give any indication as to the "best" way of using the land.

This may be the case in two main types of situations:

1) There is a risk of spread of the fly into adjacent cattle areas.

Natural barriers may be lacking and the creation of artificial barriers may involve prohibitively high costs. It is therefore decided to eliminate the tsetse up to a place where a consolidation line is possible along a narrow front. Such purely "preventive reclamation" will be dealt with in connection with the general problem of tsetse spread as indicated in the foregoing chapter.

2) Development requires the expansion of economic activities into new land. It is this case that is considered in this chapter.

The conflict between tsetse control schemes and proper land use planning arises from two considerations:

1) The agreement to expand the cattle industry does not imply that all the new land opened up has to be devoted to cattle. There is still the task of finding the most suitable areas for the expansion of the cattle industry and of reserving and developing other areas for their appropriate uses.

2) Tsetse control is not a "neutral" investment into land like e.g. the construction of a road to open up an area. While the latter may be appropriate irrespective of the type of subsequent land use, the former is only called for if the land is to be predominantly used for cattle, (disregarding for the moment the fact that it may be necessary to protect humans against possible infections with T. rhodesiense or T. gambiense). Tsetse control schemes may be unnecessary where the land is to be used predominantly for crops with animal production playing a minor role,[1] where land is to be used for wildlife, for forestry production, where land has been allocated to military use (which has interfered with the use of land for cattle subsequent to tsetse eradication in several instances in Uganda), not to speak of land for which resource studies indicate no economic use at all.

The conclusion for a country like Uganda[2] is that before embarking on tsetse control schemes in "new" land, pre-investment surveys

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1) Not only because the potential incidence of bovine trypanosomiasis is limited in the first place, but also because settlement and cultivation per se usually make the land unsuitable for the tsetse.

2) In a country like the Central African Republic the situation is completely different. Here the land has been surveyed with respect to its potential for livestock production. Suitable areas have been accurately defined and by law they are exclusively reserved for this type of land use.

would have to be carried out. This necessitates a fact-finding mission into the area under consideration, whose objective is to investigate and produce a report on the general development potential. A minimum team for this purpose might consist of (1) an epidemiologist conversant with all aspects of the trypanosomiasis problem, (2) a tsetse ecologist, experienced not only in work with tsetse but also in trypanosomiasis of domestic animals, (3) a livestock ecologist, who would be concerned with animal production and the plant life potential (4) an agricultural economist, who could study local economic potential in relation to the national economy, and (5) a wildlife ecologist, who could assess the economic potential of wildlife where it supports the tsetse population.[1)]

While the necessity of such intensive surveys is stressed they are beyond the scope of this study. Only rough assessments will be possible based ecological zones[2)] (for ex-post and ex-ante evaluation purposes) and based on present land-use in areas where tsetse control schemes have been carried out in the past[3)] (for ex-post evaluations). For reasons explained below more explicit consideration will however be given to the possibility of game utilization as an alternative to tsetse control and subsequent establishment of a cattle industry.

So far the considerations have been of a static nature. Assuming that a certain area has been unambiguously allocated to the cattle industry as the most rational present type of use there remains a problem that only becomes evident in a dynamic context, namely that of "when" to develop the land for this predetermined use. This is a proper problem of dynamic investment planning and concerns the timing of investment projects in relation to changes over time in the value of goods and services they provide.[4)] [5)]

For tsetse control schemes this is mainly relevant for the following reason: Tsetse control alone does not result in any production (in unpopulated areas). Additional investments have to be undertaken, e.g. all the investments connected with the

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1) WHO/FAO(1969) Expert Committee op.cit. pp. 51/52.

2) Langdale-Brown, I., Omaston, H. A., Wilson, T. G.(1964) The Vegetation of Uganda and its bearing on land use.

3) Uganda Atlas (1967);
Petrides, G. A. (1959), , A Land Use Map of Uganda in: The East African Agricultural Journal, July 1959.

4) See e.g. Marglin S. A.(1962) Approaches to Dynamic Investment Planning.

5) This is not essentially a problem of uncertainty with regard to future technology and/or markets etc., but may result merely from the fact that values of goods produced in the future are discounted.

establishment of a ranching scheme. The time that elapses between the first investment (tsetse control) and the commencement of production determines to a considerable degree the economic soundness of these development efforts.

During the past few years some 4,000 sq.km. have been rendered tsetse-free and ready for ranching schemes in Uganda. There is evidence that this area is well beyond the handling capacity of the organizations responsible for ranching development. It will therefore have to be examined whether it is feasible at present to embark on vast new tsetse eradication schemes, as it is proposed.

This seems particularly warranted since cleared areas that are not used for a considerable time are under a heavy risk of re-infestation or else require costly efforts to maintain the results of the tsetse eradication scheme.

b) Game Utilization as an alternative land use

For two major reasons this study will concentrate on game utilization as an alternative:

1) Tsetse control is not only competitive with game utilization but usually destructive to game (be it by shooting the game directly or by permanently excluding it from certain areas). The decision in favor of tsetse control and cattle is therefore of a much more radical and permanent nature with regard to game utilization than with regard to cropping or other alternative land-uses.

2) A good deal of the arguments used in favor of game utilization are mere guesswork or are based on emotions. They are easily done away with by sober quantitative arguments in favor of tsetse control and cattle. It is therefore attempted to assess more accurately the value of game in the light of its scarcity and in the light of its economic potential.[1)] This in turn is necessary for a realistic evaluation of tsetse control operations since these have to be debited with the opportunity costs of the resources used (or destroyed as in this case).

Game utilization is a complex term referring to different activities and combination of activities. It seems possible to distinguish the following types:[1)]

1) Hunting for meat both by hunting tribes and by members of agricultural or semi-agricultural tribes.
2) Hunting for trophy or for sport.

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1) German Foundation for Developing Countries (1964) Utilization of Wild life in Developing Countries.

3) Protection of animals in parks and reserves as tourist attractions.

4) Commercial use of animals and animal products, specifically the sale of meat, skins and other trophies and musk.

5) Capturing and selling live animals.

6) Game cropping - culling in parks and reserves
- ranching (game encouraged to graze in certain areas outside the parks and reserves)
- farming (domestication)

this exclusively or in combination with cattle keeping.

It will be tried to determine areas where game utilization was or still is a feasible alternative to tsetse control and livestock keeping.[2)3)] This will only be the case in areas that meet at least the following conditions:

- Game is present in sufficient numbers. It seems difficult to define what is meant by sufficient numbers due to the inherent difficulties in estimating game numbers and densities.[1)]
- Livestock production is likely to bring low returns (as other alternative land uses) which may be due to a low natural potential of the land or low husbandry standards.[4)]

A special situation prevails where land is endangered by erosion. Prudent game utilization may then not only be the only way of obtaining a continuous - if low - return from the land, but may help restoring the potential of the land.

It will then be attempted to obtain some quatitative estimates of costs and returns of game utilization in these areas.[5)]

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1) See e.g. Robinette, W. L. (1970) Game Animal Surveys, W.H.O., Tryp/Inf./70.37

2) Outside the existing National Parks and Game Reserves.

3) Roth, H. H.(1969) The Integration of Wild life in Agricultural Development, F.A.O. An:AFA/69/22.

4) Thane Riney(1964) The Importance of Wild life as a Marginal Form of Land Use in Developing Countries in Utilization of Wild life in Developing Countries op.cit.

5) Which is facilitated by work already done by the Game Department. Considerable emphasis has been put on assessing the economics of game utilization.

Game utilization seems to deserve particular attention for another reason yet. It can be seen as a temporary form of land use. It has a preserving effect on the land, involves no radical and binding changes of the environment and necessitates no great capital out-lays. With increasing population pressure and expanding economic activity it is very likely that game will eventually be pushed back to Parks and Reserves. It seems however unnecessary to precipitate this process by tsetse control schemes that do not result in immediate and more productive land use.

The possibility of game utilization as a temporary form of land use receives even more weight when considering that a vaccine or more efficient drugs may be developed in the near future. Especially in the immunological field considerable efforts are being made[1] and while results of research activities are unpredictable it is characteristic of a wise policy to account for uncertainty.

6) "Efficiency" Analysis of Trypanosomiasis Control

In the preceding chapters of this section problems of choice have been outlined (developing the cattle industry against developing other sectors, trypanosomiasis control against other development activities, tsetse control against game utilization). Decisions with regard to these choices attempt to economise i.e. to make the "most, in which every way this may be conceived, of whatever resources are available.[2] A solution which achieves this goal may be called an efficient solution.[3]

The consequences of some of these alternative courses of action are very complex, necessary data are lacking and analytical

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1) See e.g. (1) recent Annual Reports of the East African Trypanosomiasis Research Organization.

(2) Lumsden, W. H. R. (1967) Trends in Research on the Immunology of Tryp. Bull. WHO 1967, 37. pp. 161-175.

2) McKean R. "Efficiency in Government Through Systems Analysis, 6th ed. 1967, pp. 3.

3) This has to be distinguished from more sophisticated definitions of efficiency based on the theory of welfare economics.

aids are not sophisticated enough to allow a formal efficiency analysis in each case. Decisions will still have to be taken on these (higher) levels but they are more concerned with the coordination of efforts and consistency between decisions. They result in the opening up of feasible concrete development activities, and it is only at this (lower) level that the efficiency in the use of resources may be formally and quantitatively examined. Where it is attempted to evaluate past policies the following through of the higher level decisions points to those concrete activities that should be subjected to an ex-post efficiencyanalysis.

These analysis on the other hand will result in a considerable feed-back to the higher-level decisions.[1] As more accurate information on the concrete development activities comes forth, the original higher-level decisions may be confirmed or revised and may even result in a change of the political and legal framework that influences the decision-making process and the efficiency of economic activities.

Efficiency analysis and the supply of general information is the concern of this chapter and of Section C. The feedback process will be followed through in Section D.

a) Principles of Efficiency Analysis.[2]

The meaning of "making the most of whatever resources are available", or as others put it "maximizing utility subject to whatever constraints") needs specification.

For a private firm this may be a comparatively easy task. The hypothesis that a firm's utility is the monetary profit and that a firm therefore seeks to maximize the difference between its monetary revenues and costs may not be unrealistic.

In other cases, e.g. for government units, the utility function is more difficult to specify. There is no simple way of describing the desirable and deleterious effects of economic activity from the point of view of a government and one of the major problems lies in defining the government's utility function.

In the case of countries like Uganda where the framework for economic growth is outlined in Development Plans, it may be possible to derive the objectives of Government activity from these Plans.

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1) e.g. Marglin L967) Public Investment Criteria, p. 19.

2) The chapter is based on Little and Mirrless (1969) Manual of Industrial Project Analysis in Developing Countries, Vol. II, Social Cost Benefit Analysis.

For the present purpose it may suffice to interpret these stated objectives as (1) to increase national income and (2) to promote greater equality in income distribution. It will have to be examined whether these two objectives can be combined into a single objective function or what type of consideration should be given to the distributive objective. For the sake of simplicity the following discussion is mainly concerned with the "national income objective".

"Costs" and "benefits" have only instrumental character. Only when they are defined as deleterious or desirable effects on the national income objective the notion of costs and benefits becomes sufficiently meaningful that a quantitative appraisal of economic alternative within the public sector can be expected to lead to a higher level of efficiency (increase of national income) than more intuitive methods of decision-making permit.

The criterion by which to choose among alternative investments will then basically be the difference between benefits and costs (social gain, for the above objective equal to increase of national income).

Another way of explaining the nature of cost-benefit analysis and also the preferable approach for application in practice starts from a conventional profitability analysis of a private firm as shown in the following table:

1.	Current Sales (net of indirect taxes	R	- 'Normal' Accounting
2.	Payment for current inputs (including wages and salaries).....	C	
3.	Gross Operating Profit.....	R-C	
4.	Depreciation.....	D	
5.	Net Operating Profit.....	R-C-D	
6.	Interest Charges.....	I	
7.	Net Profit before Tax.....	R-C-D-I	
8.	Direct Taxes.....	T	
9.	Net Profit after Tax.....	R-C-D-I-T	
	Add back Depreciation.....	D	
10.	Current 'Cash Flow'.....	R-C-I-T	- 'Cash Flow' Accounting
11.	Less net capital expenditures.....	K	
12.	Total Cash Flow (excluding Borrowing and Lending).....	R-C-I-T-K	
13.	Add Net New Borrowing.....	B	
14.	Total Cash Flow.....	B+R-C-I-T-K	
	Less Cash Flow arising from financial transactions.....	B-I	
15.	Cash Flow from Non-Financial Operations.....	R-C-T-K	

	Add back direct tax.....	T
	Add indirect taxes on inputs.....	T*
16.	Social Cash Flow.....	R-C-K+T*

1)

The cash flow which is relevant to assessing profitability from the point of view of the firm is the cash flow from non-financial operations (row 15). The essence of cost-benefit analysis is that it does not accept that actual receipts adequately measure social benefits and actual expenditures social costs (even if adjustment for taxes is made as in row 16). The conditions which would bring about coincidence are never met in the real world and particularly wide deviations may be present in developing countries.[2]

Cost-benefit analysis does however accept that actual receipts and expenditures can be adequately adjusted so that the difference between them which is very closely analogous to ordinary profit will properly reflect social gain. This adjustments may involve using accounting prices instead of market prices, the rate of discount which an enterprise would apply to future profits to reduce them to their present value may not be accepted, elements may be included as social costs and benefits that do not bring about expenditures or receipts for the private firm etc.

The discussion so far only amounts to saying that there exists an instrument by which the social desirability of government activities can be assessed. In the actual study it will be attempted to outline more accurately the computation of cost and benefits and the principles that govern the modifications of a private profitability analysis.

b) Application of efficiency analysis to trypanosomiasis control

One of the more obvious difficulties in analysing costs and benefits of trypanosomiasis control schemes is to state the immediate benefits (fly-free land, reduced incidence of trypanosomiasis) in terms comparable to the costs in shillings. If costs and benefits are not commensurate the cost-benefit criterion is no longer applicable. One may then resort to cost-effectiveness studies. This will determine the most efficient way of achieving a stated end, but it is obvious that the end itself will then need particular examination to ensure that it is consistent with higher level objectives.[2]

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1) From Little and Mirrlees op.cit. p. 19.

2) See McKean (1967) op.cit.

3) See e.g. Eckstein O. (1965) Water Resource Development, pp. 19.
Little and Mirrlees op.cit. pp. 31.

It is not clear yet whether this approach will be necessary, and it seems likely that benefits of trypanosomiasis control schemes can to a considerable extent be imputed by viewing the cattle industry of an area as a production unity and trypanosomiasis control as an input (costs) that results in increased output (benefits).

Nothing is lost and much may be gained in terms of clarity if trypanosomiasis control schemes and the cattle industry are first considered separately. The following rough procedure is proposed:

1) examine the costs of trypanosomiasis control schemes
   - in terms of nominal expenditures
   - in terms of social costs
2) examine the economics of the cattle industry in the area concerned
   - in terms of a "private" profitability analysis
   - in terms of a social cost-benefit analysis
3) examine the economics of the combined operations
   - in terms of a "private" profitability analysis
   - in terms of a social cost benefit analysis

Having established appropriate estimates of the social gain sensitivity analysis will be carried out. Sensitivity analyses are generally used in order to gain an idea of the possible impact of uncertainty on the worthiness of a project by varying those elements that are particularly subject to uncertainty. In this study those elements will be varied that constitute policy variables. The control method applied, the standard of cattle production (as measured by average slaughter weight, calf mortality etc.), the value of the land for other uses (in terms of benefits foregone), the timing of investments (years between tsetse control and the onset of production) are likely to have considerable influence on the social gain from development activities. Sensitivity analysis attempts to quantify this influence and helps in the formulation of future policies.

c) Limitations

Ideally efficiency analysis as described above would result in an unambiguous measure of the social desirability of trypanosomiasis control schemes. Through sensitivity analysis and suitable choice of the case studies the most important variables determining this desirability could be determined. This would lead to recommendations for future policies likely to result in greater efficiency of the Government's development efforts.

There are however two major factors that prohibit such clear-cut unambiguous results:

Intangibles

Intangibles are some of the consequences of the alternatives compared, but they are consequences of a special sort. Their distinguishing characteristic is that they cannot readily be translated into the common denominator that is being used. Thus if gains are measured in shillings those effect that cannot be measured so are intangibles.[1] Extensive application of insecticides may lead to the contamination of the whole environment, game destruction may lead to the complete disappearance of threatened game species, rendering low potential land fly-free may lead to a rapid and irreversible phytodegradation and erosion due to overstocking. These effects may be clearly foreseeable but quantification in terms of shillings may be difficult if not impossible. They are thus not accounted for in the efficiency criterion used.

Even if they are given some type of treatment lime explicit description or quantification in physical terms the efficiency criterion is not unambiguous any more.

Uncertainty

Another consideration that cannot be priced is the degree of uncertainty about a project's cost and gain.[2] Market prices of inputs and outputs may undergo radical changes in future years (insecticides, beef), new techniques of trypanosomiasis control may be developed that necessitate a complete change of outlook (sterile male technique, vaccine, more efficient drugs). Efficiency in the light of present technology and market situations may be completely different from efficiency in the light of tomorrow's conditions.

Attempts to quantify uncertainty not only fail to eliminate the ambiguity of the efficiency criterion but may in fact be harmful when they induce greater confidence in the results of the efficiency analysis.[3]

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1) See McKean (1967) op.cit. pp. 58.

2) McKean op.cit. pp. 64.

3) Ciriacy-Wantrup, S. V.
Policy Considerations in Farm Management in the Decade ahead.
Giannini Foundation Papers No. 156 p. 1310(modified)
University of California, Berkeley.

The existence of uncertainty should lead to a policy that aims less at efficient solutions and more on flexible solutions. As Ciriacy-Wantrup puts it, the emphasis should be "on minimum standards in resource use rather than on the optimum use, on avoiding dead end streets and on keeping direction rather than on computing the shortest distance, on mobility and adaptibility of productive factors rather than on their optimal combination."[1] These considerations will have to be borne in mind when interpreting the results of the efficiency analyses to be carried out (Section C and D).

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1) Ciriacy-Wantrup, S. V.
Policy Considerations .... op.cit. p. 1311 (modified)
See also:
Ciriacy-Wantrup, S. V. (1968)
Resource Conservation
Economicsand Policies
3rd. ed.(Univ. of California)

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