


PROBLEMS AND CONTRADICTIONS IN THE DEVELOPMENT OF
OX-CULTIVATION IN TANZANIA
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PROBLEMS AND CONTRADICTIONS IN
THE DEVELOPMENT OF OX-CULTIVATION
IN TANZANIA

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CHAPTER ONE

1. INTRODUCTION

1.1 THE POTENTIAL OF ANIMAL TRACTION AND THE PROBLEM OF INAPPROPRIATE TECHNOLOGY

Over the last five to ten years, there has been a growing interest in the development and diffusion of appropriate technology both among the international aid community and among governments in the Third World. The development of animal traction as a form of intermediate technology for smallholder peasant farming has received particular attention. This is a result both of past failures with more capital-intensive technology, the cost of which is now excessive, and of the present energy and production crisis in the poor underdeveloped countries. The spread of the biochemical package of the Green Revolution has been slow and uneven in Subsaharan Africa and has not achieved the results expected, partly because of the lack of a well-developed infrastructure for distribution, partly because of the soaring costs of chemical inputs and partly because of lack of suitable packages for the highly variable soil and rainfall regimes. The need for increasing the source of farm power in agricultural systems dependent on hoe cultivation and human energy is increasingly acknowledged (United Nations 1981:4).

The potential of animal traction is stressed in a growing body of literature. This potential involves:

1. increased production through increasing the area of cultivation, the intensity of cultivation and the level of labour productivity;

2. intensification of production through crop-animal integration, i.e. production of fodder crops, stall-feeding of cattle, application of farm-yard manure on crops;

3. raising the general level of technical capability in rural areas and creating integrated linkages to non-agricultural sectors by establishing production and
maintenance facilities in small-scale industry and rural craft production;

4. developing the multi-purpose potential of cattle in the production of milk, meat, hides and ancillary animal products. Cattle as a source of draught animals represent a vast source of renewable energy to be utilized both in cultivation, water lifting, crop processing and in transport;

5. reducing the dependence on foreign exchange imports in contrast to using petroleum-based mechanization and chemical packages. Animal traction involves a self-reliant strategy, which implies greater control of the means of production at the local level;

6. last but not least, peasants in many parts of Africa are reported to show increased interest in animal traction. This certainly applies to Tanzania (see Chapter Six).

Over the past decades, there have been a number of efforts to develop animal traction, in some countries supported by both governments, international agencies and farmer's interest. This applies in particular to Senegal, Gambia, Upper Volta and Botswana, but also more recently to Zambia, Sierra Leone and Kenya. At the practical level, the Tanzanian government has rather neglected the development of animal traction (see Chapter Six).

The efforts to develop animal traction include:

1. the development of testing trials and designs of both single-purpose implements (ploughs, ridgers, harrows, seeders, inter-row cultivators, groundnut lifters) and multi-purpose tool carriers which can perform a number of cultivation activities;

2. the setting up of ox-training and farmers' training centres, including credit and extension services, and more rarely pilot farmer verification trials and farm implement supply schemes;

3. the setting up of workshops and factories for the manufacture of equipment.
However, the rate of adoption of the new technology among small-holding peasants is reported to be generally speaking very low (Moody 1980) apart from a few apparent successes, notably in Senegal, Gambia and Upper Volta, and localised areas in other countries. The reasons for this low rate of adoption can generally be summarized to the following factors:

1. The implements are inappropriate to local-specific conditions from an agronomic point of view.

2. The implements are technically too sophisticated. Parts break or get lost and no repair can be done in rural areas. This applies in particular to tool bars and seeders.

3. The implements are too heavy for oxen to pull, are difficult to transport to the fields and are difficult to operate. They generally have too high draught-power requirements.

4. The implements are too expensive.

5. The advantages and profitability of using animal drawn implements by comparison with hoe farming have not been demonstrated under peasant farm conditions to the satisfaction of the peasant.

6. The equipment is actually not available in rural areas at the right time and place when it is most needed.

7. Ownership of cattle is unequal and access to draught animals is limited and if purchased very expensive.

In Tanzania decades have been spent on designing and testing implements and conduction cultivation trials under rather favourable, closely controlled experimental conditions with fairly well-trained manpower at Arusha (TAMTU), Morogoro (Faculty of Agriculture), Mbeya (Uyole Agricultural Centre), and at Mwanza (Ukuriguru Agricultural Research Centre), and possibly at other places as well. Hardly any of this equipment has yet reached beyond the research centres, ox/farmers' training centres and workshops, which produce and try to market some of the implements, for most of the reasons listed above (especially points 2 to 6 of which 4 and 6 weigh heavily). Points 2 to 4 suggest that the experimental stages still have
a long way to go in order to achieve the necessary level of appropriateness.

The alternative might be to import equipment which has been used for some time on peasant farms in other countries and has achieved at least some rate of adoption among farmers. The most successful make, used in Senegal, Gambia and Upper Volta, seems to be the 'Sine Houe' toolbar system, suitable for semi-arid conditions and available at a relatively low cost due to mass-production by the SISCOMA factory in Senegal (Moody 1980: 13-15). The question is whether or not the past experience with design and experimental work in Tanzania suggests that the time has come for letting interested peasants use proven equipment for several seasons by trial and error, with training assistance and monitoring of results, in order to ascertain the appropriateness of the equipment under peasant farm conditions.

Given past experience and present conditions in Tanzania, it is extremely difficult to see how the concentration of limited efforts and funds on experimental work under favourable conditions can achieve appropriate results in the near future, not to mention the problem of how these results are to be extended to peasant farms and actually adopted by peasants. In spite of this, it is quite likely that there will be resistance to a peasant oriented approach in the development of animal traction, both among those with vested interests in design and experimental work and more importantly within the relevant government authorities because of the widespread "distrust of the smallholders' capacity to undertake activities unaided..." in government circles (IDS 1981:93).

The growing body of literature concerned with the potential of animal traction continuously stresses the importance of appropriateness and identification of the needs and constraints of local farming systems in terms of technology design and cost. The generally low rate of adoption of this technology suggests that the advice is not followed in practice. There is a wealth of 'normative' studies which tend to focus on the good and potential of a technology developed under isolated trials.
1.2 CONTENTS OF THE STUDY

The approach of this study is rather a different one. Through a survey of available literature the intent has been to trace the development of ox-cultivation in Tanzania. Apart from the general use of home-made sledges made of forked tree branches and the very limited use of ox carts, the development of ox-cultivation in Tanzania has so far only depended on the use of the Ransome 'Victory' type of single-furrow mouldboard plough and a similar type of Chinese design, less superior in quality and made by Ubungo Farm Implements Company (UFI) in Dar Es Salaam.

In contrast to the newer type of implements designed for comprehensive ox cultivation (ridgers, chisel and tine implements, inter-row cultivators, seeders, toolbars), the use of the mouldboard plough has a history of some fifty years in peasant farming in Tanzania and has by and large spread spontaneously, unaided by credit or government extension, and in some cases against restrictions imposed by the colonial government.

Chapter Two describes the evolution of land-use systems in terms of fallow periods, cultivation techniques and labour intensity, and we indicate the systems in which ox-cultivation is found. The process of intensifying labour and land-use is then analysed in terms of the question of land and labour productivity and finally, the general conditions of labour productivity in ox-cultivation are outlined.

Chapter Three focuses on agro-pastoralism, the most common system of land-use in which ox-ploughing has expanded. A description of the important role of cattle is given and the contradictory relationship between crop and cattle production is discussed in terms of land-use intensification. Finally, we provide an example of the territorial expansion of this system with focus on the effects of ox-ploughing on cultivation techniques and land-use.

Chapter Four looks at the historical development of ox-ploughing in those areas of Tanzania for which relevant
literature could be obtained. An attempt is made to focus on the social, economic and political causes which have determined the development of ox-ploughing and its uneven spatial expansion and limited individual adoption.

Chapter Five contains an analysis of the socio-economic effects of ox-ploughing by comparison with hoe-cultivation. The chapter focuses on the relationship between size of cultivated acreage, returns to land and labour, use of hired labour, family income and preconditions for capital accumulation. Finally, the question of the hiring of ox-plough teams by non-owners and the material position of women in ox-farming are discussed.

Chapter Six provides a general, critical review of the agricultural mechanization policies of the Tanzanian government during the 1960s and 1970s. Despite the disastrous failures of the cooperative tractor mechanization schemes in the 1960s and despite the emphasis on animal traction given in political statements after the Arusha Declaration, the lion's share of state funds and efforts continued to be concentrated on tractor mechanization for villages and especially in the parastatal and state farm sector. The consequences of these policies for the development of animal traction are discussed together with the involved role of foreign donor agencies like FAO and the World Bank in supporting tractor mechanization.

Chapter Seven presents data from a regional survey of recorded ox-equipment and assesses the present number of ox-ploughs in Tanzania so as to get a general outline of the trend in the use of ox-ploughs during the 1960s and 1970s. An assessment is made of the number of ploughs produced in Tanzania over the 1970s and recent plans for the increased production of ox-equipment are criticised in terms of involving the choice of inappropriate equipment. This is followed up with recommendations for selecting more appropriate equipment. Finally, the shortage of and demand for ox-ploughs is discussed, together with the question of credit for the purchase of ploughs.

Chapter Eight analyses the state of affairs of animal-drawn equipment other than ploughs in Tanzania, in terms of research,
development and extension of such equipment and in terms of its production, availability, appropriateness and demand. A description and detailed critical evaluation is made of all pieces of ox-implements found in Tanzania, and recommendations are put forward for experimental adaptive research, design and production of more appropriate implements so as to raise the possibilities for their adoption which has so far been neglected.

Chapter Nine follows up on the most important issues analysed in the previous chapters and discusses the development perspectives of some of the most crucial problems related to the further development of comprehensive ox-mechanization, i.e. the problem of land-use in the context of villagization and the problem of unequal access to the most crucial productive forces, draught oxen and labour power. A summary outline is provided on the need for selective priorities in the choice of implements and on the need for adaptive experimental research so as to avoid a continuation of the past failures of inappropriate technology.
CHAPTER TWO

2. THE EVOLUTION AND INTENSIFICATION OF LAND-USE SYSTEMS AND THE ROLE OF OX-PLoughING

2.1 INTRODUCTION

In Tanzania, the development and expansion of ox-ploughing has been associated with particular systems of land-use. These are in the main fairly extensive systems of grass-fallow cultivation found in the cool southern and northern highlands, and in the warmer, semi-arid north-western area of the Central Plateau and the more humid south-eastern area of the Lake Victoria Plateau.

Needless to say, plough cultivation is not found in the central-western, southern and coastal regions where systems of forest and bush-fallow have prevailed, due to lack of grazing land for cattle and occurrence of tsetse flies transmitting trypanosomiasis.

Expansion of ox-ploughing has tended to involve a process of overall intensification of land-use in the sense that cropped acres have expanded at the cost of pasture and fallow land used for grazing. On the other hand, ox-ploughing has been associated with more extensive techniques of cultivation. While population pressure is generally the main determinant of intensification of labour and land-use, the tendency towards extensification through territorial expansion and the adoption of ox-ploughing is crucially related to the sustainment of labour productivity (output per unit of labour time or returns to labour).

In the following section we shall first look at the factors involved in the general evolution and intensification of land-use systems, in terms of fallow periods, cultivation techniques and measures of fertility restoration and indicate the systems in which ox-cultivation is found.

The process of intensifying labour and land-use is then analysed in terms of the question of land and labour pro-
ductivity and finally the general conditions of labour productivity in ox-cultivation are outlined.

2.2 LONG-FALLOW SYSTEMS

Long-forest fallow systems are characterized by very low population densities, long fallow periods of twenty to thirty years allowing for forest regrowth, and a cropping period of only two to three years. Both labour productivity and yields per unit of cropped land tend to be high. The naturally regenerated fertility of the fallow period is exploited in a couple of years and weed growth is hampered by forest regrowth. When weeds start to occur after a couple of years of cropping, the field is left fallow and a new plot is cleared with the help of fire as a powerful labour saving force. Thus, the labour input is limited to clearing, planting with a digging stick and harvesting. No labour is needed for land preparation, weeding, manuring or for the care of draught animals. The simple physical character of the tools involved belies the high level of labour productivity of this system.

In Tanzania, this system was once found in areas with mountain rain forest but is no longer common with the few remaining rain forest areas having been reserved as water catchment areas.

The long-bush fallow system has been much more common throughout the wood- and bushlands in Tanzania and has probably only recently been restricted by the concentration of settlement and the transition to permanent annual farming brought about by villagization. In this system, the fallow period may last some six to ten years with grass, bush and smaller trees invading the fallow. In addition to slash-and-burn techniques, which still leave tree stumps and roots on the land, hoeing becomes necessary to cope with grassy and herbaceous weeds and to prepare a seed bed. The field cropping period may vary considerably, from a couple of years (extensive variant) to as long as the fallow period, i.e. six to eight years (intensive variant) (Boserup 1965:17).
The advantage of both forest and bush-fallow systems lies in the fertility-increasing effect of clearing and burning the vegetation with a relatively low input of labour. But yields will tend to be lower under bush-fallow than under forest-fallow, due to the shorter fallow period and consequently lower capacity for fertility regeneration. Hence, the per capita cultivation factor (annual per capita acreage) must be extended. This, together with the labour-demanding task of weeding will result in lower productivity of labour, but the system can support higher population densities.

A transition to a more intensive, labour-demanding system will generally not take place until population pressure and/or deterioration of vegetation and soil fertility enforces such a change.

2.3 SHORT-FALLOW AND INTENSIVE CROPPING WITH PLough CULTIVATION

Under a system of short-fallow cultivation the fallow may last only for a couple of years and only grasses and shrubs can invade the fallow before the cultivator returns to the same field (Boserup 1965:16). In Tanzania a more extensive medium-term variant of such a grass-fallow system is common, in which the fallow period is some four to five years, with shrubs and bush growth checked by fire and browsing goats. Under both systems, bush and tree growth increasingly disappears from the landscape together with tree stumps and roots.

According to Boserup (1965:24) it is under systems of grass-fallow where plough cultivation becomes both indispensable and is facilitated by the gradual disappearance of roots and tree stumps in the fallow. Clearing the land by burning is insufficient since burning leaves the grass roots intact and it becomes exceedingly difficult to remove them by means of hoeing. Apart from the initial effects of fallow resting and grass burning, fertility is restored either by the mulching effect of leaving crop residues and uprooted weeds on the top soil when using scratch ploughs (cf. India and Ethiopia) or, when using the steel mouldboard plough, by
deep-ploughing weeds and crop residues into the soil (the latter method is slightly more intensive, requiring more energy or power per unit of land).

Moreover, the droppings from the animals grazing the fallow will contribute to fertility restoration. However, under tropical conditions of heavy showers, high temperatures and exposure of droppings to open sun burning, most of the plant nutrient value of such droppings is likely to disappear during the dry season before it can be utilized by the plants (ILOCO 1981: 536). Most important, however, grass-fallow systems open up the land for extensive forms of cattle grazing.

The next stage of land-use intensity is reached under annual cropping. In the general perspective it will occur as a result of population pressure necessitating a further reduction of the fallow period to one lasting about half a year between two annual crops. In Tanzania, under particular local conditions involving the existence of fertile or heavy soils and vigorous weed growth, the chosen system of cultivation may become annual, not because of population pressure but simply because weed eradication and annual re-cultivation is easier than breaking up older fallow land. The more marginal or 'difficult' land can still be kept for grazing purposes.

Unless the land is unusually fertile, more labour intensive methods of fertility restoration become necessary under annual cropping due to the short duration of the fallow period. In Tanzania, these broadly involve methods of green manuring (pit, mound and ridge cultivation where grass and weeds are laboriously dug into the soil) and systematic application of farmyard manure or chemical fertilizer. When land in annual cropping expands and pasture is reduced, it becomes a problem to graze livestock extensively and it may become necessary to collect or grow fodder for stall-feeding the animals.

In many parts of Asia and the Middle East, plough cultivation is associated with irrigated swamp rice production, in many places under intensive systems of multi-cropping (see below).
In Tanzania, virtually all the rice produced on peasant farms is grown as annual crops, and very little of this is actually irrigated. The only proper example of irrigated paddy production with ox-ploughing is to my knowledge found in Usangu Plains in Mbeya Region where it was introduced by Baluchis (Pipping 1976: 10; Branner Jespersen 1973:36).

In Sukumaland and Tabora paddy production with ox-ploughing takes place on fields around which small dikes have been built to hold rain water, but this can hardly be called irrigation. On the flood plain north of Lake Nyasa in Kyela District, ox ploughing is very common in swamp rice production but again, there is no control of the water level through irrigation and drainage, and production fluctuates highly as a result of precipitation, flooding and drought (Luning 1969). All of these systems may even make use of occasional fallow periods and are thus fairly extensive in terms of swamp rice production. In all of these cases ox cultivation is limited to initial ploughing only, not to field levelling, puddling, furrow-making and weeding, for which no implements are available.

The most intensive form of land-use is systems of multi-cropping where a sequence of two or three crops is taken on the same plot of land every year. The more extensive variant of this system is mainly found in the most well-watered mountain areas of Tanzania where two crops can be grown annually without irrigation. With the amount of rainfall being the most important limiting factor for crop production in Tanzania, this system is by and large limited in its geographical extent to areas originally carrying mountain rainforest and now carrying perennial crops like bananas, coffee and tea. Due to perennial cropping, the steep topography and the small size of plots, ox-cultivation is impossible. A sequence of two crops in one year is also taken in limited areas with moist depressions and in floodplains where the second crop follows the recession of the flood.

The more intensive variant is irrigated multi-cropping. These systems are most common in South-East Asia and are capable of sustaining very high yields per acre, but with fairly low labour productivity unless motorization and/or
the use of chemical fertilizer are involved. This is due not only to very high initial investment of labour and recurrent maintenance of irrigation and drainage works, but also to the fact that a proportionately high amount of labour is involved in water management and fertility maintenance. Ploughing, levelling and puddling with oxen or water buffaloes is the characteristic technique of land preparation in such systems, but some of the main constraints are water control, land shortage and procurement of fodder for the draught animals.

In Tanzania, irrigated multi-cropping is only practised on a limited scale, in patchy areas along lake shores, swamps or small rivers which can be controlled. Although this system also depends on natural inundation during the wet season, the water level can be controlled, both in the wet and dry season, by means of canals. Ox-cultivation is found in some of these systems, e.g. Mubulu Highlands and Usangu Plains, but is limited to initial ploughing. Fertility is secured by the utilization of unusually fertile alluvial soils deposited in depressions and flood plains and by silt deposits and mineral fertilization through the water flow.

The classification of land-use systems presented above broadly describes the general stages of agricultural evolution in the tropics in relation to population pressure and local-specific land, vegetation and rainfall conditions. Although a particular system of land-use may be dominant in one area at a particular period of time, the total land-use pattern in one area and even within the total area utilized by one household will usually show a co-existence of land-use systems with different intensities.

For example, intensive multi-cropping of a small nearby vegetable plot manured with homestead refuse co-exists with a larger area under annual cropping or grass-fallow, and perhaps further away a plot is utilized under bush fallow. A few weaned calves may be stall-fed on crop residues or collected hay during the dry season while the main herd is still grazed extensively. Intensity of land-use and animal husbandry is generally highest near the homestead or around
the village and decreases with increasing distance. In reality, the actual pattern of land-use is more complex than the general classification suggests and intensity tends to differ between plots and even within one plot.

2.4 THE PROBLEM OF INTENSIFYING LABOUR AND LAND-USE

Each general stage of land-use intensity is associated with a characteristic complex of tools, cultivation techniques, fertility maintenance and water/vegetation control. The general process of land-use intensification involves additional inputs of labour in land preparation, planting, weeding, water control, manuring and animal husbandry, and although yields will increase with manuring and water control, the increased output generally cannot compensate for the extra initial and recurrent input of labour. The process of land-use and labour intensification under population pressure is associated with a tendency for the average productivity of labour to decline⁵ (Boserup 1965:41; Ruthenberg 1968:334). M. Upton (1973: 101-102) relates this tendency to the working of the law of diminishing returns in agriculture or declining marginal returns to labour.

With increasing intensity of land-use, in particular where sufficient manuring and water control is secured, yields per unit of cropped land will tend to increase and the agricultural system will achieve a higher level of stability in production. However, this is not always the case. Where the conditions for intensification are limited, e.g. as a result of marginal land and rainfall conditions, rapid population immigration, heavy population pressure or impoverishment because of heavy surplus extraction, yields may actually decline because of soil exhaustion and this may result in land degradation⁶.

Even if yields decline under growing land-use intensity, the overall increase in population densities and expansion of the cropped acreage will generally involve the production of a higher aggregate output in a given area. The decline in the average productivity of labour in the transition from an extensive to a more intensive system of land-use has to be compensated by working longer hours, either per day if no bottle-
necks are involved, or by lengthening the working year in the sense that total labour time is extended more evenly over the year. This is the case for additional labour time involved in maintenance of irrigation works, transport and application of farmyard manure, stall-feeding of animals, etc. These activities are done outside the cultivation season. The most intensive, high-yielding systems are characterized by long working days throughout the year (e.g. South-east Asia, Kilimanjaro, Ubara Island) whereas extensive systems are characterized by short working days and long, slack off-seasons.

The decline in the average product of labour and the higher intensity of labour associated with a transition towards more intensive systems tends to restrain or delay the transition until population pressure enforces gradual intensification. Delayed transition under pressure may again involve soil exhaustion and a decline in both aggregate output and average product of labour. At this stage intensification becomes both necessary and less constraining with respect to labour intensity. Nonetheless, impoverishment and surplus extraction, e.g. with the terms of trade turning against the peasants, may impose severe limitations to land-use intensification and we thus have a case of productivity/surplus squeeze.

We have belaboured the point above that the level of average labour productivity is a crucial factor both in the general evolution of agricultural systems and in any short-term process of land-use intensification. The point is important to stress, because the agricultural policy of both the colonial and independent government in Tanzania precisely involves land-use intensification. The colonial government was in particular concerned with soil conservation by means of intensive green and farmyard manuring. The present government has throughout been involved in concentrating the peasants in villages, which involves a transition to more intensive systems of land-use. Exhorting, 'educating' or forcing the peasants to work harder on the land has been a general political theme without any consideration for what this implies for the peasant in terms of the tendency for the productivity of labour to decline. Policies which are said to aim at
higher productivity do in fact involve the opposite as long as no appropriate labour productivity increasing means of production are available at reasonable cost.

The motive force of the agrarian history of Tanzania has more than anything involved migration, scattered settlement and territorial expansion into the open land frontier as a means to maintain extensive systems of agriculture and high productivity of labour. The tendency towards extensification has with variable force been counteracted by intensification as a result of population concentration, conditioned by the existence of favourable island eco-systems (e.g. volcanic mountain areas), trading and communication networks, water supplies, crowding as a defensive measure or as a result of control exerted by powerholding classes as a means to appropriate surplus. In the latter case, the aggregate surplus produced will depend more on the ability to concentrate and control a population within a given area than on the productivity of labour - and hence the surplus producing capacity - of individual households. There are numerous historical examples in which intensive systems of land-use have been given up when defensive or control measures were relieved. This goes to show that the strive for high labour productivity is one of the overriding principles of production for individual households.

2.5 Ox-cultivation and Labour Productivity

As a cultivation technique per se, ox-ploughing can increase the productivity of labour by comparison with hoe-cultivation. In the evolutionary time perspective within which Rössrup operates, she argues that the advent of plough cultivation in systems of short-fallow and annual cropping is a measure to prevent a fall in output per man-hour by comparison with long-fallow (1965: 32-34). This is a result of initial labour investments in destumping land, removal of stones, and training of draught animals together with the additional, recurrent input of labour needed for taking care of animals and manuring of land. And labour productivity will certainly decline further if fodder has to be procured for stall-feeding animals. Although the initial labour investments will pay off at some point, it is important to keep in mind that the intro-
duction of plough cultivation is a wholly new technological complex associated with overhead and current costs and additional inputs of labour. Unless there is easy access to draught animals and grazing land, plough cultivation may compare unfavorably with the economics of hoe cultivation based on human power at the same level of intensity.

We have so far outlined some of the aspects of plough cultivation in the general perspective of intensification. However, most reports on ox-cultivation in Africa during the colonial period point to the fact that the introduction of the technology has been accompanied with a definite tendency towards extensification of the system of crop cultivation.

Clearly enough, if land for expansion is available, ox ploughing is capable of extending the per capita cultivation factor by almost two. Additional labour for manuring the land is avoided. The bottleneck of hoe-weeding is greatly increased but is overcome by more sloppy weeding or by reducing the second or third weeding and the result is a drop in yields. Nevertheless, despite low yields and the careless appearance of such extensiveness the overall productivity of labour may well be higher when compared with yield-increasing and more intensive methods.

Under such extensive forms of plough cultivation, weeding and shortage of grazing tend to become major bottlenecks. The precondition for yield-augmenting intensification lies in introducing inter-row cultivators for weeding and ox-carts for easing transport of manure to the fields. Initial and recurrent capital costs will be considerably increased, and inter-row cultivation may often involve a substantial change in cropping practices, necessitating planting with parallel row-spacing (not straight rows as is often propagated in Tanzania) and perhaps even a change in the pattern of mixed cropping or inter-cropping.

In the dry season, half-starvation of animals on overgrazed fallows and pastures and scavenging on crop residues of stubble fields causes the oxen to be weak at the onset of the ploughing season. It may thus become necessary to collect stalks and crop residues at harvest time, transport them
home, conserve and store them and feed them to the draught animals some time before ploughing - not to speak of the changes involved in rotating a leguminous fodder crop with the usual crops.

Beneficial and minor measures of intensification to all appearances do in fact involve a whole complex of changes associated with increased capital and labour intensity, involving risk and perhaps even neighbours' ridicule or disapproval on top of the tendency for the productivity of labour to decline. Contrary to official wisdom in Tanzania, peasants' restraint in change and innovation is not due to their ignorance or to the lack of knowledge about more intensive methods, given the fact that most areas contain a variable pattern of high, medium and low land-use intensities associated with respective techniques and labour intensities. Rather, so-called 'resistance to change' among peasants is based on solid experience and knowledge. The policy and ideology of 'modernization' involving 'educating' the peasants to the contrary of their experience is a rather counter-productive practice of demobilization in so far as it induces resistance on its own account.
CHAPTER THREE

3. AGRO-PASTORAL SYSTEMS OF LAND-USE

3.1 INTRODUCTION

So far, we have mainly looked at the intensification of land-use systems from the point of view of the intensity of cropping systems related to the length of the fallow period in an evolutionary perspective. In Tanzania, plough cultivation has mainly developed in areas with agro-pastoral systems of land-use. In the following section, the particular relationship between crop and cattle production will be analysed in more detail. An understanding of this relationship is of importance for understanding the problems of intensifying agro-pastoralism and the role which plough cultivation has played.

Agro-pastoralism in combination with medium and short-fallow systems and annual cropping is one of the most common agricultural systems in Tanzania. It is characteristic of Sukumaland including Mara Region, the medium potential areas of Arusha and Kilimanjaro Regions, the whole of north-central Tanzania and many parts of the Southern Highlands.

3.2 AGRO-PASTORAL SYSTEMS OF LAND-USE

A distinguishing feature of agro-pastoralism is its land-extensive nature and the lack of organic integration between crop and animal production. The cattle are grazed extensively on grass fallow land and more permanent pastures and there is no fodder production or fodder procurement for stall-feeding, no or little manuring of crops with farmyard manure and no systematic inclusion of a livestock grazed grass ley into a system of crop rotation. Although the livestock may graze and scavenge on crop residues around the homestead and on the stubble fields in the dry season, the supply of droppings will tend to be low and will occur mainly in the early dry season so that most of its crop nutrient value will be lost before cultivation can start.
The gradual process of intensification of agro-pastoral systems of land-use entails a competitive and contradictory relationship between crop and animal production. With growing population densities and an increase in the cultivation factor, the area under grass fallow and pasture is reduced and stocking densities tend to increase to the extent where overgrazing may occur. Grass growth and grass cover is not allowed to develop fully and the less nutritive perennial or annual grasses may take over. Decomposition of organic matter and fallow resting is hampered, the soil surface is exposed and the process of fertility regeneration is consequently impaired, if not sheer erosion takes place.

A similar process may occur when the stubble fields are grazed after harvest. Crop residues, protecting the ground surface and supplying organic matter to the soil, are removed exposing the soil to sun burning and erosion, and this is aggravated by pulverization of the soil because of hoof trampling.

Thus the extensive nature of crop production, determined both by the producers' historical experience with more extensive methods of fallow systems and the strive for a high productivity of labour tends to involve an extension of cultivated land and a reduction of grazing land to the extent where output from cattle production is constrained, while cattle grazing on the other hand is carried out to the detriment of yields in crop production. The way to overcome this contradiction has mainly been to migrate from the densely settled areas to frontier areas where new land could be cleared from bush, whereby new grazing land in turn was opened up. An example of this is provided by the enormous Sukuma expansions. In the more semi-arid areas and especially in Arusha Region, the expansion of the Arusha, Iragw, Nyaturu and Irangi peoples has taken place at the expense of the pastoralist territories of the Maasai and the Barbaig.

However, in more densely settled areas, e.g. around Lake Victoria and in Mbeya Region, fertility restoration has taken place through more intensive methods of cultivation with the digging in of weeds as a form of green manure
through ridging (Sukumaland), and mound and pit cultivation (Mbeya). Moreover, in the Lake Victoria area, the expansion of cotton cultivation has been associated with an expansion of cassava cultivation. The three or four years in which a cassava crop is left in the field produce an effect comparable with a long period of fallow (von Rotenhan 1968: 64). A thick cover of grass is allowed to grow up and cattle is either not allowed to enter the field since it is in crops or is prevented from it because of the woody, expansive nature of the cassava stems. Experimental results from Ukiringuru have shown that a fallow period of three to four years has the same effect as six tonnes of manure per acre (Peat & Brown 1962: 313).

3.3 THE MULTI-PURPOSE ROLE OF CATTLE IN AGRO-PASTORAL SYSTEMS

It is important shortly to look at some of the reasons for keeping relatively large numbers of cattle despite the detrimental effect this may have for crop production. This takes us to the other definitional characteristic of agro-pastoralism, i.e. the existence of economic and social complementarity between crop and livestock production in the annual and especially generational reproduction of households.

With respect to the societies under consideration here, crop production constitutes the main overall basis of the peasant economy but combines with livestock keeping in such a way that the latter is a necessary condition for the maintenance and reproduction of the socio-economic system (Kjaerby 1980a; Brandström et al. 1979:8).

A lot of the more technical, agronomic and economic literature on these societies, including government reports and official statements, tend to misconceive or understate the role of cattle. This tends to be so because of a narrow focus on yield increasing factors in crop and livestock production. It is important therefore to stress the multi-purpose role of livestock keeping.
Milk is a highly valued product and its value cannot simply be expressed in terms of local prices. The low purchasing power in many rural areas implies that the scarce money has to be spent on more basic necessities. When milk is in high supply during the rainy season, ready cash is in short supply and priority is given to the purchase of agricultural inputs and basic necessities. Local milk prices do not necessarily reflect the real demand. Although sufficient calorie intake rather than low protein consumption may constitute the main problem of nutrition, the role of milk as a source of weaning food can be crucial in many areas where other types of proper weaning food do not exist or are not given to the children. Finally, milk can be turned into ghee when there is a shortage of cooking fat.

The hides of dead animals are made into leather for a variety of purposes or they can be sold to acquire cash. Manure is used as cooking fuel, for plastering houses and storage bins or as fertilizer for crops. The homestead and stock pen is shifted at intervals so as to enable the exploitation of the old fertile site for a vegetable or tobacco garden.

Although the rate of home-slaughter of cattle for meat consumption is generally low, slaughter may be necessary in connection with a ceremony, a woman giving birth or a person falling ill. It is often overlooked that meat consumption from cattle dying a natural death is considerably higher than that from home slaughter. The slaughter of an ox can be a means to recruit the young men's work party for cultivating one's field.

Cattle are kept as a source of draught oxen in some areas and the sale of stock provides one of the most important and ready sources of cash. Livestock is an important means of investment, savings and a hedge against inflation and frequent short-falls in crop production due to drought, flooding, vermin, etc.

Livestock is a necessary means of social exchange in generational reproduction. Kinship relations, the very basis of social security and recruitment and reproduction of the household labour force, are only activated or sanctioned through bridewealth, gifts, exchanges and inheritance of livestock.
In some places an ox may be exchanged for grain or for the right to a piece of land. Gifts of livestock to "stock friends" or the lending of cattle is a means to secure future assistance if need should arise and it can be a means to secure political support and influence.

Livestock is wealth and a rich stock owner certainly is a wealthy man by most standards. And this confers upon him the status of being wealthy. Prestige, however, is mainly acquired through generosity and redistribution of livestock. The all too widespread idea that it is the sheer number of cattle owned which gives prestige and thus constitutes the main, and hence implicitly irrational, reason for accumulation of cattle is a total misconception which precludes an understanding of the multi-purpose role of livestock and the reasons for keeping and accumulating cattle.

The above listed purposes of livestock keeping should have made it clear that from the point of view of the individual producer there are so many good and perfectly rational reasons for attempting to accumulate livestock. To this should be added that those who manage to accumulate fairly large herds are also in much better position to avoid the problems of overgrazing, including problems of increased susceptibility to disease because of crowding and higher rates of mortality. Since they can acquire several wives, more children and are in a position to attract the herding services of poor young men, they are able to establish homesteads in more thinly stocked frontier areas.

There are definite economies of scale involved in livestock herding. One herder can easily tend to a much larger herd than the average size of a herd looked after per person in most areas. For the smaller herds, there is often an under-utilization of the labour capacity of one herder. This again relates to the issue of labour productivity: the larger the herd is, the higher the productivity of labour.

This leads to the question of competition for labour between crop and livestock production. During the wet season and in most areas also during the dry season, children who may
not contribute significantly to crop production apart from weeding tasks can be employed in herding activities, so that labour competition is not a general problem and certainly not so for the stock-wealthy households. But for households which are short of the right age groups of children and youth (especially poor ones and households in their early and declining phases of the family developmental cycle) labour competition may constitute a problem which may have to be solved through lending out the stock, borrowing a child from a friend or relative or through co-operative herding with neighbours. The problem is now being compounded by the high rate of school attendance brought about by compulsory Universal Primary School Education.

3.4 THE CONTRADICTORY NATURE OF AGRO-PASTORALISM

We are now in a better position to understand the underlying causes determining the inherently contradictory nature of agro-pastoralism in terms of the ensuing competition between crop and livestock production for land in a situation of population growth and land-use intensification.

However, whether this process of competition leads to land degradation and soil destruction in a situation where the possibilities for expansion are limited depends on a number of circumstances. These include the particular nature and distribution of land and soil types, climatic conditions, vegetation changes, the degree of relative dependence on livestock and crop production and possibilities for intensifying crop and livestock production.

We have already mentioned how intensified methods of cultivation and the digging in of green manure such as ridging, pit and mound cultivation as well as the extensive method of including a cassava fallow in the cropping sequence tend to limit destructive competition by livestock.

The previously pastoral Barbaig in Hanang District have experienced a drastic reduction of their territory due to the rapid expansion of large-scale mechanized wheat and bean farming and immigration by predominantly cultivating agro-
pastoralists. The reduction of grazing land and a consequent decline in the animal/man ratio resulted in a fairly rapid transition to an extensive form of agro-pastoralism. The decline in the animal/man ratio is likely to continue with the growing pressure from crop production made possible by fertile land conditions and the possibility of harvesting a reasonable crop in the better rain years. Although there is overgrazing in some densely settled village areas, soil erosion is not a problem due to the fertile and flat land conditions.

In some of the agro-pastoral areas of Kondoa District and to a lesser extent in Dodoma District, soil erosion has reached an alarming state. However, the causes of soil erosion cannot solely be blamed on the cultivation and grazing practices of the agro-pastoralists as there has been a tendency to do.9

First of all, the slope gradient of some of the land and the prevalent type of soil make these areas unusually susceptible to erosion (Allan 1965:209). Secondly, the low and unreliable rainfall of the area is a cause of frequent crop failure and famine in the area and this makes livestock production an indispensable, complementary economic activity in household reproduction. Thirdly, the most seriously eroded areas in Kondoa are those where the British colonial authorities undertook clear-felling of all the bush and tree cover as a measure to eradicate the tsetse fly.

However, there seems to be at least one general conclusion which can be made with respect to a situation of agro-pastoral population pressure, where the possibilities for territorial expansion or out-migration are limited: If no intensification (e.g. through a development of organic integration between crop and animal production) takes place for one reason or another, the expansion of cultivated land is bound to result in a reduction of the livestock population, and this may occur the hard way through overgrazing, land degradation and at least a temporary lowering of the carrying capacity of land. This enforces a reduction both of the overall livestock population and of stocking densities on
the degraded pasture land. The situation may become so pressing that intensification through crop-animal integration with the use of manure remains the only solution. A detailed analysis of this transition falls outside the scope of this paper.

3.5 EXTENDING THE LAND FRONTIER WITH OX-CULTIVATION:
THE CASE OF SUKUMALAND

As mentioned already, extending the land frontier through gradual territorial expansion or outmigration to previously unsettled or thinly populated areas has so far remained the main response to and safety valve for agro-pastoral systems under conditions of growing land pressure. The territorial expansion of the Sukuma represents one of the most prominent examples of extending the land frontier in Africa. In the following we shall look at some of the processes and factors involved in the southern and south-eastern direction of this expansion since it does provide a good example not only of the nature of agro-pastoral expansion but also of the role of ox-ploughing in this expansion.

Central Sukumaland is here used to refer to the old densely populated Sukuma settlement areas of Mwanza Region. Most of this country is undulating table land characterized by a catena profile with mostly unfertile, erodable sandy soils on the top and upper slopes of the rides, hardpan soils further down and fertile but heavy, black 'cotton' clays in the flat, marshy bottom valleys used mainly for dry season grazing because of drainage problems.

It is in this area where the intensive methods of ridge cultivation are practised and this intensity refers both to the high labour input required for making the large five-foot ridges and to the yield increasing effects this method implies: The soil is worked over deeply and thoroughly; weeds are effectively buried and are more easily controlled at a later stage; the absorption rate and water-holding capacity of the field is increased; run-off and soil erosion is controlled; a drainage effect is maintained in wet lands, since plant roots are raised above the surface; ridge cultivation auto-
matically ensures row-planting and thus eases the task of weeding (von Rotenhan 1968: 69).

In addition, a cassava fallow period of three to four years is in use in some areas (ibid: 64). Nevertheless the fields, after a long period of annual cropping, may become exhausted and the general shortage of arable and grazing land may then force households to move into more thinly populated or unsettled areas (Brandström et al. 1979:35).

Those who moved west into Kahama and Geita Districts clearing tsetse-infested Miombo woodland, had little or no cattle but gradually acquired them as bushland was turned into open grassland. Those who already possessed cattle moved into the more fertile and flat grassland areas to the south and east where rainfall, however, is increasingly marginal to crop production (ibid: 35).

With the cotton boom and the rising cotton prices in the 1950s, including the development of higher yielding cotton varieties at Ukiriguru Agricultural Research Station, cotton acreages expanded in a big way. So did the adoption of ox cultivation in the south-eastern expansion areas where the absence of trees and roots in the flat grass-steppe provided very suitable conditions for ox-ploughing (De Wilde et al. 1967, Vol 2:426).

"The expansion of cotton cultivation partly led to extension of cultivated area, partly, through earnings of cotton invested in livestock, to a higher grazing density. Both processes led to shortage of arable land and pasture as well. In the new settlement areas, the mutually reinforcing relation between agriculture and pastoralism was further accentuated. Thus in areas suitable for flat cultivation, the adoption of the ox-plough became fairly common, leading to an increase in agricultural productivity (i.e. labour productivity, not yields, F.K.). Further, livestock as the main form of accumulated wealth was of decisive importance both in control of labour and in acquisition of agricultural machinery. M.P. Collinson (1972:26), comparing an old settlement area with an area of more recent settlement, finds that in the former, 29 per cent of the cropped area was cultivated by means of purchased resources, whereas the figure in the latter case was 72 per cent" (Brandström et al. 1979: 36).

Though it should be kept in mind that the long quotation refers to an extraordinary phase of economic boom with the
existence of a wide, open land frontier, it does indicate the extensive dynamic of an agro-pastoral system into which a profitable cash crop and ox-cultivation are adopted.

"In Maswa and Shinyanga districts .... "the ox-plough, supplemented modestly but increasingly by the tractor, has been the primary instrumentality of the extension of cultivation. ....In Maswa alone there were 8,482 ox-ploughs as of 1962; ....Ox-ploughing made it possible to increase the cropped area about 80% by comparison with hand-ridging" (De Wilde et al. 1967, Vol. 2:430).

Together with increasing population density, this expansion in cash crop production and extension of plough cultivation was not without its problems for the system of land-use, since it entailed a reduction of fallows, the cultivation of hitherto unused land within an area and a change from shifting cultivation to semi-permanent land-use within a period of a few decades (Rotenhan 1968:76). The colonial authorities were alarmed at the dangers of soil erosion, both as a result of ox ploughing, and of overgrazing and increased stocking densities as a consequence of the reduction in grazing land and the investment of cotton proceeds in increased cattle holdings. As one colonial officer aptly put it:

"The increasing use of the plough in those regions whose livelihood is based on only one market crop is a threat to the only existing alternative of keeping cattle. It is paradoxical that the oxen should have to draw the plough which is reducing their pasture ground" (Tanganyika 1960:74).

Ox-ploughing was reported invariably to lead to technically inferior flat cultivation, implying a 'grievous deterioration' in the quality of cultivation as compared with hoe-ridging. (Rotenhan 1968:70; Ruthenberg 1964:184). Ox-ploughing required laying out larger fields which facilitated erosion. The 'Sukuma Plough Rules' were issued after the Second World War, confining ploughing to heavy soils and prohibiting ploughing on light soils (Tanganyika Territory 1946:29). Flat cultivation with ploughs involved broadcasting of seeds, and higher seed requirements whereas hoe-cultivation led to hand ridging, consequent row-planting and proper plant spacing (Rotenhan 1968:70-71). The less efficient method of soil tilling associated with ploughing on the
flat had the effect of propagating weed growth, whereas hoe-weeding of flat-cultivated crops was less effective than for ridged crops and required more effort because of the broadcast, irregular plant distribution over the field.

This would involve lower yields and more weeding hours per acre in plough cultivation. "In Sukumaland, in places where ox-ploughs are used, the yields per acre have been reduced, sometimes to such an extent that despite the fact that more land is planted, the yields per farmer are not greater than before, when the hoe was used on less land." (Ruthenburg 1964:185).

Rotenhan (1968:74-75) presents a table on labour input for the cultivation of several crops which shows high labour input in weeding and harvesting for plough-cultivation (Shinyanga-flat) by comparison with ridge cultivation (Kwimba and Ukerewe Island). The table is reproduced below together with an extensive quote of the explanation to the table.

However, it is not explicitly stated whether the figures really represent recorded labour time or available, potential labour time needed to achieve optimal yields.

"....Hardly more than a third of the available time is actually utilized for field work. Table (1) gives an idea of the labour input of the average Sukuma farmer for field work according to different crops and methods of cultivation" (Rotenhan 1968:74), (my stress).
Table 1

LABOUR INPUT FOR THE CULTIVATION OF SEVERAL CROPS
(in hours per acre)

<table>
<thead>
<tr>
<th>Type of crop</th>
<th>District</th>
<th>Method of cultivation</th>
<th>Maize-Forghum</th>
<th>Maize-Sorgh. Leguminosae</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shin-</td>
<td>flat</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yanga</td>
<td>ridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kwimba</td>
<td>ridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ukerewe</td>
<td>flat</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shin-</td>
<td>flat</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yanga</td>
<td>ridge</td>
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<td></td>
<td>Shin-</td>
<td>flat</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kwimba</td>
<td>ridge</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Phase:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Flat</th>
<th>Ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levelling</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>Ridging and planting</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Ploughing and planting</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Cultivation and planting</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>1st hoeing</td>
<td>160</td>
<td>70</td>
</tr>
<tr>
<td>2nd hoeing</td>
<td>90</td>
<td>50; 90</td>
</tr>
<tr>
<td>3rd hoeing</td>
<td>40</td>
<td>70; 70</td>
</tr>
<tr>
<td>Weeding</td>
<td>290</td>
<td>180</td>
</tr>
<tr>
<td>1st harvesting</td>
<td>150</td>
<td>90</td>
</tr>
<tr>
<td>2nd harvesting</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>3rd harvesting</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Harvest</td>
<td>250</td>
<td>160</td>
</tr>
<tr>
<td>Additional post-harvest work</td>
<td>30</td>
<td>110</td>
</tr>
</tbody>
</table>

Totals 620 600 590 320 430 380

\( ^a \) Ploughing is generally done with three people.

\( ^b \) Including thinning, which is generally done at the first hoeing.

Source: Rotenhan 1968:75.
"For ploughing (with three people) and the subsequent sowing of cotton, a total of 50 hours per acre of cotton are needed in Shinyanga. Only 40 hours per acre are needed for maize-sorghum and 50 hours per acre for maize-sorghum-leguminosae mixtures. In Kwimba and on Ukerewe, where cultivation is done exclusively with the hoe, the ridging and subsequent sowing require 150 hours per acre.

The work of weeding plays a dominant part on the farms where the plough is used and requires 290 hours per acre for cotton, whereas on the hoe-farms only 180-190 hours are needed for weeding. The time spent on harvesting the cotton fluctuates according to the care with which it is done and the yields. On an average, 280 hours per acre are needed in the plough-region and 260 in the hoe-region. This includes the work of sorting and transport. The harvesting of the grain crops requires about 60 hours per acre and that of the maize-sorghum-leguminosae mixture about 170 hours in Shinyanga and 110 hours per acre in Kwimba.

Altogether, about 600 hours per acre are needed for cotton. In contrast pure grain crops require 320 hours per acre, and maize-sorghum-leguminosae mixtures 380 to 430 hours.

Rice is the most labour-demanding crop. About 850 hours per acre are needed every year for the work of levelling the fields, sowing the seed-beds, transplanting, weeding and harvesting.

It is particularly worthy of note that the amount of work per acre is the same for plough and hoe cultivation. The saving in labour which can be achieved with plough cultivation is cancelled out by the great amount of time which subsequent weeding with the hoe requires. The only real advantage of the plough is that the hard work of constructing the ridges is made unnecessary, but greater erosion is a disadvantage. What plough cultivation still needs is proper planting in rows and weeding by an ox-drawn weeder."

Table 1 can be compared with the figures in Rotenhan's Table 2 (ibid: 55):
### Table 2

FARM MANAGEMENT DATA FROM SHINYANGA, KWIMBA AND UKEREWE

<table>
<thead>
<tr>
<th>PRINCIPAL IMPLEMENT</th>
<th>Shimanyanga</th>
<th>Kwimba</th>
<th>Ukerewe</th>
<th>Plough</th>
<th>Hoe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persons per farm</td>
<td>5.9</td>
<td>6.6</td>
<td>9.0</td>
<td>7.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workers per farm (ME)</td>
<td>2.5</td>
<td>3.0</td>
<td>4.2</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of farms (acres)</td>
<td>23.4</td>
<td>19.4</td>
<td>12.1</td>
<td>18.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area cultivated (acres)</td>
<td>8.1</td>
<td>5.7</td>
<td>6.1</td>
<td>5.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acreage of cotton</td>
<td>3.7</td>
<td>2.5</td>
<td>2.2</td>
<td>2.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acreage of subsistence crops</td>
<td>4.4</td>
<td>3.2</td>
<td>3.9</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of total occupied land which is cultivated</td>
<td>35 %</td>
<td>28 %</td>
<td>52 %</td>
<td>33 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of ME per acre of cultivated land</td>
<td>0.3</td>
<td>0.5</td>
<td>0.6</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Economic return per farm (shs):

<table>
<thead>
<tr>
<th></th>
<th>Shimanyanga</th>
<th>Kwimba</th>
<th>Ukerewe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash crops</td>
<td>1,362</td>
<td>632</td>
<td>414</td>
<td>803</td>
</tr>
<tr>
<td>Subsistence crops</td>
<td>603</td>
<td>434</td>
<td>414</td>
<td>482</td>
</tr>
<tr>
<td>Gross return from cropping</td>
<td>1,965</td>
<td>1,066</td>
<td>828</td>
<td>1,285</td>
</tr>
<tr>
<td>Gross return from animal husbandry</td>
<td>482</td>
<td>409</td>
<td>105</td>
<td>332</td>
</tr>
<tr>
<td>Total gross return</td>
<td>2,447</td>
<td>1,475</td>
<td>933</td>
<td>1,617</td>
</tr>
<tr>
<td>Less expenses for means of production</td>
<td>107</td>
<td>55</td>
<td>34</td>
<td>66</td>
</tr>
<tr>
<td>Income</td>
<td>2,340</td>
<td>1,420</td>
<td>899</td>
<td>1,551</td>
</tr>
<tr>
<td>Less wages</td>
<td>110</td>
<td>32</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>Family income</td>
<td>2,230</td>
<td>1,388</td>
<td>890</td>
<td>1,501</td>
</tr>
</tbody>
</table>

#### Employment in field cultivation, in % of labour availability

<table>
<thead>
<tr>
<th></th>
<th>Shimanyanga</th>
<th>Kwimba</th>
<th>Ukerewe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>47 %</td>
<td>41 %</td>
<td>23 %</td>
<td>35 %</td>
</tr>
</tbody>
</table>

#### Degree of commercialization in %:

<table>
<thead>
<tr>
<th></th>
<th>Shimanyanga</th>
<th>Kwimba</th>
<th>Ukerewe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The farm as a whole</td>
<td>60 %</td>
<td>45 %</td>
<td>46 %</td>
<td>53 %</td>
</tr>
<tr>
<td>Field sector</td>
<td>69 %</td>
<td>59 %</td>
<td>50 %</td>
<td>63 %</td>
</tr>
<tr>
<td>Animal sector</td>
<td>15 %</td>
<td>8 %</td>
<td>10 %</td>
<td>13 %</td>
</tr>
</tbody>
</table>

#### Lbs of cotton per acre

<table>
<thead>
<tr>
<th></th>
<th>Shimanyanga</th>
<th>Kwimba</th>
<th>Ukerewe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lbs of cotton per acre</td>
<td>857</td>
<td>575</td>
<td>482</td>
</tr>
</tbody>
</table>

#### Hours of field work per ME annually

<table>
<thead>
<tr>
<th></th>
<th>Shimanyanga</th>
<th>Kwimba</th>
<th>Ukerewe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of field work per ME annually</td>
<td>895</td>
<td>709</td>
<td>365</td>
</tr>
</tbody>
</table>

#### Hours per acre of cultivated land annually

<table>
<thead>
<tr>
<th></th>
<th>Shimanyanga</th>
<th>Kwimba</th>
<th>Ukerewe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours per acre of cultivated land annually</td>
<td>279</td>
<td>381</td>
<td>303</td>
</tr>
</tbody>
</table>

#### For each ten farms there are:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>189</td>
<td>118</td>
<td>19</td>
</tr>
<tr>
<td>Goats and sheep</td>
<td>142</td>
<td>99</td>
<td>18</td>
</tr>
<tr>
<td>Chickens</td>
<td>54</td>
<td>117</td>
<td>94</td>
</tr>
</tbody>
</table>

**ME**: man equivalent

Source: Rotenhan 1968:55.
The survey covered 25 farms in each district and was carried out in 1963 when growing conditions for crops were average to good at Ukerewe and Kwimba, and particularly good at Shinyanga (ibid: 56). There is good fertile soil in Shinyanga and less fertile soils in Kwimba and Ukerewe (ibid:61).

Table 2 shows how cotton yields per acre and family income are substantially higher while hours per acre of cultivated land (supposedly an average for all crops) are lower in plough-cultivation by comparison with ridge-hoe cultivation. The different total labour input figures in Tables 1 and 2 do not seem to bear any relationship with each other; - which of them are we to believe? Since Table 2 is at least referred to as part of the survey and since the figures in Table 1 are conspicuously round, we are more inclined to take note of the figures in Table 2.

Rotenhan's intentions with Table 1, which are to present a high labour input in plough-cultivation, contradict his survey results.

In fact all other well-informed studies on the subject, including the most experienced ones by M.P. Collinson, record that returns to labour are highest for plough cultivation.

In Rotenhan and his survey supervisor, Ruthenberg, as in the colonial officers' reports, one does sense a strong bias against land extensive forms of cultivation and prophesies about increased soil erosion and ecological imbalance which have apparently not yet materialized. This is not meant to say that the methods of extensive cultivation, to which they refer as soil mining, are the most agronomically appropriate. But the most optimal technical or agronomical solution tends often not to be the most economical (Upton 1973: Chap. 1). The resource-constrained peasant households tend to opt for an economic balance between an acceptable level of output required for household reproduction and a level of labour productivity which can accommodate preferences for other not strictly economic activities, including leisure time.
It should also be added that Rotenhan and Ruthenberg do not adequately account for out-migration of a congested neighbourhood as the safety valve of the system. Though the existence of medium and long-term fallows is acknowledged together with their fertility-regenerative power, there is a tendency to focus on soil exhaustive methods. The Sukuma system is rather characterized by a cycle of 'exploit-and-move', leading to regeneration (Brandström et al. 1979:35). While this cycle could take 30-50 years in the early 1950s it was greatly accelerated with the expansion of cotton cultivation and ox-ploughing. Yet, the system has been characterized as remarkably stable though keeping barely to the margins in some of the most congested areas of old settlement with population densities approaching 100 persons per square kilometer (ibid:36). The drastic decline in cotton cultivation during the 1970s has most likely contributed to the maintenance of this stability and it remains to be seen whether the impact of villagization will upset it.

Finally, it should be mentioned that hoe and plough cultivation are not invariably associated with ridge and flat cultivation. There are lots of cases where hoe-cultivation is done on the flat and it is quite common to throw smaller 3 foot ridges with the single furrow plough. These ridges may be less superior, especially in areas with heavy showers, and the problem still remains that no appropriate ox-drawn ridger is available.

The critical comments to Rotenhan and Ruthenberg are not intended to down-play the negative consequences of ox-cultivation. Rather, the intent is to bring out the most important critical problems associated with ox-ploughing, both from an agronomic and the peasants' point of view.

We have so far looked only at one case, Sukuma cotton growers, because it is the best documented and most prominent example of plough cultivation in Tanzania. There are a number of other examples from Tropical Africa which show similar problems of ox-ploughing in terms of extensive cultivation, late ploughing, poor and late weed control, increased dangers of erosion, lower yields, reduction of pasture land, etc.
(De Wilde 1967, Vols. 1 & 2 Weil; 1970). But field studies showing that ox-cultivation improves timeliness of operations, weed control, yields and labour productivity can also be found (Raikes 1971b, Starkey: forthcoming; Tiffen 1976:105; Laurent 1968:249-50; Beeney 1975). It cannot be sufficiently stressed that the effectiveness and impact of ox-cultivation depends, more than anything, on the local specific environment, not least land and climatic conditions. Moreover, the potential for improving equipment and methods of cultivation is far from realized in Tanzania.
CHAPTER FOUR

4. THE ORIGINS AND DEVELOPMENT OF OX-PLoughING IN TANZANIA IN RELATION TO ECONOMIC, SOCIAL AND POLITICAL FACTORS

4.1 INTRODUCTION

In Tanzania, as in most of Tropical Africa, ox-ploughing by African farmers has had a history of only some fifty years, and more widespread adoption of ox-ploughing did not occur until the 1940s and 1950s. A few pockets of an earlier start were found in Southern Africa, Northern Nigeria and West Africa, including of course the settler communities of East, Central and Southern Africa. The spread of ox-ploughing among African farmers in all the anglophone countries depended almost exclusively on the use of the single-furrow mouldboard steel plough, in most cases the 'Ransome Victory' make. In Ethiopia, a locally made wooden scratch plough (the 'ard') with a horizontally fitted iron blade has been widely used for more than one thousand years.

In the following we shall try to trace the development and expansion of ox-ploughing in Tanzania, both in relation to the general socio-economic developments which provided the preconditions for ox-ploughing, and in relation to more specific factors influencing or limiting the adoption of ox-ploughing. The techno-environmental conditions and land-use systems facilitating or limiting the introduction of ox-ploughing have been analysed in the previous chapter.

It was shown in the previous chapter how ox-ploughing in Sukumaland developed as a result of the introduction of a profitable cash crop, cotton. Evidence from other African countries also shows that especially cotton and groundnuts - both fairly land extensive crops - but also maize, wheat and rice were the most important cash crops which were associated with the development of ox-ploughing. Some of the most important examples of crop-plough associations were: Groundnuts in Senegal and Gambia; cotton in Northern Nigeria, Niger, Uganda (Teso) and Tanzania (Sukumaland); maize in North Rhodesia (Tonga), Malawi, and Tanzania (Iringa and North Mara).
Thus animal traction is clearly linked with the development of a commercialized economy and in fact to circumstances resembling a period of 'boom', whether this came about by high prices on export crops or on food crops demanded by areas with a large force of wage labourers employed in mining or on estates.

4.2 THE ORIGINS AND SPREAD OF OX-PLOUGHING

The following section contains a survey of the socio-economic factors involved in the initial adoption of ox-ploughing in the most important ploughing regions in Tanzania. A more detailed analysis of this process has not been possible since the evidence is, to say the least, rather fragmentary and we have to rely heavily on John Iliffe's comprehensive work: "A History of Modern Tanganyika":

"The plough was the key innovation of the interwar years and the chosen implement of the emerging farmer. Probably the expansion of markets by motor transport made ploughing profitable for the first time. German experiments had failed entirely, but by 1931, with the Lupa goldfield providing the Nyakyusa with a market for lakeshore rice, 'the natives in the area are keenly interested in the plough', and fifteen years later more than 700 were in use on rice fields".

The above quote from Iliffe (1979:293-294) refers to the present Kyela district north of Lake Nyasa in Mbeya region. In the same area..... "earnings from labour migration to Southern Africa were substantial. In Ngamanga rumour has it that the farmers' ploughs have actually been earned in South Africa". (Luning 1969:33).

In Mbozi district west of Mbeya, "Nyiha entrepreneurs began to use ploughs in 1934 because they were cheaper than hiring additional labour" (Iliffe: 294). As among the Fipa in Rukwa region, the missionaries in Mbozi reportedly introduced the first ploughs, but in Mbozi more widespread adoption did not take place until the 1950s when coffee and food crop prices rose sharply.

There were an estimated 5320 ploughs in Mbozi by 1967, roughly one for every five to six families.
"The plow seems to be making an important contribution in Mbozi toward expanding the land in cultivation and relieving seasonal labor bottlenecks in preparation of fallow grassland for planting. The ox-drawn plow is also extremely effective for cultivating among coffee trees when the oxen are well-trained and the farmer skilled in handling them" (Gregory Knight 1974: 144-5).

The use of ox-ploughs was particularly common in areas where cash crops like coffee and wheat were grown and in areas where sesame cash crop production and labour migration were common. In the former areas there were a number of settler estates employing wage labour as well (ibid: 231).

"Ploughing experiments in Usukuma came to little until the late 1930s, when ploughs were widely adopted on the eastern shore of Lake Victoria under the stimulus of the food demands of local gold mines and the arrival of Luo entrepreneurs from Kenya who grew maize on a large scale" (Iliffe: 294).

Here Iliffe actually refers to the present Tarime district or North Mara rather than to Sukumaland.

In the Tarime Highlands government efforts to secure peasant production of maize - a new crop in the area - for the mines had been going on since 1927 and included compulsory cultivation of half an acre of maize per household under a bye-law.

"In spite of the legislations the desired change in peasant production was realized utterly slowly and it was not until the iron plough was introduced in the early 1940s that peasants found maize cultivation worthwhile. Within a decade roughly 20 per cent of the households in Tarime district possessed a plough". (Tobisson 1980:41-42).

By 1947 there were some 3,500 ploughs used in the district.\(^{11}\)

In Mufindi district, Iringa region, ox-ploughs were first used by settlers on tea estates, employing a large number of labourers some of whom through time learned how to use ox-ploughs and became pioneers of this technology in their villages:
"We learned from village leaders and elders at Mtambula (village in Mufindi district) that in the 1940s eight elders who had worked with the settlers started using ox-ploughs at Mtambula. From there on more people developed interest in this technology and by 1953 the number reached 12. More and more people started using ox-ploughs and today many households own a pair of oxen and a plough and most likely a locally made ox-pulled cart. There are 462 ploughs and 812 trained oxen all owned by individual villagers. During the early days it was difficult to get an ox-plough, the pioneers used to get it from their employer either free or pay some money from their earnings. Later in 1953 a few Indian shops started selling ox-ploughs. Also some Indians came to the villages with ploughs with the intention of exchanging them with maize." (Mlambo & Mnko 1982:1 -11).

To meet wartime food shortages the colonial government paid planting grants to European farmers who cultivated more than 10 hectares of grain and by 1947 extended these grants to Africans. In Ismani north of Iringa, large acreages were cleared by traders, drivers or mechanics from Iringa town together with some migrant farmers and native administration officials who employed labourers, often from famine-stricken Ugogo in Dodoma region (Iliffe 1979:457). Extensive ox-ploughing developed in this area but was soon to be rivaled by tractor cultivation, especially in central Ismani, where tractors enabled earlier and deeper ploughing of the hard-pan soils. By 1971, over 3/4 of the land used was cultivated by tractors and the remaining 1/4 by ox-ploughs. (Awithi 1972: 42-43).

An almost identical pattern developed in Karatu in northern Mbulu, Arusha Region. Tsetse clearings were undertaken in the 1930s to open the land up for grazing. By 1943 Iraqw who had learned the skills of wheat growing and ox-ploughing from Afrikaaner settlers started wheat cultivation with oxen. In 1947 Iraqw bought their first tractor (Iliffe: 456-7). The pioneers, most of them Christians, were cattle buyers, government clerks, had grown onions as a cash crop or had worked for settlers as tractor drivers ...."and the only ones who might be described as coming from the traditional environment were large cattle owners who thus had at their disposal a ready source of realisable capital" (Raikes 1971a: 91-2).
By 1961, Africans possessed some 40 tractors in Mbulu district (Schultz 1971: 254) and "from 1963-1968 the number of tractor ploughs rose almost fourfold to 220, that of oxen ploughs more than threefold to 1,900 (ibid: 273).

Another striking example of mechanization was around Mt. Meru at Arusha:

"Before the war, local entrepreneurs established small coffee plants on the mountainside. After 1945 they turned instead to the surrounding lowlands where wheat and maize could profit from government subsidies to larger producers. Exploiting land tenure systems which allowed pioneers to own whatever they cleared, Arusha entrepreneurs carved out large holdings in the Musa area, while ambitious Meru soon followed their example in Kingori, Leguruku, and Mwakirura. Initially they used ox-ploughs, but in the early 1950s they began to buy tractors, while two also possessed combine-harvesters. "The old ox-plough is slowly dying out", the district officer recorded" (Iliffe 1979: 455-6).

During the last few years of the colonial period, the restrictive policies regarding ox-ploughing were given up. The Plough Rules, introduced in Sukumaland after the Second World War, which stipulated permits for using ploughs, supervision by Agricultural Department staff and the type of soils to be ploughed (i.e. only heavy soils) were no longer enforced. Ox-drawn cultivation was reportedly even receiving active encouragement. Probably, the Department of Agriculture had no other choice, given the strong demand for the technology by the peasants and their active support for the nationalist TANU party which capitalized on policies of abandoning enforced anti-erosion measures. It was reported for 1959 (ibid: 20) that there were 16,000 ploughs in Mara, some 15,000 of them in North Mara (Tarime) and large numbers in Nzega (Tabora Region) and Singida. The number of purchased ox-carts, although small because of high initial costs, were gradually increasing. In 1960 (ibid: 20) in the Lake Province, sales of ox-ploughs were heavy, 4,000 in Shinyanga alone. There were at least 4,000 ploughs in Nzega (Western Province) and 1,000 in Ufipa (Rukwa) (ibid: 21). In 1961 there were an estimated 40,000 ox-ploughs in use in the Lake Region. 9,000 were sold in Shinyanga alone during the year (ibid: 19). With such heavy sales in relation to the reported total numbers, the latter might very well be underestimations.
A rough estimate, based on the above figures and on guess estimates derived from more recent figures on other important plough regions would give some 70-80,000 ox-ploughs in Tanganyika at the end of the colonial period. Most of these ploughs were purchased after the Second World War and in particular during the 1950s with sales apparently accelerating towards the end of the decade.

4.3 SOCIO-ECONOMIC FACTORS DETERMINING THE SPREAD OF OX-PLOWS

We are now in a position to summarize the main factors involved in the development of ox-cultivation in Tanzania. The two most important preconditions were clearly the development of a profitable cash crop and of wage labour, whether migrant labour in mines, employment on settler farms or salaried employment.

The accelerated rate of adoption of ox-ploughing in the 1950s took place under 'boom' conditions. Tiffen's very detailed study of similar developments in the Gombe area of Northern Nigeria shows how the purchase of ploughs was closely correlated with cotton prices (1976:107). Whether cash crop production in Tanzania combined with wage employment or not, conditions were provided for the accumulation of savings which were invested in ploughs and draught oxen if these were not already owned. Over the years, the cost of two pairs of oxen necessary for drawing the plough has generally been eight to ten times higher than the cost of the plough and draw chain. In addition, there often were capital outlays for seeds and hired labour for clearing, weeding and harvesting.

It is important to consider here, that in most of the cases cited above, savings from cash crop production and wage employment rather than credit constituted the main source of investment capital for the purchase of oxen and ploughs. This seems to have been the general rule for development of ox-ploughing in colonial Africa (Tiffen 1976: 107; De Wilde Vol. 1: 149). Since ploughs had to be imported for European and Asian owned farms, it became possible for Africans to acquire ploughs through them and from Asian merchants. In some places missions acted as middlemen and extension agents as well.
The above-mentioned cases moreover tend to indicate that it was a combination of cash cropping and wage labour which was responsible for the fairly widespread adoption of ox-cultivation. Mbozi, Kyela, Iringa, Mufindi, Tarime and perhaps also Rukwa (Ufipa) represent such cases. But apart from a few initial innovators in Mbulu and the Arusha area who had had employment, those areas together with Sukumaland and Usangu Plains in Mbeya represent cases where cash crop production alone played a role. In other areas not referred to above, i.e. Singida and Dodoma, the main sources of investment responsible for adoption of ox-ploughing seem to have been migrant labour and possibly the sale of livestock rather than crop sales\(^{17}\). In Singida, Dodoma and Rukwa, the main crops grown were sorghum and finger millet.

As with credit, government extension and trial work played virtually no role in spreading the innovation of ox-ploughing. Attempts by the German administration to introduce the technology failed as did the initial ploughing experiments in Usukuma.

Granted the boom conditions, the spread of ox-ploughing took place in spite of the attempts by the British administration to restrict it. And the apparent acceleration in plough sales towards the end of the 1950s would most likely have occurred even if no encouragement had been given.

The process and pattern of adoption was thus one where initial innovators had the opportunity to learn about the profitability and skills from settlers and missionaries. They succeeded with ox-ploughing in their villages where others became interested and could learn the skills. Personal experience rather than government extension was the matter.

The spacial distribution of ox-ploughing both in the country and within regions and districts has until the present time remained very uneven and 'island patterned', and has depended on a variety of factors including infrastructural facilities for marketing, transport and repair services, soil conditions and availability of grazing access to cattle, the possibility of growing suitable crops like cotton, rice, maize, wheat and even coffee, and presence of settler farms and missionaries.
Once the profitability of ox-ploughing had been established in such areas it would tend to spread beyond the group of initial entrepreneurs who had acquired particular experience and opportunities for accumulation through travelling, employment, trading, etc. Given the extensive nature of ox-ploughing and the lack of equipment enabling more intensive methods of cultivation without jeopardising the productivity of labour, the existence of an open land frontier evidently facilitated the spread of ox-ploughing.

It was precisely also in those areas where tractor cultivation expanded on a large scale, supported by planting grants and after independence by credit, and in some cases assisted by capital accumulated in ox-ploughing (Brandström 1979:19; Raikes 1971b: 470). The spread of tractor cultivation tended to limit the further spread of ox-ploughing in such areas (Raikes 1971a: 98 and 1971b:469-73). But it has not died out as the district officer in Arusha would have us believe. Rather it is on the increase again, due to increasing shortage of tractors in working condition and skyrocketing hire rates. In some villages in Hanang, the rapid increase in the number of tractors during the 1960s totally prevented ox-ploughing from establishing itself. In the early 1970s, around 70 per cent of the smallholder peasants had their land ploughed by tractors, either on contract hiring basis or on a share-leasing basis (Kjaerby 1976). This is also an area where a strong interest in acquiring ox-ploughs has recently developed (see next chapter).

It is probably safe to conclude that even in areas where ox-ploughing became fairly common, the ratio of those who actually acquired ploughs remained low in relation to the total number of households. Though this may to some extent be ascribed to individual social and economic characteristics and experience, the main reason for this is no doubt the general tendency for highly unequal ownership of cattle, which more than any other factor determines individual access to draught oxen, granted that their purchase price is very high.
CHAPTER FIVE

5. Socio-economic effects of ox-ploughing

5.1 INTRODUCTION

What are the social and economic effects of the adoption of ox-ploughing in Tanzania? Most studies indicate that plough farmers are considerably more wealthy than hoe farmers and that the former cultivate larger acreages. This may in turn necessitate the use of more hired labour, while the prevalence of hiring out ox-plough teams may similarly constitute the basis for exploitative relationships. To what extent have these determined the preconditions for capital accumulation, and how has the material position of women been affected by ox-farming?

In order to answer these questions, it is necessary to reconsider in more detail the relationship between ox-plough farming, cultivated acreage, use of hired labour and family income, and to draw comparisons between hoe farmers and plough farmers on the basis of the most detailed evidence from Sukumaland. It should be kept in mind that reference to ox-ploughing, ox-cultivation or ox-farming here involves only part-mechanization, i.e. the use of single-furrow mouldboard ploughs, in most cases drawn by a team of four oxen, led and operated by at least two and sometimes three persons. All other operations are done manually.

5.2 RETURNS TO LAND, LABOUR AND CAPITAL

According to Iliffe (1979:460) concentration of land ownership tended to occur in areas with ox-ploughing. This was especially the case on the Kyela lakeshore and also in Ismani, Arusha and north Mbulu, though in the three latter cases it was rather an effect of the emergence of a capitalist class of farmers based on large-scale commercial production with tractors.
In Katyongole, a paddy growing village in Kyela, the bottom 45 per cent of peasant households had less than 15 per cent of the rice land while the top 15 per cent cultivated 38 per cent of the total rice land (Luning 1969:82). This skewed pattern of ownership was considerably more pronounced than for other areas in Rungwe which produced pyrethrum and coffee, including a maize area with an open land frontier where land distribution was more equal as well.

However, the unequal distribution of land was not only an effect of unequal control over bullocks and ploughs, although these can be used as a means to obtain labour and borrow land (ibid:84). It was also an effect of the old hierarchical power structure of the Nyakyusa, unequal inheritance of land, and differences in the time of settlement (age of farmer) which is of particular weight in areas with closed land resources such as the lakeshore area (ibid: 86-7). Moreover, the percentage of farmers organizing work parties or hiring labour was rather low on the lakeshore, i.e. 15 per cent, by comparison with the other areas in Kyela and Rungwe. A paradoxical pattern of stagnant underdevelopment has emerged: Ploughing of larger acreages by the bigger land owners was associated with poor and staggered weeding, little use of hired labour, low yields and thus rather inefficient use of the scarce land resources. While this compounded the problem of land shortage and proletarianization of young men, who had to look for migrant employment, it led on the other hand to lower disparities in income from farming.

On the irrigated paddy land of Usangu Plains in Mbeya district, the pattern was rather different. On average oxen/tractor farmers cultivated 4.7 acres of land compared to 3.6 acres for hoe-farmers, of which 2.9 and 1.53 acres respectively were grown in paddy. The yields of plough farmers were higher because they had longer experience and controlled the best land, although the cultivation techniques of hoe farmers were more careful and involved more labour time per acre. Family labour per acre amounted to 627 hours for plough farmers and 1064 hours for hoe farmers while hired work party labour amounted to 305 and 122 hours for plough and hoe farmers respectively. Average cash expenditure was three times higher for plough farmers, while average net returns per acre were almost the same, 539 shs
for plough farmers and 520 for hoe-farmers. Returns to labour were consequently higher for plough farmers (Branner Jespersen 1973:65-66). It should be borne in mind that the history of paddy production - involving feudal-like relations imposed by Baluchi mercenaries - and the intensity of irrigation here represents rather untypical conditions for Tanzania.

In Sukumaland, having the benefit of an open land frontier, a comparison of the different sources of evidence does not immediately enable a general conclusion with respect to the relationship between ox-plough farming, size of cultivated acreage, use of hired labour and family income.

Rotenhan's data from 1963, comparing ox-plough farmers in Shinyanga with hoe cultivators in Kwimba, show for plough farmers substantially higher cultivated acreage per labour unit (man equivalent) and also more than tripled wage costs, doubled family income, and higher returns to labour and degree of commercialization than for hoe farmers (cf. Table 2, Chapter Three).

M.P. Collinson's more detailed and well-informed study from the early 1960s, comparing plough farmers in Maswa with hoe-farmers in Kwimba does show the opposite: cultivated acreage per man equivalent is virtually the same for both areas (2.05 acres for Maswa and 1.98 acres for Kwimba as against Rotenhan's 3.24 acres for Shinyanga and 1.90 acres for Kwimba) (Collinson 1972: 26). Plough/team owning farmers 'hired few supplementary resources' (i.e. wage labour) (p. 28) compared to Kwimba hoe-farmers whose 'hired labour used represented about 10% of mandays worked' (p. 14). For plough farmers, mean net value of total production per acre and per man equivalent amounted to shs. 163/- and 330/- respectively compared with the Kwimba hoe-farmer's shs. 221/- and 423/-.

Rotenhan uses Collinson's computation of man equivalents. Rainfall is highest for Kwimba, somewhat lower for Shinyanga and lowest for Maswa, where expectancy of crop failures is high.
I. Singh's study from the south-eastern grain growing plains on the Mwanza-Shinyanga border for the 1975/76 cropping season (poor rainfall) shows the following: For a farm size of 15-25 acres, the value of net returns per acre and per capita (not labour unit) was only slightly higher for plough farmers, i.e. shs. 486/- per acre and shs. 357/- per capita compared to shs. 456/- and 335/- respectively for hoe farmers. Below 15 acres, hoe cultivation yielded only slightly higher returns than plough farming, while comparative returns from plough farming increased considerably above the 25 acre farm size. Moreover, ox-cultivation gave substantially higher returns per acre and per capita than tractor cultivation for all farm sizes (Singh 1977:32).

Ox-farmers accounted for 22% of the holdings and nearly 53% of the cultivated area (ibid:33). "More interesting is the fact that oxen technologies on the average reduce the need for operating capital over manual technologies because they reduce the need to hire labour among large farms. What is even more important is that both the extensive hiring of labour (under manual cultivation) or the use of tractor-hire services, even if efficiently operated, reduce cash income available per farm for farms above 6 hectares when compared to oxen cultivation" (ibid:35).

Both Singh and Collinson stress the importance of ox-ploughing in reducing the most serious labour bottleneck of land preparation found in hoe farming, but flat weeding then tends to replace ridging as a labour intensive operation to be done at a critical time of the season (Collinson 1972:30). Without presenting supporting evidence Ruthenberg (1964:185) states: "A cardinal problem is weed control. In Sukumaland, in places where ox-ploughs are used, the yields per acre have been reduced, sometimes to such an extent that, despite the fact that more land is planted, the yields per farmer are not greater than before, when the hoe was used on less land\textsuperscript{19}.'

Neither Singh's nor Rotenhan's data are presented in such a way as to allow for a comparison of hoe and plough farmers within one area having the same land and climatic conditions. Collinson's data are of interest here, since he does compare non-owners of plough teams with owners within one area, Maswa. While owners of plough teams hired few supplementary resources,
95% of non-owners hired either ox-ploughs or tractors. Both categories hired little wage labour. For non-owners, ridge and flat cultivation amounted to 36% and 64% of the cultivated area respectively, while the proportions for owners were 41% and 59% respectively. These figures are quite contrary to the intimations of Ruthenberg and Rotenhan, who say that ox-farming invariably leads to flat cultivation. Moreover, for ridge and flat cultivation, Collinson's yield figures indicate no obvious disadvantage to flat plantings (1972:29). They were the same for both methods of cultivation.

Which conclusions can be drawn on the basis of the evidence presented above? Rotenhan and Singh indicate a higher cultivated acreage, higher returns to labour and higher family income for plough farmers, but we have some reservations with Singh's figures on cultivated acreage which seem rather high by comparison with Collinson and Rotenhan, including most other evidence from Tanzania.

Both Singh and Collinson emphasize the displacement of hired labour in plough farming, while Rotenhan's data show the opposite. No doubt, the reason for the use of more hired labour in Shinyanga is related to a larger cotton acreage and a lower number of labour units per household than for the hoe farmers (cf. Table 2). Collinson's comparison of Maswa and Kwimba shows a lower cotton acreage for plough farming with the same cultivated total acreage per labour unit for both areas. Singh's data do not show proportional acreage in different crops, but his survey covered the period 1975-76 when cotton production had dropped seriously. If the acreage with which Singh operates is at the upper scale, then his and Collinson's data seem to indicate that for the average plough-farming household, per capita family income is not higher than for hoe farmers. The relatively low acreage cultivated per labour unit in Maswa is due to a shorter cultivation season which intensifies labour peaks. "The main reason for the widespread use of capital equipment in the Maswa area is probably an attempt to increase the scale of farming. It has been shown that this is not achieved". (Collinson 1972:27).
But for other areas with a longer cultivation season, ox-plough farmers do achieve a larger scale of production, and most likely a proportionally lower increase in family income as well. A somewhat generalized conclusion on the socio-economic effects of ox-ploughing, which bears on Kyela as well, would seem to be that cultivated acreage is increased, while family income is less so. Ox-ploughing does not on its own account involve the use of more hired labour, rather the opposite. For farmers not owning ploughs with ox-teams the hiring of ox-teams is fairly widespread. Apart from Kyela, having closed land resources, ox-ploughing has not led to more inefficient use of the land to the extent of accentuating the problem of land alienation and proletarianization.

The tendency for higher net value returns to land and labour accruing to the hoe farmers in Collinson's sample and to the plough farmers in Shinyanga are probably related to their larger cotton acreage and to high cotton prices relative to food crop prices during the early 1960s. The plough farmers, both in Shinyanga and in Maswa, cultivated larger food crop acreages that the hoe farmers in the two Kwimba samples. The total supply of grains and especially pulses measured in pounds per labour unit and per capita was higher in Maswa than in Kwimba. (Collinson 1972:43). The vegetarian part of the diet must have been better for plough-farming families than for the hoe-farming households who depended more on cassava as a staple food.

As regards labour productivity, it does seem safe to conclude that if the cropping pattern had been the same for all studies, returns to labour (output per manday) would be higher for ox-cultivation. If land preparation in Maswa had to be done by means of hoeing, labour time would have been considerably increased and an additional labour peak would arise. Thus, if the benefit of ox-ploughing to the Sukuma farmers is not a substantial increase in family income, it is at least higher returns to labour, turned into more leisure time or other activities outside the sphere of crop production.
Turning to the total farming system including the sphere of livestock production, a comparative survey of plough and hoe farmers in one area would no doubt show that the former on average are considerably more wealthy and gain substantially higher incomes. This would be so because plough farmers would tend to have larger cattle herds or rather, those with cheap access to draught oxen can most easily opt for plough farming - also because they tend to live in less congested places with better access to land\textsuperscript{20}. The conclusion of the analysis presented above seems to be that ox-ploughing per se is not the cause of land concentration and social differentiation. Its adoption is rather associated with or correlated with the more wealthy section of households who also tend to be of larger size, often polygynous or extended, with a larger force of family labour at their disposal\textsuperscript{21}.

If the costs of wage labour are discounted, plough farming is definitely more capital intensive than hoe farming, but this does not automatically lead to further capital accumulation. In a similar vein, control of land per se does not automatically create wealth. A range of other factors must be controlled and properly allocated. Even so the particular social and political organization in a community might come to play in such a way as to resist attempts at accumulation. In North Mara (Tarime), one of the most prominent areas of ox-ploughing 'there was strong resistance to enclosures; Mrs. Ogot's tale of colonisation there turns on the use of witchcraft to curb too eager entrepreneurship' (Iliffe 1979:461).

Even where ox-ploughing did not take hold, land concentration could and did come about in a number of ways, e.g. through hiring labour by means of savings from sale of livestock, off-farm employment or hoe-based cash crop production, including tractor farming and the more traditional process of acquiring more wives and family labour through control of cattle which is not least important. Schneider (1970:61) quotes 'Mwajuma, one of the rare Turu Women who by circumstances and enterprise has managed to approximate the role of a man', as saying: "Cattle are our banks, our stores, our farms, our wives, our clothing, everything".
5.3 HIRING OF OX-PLough TEAMS

Relationships between families owning bullocks and ploughs and those that do not, in which services provided in the form of ploughing are paid for either in terms of ploughing labour or cash, seem to be fairly common in most places. This also constitutes a potential for exploitative relationships but can at the same time be instrumental in spreading the adoption of ox-technology:

"For those who didn't have their own ox-ploughs, one of them hired while others worked with their friends who have one, but the agreement was to plough the owner's shamba first. The agreement according to those who don't have ploughs had serious repercussions on the yield in that they were always late in planting resulting in low yields. This therefore has increased the desire for every head of household at Mtambula to invest first and foremost in an ox-plough and a pair of oxen before investing in anything else". (Mlambo & Nkko 1982:11, referring to Mufulidzi district in Iringa).

From a survey of two other districts in Iringa region, the following evidence is provided:

"Presently the average number of ox-ploughs is about 15 in all villages in the sample, with an average of 19 in the Njombe area and 11 in Southern Iringa. This corresponds to one plough for every 18 families in Njombe and one plough for every 43 families in Southern Iringa. There are differences from village to village, from no ploughs at all up to 100 ploughs in one village in Njombe.

".....The impact of oxen implements is much larger than the number of ploughs per family shows, because the owners rent them out to non-owners. The price for renting out varied considerably, in Njombe from 40-150 shs. per acre, with a medium around 70/= and in Southern Iringa it ranged from 70 to 120/= per acre with a medium around 90/= "(TRDB/CDR 1981:18).

The rate for hiring tractors varied from 100 to 150 shs. per acre. However, the statistics of the village survey, giving number of ploughs and hire rates, are neither sufficiently accurate nor detailed to allow any conclusions on the relationship between the different rates, the number of ploughs per village and the demand for hiring. The rates might also adjust to tractor rates, but only few hired tractors."
Nevertheless, there is no doubt that the hiring out of an ox-team can be a profitable undertaking which in some areas does account for the high demand for purchasing ploughs. It would also seem reasonable to assume that where the number of ploughs in a village is high and rising, hire-rates would tend to drop, and borrowing arrangements would become more common. The latter are very common in Tarime, where there is a plough for every 5 families. At the moment we lack more substantive evidence on the subject.

5.4 OXENIZATION AND THE WOMEN QUESTION

A much more important social and economic problem is constituted by the increased burden of weeding and harvesting of a larger acreage associated with plough farming, in terms of its impact on the sexual division of labour. Tobisson (1980:52) writes for Tarime Highlands:

"Although the plough facilitated cultivation, it served to increase the burden of work at later stages of the agricultural cycle. By using the plough more land could be put under cultivation with the implication of additional land to weed and to harvest. At the time when the plough was introduced, it was handled by men exclusively. The fact that it involved a monetary investment, oxen and presupposed skill made it a prestigious object. While the household head operated the plough, his wife walked in front of the oxen in order to direct their moves. Yet, within a decade the women were increasingly acknowledged to operate the plough without male assistance. This change in division of work was primarily necessitated by the fact that men were absent for more or less extensive periods in mines, road constructions, etc."

It should be noted here, that men used to be primarily responsible for the first hoeing of fields in Tarime before the advent of the plough. On the top of the greater efforts involved in weeding and to a lesser extent in harvesting, women now had to spend additional labour in land preparation with ploughs.

Reference to the increased workload of women in households using ox-ploughs is conspicuously absent from the literature on plough farming in Tanzania, so we can at best speculate on the issue—Where women did participate in land preparation, they would to a large extent be relieved of this task in plough farming provided it is mainly the men who operate the ox-team;
and I only know of women who operate ox-teams in Tarime. The increased workload in weeding and harvesting would tend to fall on women. Men do participate in weeding in some areas if need arises because of a labour peak crisis. Nevertheless, increased burden of work on women with regard to the task of weeding, which is already the main labour bottleneck, does not only compound the problem of sexual inequality but it constitutes the main constraint on increasing the output of crops by households and limits the aggregate production capacity of the agricultural sector as a whole. Improving the lot of women should not remain an empty political catch word as it still is in Tanzania.

In case of the larger, more wealthy households which already cultivate large acreages, the introduction of the plough might simply amount to more leisure time for the men. The clue to the popularity of the ox-plough might well lie here. It is clear, however, that the introduction of ox-drawn weeders and carts - to relieve women of head transport - must be a main priority, although the need for this priority might be less strongly felt among men, especially the elder most influential heads of household, who have withdrawn from manual work anyway. But this is mere speculation.

In Senegal and Gambia, comprehensive animal-powered mechanization has reached an advanced stage with the use of seeders, inter-row cultivators and carts. In both countries, the sexual division of labour and the roles of men and women in agricultural production are fairly clearly defined and differentiated. Venema presents quite detailed qualitative and quantitative evidence for Wolof in Senegal which shows that the workload of women has been reduced with comprehensive plough farming while the material position of women, with respect to their control over the distribution of the products of their labour, has actually improved (Venema 1980).

H. Mettrick, in his excellent analysis of oxenization in The Gambia, concludes:
"The workload (of women) would not, therefore, appear to have changed appreciably. Lowe found that the pattern of female labour use between his oxenised, manual and control compounds was very much the same. In all cases there was a greater expenditure of male than female labour". (1978:35)

Oxenization mainly involved dry-land crops and in some cases men, who operated the ox-teams as in Senegal, helped the women cultivate their dry-land crops with oxen. This, together with the use of carts in some areas, had reduced the workload of women.

However, women are mainly responsible for rice cultivation, and....."there has been no attempt to introduce ox-cultivation to paddy in The Gambia. .....Because extension has been so closely geared to the oxenisation programme, women have been largely left out. Half the agricultural labour force responsible for a large part of the food supply is ignored by the extension service". (ibid: 35).

It could be argued that the social status of women would deteriorate, and that their subordination to men would increase with the introduction of ox-technology which is controlled by men. Causality and effect is generally not as simple as that, and the scant evidence provided above, including that of Tarime, does not support this argument." Beneath the level of appearances, the subordination of women to elder men in agropastoral societies is inherently associated with the sphere on women and bridewealth exchange in the lineage-kinship system, and the origins of women's subordination cannot be explained as a direct effect of men's control over the means of production (Kjaerby 1981).

5.5 CONCLUSION

It is rather difficult to assess the impact which the development and spread of ox-farming has had on the regional and the national economy. It seems that the issue of lower yields and extensiveness of plough farming in Tanzania has been somewhat exaggerated, based as it was on the short-term colonial concern for soil conservation and intensification. This concern has come to the fore again, not least as a consequence of
villagization and the closing in of the land frontier as a result of population growth.

In the long run, the only way to overcome the problem is to intensify production through the development of ox-powered comprehensive mechanization, spread more evenly over the farming population in relevant areas. Of even greater importance is the fact that comprehensive ox-cultivation can relieve one of the most immediately pertinent constraints on agricultural productivity, i.e. that of an overburdened workload on women in weeding and transport.

In the historical perspective, ox-cultivation

".....has made a considerable contribution to agricultural development, primarily by expanding the area under cultivation in such a way that cash crops could be grown in addition to subsistence crops" (De Wilde 1967, Vol. 1:111).

In migrant labour areas, where men were chiefly responsible for land preparation, ox-ploughing may have contributed to maintaining the system of production by reducing a labour peak which would otherwise arise in land preparation because of male absence.
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CHAPTER SIX

6. POLITICAL CONTRADICTIONS AND PRACTICAL PROBLEMS IN THE DEVELOPMENT OF COMPREHENSIVE ANIMAL TRACTION

6.1 INTRODUCTION

This chapter starts out by providing a critical review of the overall policies of mechanization in Tanzania after independence and the consequences of those policies. Virtually all concrete evidence and evaluation reports show how most of the government's efforts, man-power and funds for agro-mechanization (animal and tractor) have been concentrated on tractor mechanization, whether in the form of cooperative Mechanized Block Cultivation Schemes; favourable tractor credit terms to private, large capitalist farmers; tractor allocations to Ujamaa and Development or Planned Villages; regional or district authority tractor hire schemes; Agro-Mechanization Centres; parastatal organizations, and not least, state farms.

Apart from the economically viable and generally more efficient use of tractors by the large, private capitalist farmers, all of the above-mentioned forms of tractor mechanization have been very costly for the Tanzanian economy amounting to a serious waste of funds. Not only could those funds have been spent on the development of animal traction which has by and large been neglected. Moreover, to the extent that these funds have been generated internally in the Tanzanian economy, they have constituted a heavy surplus drain on the peasant sector and have not sparked off capital accumulation to the benefit of the peasant sector. Hence, in the general perspective, the lack of development of comprehensive animal-powered mechanization cannot be understood without providing an outline of the general mechanization efforts. The role of influential donors like the World Bank is also discussed in this respect.
6.2 THE POLICIES OF AGRO-MECHANIZATION AFTER INDEPENDENCE AND THEIR CONSEQUENCES

"But the real failure seems to have been a lack of political leadership and technical understanding at the village and district level. Despite the call in 'Politics is Agriculture' for all political leaders to learn the basics of good husbandry in their areas, and to join with the peasants in production, we have continued to shout at the peasants, and exhort them to produce more without doing much to help them in a relationship of mutual respect. Many of our leaders know nothing about agriculture; what is more, they don't want to learn" (Nyerere 1977:20).

Although we lack data for the first six years after independence (1961), it is quite likely that the heavy sales of imported ox-ploughs during the late 1950s (see p. 51 above) continued, perhaps though at a slower rate of growth. In spite of this, most efforts at mechanization by the newly independent government were turned to promoting tractor cultivation on the Village Settlement Schemes and on the Mechanized Block Cultivation Schemes in Sukumaland.

In Arusha, Moshi, Iringa, and to a lesser extent in Shinyanga, an emerging capitalist class of large-scale farmers received favourable credit terms for purchasing tractors. A number of contract hiring schemes for tractors were also set up in various parts of the country, mainly within the Cooperative Unions.

This is not the place to review in detail the failure of the tractor adventure in the 1960s. An extensive body of literature is found on that28. Suffice it to say here, that apart from the privately owned tractors by the capitalist farmers, the tractor mechanized schemes rapidly turned out to be a fiasco. The main essentials for efficient and profitable tractor utilization were simply not there. These included:

"competent management and strict supervision; trained mechanics, adequate workshop and repair facilities; skilled and responsible drivers; availability of cash and credit when needed; large fields and scale of operations large enough to utilize tractors fully; high value-per-acre cash crops of which the major labor bottlenecks can be relieved by mechanization; alternative sources of productive employment for labor saved by mechanization and additional productive uses for tractors when not being used on main cash crops"29.
The same government study of 1968 reported that 'the performance of these tractors has been appalling' and that

"the experience with these tractors (had) been so bad that it must be recognized that the assumptions which were made at the time that they were introduced were wrong and that no degree of tinkering with the organizational set-up can possibly make it work" (Singh 1977:12).

In Mwanza particularly 'unoccupied land was only rarely immediately available', and in many cases 'peasants who actually farmed the land chosen for the block schemes were simply told to quit'.

"Finally many farmers turned to oxen cultivation and it was concluded that 'there was no case for the introduction of tractors in areas where ox-plowing is established, these can perform the same function more cheaply'.

In contrast to the above-mentioned schemes, the large-scale capitalist farmers in northern Tanzania and Iringa were engaged until the onset of villagization, in a process of extended agrarian capital accumulation, initially at the expense of favourable credit terms and loan defaults (Raikes, 1975), and increasingly so at the expense of labour exploitation (Awithi, 1972), lucrative share-renting of land from peasants and alienation of pastoral and agro-pastoral peasants from their pastures and fallow (Kjaerby, 1976, 1979; Raikes, 1975).

The failure to attract foreign capital for industrial investment, of the development of capitalist rural relations and the failure of the capital-intensive focal transformation approach of the First Five-Year Plan were some of the main internal economic factors which led to the socialist oriented policies of the Arusha Declaration (1967) containing strong emphasis on a self-reliant peasant oriented strategy. A more cautious attitude was taken towards tractor mechanization in the Second Five-Year Plan 1969-74 and more encouragement was to be given to ox-plough cultivation and the design of animal-drawn equipment considered suitable for peasant farm conditions and utilizing the potential of the large cattle population (some 12 million head of cattle in 1978).
The Tanzania Agricultural Machinery Testing Unit (TAMTU), set up in Arusha in 1957, was to develop suitable implements for ox-cultivation and test them in various parts of the country. Further field testing of ox-drawn equipment was to be carried out at several research stations, and nine regional ox-training centres were to be revived or expanded and five regional Farmers' Training Centers (FTC's) were set up. In 1969, TAMTU was given permission to enter into small-scale production of equipment it had developed and later an Intermediate Technology Section was added, to train village artisans to manufacture low-cost implements and tools with local materials (Singh, 1977:22).

In 1970 a relatively large factory: Ubugo Farm Implement Manufacturing Company (UFI) set up by the People's Republic of China on an interest-free loan, started operating. Its highest production capacity was for hand tools (hoes, machetes and axes). During the first five years of its operation, the utilization of its annual capacity of 8,000 ox-ploughs (single-furrow mouldboard ploughs) was somewhat higher than the 40 per cent recorded for hand tools (Müller, 1980: 91-92).

Apart from the attractive economies of ox-cultivation to peasants, the general economic and political optimism and stronger encouragement of animal traction after the Arusha Declaration - including perhaps greater availability of imported ploughs - did produce some results. 'Some 8,250 ploughs were bought in 1967, and this increased to 9,100 in 1968 and an estimated 15,000 by 1974',

'In spite of this emphasis on oxen cultivation, the cautious views on mechanization expressed in the Second Plan's documents were largely overtaken by events following the Iringa Declaration in May 1972' (TANU 1972: 'Politics is Agriculture').

Although the document is often credited for giving priority to animal traction, it is rather ambiguous in terms of establishing priorities between animal traction and tractor cultivation. The emphasis placed on 'modernization' of farming and farming techniques through gradual development
of communal production was interpreted in practice to mean villagization through a promise to make tractors and other modern inputs available. 'Thus with the emergence of Ujamaa and villagization, mechanized tractor cultivation continued to be seen as a panacea and tractors continued to be distributed to selected Ujamaa villages during the Second Five-Year Plan' (Singh, 1977:22).

Villages continued to get tractors from Tanzania Rural Development Bank (TRDB) loans, from Rural Development Funds, through tractor hire services operated by regional or district authorities or by such crop authorities as the Tanzania Cotton Authority (TCA) and the Tobacco Authority of Tanzania (TAT). In the annual peasant-day competitions, the best villages were rewarded with tractors. All this happened in spite of the fact that the villages neither had infrastructural facilities, experience, organization nor the economic capacity to support tractor mechanization; in many instances the tractors turned out to be a burden on the villagers if loan defaults by cooperative villages could not be relied upon (FAO Mission Report 1975; Dumont & Mottin, 1980).

Planning ideas about tractor mechanization also seem to have influenced the land-use lay-out which became common upon villagization after 1974. The large block farms intended for cash crop production were to provide the field basis for economies of scale in tractor mechanization. Where possible the block farms were laid out on flat land, in most cases without any consideration for soil fertility or land suitability with respect to the local farming systems. No doubt, the intention of the block farm lay-out was also to provide the basis for 'management from above' through the state imposition of household minimum acreages, cultivation of specified crops, compulsory use of specified inputs (especially fertilizers), 'communal' timing of operations and close supervision (Kjaerby, 1980b). I am not sure to what extent the idea of the Block Cultivation Schemes of the early 1960s did influence the 'planning' of block farms upon villagization. It is, however, clear that the
government either made no attempt or did not want to draw on the negative experience of earlier years so clearly spelled out in its own reports (cf. Tanzania, Government of, 1968).

6.3 STATE FARM MECHANIZATION VERSUS PEASANT SECTOR OXENIZATION AND THE ROLE OF DONOR AGENCIES

Quite apart from the state farm sector, which is discussed separately below, the government has since the mid 1970s made repetitive efforts to review its policies on agro-mechanization, evaluate performance and seek assistance, especially for FAO, for mechanization. J.M. Beene who like Singh had made a detailed comparison of the economics of animal traction and tractor mechanization states:

"The tractor-powered mechanization programme is in disarray, some third of the country's tractor population (mostly in the public sector) needing mechanical attention" (Beene, 1975:7).

He goes on to list 21 reasons for this. His comparison clearly shows how the economics of comprehensive ox-powered mechanization (based on apparently experimental results from Uyole Agricultural Centre, Mbeya) are far superior in terms of returns to land, labour and capital than both manual cultivation and tractor mechanization (ibid, appendix). Yet, a large part of the report is devoted to a proposal of four agro-mechanization centres for tractor hire services and oxen techniques in Arusha, Mwanza, Mbeya and Iringa regions. The reason for this seems to be that, apart from the quoted consultant's terms of reference, the consultant was additionally asked to study in detail eight regions of Tanzania with the purpose of making recommendations to the Ministry of Agriculture for the siting of 4 Agro-Mechanization centres' (ibid:3). Very little is said about the planned position of ox-technology at those centres compared to the tractors.

"- at Ujamaa Village and individual shamba level the promotion of comprehensive oxen techniques is the approach most likely to offer the greatest advantages at the least capital cost and greatest saving of foreign exchange;
- at large farm level, well-operated and maintained power equipment employing appropriate minimal cultivation techniques is the only feasible form of mechanization;

- on hard soils with restricted working seasons, or on the larger more successful Ujamaa villages, the employment of power chisel type equipment followed by oxen cultivation is the technique most likely to be of benefit". (Ibid:5).

The recommendations as such were perhaps reasonable enough at the time of the mission, but they are ambiguous in terms of establishing overall priorities between oxen and tractor techniques and they can, and apparently have been, used to concentrate efforts and funds on tractor mechanization. To my knowledge, the only agro-mechanization centre still 'in operation' has been situated at Mkongo in Coast Region for cultivation of the heavy, fertile soils in Rufiji flood-plain. The centre is in disarray and is an economic and technical disaster (personal communication with Kjell Havnevik).

I. Singh's study, sponsored by the World Bank, also shows the economic and social advantages of animal traction and he states:

"The burden of evidence from past studies seems to be that as far as possible tractor mechanization should be discouraged in Tanzania except in very special circumstances and only after careful study of its economic efficiency and viability whereas oxen cultivation should be pursued vigorously wherever possible. There seems to be little justification for additional studies on the subject" (Singh, 1977:24).

Singh - or the World Bank? - goes on to recommend:

"-- no one solution should be accepted for any country as diverse as Tanzania as a whole. Mechanization in Tanzania has in the past and should in the future continue in its two forms -- animal-powered -- but specific studies based on locally identified conditions should be carried out to determine the appropriate choice" (Ibid:52).

The ambiguity if not self-contradiction in these statements is evident. There are good reasons to ask about the role of foreign aid-mission reports and financial assistance in Tanzanian policy formulation, a point to which we shall turn briefly below. The point is clear, however, that the Tanzanian government through persevering in its implementation
of tractor mechanization, has until recently had the go-ahead and financial assistance from major donors like the World Bank and FAO/UNDP.

In a similar vein it seems worthwhile briefly to take a critical look at the way the World Bank, in its recent important document (Accelerated Development in Sub-Saharan Africa, 1981) treats animal traction:

"Over the last decade, it has been recognized that labor bottlenecks are a key constraint in agricultural progress in Africa, but rural development strategies have not fully reflected this insight. Instead, most of the methods encouraged still aim to increase productivity of land (fertilizer and seed packages). More emphasis should now be placed on measures that increase labor productivity, in particular, use of farm implements, ox-drawn cultivation40, ..."

"40. A breakthrough in ox-drawn cultivation would obviously have the most powerful effect on labour productivity. However, progress has been strikingly uneven in different countries, and on the whole disappointing. This is another field in which too little is known about the conditions governing acceptance or rejection of this innovation and where more research is warranted in order that officials can better target future efforts. Prime factors appear to be: varying costs of maintaining cattle in the off-season; varying costs of destumping fields, .... and familiarity with animals and social taboos attached to handling animals" (World Bank, 1981:75).

This is about all that the World Bank has to say about the development of animal traction, whereas it says a lot about land, labour, and capital intensive fertilizer technology. In its case example of the highly successful cotton programme in Upper Volta no mention is made of the successful comprehensive oxenization programme which has also contributed to the expansion of cotton and cereal acreages.35 We could add that the few remarks in the second footnote quote on past experience and present issues in oxenization are rather superficial. There is no attempt to analyse the problems and potential of animal traction in the view of experiences actually gained.

We do agree fully with the first quote, but should like to add that the World Bank more than anybody else has focused and concentrated its policy and financial assistance on capital and labour intensive land productivity increasing
technologies, even in Sub-Saharan Africa, where low man/land ratios in most areas - not least in Tanzania - do not justify the costs. The influential World Bank Rural Development Sector Policy Paper (1975) focuses exclusively on capital and land intensive techniques and apart from the two quotes above, so does the 1981 document.

The critical role of the World Bank, and to a lesser extent of other bilateral donors, in financial support to a non-peasant oriented strategy of agricultural development in Tanzania takes us to the state farm sector.

"During the 1960s and 1970s, for example, many African countries directed a substantial proportion of their agricultural investment to large-scale, government-operated estates which involved heavy capital outlays for mechanization (as with rainfed crops) or irrigation schemes, or both. Why did they follow such a course? First, there was the notion that only a rapid transition to mechanized, high productivity schemes, as practiced in the industrialized world, would overcome the stagnation linked with the traditional low-input, low-output methods. Also, it was considered a reasonable solution to labor shortages, where these existed. Further it was a response to the drought of early 1970s, .... And at last, it was reasoned that while productivity was often lower on state farms, the share of marketable surplus would be much higher; thus an emphasis was placed on such enterprises in Congo, Ethiopia, Somalia, and Tanzania."

But most of these ventures did not fulfill expectations, and their contribution to growth was small when compared to their cost. They were beset with problems of management, overemployment of staff, underutilization of expensive machinery, and maintenance of equipment and infrastructure" (World Bank, 1981:51).

It should be added that the state farm sector in Tanzania consumes at least half of the agricultural sector development budget to produce a relatively low marketed surplus of high quality food for upper-class consumption in the urban areas without generating further investible surpluses. Thus, to the reasons for concentrating funds and efforts on the parastatal sector - put forward by the World Bank - we should add what looks like sheer class interests of the Tanzanian parastatal technocracy. The critical World Bank comments on large-scale parastatal investment and the bank's suggestion of giving priority attention to smallholders (1981:51-52) should be welcomed since the World Bank has been the single
largest donor of finance to the state farm sector in Tanzania during the 1970s.

To the overall picture of starving the peasant sector of productive investments and development efforts as a consequence of the high opportunity cost of state farm development should be added the trend of surplus transfers from the peasant sector to the state through its pricing policies:

"The analysis of this paper provides empirical substantiation of rapidly increasing transfers of financial surplus between peasants and the state in Tanzania during the period 1970 to 1980. The quantitative estimate of such transfers is an aggregate of T.Shs. 4.6 billion, representing an average implicit tax of 26.6 per cent of peasant crop income. The incidence of surplus transfer was progressive through time so that if 1970 is taken as the base year net additional resource transfers out of agriculture had reached a level of nearly T.Shs. 1 billion per annum by 1980.

These results amplify and extend the conclusions reached in an earlier paper on agricultural prices in Tanzania (Ellis, 1982a). They show that the basic process of Tanzania's political economy during the 1970s was the impoverishment of the rural economy to the end of supporting a proliferating state and parastatal bureaucracy. It is argued that such an economic process could not be sustained indefinitely since it does not contain any internal cycle of productive investment and accumulation" (Ellis, 1982b).

The overall picture of parastatal concentration of development efforts provided above should not be taken to infer that all tractors are publicly owned. During 1976-78, a detailed but partially incomplete agro-mechanization survey states:

"A total of 5,127 tractors were recorded of which 69.1 % were in working condition. It must be noted, however, that probably not more than half of this percentage could be described as being in good working condition, the remainder being in various stages of need of repair, though still running.

Close on half (48.1 %) of all tractors recorded were privately owned with Shinyanga and Arusha Regions (which account for 35 % of the country's total no. of tractors F.K.) indicating 91.2 % and 80.4 % private ownership respectively. Parastatal ownership on a commercial or cooperative basis accounted for less than 2.6 %. As this category also included tractors of unknown ownership and those on refugee settlement schemes probably not more than 1 % of all tractors were owned by villages or cooperatives at the time of the survey" (Dagg, 1978:5).
The survey figures provided above unfortunately do not include Iringa Region which is among the most important tractor regions.

A more recent report states:

"Despite the formal policy emphasis on communal and peasant farming, it is clear that a large proportion of new tractor imports end up in the hands of private - and by definition relatively wealthy - individuals\textsuperscript{39}. ... One (confidential) estimate was that, as the rate of new imports had gradually tailed-off during the 1970s, to a zero rate in 1981, the proportion of the total tractor stock which was serviceable had declined from more than 90% in the early 1970s to less than 50% currently. This kind of estimate was supported by the experience of two mechanisation projects, which had commenced by trying to repair tractors and bring them back into use, but given up because of further breakdowns occurring so rapidly" (IDS/Sussex, Nov. 1981:91).

There can be no doubt that private farms use tractors more efficiently and lead to the production of a relatively larger marketed output than the state sector and that a reduction of tractor allocations to private farmers might have repercussions for the marked output of especially food crops. It should be assured, however, that the tractors are more equitably distributed, since there is little reason to believe that the very largest farmers are actually the most efficient ones in terms of pure economic accountability\textsuperscript{39}.

If tractor imports have actually stopped - and there is perhaps too scarce foreign exchange to warrant imports in the near future for rebuilding stocks - what will happen? At Kibaha in Coast Region, Tanzania Tractor Manufacturing Company (TRAMA) is being set up with the assistance of Finland and the Finnish state-owned VALMET tractor factory. All components have to be imported from Finland for the first ten to twenty years. Original plans to start production in 1981 with a target of 500 tractors have not yet materialised\textsuperscript{40}. Numerous examples in the Third World of this form of import based industrialization have shown that the cost of local production considerably exceeds the cost of importing the finished product.
So-called import substitution has in fact generated higher import expenditure, pocketed by industries in the industrialized countries. It is quite likely that this project will do the same, in addition to the problem that the tractors cannot be used at any justifiable rate of economic return.

The recently completed hand tool and ox equipment factory, set up in Mbeya with Indian assistance, is to produce 800 tractor disc-ploughs, 500 disc-harrows and 200 spring tine cultivators. Although technically more feasible than producing tractors, the economic feasibility of producing these tractor implements remains to be seen, pending first of all the supply of electricity to the plant. More important is the fact that the continued use of disc implements has over and again been strongly discouraged on most Tanzanian soils by agronomic expertise, since disc implements pulverize the soil and accelerate erosion. Disc ploughs are only appropriate under very humid conditions with heavy weed growth and for breaking up fallow land (Beene, 1975; Raikes, 1971b; Northwood). Most settlers and the Basotu state farms in Arusha mainly use chisel/tined cultivators for their superior soil and moisture conservative properties.

In spite of all the rhetoric on peasant-oriented strategies, appropriate technology and the development of animal traction - the latter continuously stressed by the president - most efforts and funds have been devoted to large-scale farming, inappropriate technology and tractor mechanization. By contrast, the FAO Mission Report on agricultural mechanization (1975:9):

"... found it extremely difficult to find any concrete evidence in the regions of a concerted effort to promote a wider and more intensive use of animal power. The program of establishing ox-training centers, mentioned in the Five-Year Plan, appeared to be virtually non-operative and little technical progress had been made at the village level beyond the use of the single furrow ox-plough".

Thus, in the Mission's view, '... ox-equipment has yet to be given a real chance to prove itself, even in those districts where there is a tradition and aptitude for its employment' (ibid:13).
Since the recent greatly expanded production capacity of ox-equipment from UFI, TAMTU and the Mbeya factory is yet to materialize in actually increased production and supply of equipment to the rural areas, the same still holds true at this moment of writing (June 1982), although it must be stressed that the expanded production capacity does represent a great step forward, and hopefully also a shift in real policy and not least implementation practice.

However, if there is such a shift in policy, it cannot be gleaned from the Tanzania Rural Development Bank (TRDB) lending budget for 1981/82. The lending potential (or applications) prepared and submitted by the bank's regional offices to Head Office for further processing totalled T.Sh.s 48,191,000 for tractors and 1,660,000 for ploughs and implements (presumably ox-equipment) while approved lending by Head Office totalled T.Sh.s 7 million for tractors and 1 million for ploughs and implements.41

It would seem that oxenization is not yet a real priority to the most important rural credit institution in Tanzania, and that even a real policy shift in the central government would take some time to penetrate down to lower government and parastatal level. Central policy impact and the impact of peasants' and private farmers' interests on the new District Councils, who are to finance important parts of their recurrent and development budget from local taxation, is in that respect still a matter of intelligent guestimates.

Meanwhile, the real chance for and problem of developing peasant oriented animal traction might seem to depend on the sheer weight of Tanzania's deep economic crisis - which would apparently set tight economic limits to further tractor adventures in the first decade or so, at the same time as it inhibits the production and distribution of ox-equipment - and on the direction and control of foreign aid towards the development of animal traction.
Apart from the critical role of the World Bank, the EEC, U.K. and some private donor agencies have shown some positive signs of directing assistance towards animal traction. Whether assistance is enough - or whether insistence on the direction of priorities is necessary - is another difficult question. At the other extreme, a 'frontal operation' by the Tanzanian government to enforce rapid oxenization upon the peasantry would - given all past experience with such campaigns - just strengthen demobilization and peasant resistance to overzealous state intervention in the name of development. Yet, peasant-oriented development of comprehensive animal traction is critically dependent on active and informed state support, as we shall see in the next section.
Chapter Seven

7. The Regional Distribution, Production and Demand of Ox-ploughs and Related Implements

7.1 Introduction

"People still think in terms of getting a tractor for their farms - even when they are small - rather than learning to use ox-ploughs". (Nyerere 1977:19).

As referred to in the previous chapter, ox-cultivation in Tanzania depends almost exclusively on the use of the single-furrow mouldboard plough. Adoption of ox-ploughing started to gain ground in the 1940s and then spread fairly rapidly during the 1950s and 1960s. There is evidence to indicate that the further development of ox-ploughing was severely hampered - if ox-ploughing did not decline in importance - during the 1970s, despite a strong demand for ox-ploughs and despite much political rhetoric about the development of ox-ploughing.

In fact there has been a situation where peasants have been urged and educated to use ox-ploughs even though the ploughs were actually unavailable and in high demand among some of those peasants. At the same time, attempts to promote ox-ploughing have been made in regions with tsetse infested bush country and absence of cattle - probably as a response by regional authorities to top-bottom blanket recommendations.

Ox-ploughing can be characterized as somehow invisible in Tanzania, despite the ideological emphasis given to animal traction. The insufficient production of ox-ploughs does in no way express demand; apart from one incomplete survey with limited circulation, ox-ploughing hardly figures in statistics; the demand for ox-ploughs is not recorded although it is complained about. Credit for ox-ploughs has recently been institutionalized, but those who apply cannot get ploughs; reports by international aid agencies, stressing the need for ox-technology, devote most of their analysis to tractor mechanization and funds have been spent on that. Some of these problems will be discussed below.
7.2 REGIONAL SURVEY OF THE PRESENT NUMBER OF OX-PLOUGHS, EQUIPMENT AND TRAINED OXEN IN TANZANIA: SOME REGIONAL PRIORITIES

Between 21 November 1976 and 29 April 1978, the FAO/Kilimo Agro-Mechanization Survey (Dagg 1978) was conducted. Although the survey was not complete, the approach did involve door-to-door visits to record and inspect implements. Not all households or even villages were visited in the districts actually covered by the survey, but even so the data recorded are said by Dagg to have good reliability, and to my knowledge it is the first survey of its kind in Tanzania. Table 3 below presents the survey results.

Dagg's comments to the survey results presented in Table 3 are confined to the following remarks, the rest of his report being devoted to tractor mechanization:

The data presented in this table do not constitute an inventory for any one location or for the country as a whole.

As far as possible, only trained draught oxen were recorded, although it was impossible to determine how well trained these were.

No data were recorded for Iringa and Dar es Salaam regions.

Five categories of ox-drawn implements were recorded. Interrow cultivators (weeder) were recorded under "Harrow". All ploughs recorded were mouldboard ploughs, accounting for 93.4 % of all implements recorded.

With the exception of oxen and implements purchased by Regional Authorities for the promotion of oxenization almost all others were said to be owned by individual peasant farmers. Regions which reflect a high ratio of implements to oxen are those in which oxenization is not traditional. Implements were purchased by these regions in an effort to promote oxenization, many of which remain unused.

No attempt was made to record in detail the conditions of each implement. A substantial proportion were, however, seen to be in a non-working condition.

Many of the regions heavily populated with tractors are also those in which the use of draught oxen is widespread. Very few instances of 'mixed power' (i.e. tractor power plus ox-power) farming were observed however, efforts to promote oxenization being carried out in relative isolation. The introduction and demonstration of a suitable range of implements is an obvious priority for increasing the utilization of trained oxen and for future extension of oxenization (extracts from p. 7,9 and appendix 3 in Dagg 1978).
<table>
<thead>
<tr>
<th>Region</th>
<th>Ploughs</th>
<th>Riders</th>
<th>Harrows</th>
<th>Planters</th>
<th>Carts</th>
<th>Oxen</th>
<th>No. of oxen per plough</th>
<th>No. of ploughs per ox.</th>
<th>Rounded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coast</td>
<td>24</td>
<td>6</td>
<td>12</td>
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<td>6</td>
<td>26</td>
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<td>-</td>
<td>-</td>
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<td>17</td>
<td>15</td>
<td>3</td>
<td>66</td>
<td>348</td>
<td>-</td>
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<td>210</td>
<td>17</td>
<td>754</td>
<td>45243</td>
<td>1.35</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Singida</td>
<td>26505</td>
<td>23</td>
<td>68</td>
<td>24</td>
<td>168</td>
<td>52973</td>
<td>2</td>
<td>-</td>
<td>-</td>
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<td>340</td>
<td>71</td>
<td>5</td>
<td>324</td>
<td>102540</td>
<td>3</td>
<td>-</td>
<td>-</td>
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<tr>
<td>M’gororo</td>
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<td>13</td>
<td>19</td>
<td>4</td>
<td>149</td>
<td>1.1</td>
<td>-</td>
<td>-</td>
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<td>nr</td>
<td>nr</td>
<td>nr</td>
<td>nr</td>
<td>nr</td>
<td>nr</td>
<td>nr</td>
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<tr>
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<td>22</td>
<td>23</td>
<td>14</td>
<td>141</td>
<td>141</td>
<td>na</td>
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<tr>
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<td>5</td>
<td>27</td>
<td>nr</td>
<td>50</td>
<td>26244</td>
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<td>-</td>
<td>-</td>
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<td>Mbeya</td>
<td>18676</td>
<td>58</td>
<td>122</td>
<td>12</td>
<td>69</td>
<td>3368</td>
<td>na</td>
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<td>3012</td>
<td>14</td>
<td>7</td>
<td>nr</td>
<td>12</td>
<td>8020</td>
<td>2.7</td>
<td>-</td>
<td>-</td>
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<td>17</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>15</td>
<td>-</td>
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<td>-</td>
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<td>6000</td>
<td>2</td>
<td>13</td>
<td>1</td>
<td>61</td>
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<td>23</td>
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<td>7</td>
<td>38</td>
<td>51</td>
<td>-</td>
<td>1.7</td>
<td>-</td>
</tr>
<tr>
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<td>6</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>40</td>
<td>2.5</td>
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<td>-</td>
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<td>nr</td>
<td>1</td>
<td>nr</td>
<td>17</td>
<td>45</td>
<td>-</td>
<td>1.8</td>
<td>-</td>
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<tr>
<td>Lindi</td>
<td>512</td>
<td>nr</td>
<td>59</td>
<td>nr</td>
<td>11</td>
<td>61</td>
<td>-</td>
<td>8.4</td>
<td>-</td>
</tr>
</tbody>
</table>

| Total     | 162949  | 757    | 5999    | 3028    | 1821  | 295030| na                    | na                    | na      |

% of total implements: 93.4 0.4 3.4 1.7 1.0 na na na

Source: Dagg 1978 (rearranged)

nr = no data recorded  na = not applicable

1 Data recorded for Kisarawe and Bagamoyo Districts only.
2 No data recorded for Kondoa District (ploughs fairly common)
3 No data recorded for Kilosa District (ploughs fairly common)
4 No oxen recorded for Bukoba and Muleba Districts
5 No impl. recorded for Serengeti, no oxen for Musoma (ploughs fairly common)
6 No data recorded for Mbuji District, no oxen for Mbeya + Kyela District
7 No data recorded for Mpondi District
8 No data recorded for Kigoma District
9 No data recorded for Mwanza and Geita Districts (ploughs fairly common)
10 Data recorded for Arumeru only (ploughs + oxen fairly common in Hanang, Mbulu and Monduli Districts)
11 Data recorded for Songea District only
12 No data recorded for Kilwa District.

(My remarks in brackets)

(ploughs rare in all other nr districts)
The number of trained oxen recorded cannot be considered at all accurate. How the questions on oxen were actually asked is not indicated. Unless different ways of questioning are carefully made and checked through other informants, a hit and run survey like this would get too low figures. Only the figures from Shinyanga, Mara, Rukwa, and Mwanza on the one hand, and from Coast, Kigoma, Lindi, and Mtwara would give some idea. The number of plough oxen in Dodoma is very likely to be under-reported. Generally 4 oxen are required to pull the plough, although an ox-team of only two is being used especially for second ploughing of light soils with limited weed growth. The other implements, apart from ploughs, are discussed in sections 8.3 - 8.9. Sledges, made by the peasants from heavy, forked tree branches, are everywhere common.

Although the survey is incomplete, omitting implements of 8 rather important ploughing districts (Kondoa, Serengeti, Mbozi, Mwanza, Geita, Hanang, Mbulu and Monduli), it does confirm the importance of regions like Arusha, Singida, Mara, Mwanza, Shinyanga, Mbeya, Rukwa and possibly also Kilimanjaro.

Below, we have tried to upgrade figures for the most important plough regions by guestimating the number of ploughs for the unrecorded districts, partly based on district figures from the end of the colonial period. Iringa is known as one of the most oxenised regions, having an extended highland area suitable for ox-cultivation and the most easy transport access to ploughs from Dar. The region might well have some 40,000 ploughs. In Mara, a recent survey - based on apparently fairly accurate village-provided data - gave some 12-13,000 ploughs for Tarime District alone, and Serengeti plus Musoma might have some 3,000 giving a total of say 15,000 for Mara. Mwanza Region might have a total of some 10,000 ploughs, Mbeya 25,000, Arusha some 35,000, Dodoma some 3,000 and Iringa 40,000 ploughs, giving a total conservative estimate of some 226,000 ploughs for Tanzania as a whole. If a 10 per cent undercounting and underestimation is reckoned with, Tanzania might have 1/4 of a million ox-ploughs. This figure can be compared with my rough estimate of some 80,000 ox-ploughs in Tanganyika in 1960.
It is rather difficult to say how many ploughs were purchased during the 1960s and 1970s, since we lack exact plough import figures and estimations as to how many ploughs have survived from before 1960. Most of the ploughs from the colonial period were the extremely durable Ransome 'Victory', a number of which are still in operation. Based on a fairly reasonable assessment, IFU's average annual production between 1971 and 1978 amounted to only some 3,500 to 4,000 ploughs and to my knowledge, very few if any imports were made. Plough sales through imports were thus several times higher during the 1960s. Despite all the political rhetoric centering on the development of ox-cultivation, the government has done little to meet the demand for ploughs during the 1970s. The state has been responsible for the growing scarcity of ploughs for the peasant sector (see also section 7.4).

It is also difficult to assess the impact of ox-ploughing. We can only get a rough idea about the acreage ploughed and the number of households involved. First of all, probably no more than some 65 per cent of the ploughs are actually being used (due to breakage and lack of spares, chains and perhaps oxen) in some places, like Kyela, giving some 160,000 ploughs in use by say 1980. Plough households would on a gross average cultivate some 7 acres, but since extensive borrowing and hiring out of ploughs take place, and since the ploughing season in most places would last from one to two months, the number of households utilizing one plough might on average be some 2-3 households.

Taking the conservative estimate we get 14 acres per plough times 160,000 = 2.2 million acres ploughed by some 320,000 households. On a national scale that gives some 12 per cent out of a total of 2.7 million rural households, and the percentage acreage cultivated with ploughs would be somewhat larger than the percentage number of households using ploughs. It should be kept in mind that ox-ploughing - with the exception of Mara and Singida - is concentrated in the most productive regions in terms of marketed food and export crop output (i.e. Iringa, Arusha, Shinyanga, Tabora, Mbeya, Mwanza, and Rukwa).
As we shall see below, the demand for ploughs has, not least in recent years, been far above the purchase figures presented above. If policies, efforts and funds, both during the 1960s and especially during the 1970s, had been concentrated on animal traction rather than tractors in the relevant regions and especially if sufficient ploughs had actually been available, ox-ploughing would no doubt have been even more important.

The FAO/Kilimo survey helps to stress one important conclusion: Oxenization should not be promoted in regions like Tanga, Coast, Lindi, Mtwara, Ruvuma, Kigoma, West Lake (Kagera), and probably also Morogoro although we know too little about the state of ox-ploughing in Kilosa District.

7.3 THE PRODUCTION OF OX-PLoughS AND PRODUCTION PLANS: SOME TECHNICAL RECOMMENDATIONS ON THE CHOICE OF EQUIPMENT AND PRODUCTION PRIORITIES

During the 1970s, Ubungo Farm Implement Manufacturing Company (UFI) has had a virtual monopoly in producing, importing and supplying single-furrow mouldboard ploughs to the Tanzanian retail outlets (mainly regional trading companies (RTC's) and Tanganyika Farmers Association (TFA)). For the initial period of its operation, UFI's production capacity of 8,000 Chinese designed ploughs was utilized at between 40-50 per cent (Müller 1980:91-92) 42.

UFI's '... production plans for the various items (ploughs, hoes, axes, matchets, etc. F.K.) are usually based on their respective demand each year. Hence every year production is manipulated in such a manner as to meet demand of every item but within the factory's production capacity' (Commonwealth Secretariat 1979c:111). Production plans for 1977 and 1978 stood at 10,000 ploughs and 150,000 plough shares. Actual production was reported to be 3,836 ploughs and 112,944 shares in 1977 and 6,000 ploughs and 81,000 shares for 1978 (ibid:112). However, since the 1978 figures are conspicuously round, and for all items, except shares, considerably higher than the 1977 figures, the 1978 figures are questionable.
By 1980, UFI's production capacity had been expanded to 12,000 ploughs and 235,000 plough components (mainly nuts and bolts). One of the most recent reports, strongly encouraging oxenization, states:

"The only source of supply is the Ubungo factory, which is actually assembling kits imported from India, probably at rather more than the landed cost of the completed item. However, due to the same kinds of problems which have afflicted Tanzania's industrial sector generally, ox-plough assembly at Ubungo seems to have almost ground to a halt" (IDS/Sussex 1981:90).

The Mbeya Factory, set up with Indian assistance, was initially expected to start production in early 1980 (Commonwealth Secretariat 1979c:112). Its installed production capacity of ox-equipment - apart from 1,500 items of tractor implements (cf. p. 77 above) and 2,065,000 hand tools - is 10,000 mouldboard ploughs (40 kg) and 1,000 disc harrows (Phillips & Zachariah 1980). To my knowledge the actual start of production is still pending the supply of power, expected to be installed during the latter half of 1982.

There have also been negotiations with Bulgaria on a planned factory in Mwanza intended to produce 10,000 ox-ploughs, 4,400 disc harrows, 6,000 cultivators (probably inter-row weeders) and 4,000 toothed harrows (ibid). To my knowledge these plans have not yet materialized. It is worth noting, however, that these plans do envisage a fairly extended range of equipment by Tanzanian manufacturers' standards, and thus at least a planning step towards comprehensive ox-mechanization which is to be commended.

With partial exception of the Mwanza plans, and seen in a long-term perspective, the most disturbing thing about UFI and Mbeya is perhaps not that they have not yet started production. Rather, it is the installed concentration on single-furrow mouldboard ploughs and plans to produce disc harrows.
"The conventional system of cultivation that involves soil inversion with a disc or mouldboard plough (developed largely under temperate conditions) is not only unnecessary in terms of crop growth and yield but is also basically unsuited to large areas of the tropics having intense rainfall and therefore high erosion potential. Soil inversion and trash burial followed by disc harrowing results in a fine textured or completely pulverized, bare seed-bed which 'caps' readily and provides optimum conditions for rainfall or wind erosion. This system resulted in the North American 'dustbowls' of the 1930s" (Northwood n.d.)

At best, an ox-drawn disc harrow pulled at slow speed might not effect pulverization. But to achieve any effective seedbed preparation it has to be heavy, and this cannot be recommended for the small-sized, weak and half-starved oxen in Tanzania. Quite apart from this, how is the disc harrow to be transported from homestead to fields? Pulling it over stony ground may easily result in breakage of the discs. If it has wheels, it is even more sophisticated. Are the discs to be imported?

The cost of a disc harrow is generally high, much too high for a single-purpose implement, the performed operation of which is highly questionable under Tanzanian conditions. Would the peasants buy it? Very unlikely, judging from the lack of sales of the simpler and cheaper spike tooth harrow from TAMTU. The disc harrow is unfeasible in all respects, as proven even by experimental trial work in West Africa. Production should never be allowed to start. It can probably only benefit the Indian and prospective Bulgarian manufacturers and would take up production capacity for much more needed implements.

As regards the single-furrow mouldboard plough, the choice is not so obvious. From an agronomic and draught-power-requirement point of view, the mouldboard plough is generally in-appropriate to the semi-arid areas of Tanzania, but less so to the more humid, cool highland areas. The plough may be necessary for cutting up fallow grassland, but if villagization and annual cropping is to stay, and since increasing population densities assert themselves in more permanent land-use systems, the need for this operation will increasingly be reduced.
The plough can be useful for the digging in of weeds in humid areas to act as a green manure, but the UFI plough - in combination with low, uneven draught of poorly trained weak oxen, lack of proper hitch adjustment for furrow depth and width, and perhaps poor steering control and plough stability - is mostly blamed for poor weed inversion which actually may accelerate weed growth. Especially when planting finger millet and sorghum, it is common to crush clods and prepare the seedbed with a hoe after ploughing. Fields normally have to be ploughed at least twice, sometimes three times but two operations would probably be necessary with most other types of ox-equipment.45

Finally it is important to stress that in Tanzania the plough is also used for inter-row weeding - tilted so as to scrape the surface and under-cut weeds - where oxen are well-trained; and it is much more widely used for making 2-3 foot ridges. Although a single-purpose implement, inventive peasants use the plough as a multi-purpose implement. The point has to be made that there is a well-established tradition and level of skill and experience in using ox-ploughs, and this is not changed overnight, even if agronomically and technically more appropriate implements become available.

Should the production of single-furrow mouldboard ploughs not be allowed to start up again? Yes, it has to, since there is no other alternative for the next years to come, and there is a crying demand for ploughs (see below). First of all there should be serious efforts to improve its durability and technical properties, although there may be conflicting demands. Since light weight and low draught power requirements are everywhere reported to be critical - especially so in Tanzania - there is no reason to produce a 40 kilos plough in Mbeya, when UFI's light plough only weighs 31 kilos (Commonwealth Secretariat 1981:16). Vertical height of the handles of the UFI plough appears to be too low, making the average sized operator walk in forward-bent position. And certainly, the front steering wheel which is expensive, breakable and clogs, should be replaced by a cheaper, more efficient and durable skid attachment.
As regards durability, control and stability, a lot could be gained by studying and perhaps copying the old exceptionally robust Ransome 'Victory' plough (38 kilos), some of which have been in use in Tanzania and elsewhere for 30 to 40 years (personal communication with Torben Rasmussen; Starkey 1981 Chapt. 5:2).

Now, the most needed implement - in addition to the ox-cart - required for relieving the critical labour bottleneck of weeding is an inter-row weeder or cultivator. To produce two single-purpose implements, i.e. a plough and a cultivator, does not make sense if the costs of both are prohibitive to the average peasant. It would make much more sense to start planning production of a tool bar, like the proven light-make 'Houe Sine' (36 kilos) from the SISCOMA factory in Dakar to which can be attached a single plough share, a ridger share, chisels, tines, a groundnut lifter and even an Eco Seeder. The first priority for several years would be to go for a small single plough and three chisels - not five because of higher draught power requirements. Skids, not wheels should be attached. External clamps - not bolts, nuts or eye bolts with tommy bars - should be chosen for the attachments because of strongness, ease of adjustment and repair and not requiring a spanner which notoriously gets lost (see Starkey 1981:Chapt. 5).

The 'Houe Sine' is a rather simple, robust, multi-purpose, tool bar system which has proven its worth under peasant farming conditions more than any other tool bar (Moody 1980; Starkey 1981; Mettrick 1978; FAO/DANIDA 1975). It should be easier to produce in Tanzania than the disc harrow, including the TAMTU weeders, seeders and double furrow ploughs. The question is now how long time it would take to locally test and develop imported Sines to actual production start? Probably a very long time, since factory assembly lines might have to be reinstalled. The question is also how the Indian donors and experts would react to such a change of plans.
As mentioned above, it might be more efficient and appropriate, in the short run to import a limited number of 'Sines' from Senegal or Kenya (see Chapter 8.10) and let them be tested by interested peasants under peasant farming conditions. This would involve trials sited on farmers' fields as an integral part of their plots, not on a separate plot rented from the farmers or just used for trial purposes. In this way the trials would be subject to the same technical challenges and managerial constraints imposed upon the peasant in terms of timeliness of operations, cropping patterns, weed growth, etc. The peasant should just receive advice when required and be helped to record results. TANVU, the ox-training centres, Uyole, Ukiriguru, Morogoro etc. could assist in such work.

Would it be difficult to import such kits from a distant French-speaking country like Senegal? Though it is no doubt considered more convenient to import equipment from England - some of which has been tested at Morogoro - there has in other places been criticism of its appropriateness as well as of supply problems from U.K. manufacturers. Promotion of unsuitable implements and cuts in supply may cause major setbacks for the progress of an oxenization programme (Mettrick 1978:3; personal communication with David Gibbon).

A third alternative, combined with the testing of 'Sines', would be to modify the UPI plough frame in such a way that the plough share becomes detachable and chisels/tines can be attached with a clamping system. It should be designed in such a way that ploughs from the rural areas can be modified at a welding workshop (mobile?) with access to the appropriate spares. Tests should be made for making tines/chisels out of old car or lorry springs (see Macpherson 1975:165).

There is a lot of fancy, sophisticated ox-equipment for sale and copying, both in Africa, Europe and not least India, some of which is used by the few, more wealthy enterprising peasants. Rural Tanzania is at a very low shelf of technology and service infrastructure, and neither the peasants nor the national economy can afford expensive, sophisticated, heavy
and non-durable equipment. There is a necessity to cut imports and to start from what is already there, even if a few agricultural engineers, officials, managers, skilled craftsmen, foreign experts and donors fancy the more sophisticated equipment.

The scale of appropriateness and likelihood of success in terms of adoption rate among peasants in Tanzania involves proper combination of three critical factors which should constantly be kept in mind:

1. **Cheapness which means simpleness and durability**

2. **Agronomic and farm management suitability** and

3. **Lightness and low draught power requirements.**

Point 1 would seem rather obvious but has far from been taken sufficiently into account at the practical design and engineering level. Rather few Tanzanian peasants can afford expensive equipment, not least in these years of economic crisis. Point 2 refers to the urgent need for interrow cultivation in such a way that the gradual introduction of chisels and tines can be added and attached to the basics of a toolframed mouldboard plough. We should expect very few peasants to buy the full equipment system in one go.

Point 3 refers to the need for ease of operating the implement for the peasant and to the very basic fact that most Tanzanian cattle are small-sized and weak, and this cannot be changed, at least in the next 20 or 30 years to come. Moreover, the cost of the usual team of four oxen to a non-cattle owning household is some 6-10 times the price of a plough. This, together with the common situation that, roughly, only some 50 per cent of rural households own cattle, let alone oxen in the major ploughing regions, is the most serious socio-economic constraint on the further development of an spread of animal traction. If draught power requirements for most operations on an average could be reduced to two oxen it would mean a tremendous step forward.
7.4 THE SHORTAGE OF AND DEMAND FOR OX-PLoughS, AND THE 
QUESTION OF CREDIT: THE CHOICE OF PRACTICAL AND 
POLITICAL PRIORITIES

Meanwhile, there is an urgent need for increased production 
and distributed supply of ploughs, spares and chains at reason-
able prices. During the 1970s the average annual production 
of between 3-4,000 ploughs from UFI has certainly been far 
below demand and can be compared with the sale of 9,000 ploughs 

"Our own field visits and supporting evidence suggested that the 
current shortage of ox-ploughs (and chains) is both an important 
constraint on the increase in agricultural production and one which 
could be broken easily. An indication of the urgency of the 
problem is that we were informed that, in the past year, there 
had from one division of Iringa District been 5,000 requests for 
ploughs from people ready to pay cash (500/-). The experience of 
the European Community's (EEC's) RIDEP team in Iringa supports 
this. The ox-ploughs they had assembled locally in their work-
shops had sold out very quickly, and a large unsatisfied demand 
was reported" (IDS/Sussex 1981:89).

In Njombe 'no ploughs were available for three years. When 
fifty ploughs arrived at TFA they were snapped up' (personal 
communication with Torben Rasmussen, June 1980).

The EEC/RIDEP project in Iringa had by April 1981 supplied 
peasants with 300 ploughs, while TFA had sold 150 and RTC 
600 ploughs into the region between 1978 and 1980. In March/ 
April there was, for the first time, an important stock of 
ploughs available for sale in the region: 1,100 (RIDEP), 
450 (TFA) and 500 (RTC). The region's estimated demand was 
20,000 ploughs.

In Hanang District, Arusha Region:

"Three villages, Katesh, Wareta and Ndareda ordered 50 ploughs 
from TRDB by advancing one quarter of the cost to TRDB, Arusha in 
September 1979. TRDB ordered from UFI but they had none. The same 
year, one businessman came with a lorry full of ploughs and sold 
them in the Galappo area at 1,000/-. People came as far as from 
Bashanet and Kondo in Dodoma Region. Those who went to buy ploughs 
in Singida and Arusha paid 900/- in private shops" (personal 
communication with informed peasant) 48.
In Kowak village, Tarime District in Mara (May 1980) there were about 180 ploughs. 'Only about 90 are operating due to lack of spares like handles, shares, wheels, nuts, bolts, everything. Nobody uses hoes, except for ridging cassava. Three farmers have ox-carts and two have ridgers' (personal communication with village chairman). In the 1960s he had himself imported a robust German tool bar system (plough, ridgers, chisels and tines plus a light cart and a zigzag spike-tooth harrow) which he still uses with a modification made for attaching UFI's plough share. Its frame is rather similar to that of the UFI plough, but more raised to give clearance for interrow weeding with attachable duck feet (cf. my third production alternative above). In Komuge and Kirongwe villages we heard similar complaints about large numbers of idle ploughs. Peasants complained about the problem of getting spares which involved 'a long bus safari to Musoma, only to find no spares available'.

"The major problem facing the peasants now in most of our villages is the sudden rise in the price on farm implements, especially ploughs. A normal plough in our RTC branches now costs 2,000/-. This applies to Mwanza and Shinyanga Regions where ploughs are in high demand" (letter to the editor, Sunday News 22/11/81).

Questions have also been raised in Parliament on the lack of ploughs and spares from UFI (Daily News 27/7/80). There is no reason to trot out further evidence since the problems of production, distribution and supply apply not only to ox-ploughs but to most other essential commodities of production and consumption required by the peasant sector. One important reason for producing the evidence is, however, to blast the assumption, widespread in the literature as well as among a few officials in Tanzania, that there is a problem with 'adoption' (the academic notion) and with 'traditionalism and resistance' towards ox-cultivation (the politico-ideological notion) expressed in imperatives like 'Use ox-ploughs', 'You can't do much with the hoe', etc.
Where will the peasants get the ploughs in the first place? Such messages are not swallowed without restraint by those who have tried to get ploughs in vain. Further, it seems a waste of efforts to promote oxenization in regions and places where the peasants have no experience of it, or are plainly uninterested, when demand is high and unmet elsewhere.

In the early 1960s an ox-plough (imported) cost (retail) around T.Sh110/- (Ruthenberg 1964:183). In 1970 it cost around 120/- (Raikes 1971b). By 1975, the list price ex-UPI was 280/-; In 1978, the UPI retail price was 404/- and by April 1980, the price was 450/- at RTC in Arusha. By April 1981, ox-training centres (OTC's) under the Iringa EEC project sold ploughs at 634/-. This price might be somewhat higher than the official RTC/TFA price, due to extra transport costs. The evidence provided further above also indicates that there is a growing 'black' market for ox-ploughs.

How private shops and businessmen get hold of the ploughs I don't know, but they might simply buy them at RTC's or TFA. The only way to overcome black marketing and high prices is to increase supply; restrictions will not help, but will just aggravate the problem. Even if some peasants are prepared to pay double the official price it should not be taken to mean that official prices should be raised even further. Only the few wealthy can pay such prices.

This takes us to the problem of credit, which, for purchasing ox-ploughs has become available through the USAID/TRDB financed National Agricultural Food Credit Programme (NAFCREP), which took over from the former World Bank financed National Maize Programme (NMP). Generally it is only villages under NAFCREP and the EEC project in Iringa which can in principle get credit for ox-ploughs, but not for purchasing draught oxen, for which there is no credit. For the 1981/82 season, TRDB approved a lending budget of T.Sh1 1 million, corresponding to some 1,700 ploughs. If UFI's and Mbeya's production capacity in the coming years is utilized at say 40
per cent, giving a supply of some 8-9,000 ploughs, this amount of credit might be too low. But in the event the available ploughs would surely be bought even without credit.

Quite apart from this, it could be argued that it would be difficult to recover loans on ploughs by comparison with seasonal loans to production of especially export crops which have no unofficial market outlet. Yes, but loans for ploughs involves security in a fairly durable item which at least in principle can be taken back from the formal owner upon loan defaults.

There have been understandable problems with TRDB's credit for ox-implements. The work of the bank is to appraise village loan applications, to sort out of the qualified villages, to give out the loans and procure the items and to deliver those items to the villages, then go to the villages and manage the credit - surely not an easy task. The village is considered credit worthy if it has competent leadership, has fully repaid previous commitments, if the project to be undertaken has prospects of generating sufficient revenues to pay back the loan plus interest and still leave the household with a favourable balance.

As regards the three Hanang villages, mentioned above, which applied for TRDB loans, I do not know whether their applications were actually approved, but it seems to be the case if they had forwarded a quarter of the cost of the 50 ploughs. Whether this is a standard or special case procedure I do not know. However, one of the villages - and most likely the two others as well, judging from the accounts of a sample of different villages - had outstanding debts to NMP amounting to T.Shs. 14,624/- for the 1975/76 season and 29,122/- for 1976/77. For all 33 villages under NMP in Hanang, total credit and outstanding debt (for the composite and hybrid seeds of maize, fertilizer and insecticide package) respectively amounted to 856,417/- and 427,332/- for 1975/76, and 1,376,487/- and 961,916/- for 1976/77. Between 1976, when the NMP started, and March 1978, total debts had accumulated to 1,611,017 shillings.
The problems of the NMP were stated to be:

"There is no repayment of credit. Peasants refuse to use fertilizer and there is no application whatsoever ....... application of fertilizer only increases the cost of production without any returns"49.

This is not the place to discuss the fertilizer issue. Suffice it to say that for most areas in Manang, the soils are rather fertile, thus not warranting the costly use of fertilizer. The main limiting constraint is low and unreliable rainfall. Especially in dry years, the use of fertilizer actually reduces yields and even in good years like 1977 and 1978 the use of fertilizer involved negative risks. This is also one of the reasons why the Basotu state farms have stopped using fertilizer - vigorous weed growth, supply and cost problems being the others - and why the settlers in the area have never used it for food crops.

However, Bashanet Division in the Mbulu Highlands - which has poor, leached soils and higher, more reliable rainfall - is not included in the NMP, although the very low maize yields here probably could benefit considerably from proper use of fertilizer as they have done under similar conditions in Iringa, Njombe and Mufindi districts50. This does seem to be yet another case of wrong resource allocation since many of the Bashanet villages are not appreciably more difficult to reach by lorries than many of the NMP villages.

But taken in the national context, it would be more economical to concentrate the supply of fertilizer - not seeds and other inputs - on those extended areas which have poor soils (e.g. Tabora and Iringa Regions) and high-value crops involving necessary and profitable use of fertilizer (tobacco, coffee, tea). In any case, the experience from Tanzania and elsewhere clearly shows that the timely supply of a seasonal input like heavy-bulk fertilizer is contingent upon a rather well-developed and functioning service infrastructure. Given the waste of funds of the fertilizer programme in some areas, and given the economic crisis and the problem of supply, it might be necessary to exclude certain areas like for example
Hanang District (including Bashanet) and the isolated Tarime District (also under NAFCREP) - even at the expense of the successful minority users - and then instead concentrate efforts to improve the conditions for using manure - not exhortation - since both areas have a high livestock population.\(^{51}\)

This was a detour. Given the TRDB criteria for loan approvals, it is difficult for many villages to qualify. In Iringa, of the first 35 villages having applied for a loan to purchase ox-implements, only two applications were approved and 9 others were still being studied (April 1981).

It is absolutely necessary that a bank like TRDB applies strict criteria for loan approvals so as to limit the wastage of resources which have been a result of the World Bank financed NMP. Further, loan defaults are not to be considered a 'gift' to the peasants. The peasant sector as a whole has to pay them back in terms of heavy produce taxes (low producer prices and high input prices), though loan defaults may give programme participants an advantage over non-participants.

The problem of credit worthiness cannot be overlooked. But should it apply to the village as a whole or to the individual applicant? And should a village be excluded from credit for ox-ploughs because it has incurred heavy debts from a rather ill-conceived fertilizer programme, imposed upon it from above without choice? In many villages, given the experience of being burdened with unwanted credit and other state-imposed unviable programmes - at times involving compulsory labour service without returns to the individuals involved and with imposition of fines or in a few cases even jail sentences for defaults - has the practice of defaulting on loans and top-to-bottom orders become an ingrained peasant response of retribution towards the state? My experience indicates that this is a fairly common response which most individuals normally get away with.
The credit issue could be taken much further, which is however hardly warranted for the time being, since there are several times more peasants who are ready to pay cash than there are ploughs for sale. Those who can pay will generally be those with access to oxen and they will be a minority of more wealthy peasants. Short of credit, the remaining poorer households will not have access, apart from hiring plough teams from owners. The question of priority again comes in. In a national economic context it is cheaper to forget about credit for ploughs for the time being, if the credit administrators and the funds can be utilized more productively on other programmes (?). The first priority would seem to be to get the ploughs out, rather than delaying them with credit procedures.

A poor individual peasant household which would need credit for a plough, and probably even more important for oxen, might face real difficulties in repaying the loan over a four year period. As analysed above, there is no guarantee that net income of the household will rise substantially with the addition of a plough, even if the acreage is doubled. Other inputs, including interrow weeder to relieve the critical weeding bottleneck would be required, and it will take time to introduce the whole integrated complex of changes associated with using an interrow weeder (equal row spacing, new yokes or harnesses, better training of oxen, and perhaps even changes in the pattern of intercropping and male acceptance of weeding). Meanwhile the same peasants could gain experience by watching or working with hired ox-teams if they do not already have this experience.

If for political reasons priority is given to the poorer peasants, then the remaining alternative is to give them ploughs free of charge and consider this a national capital investment. Government projects - and not least foreign donors who provide aid in the name of socio-economic equity - have provided parastatals, regional, district, and other government authorities with a whole range of material and financial means in the form of landrovers, lorries, buildings, training courses, and funds - which are sometimes
mismanaged, if not in a few cases outrightly fiddled with to produce additional fringe benefits. Seen in this context, foreign donors have supported the proliferation of a heavy state bureaucracy. By contrast, the peasants are supplied on a credit basis, producing additional delays and costs.

If a poor peasant who can borrow oxen gets his first plough free, he might be enabled to replace spares and eventually buy a new plough. How to select eligible households is another difficult question which we shall leave for the time being. Suffice it to say, that in many villages those in power through the village governments are the more wealthy, some of whom would not refrain from being named eligible for free ploughs. The purpose can be easily defeated.

Credit is likely to become an important issue when or if the more expensive tool bars become available. For the time being, it would also seem to make more sense to provide credit for the other most needed ox-implement in Tanzania, the ox-cart, the TAMTU prototype of which costs between 2 and 3,000 Shs. in 1980, depending on workshop and location. The cost is prohibitive to most households and this is the single most important reason why the ox-cart is not common, despite a lot of interest in it. There is, however, considerable scope for making this prototype cheaper, down to about half of the cost quoted above.
CHAPTER EIGHT

8. THE PROBLEMS OF RESEARCH, DESIGN AND PRODUCTION OF APPROPRIATE, COMPREHENSIVE OX-EQUIPMENT

8.1 INTRODUCTION

Especially over the last twenty years, there have been attempts to develop comprehensive animal traction through designing, testing and producing a fairly comprehensive range of equipment. These efforts have by and large been centered in the Tanzania Agricultural Machinery and Testing Unit (TAMTU) and its associated Rural Craft Workshops (RCW's).

This chapter analyses in detail the state of affairs of animal-drawn equipment other than UFI ploughs in Tanzania, in terms of research, development and extension of such equipment and in terms of its production, availability, appropriateness and demand. The first section (8.2) deals with the organizational problems of TAMTU and its rural craft workshops and puts forward some guidelines for integrated adaptive research and production of appropriate equipment.

The following sections provide a description and critical technical, agronomic and economic evaluation of TAMTU-made implements and a few other pieces of equipment, designed or tested in Tanzania. For virtually all these implements one thing is clear. They are agronomically and technically inappropriate and some of them in fact unusable under peasant farming conditions. The implements are of an unsuitable and too sophisticated design, and above all, they are too expensive.

Based on this critical evaluation and a discussion of common cultivation practices, recommendations are put forward for experimentation, design and production of more appropriate implements which above all must be cheap, simple, versatile, light and which as far as possible can be made locally, which means in the villages rather than in the towns. Priority of design and production should only be given to a limited range of implements for which a technical need and an assured de-
mand can be established and which can help relieve the most critical labour bottlenecks.

The recommendations have not been made in the usual way of development thinking, i.e. with a view to some conceived potential or optimum which it is believed will be realized. Rather the recommendations have been put forward against the background of past mistakes and unrealized potentials. An attempt has been made to establish selective priorities and above all to drop designs which may turn out to be yet another costly adventure. In the light of the present deep economic crisis in Tanzania, the arts of the possible are limited.

8.2 THE PROBLEMS OF TAMTU AND RURAL WORKSHOPS: SOME GUIDELINES FOR INTEGRATED ADAPTIVE RESEARCH AND PRODUCTION

The Tanzanian Agricultural and Machinery Testing Unit (TAMTU) was started up as a farm implements experimental station at Mwanza in 1955 and was moved to Tengeru at Arusha in 1957. In 1967 it suffered from relocation to some poor premises and in 1980 plans were going ahead for amalgamating TAMTU with AATP (Arusha Appropriate Technology Project, financed by Sweden, with a somewhat independent status under SIDO - Small Industrial Development Organization), expected to be relocated in new premises with new machinery at Tengeru in 1981. How far these plans have been realized I do not know at the time of writing. Some years ago, TAMTU was transferred from Ministry of Agriculture (Kilimo) under the aegis of the Ministry of Industries so as to expand its production role. A TAMTU officer's comment to this was: 'I think we belong to Kilimo, but the move to industries was a right one, because they are more interested and provide more assistance'.

TAMTU's main work has consisted of designing, testing and improving both hand tools and a wider range of animal drawn implements, some of them imported or supplied on promotion from manufacturers abroad. TAMTU has also been involved in testing tractors and associated implements.

According to the officer in charge (interviewed April 1980), ox-drawn equipment is tested for up to 10 hours a day for a
full season to enable necessary modifications. Then the equipment is given to a pilot farmer for use and he is visited every week for check-ups. Although testing is mainly done in Arusha it has also been tried in Kilosa and Mwanza.

The prototype equipment developed by TAMTU will be discussed in detail below. For the time being some general recommendations can be made with respect to TAMTU testing:

Tractor testing should be stopped since this is adequately done in many research and testing institutes throughout the world. 'Far more important criteria for the importation of tractors are their reliability and the dealer efficiency in the provision of spares and repairs. The market is too small for more than 2 or 3 makes'. (Beenev 1975 : 11). If production of the VALMET tractor from TRAMA starts it should also be tested abroad, and should not be allowed to occupy limited testing capacity of TAMTU.

TAMTU should start up again by testing the implements on cropped land, with a variety of pure-stand crops and crop mixtures adapted as far as possible to common patterns of peasant cropping. For example, both pure-stand maize at 2 - 3 foot row-intervals (both straight and contour-bent) and maize intercropped with beans should be grown for testing of inter-row weeders. Crops and cropping patterns cannot easily - for a whole complex of good reasons - be changed to suit an implement, whereas it is possible to design implements to suit crops as far as possible. Consequently, it might be necessary for TAMTU to possess its own land and to employ interested and dedicated agronomists or perhaps even better, Field Agricultural Assistants, with good practical experience - for conducting randomized and replicated trials on minimum cultivation techniques and moisture conservation measures. These topics assume considerable importance in the semi-arid farming conditions of most of Tanzania's main ploughing regions.

The budget for test implements should be large enough to allow for the careful selection of several interested pilot farmers in different zones to undertake further testing. Selection could in addition be undertaken on a year-by-year rotational basis, so
as to spread testing out to pilot farmers who are not just the
most able plough farmers. It is pertinent to utilize the in-
valuable know-how of the most experienced and experimental-ori-
ented farmers, but pilot testing remains useless if it is not
gradually extended to the 'average' peasants (i.e. those who
would fall within the 70 percent range of a normal distribution
curve).

Pilot farmers to be selected should as far as possible be in-
volved in the trial work on TAMTU's own plots. Group discus-
sions should be held in the fields, not in an office, concen-
trating on their perceptions of the problems and working to-
wards some consensus as regards solutions. They should be
listened to, and their advice should be discussed and taken
seriously. These discussions should be actively attended by
design and development engineers, the field officers, work-
shop foremen and managers, and the pilot farmers should be
allowed to influence TAMTU's trial work and design. The idea
must be not to get the perfect technical or agronomic solu-
tion in isolation since these do not exist under peasant farm
conditions. A pervasive issue is cost consideration, risk
and adaptation to the whole weighted complex of socio-cultur-
al and farm management factors which guide peasant decisions.
TAMTU's managerial decisions must not disregard this.

In technical and economic terms, the priority is to build up a
demand among peasants for appropriate, useful equipment which
they can actually use profitably, without too high risk, by
increasing the productivity of land, labour and oxen and by
reducing the drudgery of work. This demand cannot be imposed
upon the peasants, and they cannot be further 'educated' on
adopting innovations, unless they get real returns.

There is a vast potential of knowledge and experience - from
generations of agricultural existence under difficult environ-
mental and economic conditions - to be drawn upon from the
peasants. If the priority is the development of peasant agri-
culture, their fund of knowledge has to be utilized for fur-
ther development. If not, the peasants will continue utilizing it in the same narrow, risk avoiding, passive and defen-
sive way which appears to be such an undynamic phenomenon of
the peasant sector.
Such adaptive trial and research programmes as the one indicated above could be undertaken by Uyole Agricultural Centre, Ukitiguru Research Centre, the Faculty of Agriculture, etc., and in a more limited scope by Farmers' and Ox-Training Centres (PTC's and OTC's). At least as regards testing of equipment the OTC's and the village based Ox-Training Units (OTU's) in Iringa have already gained some useful experience - one of which is that the provided equipment was too heavy (personal communication with Per Bo).

To come back to TAMTU, instead of spending funds and capacity on testing all sorts of equipment, whether randomly imported or supplied free by foreign manufacturers, it could be cost and timesaving to test precisely those makes which have gained the most widespread acceptance among peasants in Africa. I have already suggested the 'Houe Sine' from SISCOMA in Dakar with recommendations on some technical specifications. Along these lines, another extremely urgent task is to modify and develop the UFI and Mbeya ploughs in such a way that attachable extension bars with adjustable weeding tines can be fitted, so that already used ploughs from the rural areas can be easily and cheaply modified at district workshops (COMWORKS and/or private) and possibly at OTC's relying on rotating mobile welding workshops. (For other details, see Section 7.3). The idea of modifying existing single-furrow ploughs to enable proper inter-row weeding is not new in Africa. 52)

TAMTU, in addition to its testing operations, has a small implement manufacturing line, far too small to have had any impact on satisfying the domestic demand for implements according to the officer in charge. The main problem for TAMTU has been a low budget, in 1979 amounting to only some 700,000 shillings. Funds from the sale of implements could not be used to purchase raw material but went back to the government.

In addition, TAMTU has suffered from lack of man power, both high and medium level. Thus, in a couple of years, TAMTU has lost about 20 skilled craftsmen - who had passed their tests after training in TAMTU - to the vigorous private industrial sector in Arusha which can pay salaries above government levels. If the government is to compete with the private small
industrial sector on salaries and skilled man power, then it should also compete favourably on productivity. Otherwise, it is more cost saving and productive for the national economy to leave batch production of well-tested and peasant-proven implements to private manufacturers - as TAMTU can and also has done in some instances - with proper government control of sales prices in relation to costs.

The production and sales price of TAMTU animal-drawn equipment is shown in Tables 4 and 5 below:

Table 4
PRODUCTION OF ANIMAL-DRAWN EQUIPMENT FROM TAMTU IN ARUSHA FOR THE 1975/76 AND THE 1977/78 SEASON

<table>
<thead>
<tr>
<th>Item</th>
<th>1975/76</th>
<th>1977/78</th>
<th>Ex TAMTU price, 1975, T.shs. 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ox-carts</td>
<td>57</td>
<td>80</td>
<td>937/-</td>
</tr>
<tr>
<td>Axles for ox-carts</td>
<td>23</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Bush bearings for ox-carts</td>
<td>n.d.</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>Wagons, 4-wheel (all sold to Shinyanga)</td>
<td>4</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>2-furrow ploughs</td>
<td>14</td>
<td>7</td>
<td>720/-</td>
</tr>
<tr>
<td>Seeder attachment for 2-furrow plough</td>
<td>8</td>
<td>10</td>
<td>264/-</td>
</tr>
<tr>
<td>Harrows, spike-tooth</td>
<td>19</td>
<td>n.d.</td>
<td>336/-</td>
</tr>
<tr>
<td>Seeders, single-row with fertilizer box</td>
<td>5</td>
<td>16</td>
<td>462/-</td>
</tr>
<tr>
<td>Cultivators, inter-row</td>
<td>2</td>
<td>12</td>
<td>336/-</td>
</tr>
<tr>
<td>Ridgers</td>
<td>n.d.</td>
<td>2</td>
<td>336/-</td>
</tr>
<tr>
<td>Log-pullers, 2-wheel</td>
<td>5</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Hand seed-mixers to grade seeds for seeders</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

1) Source: Officer in charge, TAMTU, 1980  
   n.d. = no data given

2) Source: Beeney (1975 : 48)

The two most important animal-drawn items produced by TAMTU (and its Rural Craft Workshops) are ox-carts and the rectangular spike-tooth harrow. The officer estimated the demand for ox-carts at around 1,000 in the Arusha area alone. The last field demonstration to promote TAMTU equipment in villages was
done in 1973, since in-flowing orders surpassed what could be produced.

The production and price figures from Table 4 can be compared with those in Table 5, some of which possibly include production by TAMTU's Rural Craft Workshops (RCW's) of which there were 7 in 1980.

**Table 5**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ox-carts</td>
<td>100</td>
<td>250</td>
<td>320</td>
<td>360</td>
<td>550</td>
<td>1,000</td>
<td>67</td>
<td>89</td>
<td>1,200/-</td>
<td>2,645/-</td>
</tr>
<tr>
<td>2-furrow ploughs</td>
<td>25</td>
<td>34</td>
<td>40</td>
<td>55</td>
<td>60</td>
<td>80</td>
<td>7</td>
<td>3</td>
<td>1,000/-</td>
<td>1,150/-</td>
</tr>
<tr>
<td>Harrows</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>250/-</td>
<td>650/-</td>
</tr>
<tr>
<td>Seeders, 1-row</td>
<td>15</td>
<td>21</td>
<td>25</td>
<td>31</td>
<td>36</td>
<td>40</td>
<td>16</td>
<td>6</td>
<td>450/-</td>
<td>860/-</td>
</tr>
<tr>
<td>Cultivators</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>25</td>
<td>40</td>
<td>12</td>
<td>8</td>
<td>380/-</td>
<td>not in stock</td>
</tr>
<tr>
<td>Ridders</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>20</td>
<td>2</td>
<td>-</td>
<td>350/-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Source: Commonwealth secretariat 1979c: 114, quotes TAMTU as source.


3) Price does not include seeder attachment which was not in stock. In two years, 3 ploughs were sold.

In Table 5, apart from harrows and seeders, most of the production figures up till 1976 are conspicuously round, and especially for 1975 and 1976, too high if production output from RCW's is not included. According to Beenen's evaluation (1975: 12) their performance has been poor and they are not equipped to produce sophisticated items like 2-furrow ploughs, seeders, cultivators and ridders. They mainly produce ox-carts and harrows, and some of them furniture for which there is a higher demand (e.g. Songea and MICO in Musoma). The 1977 figures of the two tables do tally, and the 1975/76 figures of Table 4 are the more likely correct ones. The same applies to the 1975 prices in Table 4 by comparison with the round prices of 1977 in Table 5,
some of which are too low. MICO's prices for 1980 are correct but probably somewhat higher than for other RCW's due to Mara's isolation, lack of raw material and high transport costs.

The setting up of RCW's started in 1964 with German assistance with the intention to produce items of high demand regionally, so as to cut transport costs. Apart from MICO, started in late 1978 in Musoma, the 6 others are located in Mwanza (Malia), Kahama (Wigehe), Ngega, Mbeya (town), Songea and Dodoma (Rikwe). Marketing and promotion of TAMTU's prototypes are done by the RCW's, and TAMTU is responsible for transport to RCW's. The main aim was to concentrate on ox-carts and to undertake repair of other equipment, including UPI ploughs, with the aim of extending production to a fuller range of equipment when demand was met, but this never happened (officer in charge).

In addition to the RCW's there are a number of SIDO and mission run workshops around the country producing mainly ox-carts. I do not at the moment have any information on the SIDO workshops, but it is my impression that especially the Catholic missions are doing a very good job in spite of problems with the supply of raw materials and TAMTU components like wheels, axles and bush-bearings. Thus, at Galapo in Hanang District, the mission-run carpentry workshop had already, 8 months after its start, built and sold at least 10 ox-carts, mainly large-sized with a capacity load of 900 kilo, at a price of 2,000/- by April 1980. One pair of iron wheels, from a SIDO engineering workshop in Arusha, cost 1,000/-.

Beeney provides the following evaluation and recommendations on TAMTU's Rural Craft Workshops:

"The Rural Craft Workshops programme, although basically sound, has suffered from lack of financial support and positive direction. A number of the presently established rural craft workshops are being resited. Also many of their premises are inadequate (approx. 10m x 10m) and their machine tools too small for the batch production of ox-carts that they are required to produce. The supply of raw materials and operation of suitable revolving funds is also causing difficulties. It is debatable whether small dispersed production units of this type can ever be economic propositions, unless run as small businesses by owner operators, e.g. under S.I.D.O." (Beeney 1975: 12).

"The present system of Rural Craft Workshops operated by T.A.M.T.U., should be discontinued and the various workshops
handed over to local authorities to operate. The reason for this is not that the idea of Rural Craft Workshops is unsound - far from it - but that the management of so many widely scattered units across the country is made difficult by insoluble logistics, problems in the supply of materials, supervision of production and distribution of the finished implements manufactured.

Rural Craft Workshops operating under the wing of S.I.D.O., and under local cooperative or individual management (as small businesses) would be far better placed to deal with daily problems as they would arise, and better able to reduce the malpractices that occur in connection with "government materials". " (ibid : 24).

Whether the workshops should be handed over to local authorities and be run by them is debatable since there is little experience to indicate that they are in a position to operate them more efficiently. But private businesses, perhaps with support from SIDO, and especially missions are forced, by circumstances of cost and competition, to operate more efficiently. Also, missions on the whole maintain vital links of close communication and good relations with at least the Christian section of the peasantry and are thus in a position to understand their problems and continuously discuss them, given their location right in the rural areas.

The small private businesses, mainly located in district towns and some smaller trading settlements, would probably not take the risk to start producing ox-carts, harrows etc. until they are assumed of a demand, and until production can compete with furniture making. The best assurance of this demand is to develop cheaper prototypes, based mainly on local - not regional - supply of raw materials at low transport cost.

As regards TAMTU in Arusha, it is highly commendable that they have not undertaken production based on imports. Thus, TAMTU tried to produce disc harrows but stopped because the discs had to be imported. The ex-TAMTU list price of a disc harrow was 1,176/- in 1975 (Beeney 1975 : 48).

Beeney provides the following recommendations on TAMTU in Arusha:

"One of the priority projects should be to build up a demand amongst farmers for a broad range of ox equipment. This would most easily be accomplished by effectively run O.T.C.'s supported by implements and observation teams from T.A.N.T.U. These
teams must be mobile and active in the field.

The strengthening of T.A.M.T.U. is best achieved by associating it with one or more of the proposed agro-mechanization centres. It should not be left to struggle along on its own at the moment.

It is important that both animal-drawn and power mechanization development proceed hand in hand as they can often be complementary in raising crop yields and acreage cropped. This can most easily be achieved if both sets of development and testing were carried out at the same geographical locations.

A staff having a wide range of professional disciplines would be needed including agronomy and applied soil physics as well as mechanical and agricultural engineers and economists.

Such a staff could have a greater impact on agricultural techniques if they were sited near a teaching institute specialising in agro-mechanization. There could then be the usual two-way exchange of knowledge and awareness of agricultural development." (ibid : 11).

Beeney's recommendation on the hand-in-hand development of animal-drawn and tractor mechanization is in no way based on an analysis of whether this has actually taken place in Tanzania. It has been shown in detail above (Chapt. 6) how both the expansion of tractor cultivation and not least the policies of tractor mechanization have hindered the development of animal traction, and it remains to be seen whether this will be changed in the future. The establishment of agro-mechanization centres - which are as a matter of fact tractor centres - is not to be recommended.

Beeney's first priority is important, but will take time. In this respect, TAMTU can draw on the invaluable experience and solid approach of the Arusha Appropriate Technology Project (AATP) which to my knowledge has been one of the most successful appropriate technology projects in Tanzania. The criticism that its impact has been small cannot be accepted, since it does take time to identify the perceived needs of villages - the inhabitants of which have diverting interests - to develop cheap technology based on local resources and skills, and to get production of this technology started by cooperative groups of village craftsmen. When amalgamated with TAMTU, AATP should not be allowed to be squeezed by managerial considerations but should maintain its independence of operations and be able to influence TAMTU's work. AATP's Co-ordination Resource Centre (information documentation and exchange), Communication Sec-
tion, Technical Section and Extension Section all have a vital role to play.

As regards Beeney's proposed staff development it is important not to create another big, self-contained research and development institution which carries on with academic-oriented experiments in isolation from, and inappropriate to, the peasant sector and employing natural science oriented experts, some of whom believe they already know the problems of peasant agriculture and rural livelihood better than the peasants themselves. Thus, it is proposed that a social anthropologist (or a rural sociologist with anthropological orientation) with a comprehensive experience in the political, social and agro-economic problems of peasants be employed to work closely with the agromist, engineers and one agricultural economist. The communications, technical and extension section of AATP have in fact used an anthropological approach to technical solutions, which together with their solid technical expertise, preoccupation with cost considerations and institutional independence - has been one of the measures of their success.

8.3 THE TAMTU OX-CART

Together with inter-row weeding equipment, the ox-cart is the most needed animal-drawn implement in Tanzania today. Widespread use of carts (ox or donkey-drawn) is not only necessary to relieve already overburdened rural women of the extremely time and energy consuming tasks of crop farm input, water and firewood head transport, which in most areas consume a considerable amount of available household labour time.

The need for the rapid spread of carting has furthermore become an extremely pressing issue after villagization in consequence of which distances between homesteads and fields, firewood lots, and in some cases even water, have been considerably increased to the effect of reducing available productive labour time even further. To this distressing picture can be added a drastic decline over the last 5 - 8 years in the number of tractors, trailers and lorries in operating condition available for local transport activities, and exorbitant hire rates for using these means in local transport are consequently the rule. The lack of
ox-carts can also be rated as one of the most important reasons for the limited application of farmyard manure on cropped fields.

In 1975, the number of ox-carts in use in Tanzania was estimated to be 989 only (Commonwealth Secretariat 1981 : 112) but this figure is probably too low. The FAO/Kilimo Survey 1976-78 (see Table 3, Section 7.2 above) recorded a total of 1821 carts with 754 of them in Tabora, 324 in Shinyanga, 205 in Aru-Meru District (Arusha) and 168 in Singida. Since Iringa Region and other important animal traction districts were not included in the survey, the number of carts might well be in the range of 3 - 4,000 for Tanzania as a whole. This number is still deplorably low and is to be attributed mainly to unavailability of carts, poor design and much too high cost.

Apart from a small number of carts made from old car axles/wheels by local craftsmen, the only cart produced so far is the TAMTU prototype made by TAMTU in Arusha, its rural craft workshops (RCW's) and SIDO and mission-run workshops. In the following we shall briefly describe the TAMTU cart and suggest technical modifications necessary for cheapening its cost and enabling production by village craftsmen using more local material. Village production is an absolute necessity since carts are heavy, bulky, breakable and costly to transport by lorries. Moreover, they may need frequent repair which must be done in the villages.

TAMTU OX-CART
(metal or rubber wheeled)

Price: (as at 1.7.80) Metal Rim, large : Tshg.2750.00 ($338.00)
Metal Rim, small : Tshg.2650.00 ($326.00)
Rubber Wheels, large : Tshg.2900.00 ($357.00)
Rubber Wheels, small : Tshg.2800.00 ($344.00)

Source: Commonwealth Secretariat 1981 : 85.
The 2-wheeled ox-cart, which with cheap modifications can be pulled by donkeys as well, can be built either with metal (3½-4 inch rims) or rubber wheels (pneumatic tyres), the latter of which only increased the price by some 150 T.shs. in 1980. The axle consists of 2 pieces of 2-inch pipe, fixed at each side underneath the cart box, through which a thinner pipe is fixed, each end of which constitutes the wheel hubs. The bush bearing, fixed to the wheel centre is made of wood and may last up to 3 years with frequent greasing. Arusha Appropriate Technology Project has improved the bearing system on its own ox-cart design by inserting a leather bush, soaked in oil for 10 days between the hub and the wooden bush which reduces friction and increases the lifespan of the wooden bearings, since the cart owners reportedly do not grease frequently enough. In the future, a copule of tins of grease should constitute an obliga
tory accessory with the purchase of ox-carts.

The shaft shown on the picture is of wood but in many cases it is actually made of iron pipe, which may bend with heavy or wrong loading. A strong flexible wooden pole (unplanned) should be sufficient, is cheaper, and can be replaced locally. The iron wheels constitute a problem, both in terms of durability and availability of spokes and rims. The iron wheels tend to get stuck in sandy and soft clay soils. Pneumatic tyres are much better in that respect, but slow movement on a rough surface causes frequent punctures and wear and tear of tubes and tyres which are expensive and unavailable in most villages. In terms of the popularity of pneumatic tyres it should be noted that most of the buyers have no experience with the problems involved in getting patches, tubes, tyres and the frequency of punctures, and prospective buyers should at least be informed about these difficulties, if not discouraged from buying pneumatic tyres unless they live in areas with sufficient service infrastructure.

A better alternative, enabling local production and repair, is to design wooden wheels, lined with cut car tyres, modelled on the AATP ox-cart. Tyres on old car wheels/axles can also be used when filled with sawdust. This requires refilling after some years of use. The design of wooden wheels which can be produced locally, is one of the ways to reduce the cost of
carts. A wooden wheel, designed by MICO, would cost around 150/- shs. to produce while an iron wheel from Uhandisi in Arusha cost 500/- in May 1980. The wooden wheels of the Uyole toolbar appear to have too sophisticated a construction for production by village craftsmen.

The other measure to reduce the cost relates to the way in which the cart box of the TAMTU cart is designed. The cart box is made of scarce, expensive and planed hardwood, the bottom of which is joined (rabbeted) to form a solid inflexible body and tight surface so as to prevent even finger millet seeds from dropping through. The objective of enabling the transport of unbagged grains is alright, but it is defeated by the expensiveness of the design. Furthermore, when questioning the need for planing I was told at Mara Industrial Company (MICO, one of TAMTU's RCW's) - importing its hardwood from Arusha which in turn gets it from Singida - that planing 'eased craftsmanship'. It is a bad idea to have ease of craftsmanship in the form of unnecessary planing increasing the cost of implements. Costs should be reduced in all design details where possible.

Thus, there is no need to make the heavy, too inflexible and solid cart box of hard wood, when a lighter, much cheaper body can be made from e.g. locally available eucalyptus poles or planks which do not have to be tightly joined together. A more flexible body might prove more appropriate to slow movement on a rough surface, and wastage of seeds can be avoided by placing removable old bags, cloth or iron sheets on the bottom and sides.

A third problem concerns the size and capacity of the TAMTU carts. They are made in small, medium and large size with a price differential of some 200/- shs. between small and large, and with a capacity of 500 to 750 kilos requiring 4 oxen to pull. The difference between small and large size is not all that substantial, but buyers' requests for the large size are the most common, probably because the buyers think in terms of reducing transport time. Although ox-drawn carts are rather slow moving (about 3-4 kilometer/hour) transport time in carting will not be a constraint, while draught power requirements is one, not least because most bulk carting will be uphill to
villages, most of which are located along roads which tend to follow watersheds, while the outlying traditional and most productive fields are often located on lower lying catena slopes or at valley bottoms.

Again, the problem of slow movement on rough surface is a point for reducing the size and loading capacity of carts which should also reduce breakage and perhaps even enable the use of only two oxen in the case of field to homestead transport of harvest produce. For most households, the availability of draught oxen is a major constraint in opting for animal traction. Thus, instead of producing three sizes of already too large prototypes, it would seem more appropriate to produce one small, light, and cheaply designed prototype, modelled on the AATP ox-cart, which costs only about half of TAMTU's small cart (same capacity: 500 kg) if produced by village craftsmen allowing them 30 percent profit (AATP Annual Report 1978 - 79). At least one exception to small carts could be made in cotton areas since the volume of cotton in relation to its weight is very high. The design must take into account the abilities and resource availability of village craftsmen. TAMTU's six RCW's are unable to meet the demand for a cheap appropriate ox-cart, once this demand has been built up.

As regards the dissemination of ox-carts and other equipment to village craftsmen for local production it should be noted that AATP has only managed to disseminate a handful of ox-carts over 3 years. Clearly, nobody will take the risk to produce a large, relatively expensive item when they are not assured of a demand. The only way to assure this demand is to start batch production of a well-tested and cheaper cart by TAMTU, its RCW's, SIDO, mission workshop etc. Only when these have been used by peasants for some time and have proven themselves appropriate will a further demand be created.

As regards local transport of firewood, produce and ploughs to and from fields, mention has to be made of the widely used sledges. These are made locally from heavy forked tree branches, hitched to the yoke by means of the draw chain. Contrary to the statements of one Daily News article with a picture of a sledge, stacked with firewood (ref. lacking), these
sledges are appropriate means of transport, although overloading causes strain on the oxen because of uneven draught. For lack of a better and cheap alternative for years to come, work should be undertaken by TAMTU and other workshops to improve these sledges, for example by fitting them with skids of scrap iron bars so as to ease friction on rough surface. The size of the sledges, which are generally small with a capacity of only 1 bag, should not be extended too much because of the problem with overloading. If the cost of improvement cannot be kept to a minimum, it is better to drop the idea since they will not be accepted in comparison with the almost cost-free traditional ones.

8.4 THE DOUBLE FURROW MOULDBOARD PLough

The double furrow mouldboard plough (called 'Kifaru', Kiswahili for Rhino) is a heavy duty plough manufactured by TAMTU from locally available steel components. The frame is mounted on 3 wheels, 2 forward and one rear. The 2-furrow plough can be fitted with a metered seeding unit for planting during the second cultivation pass. The whole seeding unit includes a metering wheel which trails. The two plough shares can be lifted off the ground when pulled to and from fields and they can be lowered independently of each other to get equal furrow depth.

KIFARU PLough

Price: (ex-works) (as at 1.7.80)

<table>
<thead>
<tr>
<th>Description</th>
<th>Tshg.</th>
<th>($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kifaru plough</td>
<td>1500.00</td>
<td>185.00</td>
</tr>
<tr>
<td>Seeding attachment</td>
<td>600.00</td>
<td>74.00</td>
</tr>
</tbody>
</table>


Mac Pherson who worked in TAMTU provides the following statement on the idea and qualities of the implement (1975:206):

"An enormous technical step forward in animal powered ploughing is the two-furrow plough. It needs at least four oxen, and can even do better with six or eight. It does twice the
work of the single furrow-plough, and if properly adjusted, it does the work better and faster. The operator does not hold the plough, but it runs on wheels and all the operator does is to guide the oxen and lift the plough when necessary, at the ends of the rows. Once experienced oxen are available, which follow the last furrow ploughed, one man or boy can use the two-furrow plough."

The idea makes no sense under Tanzanian conditions since ploughing time is not a constraint. In fact, the implement is in every respect inappropriate, as pointed out both by peasants who have seen it on field demonstrations and by the manager of MICO's workshop. The latter mentioned the problem of having to use a large number of oxen, which is a major constraint. Further, the combined ploughing and planting operation makes it impossible to harrow before planting so as to get better seed bed preparation and seed germination (see below under Harrows). Finally, he noted that the wheel adjusting mechanism for lifting the shares is weak and breaks easily.

The peasants pointed out that it was much too heavy to operate and could not be steered in between stones and tree stumps (like the single furrow plough can). When asked whether they would consider buying it they laughed: 'Nobody would buy an unworkable plough for over 2,000 shillings'. There is little more to say about this hopelessly expensive and sophisticated piece of equipment which smacks more of an engineer's fancy ideas than of appropriate technology for Tanzanian peasant agriculture. The 2-furrow animal-drawn plough should be dropped altogether.

8.5 THE RIDGER

A ridger is probably the third most needed implement in Tanzania, following the ox-cart and an inter-row weeder. In most parts of Tanzania, large acreages are ridged - mainly by hand - as an appropriate technique of green manuring and soil/moisture conservation for the cultivation of cotton, tobacco, cassava, maize, sorghum, bulrush millet, potatoes and most legumes. With the increased permanency of cultivation this method should (preferably or of necessity to maintain yields) become more common.

Only a single-purpose ridger has been available to a very li-
mited extent in Tanzania so far. In 1975, 344 ridgers were estimated to be in use in the country and UFI reportedly imported 300 in 1976 (Commonwealth Secretariat 1981: 112). The FAO/Kili- lingo Survey 1976 – 78 recorded a total of 757 ridgers of which Shinyanga had 340 and Tabora 236. At best, a complete survey would probably not give much more than 1,000 ridgers in Tansa- nia. That figure is again extremely low but is probably due to the fact that the UFI plough is in many places used to throw 2-3 foot ridges which then in some cases are extended to 5 feet by manual hoeing. A first pass with the single-furrow plough is in any case necessary to loosen the soil before ridging with a plough or proper ridger can be undertaken.

I have not been able to get an illustration of the TAMTU and UFI imported ridgers but the drawing below of an ox-drawn ridger from Malawi is probably not very different.

RIDGER

Description: This animal-drawn ridger/cultivator is suitable for ridging crops of maize, cotton, tobacco and potatoes. The wings of the ridging share can be adjusted to cultivate rows varying from 40 cm. to 75 cm. in width. Agrimal produce about 10,000 units of the ridger per annum.

Manufactured by:
Agrimal (Malawi)
PO Box 143
BLANTYRE
Malawi

Price: (ex-works) (as at 1.2.80) 72.50 kwacha ($88.00)


Peasants who had seen field demonstrations of a ridger in Tari- me District complained that it was too heavy. If there are stones or stumps it cannot be lifted like the UFI plough and it was said to be difficult to operate if the land was not flat.

If the latter complaint holds true it is a serious complaint since ridging is mostly required on light or sandy, sloping up- land to prevent water run-off. Furthermore, it is worth noting that a ridger requires about the double draught power of a single-furrow plough. It is thus imperative that the ridger is light and small, and also that it is able to perform splitting of old ridges.

It would thus seem most appropriate to develop a small ridger
body for 3 foot ridges which can then, if required, be extended to 5 feet by manual hoeing, rather than produce a 5 foot ridger which is unusable. The cost of a 3 foot single-purpose ridger would fall somewhere in between the equal and double price of a normal plough, which can be used to perform the same job at poorer quality over longer time, but with less drudgery for both oxen and operator. Even a good, light single-purpose ridger is unlikely to sell in any great quantity and should thus be dropped for large-scale production until its demand has been assured.

The alternative, which has become widespread in some West African countries, is to introduce a toolbar system like the 'Houe Sine' to which can be fitted a mouldboard plough, chisels, tines, weeding sweeps, a ridger share and a seeder (cf. p. 89 above). The different pieces of equipment can consequently be bought by the peasants when they have available funds and feel the need.

It should also be possible to develop and fit a tie-ridger blade to such a toolbar, enabling crosstie - or 'box' ridging for further water conservation. In this respect it is worth noting that the enforcement of tie-ridging in Sukumaland by the colonial government did not meet with much success, but rather resistance, given the extra work involved.

The British produced UNIBAR animal-drawn toolframe, designed specifically for smallholder ridge cultivation under semi-arid African conditions, was tested at Ukiriguru near Mwanza in the late 1960s. The results were reportedly quite good. The UNIBAR - probably drawn by large well-fed oxen as is unfortunately always the case in such experiments - enabled the splitting and ridging of an acre in only 2½ - 3½ hours, and the same amount of time was used for crosstying 54). Although the implement is fairly light it is rather expensive, sophisticated and consists of numerous, removable bits and pieces which are bound to get lost. For these reasons, it cannot be recommended. The best option would seem to be the 'Sine' toolbar system.

8.6 THE RECTANGULAR SPIKE-TOOTH HARROW

The rectangular spike-tooth harrow, designed and produced by
TAMTU and its RCW's is made from a heavy 10 x 10 cm timber frame, fixed with cross-members. To these are attached heavy duty steel spikes that protrude 15 cm. On the top of the frame are (not always) attached steel slides so that the harrow can be inverted for transport as a sledge.

RECTANGULAR HARROW

Price: (retail) (as at 1.5.80)
Tshg. 700.00 ($86.00)


An original design of a lighter triangular spike-tooth harrow, which together with the iron zig-zag harrow remains the most common design in most other African countries, was abandoned, not being considered as good. The rectangular design was most likely developed as an implement for wheat cultivation in Arusha Region, in which harrowing is a necessary tilling activity for seed bed preparation and for covering broadcast seeds.

In 1975 there were approximately 1,576 ox-harrows - some of them probably zig-zag harrows - in use in Tanzania and in 1976 there was a reported local production of 10 and import of 200 (Commonwealth Secretariat 1981 : 112). The FAO/KILIMO Survey (1976 - 78) figures are not very useful since they lump together harrows and inter-row cultivators in one category. The survey recorded a total of 5,999 harrows and cultivators, of which 5,291 were in Aru-Meru District alone. Tabora Region came second with 210 and Mbeya third with 122. There is no doubt that most of the implements recorded in the category are harrows. Even so, the Aru-Meru figure appears to be very high, but I am unable to substantiate this further for the time being. All the harrows I have seen in Mara and Arusha Region (about 20) were awaiting sale from TAMTU and MICO or were lying idle at district agricultural offices. I have not yet seen them used.

Instead of the usual second ploughing pass, or following it, harrowing can be performed as a measure of weed control. A good harrow will tear out the weeds of plough inverted soil. But by contrast with chisel ploughing and hoeing which leaves the cut weeds spread over the soil, tooth harrowing will tend to
collect and heap the weeds through necessary lifting of the harrow to clear the teeth, an operation which will be very burdensome with the much too heavy TAMTU harrow.

A fairly evenly spread layer of killed weeds and crop residues is of importance for preventing moisture evaporation in semi-arid areas and for protecting against the soil capping impact of raindrops. The tendency for soil capping in many areas forms hard pans which requires the germination of several seeds to enable the young plants to penetrate the surface.

Heaping of weeds is one disadvantage of harrowing. Another is that the harrow cannot be used for inter-row weeding like a toolbar with chisels or weeding sweeps. A third is that a harrow, even if it has movable teeth (e.g. by allowing for clearance in the teeth holes) cannot be used on fields with large stones and tree stumps, which is at least possible with a three chiseled light toolframe which can be steered and easily lifted.

Like chisel and tine cultivation, harrowing loosens and aerates the soil. Not least important, proper harrowing will crush the clods left after mouldboard ploughing, thus preparing a fine tilth for better seed germination. This is of particular importance when sowing wheat and the small seeds of sorghum and millets. Finally, harrowing can be performed to cover broadcast seeds. At present, manual hoeing after the first and, most commonly, the second ploughing is often performed to prepare the seed bed and cover the sown seeds.

The harrow operation overall requires less power per acre than ploughing, and at least two harrowings per acre can be performed within the time span required for undertaking one ploughing pass. Four oxen are needed to pull the TAMTU harrow.

Despite the advantages of harrowing, the number of harrows bought and used (with the possible exception of Aru-Meru District) is very low. The reason for this can be attributed to several factors. The advantages of harrowing have not been demonstrated to the peasants. One thing is to demonstrate - for one or at the most two days in a village as has been done by KILOMO
in a few areas - how to operate a harrow and explain its advantages. This method is at best to be considered an introduction of the implement. A proper demonstration must involve visible results enabling on the spot comparison of seed germination, plant emergence, weed control and yields of harrowed and unharrowed fields. If experimental oriented peasants are willing to use a harrow on some of their fields, they should be given one free and receive supportive advice in using it. In this way, co-villagers will get a better chance of assessing the advantages and disadvantages of the implement.

One important disadvantage of the TAMTU harrow is its size and heaviness requiring too much draught power and at least two persons to clear tangled weeds off the teeth. A smaller, more simple design with pole skids enabling production in villages should be developed (see MacPherson 1975: 116 - 123). Such a design should involve experiments with soil seeking teeth (i.e. teeth protruding forward in the moving direction) to ensure soil penetration. If weight is necessary to ensure soil penetration, this can be done by a design enabling stones or a heavy piece of log to be placed on top of the harrow. The timber frame does not have to be made of planed square beams but can be cheapened by using locally available poles of sufficient strength.

Another problem with the harrow is that despite its positive tilling effects, it remains a single-purpose implement, limited to the cultivation of certain crops and only well-cleared fields. The cost of the TAMTU harrow is in that respect much too high, 2 - 300 shillings higher than the cost of the UPI plough. It is quite plain why so few harrows have been sold and used even though there have been more harrows available for sale than most other TAMTU implements. The cost of an appropriate harrow must be at least half if not one-third of the present TAMTU prototype if it is to become an interesting prospect for a greater number of peasant households. Unless this can be achieved, the production of harrows for idle stock should stop.

A multipurpose chiseled toolbar can better perform most of the functions of a harrow, except perhaps seed covering and clod
crushing. Clod crushing remains a problem in some areas after mouldboard ploughing but it might be reduced with chisel ploughing. Another method might be for the ox-team to draw one or two heavy poles, fixed parallel and laterally, at right angles to the direction of ploughing. This might have a positive effect, but this remains to be experimentally tested under different soil and moisture conditions. A simple implement like this might also be designed in such a way that attachable spike teeth can be fitted through a series of holes in the poles, allowing for selective adjustability, so that only the seed bed rows are tilled, thus reducing draught power requirements and leaving a more rough soil surface for better erosion protection in between the rows. Further, it should be possible to design adjustable furrow openers on the second pole so as to allow for easier manual planting of seeds which can be covered either by foot (as is presently done) or by a harrow pass. This takes us to the problem of planting.

8.7 THE SINGLE-ROW SEEDER

The TAMTU ox-drawn planter is a heavy-duty, single-row seeder with two hoppers mounted in tandem: one for seed, the other for fertilizer. The frame is made of welded tubular steel. In front is attached a furrow opener. A vertical blade covers the seed with soil which is compacted by the single wheel to give seed-soil contact for better seed germination. However, depending on the type of seed, soil and moisture content, soil compaction is often not preferable, and this cannot be regulated as done manually with foot and hoe covering of seeds. The planter is fitted with a disc furrow marker to enable equal row width during the second pass.

TAMTU OX-DRAWN PLANTER

Price: (as 1.1.80) Tshg.1500.00 ($185.00)

Source: Commonwealth Secretariat 1981 : 45.
In the bottom of the hoppers, seed plates with holes move laterally, allowing the seeds and fertilizer to drop through the seed pipes at regular intervals. Three seed plates are required, one for maize, one for sorghum and one for finger millet. The seeds have to be carefully graded — for which TAMTU has designed a manual seed mixer — if the planter is at all to work. Even so, the seed plate device may easily damage the seeds. This may consequently reduce seed germination and plant density even further from what is already a result of dropping only one to two seeds at a time.

The tandem fertilizer dressing device would seem to have rather limited applicability to Tanzanian peasant farming conditions. Fertilizers are not applied to sorghum and finger millet, only to maize in certain areas. If the maize is planted early, when soil moisture content is still low, the combined dressing of fertilizer may burn the young plant roots. Later fertilizer dressing by means of the implement is not possible. The use of the fertilizer hopper is too limited to warrant inclusion in an appropriate planter design.

In 1975 there were an estimated 128 ox-planters in use in Tanzania. The incomplete FAO/KILIMO Survey (1976-78) recorded 3,028 planters, of which 2,934 were in Aru-Meru District alone (see Table 3 above). As with the high number of harrows/weeders reportedly recorded in the same district, this un proportionately high figure is rather questionable. Given the realistic TAMTU production figures of less than 10 planters per year and short of recorded imports, from where would all these planters come? Possibly, it is a fictive figure, not actually recorded but invented by district or regional authorities to intimate their good progress. Tanzania probably has less than 200 ox-planters, most of which remain idle with government authorities.

Considering the inappropriateness of the TAMTU planter, this low figure is understandable. Quite apart from its single-purpose nature, its heaviness and its high cost, it is highly unlikely that the planter can at all be used to increase yields and labour productivity, let alone repay its own cost. Generally, manual grain sowing is not a serious labour constraint
in Tanzania. Seeds are either broadcast as with wheat, rice and finger millet in some areas, or they are planted by manual stick dibbling or hoeing and then covered by foot or hoeing. Ox-drawn simple furrow openers, ensuring equal row width for inter-row cultivation, could reduce the labour time of manual row planting by leaving only seed dropping and foot covering to be done by two or three persons following the furrow opener.

Due to their design requirements, planters are bound to be relatively sophisticated and expensive devices with many movable parts which break or clog easily. Precision planters are not feasible under existing levels of technology as plant establishment of the seed sown may be very low. It is necessary to oversow when using unimproved or poorly improved seeds, and under unpredictable soil moisture conditions (Gibbon 1981: 14).

Planting is generally not a serious labour constraint in Tanzania and this does for the time being not warrant the expenditure of efforts and funds on the designing, testing and production of planters. One possible exception to this is the practice in some areas of broadcasting seeds of finger millet and rice which subsequently requires extremely high labour intensity in the simultaneous operation of manual weeding, thinning and transplanting. Short of the possibility of constructing a sufficiently cheap and workable precision planter which can ensure returns to labour and to the cost of the implement, experiments could be undertaken to design the light and more simple, partly manually operated two-row planting device invented for the 'Atulba' multipurpose weeding and land preparation toolbar for arid Sudanese conditions (David Gibbon 1981, see footnote 52).

The most simple planting device fitted to a toolbar is just to have one or perhaps two funnels with adjustable seed pipes after each furrow-opening blade and with a rear soil scraper for covering seeds. The funnels are fed seeds at intervals by hand by one or two planters (personal communication with David Gibbon). Such a simple device, made locally from old tins and plastic, rubber or bamboo pipe would seem to constitute the first long and slow step towards mechanized ox-powered planting. Meanwhile, a simple and cheap furrow opener which can precede the
circumstantially slower introduction of a chisel tined toolbar has to get first priority. If possible it should be able to crush clods and open furrows after the second run of a mould-board plough.

With respect to planting, a short note is required on the TAM-TU hand planter, costing 85 shs. in 1980. It is a jab planter with wooden handles and a wooden slide seed metre. The jabbing action automatically meters seeds into the planting hole. It saves stooping to put the seeds into the ground as when using a planting stick. To ensure proper row planting, a long strung-out string is required together with two measure sticks for row width, and preferably two children to move the string upon finishing a row (MacPherson 1975 : 123). 110 hand planters were sold from TAMTU in Arusha in the 1975/76 season.

The way of using this tool does not generally seem very appropriate to common peasant farming conditions in Tanzania. Excuse me the details, but the required long string is already a problem. It has to be bought, most likely at each new planting season if at all available, since it can easily get lost or be cut up for more immediate functions (personal observation from several years of stay in peasant households). Of much greater importance is that the use of necessarily straight-lined planting strings should not be recommended. In a contour rich country like Tanzania, straight line planting increases the danger of erosion. Finally, if the children are at hand - because they are not in school under the Universal Primary School Programme - they might as well be put to the direct planting task, which they normally are.

When equal row width is required for inter-row cultivation on the contour, it is difficult to see the yield and productivity increasing advantages of the hand planter.

8.8 THE TAMTU INTER-ROW CULTIVATOR AND THE ARIANA TOOLBAR

The ox-drawn TAMTU inter-row cultivator is a light-duty, triangular weeder with a small front steering wheel (no picture available). 7 small horizontally moving blades or sweeps of high-carbon steel are fixed to the frame made of iron bars.
The two side beams, each with 3 tines, can be adjusted for row width by pulling a lever during the moving operation.

In 1975, 204 ox-cultivators were estimated to be in use in Tanzania. Imports by DFI of a reportedly more robust ox-cultivator (which I have not seen) were given as 350 in 1976 and 400 in 1978 (Commonwealth Secretariat 1981: 112). The FAO/KILIMO Survey figures are unusable for indicating the number of inter-row cultivators. The inter-row cultivator together with the ox-cart is the most needed implement in Tanzania for relieving the serious labour constraint of weeding. TAMTU produced 2 in 1975/76 and 12 in 1977/78.

The TAMTU ox-cultivator has the advantage of being relatively light and, according to the questionable price figures available, fairly cheap. The row width adjusting mechanism would, however, seem to be an unnecessary sophistication, since too close weeding to the plants has to be avoided in any case, and since it is an absolute necessity in any case to plant with equal row interval to enable inter-row cultivation. By contrast to a toolbar with adjustable tines clamped to a fixed beam frame, the TAMTU cultivator cannot weed the most commonly seen fields of grains intercropped with legumes. Finally the TAMTU cultivator is too weak (personal communication with Wayne Neeshack, AATP and MICO's manager), and it is difficult to transport between field and homestead. It is inappropriate and production can be stopped to allow capacity for the development and production of multipurpose toolbars, the specifications of which have been outlined (Sections 7.3 and 8.10).

The 'ARIANA' toolbar from Siscom in Dakar is a robust heavy-duty toolbar with a tool system of mouldboard plough, ridger, groundnut lifting blades and a set of 6-8 'Canadian' duckfoot tines. The basic frame is quadrilateral, it rests on 3 wheels and is guided by two independent handles and an adjustable draught-chain hitching device. It is said to have good stability and can be used on heavy soils and paddy fields. As at 1.1. 1980 the basic frame costs $185/- and the full equipment $748/- ex-works.

The Ariana is mentioned here, since it has been tested in Tan-
zania and since UFI has advertised them in Daily News and supplied a limited number of them to ox-training centres in Iringa. Here it has been reported to be too heavy (personal communication with Per Bo and Torben Rasmussen). Its overall operational weight is 58 - 92 kilos, much too heavy for Tanzanian oxen. It is too expensive and too sophisticated and should consequently be dropped as a prospective toolbar for Tanzanian peasant farming.

8.9 THE UYOLE A.C. TOOL CARRIER

Another toolbar, which deserves mentioning although it is still at the experimental stage with only two produced so far, is the Uyoile Agricultural Centre Tool Carrier, the work on which commenced in 1977 at Mbeya. The U.A.C. tool carrier has a rectangular frame 90 x 150 cm resting on wooden wheels with a ground clearance of 90 cm to allow work in standing crop. Tines and sweeps can be attached together with a one-seed precision planter, the hopper of which also has a compartment for fertilizer and one for soil-applied insecticide like Furadan. The carrier can also be used for transport (UAC Annual Report 1980/81).

The objective of the UAC tool carrier is: 'To develop a simple and cheap tool carrier which would fit the needs of a villager' (ibid : 5). If this objective is to be followed to the letter -
which it should - the whole three-in-one hopper and drilling device can be dropped since a precision planter cum fertiliser/insecticide drill is unfeasible under peasant farm conditions, and since this sophisticated device is probably the most expensive part of the machine. The first prototype with a two-row planter also had to be dropped because it could not ensure an even stand of maize. It can be assumed that the seeds involved in the trials were well-graded and high quality, a condition which is not normally applicable to peasant conditions in Tanzania.

Experiments continue at Uyole to seek a lighter design, to test strength and durability, and to evaluate important parameters like labour requirement, weed infestation, yield and cost of production and this is commendable. However, the picture above shows a rather favourable experimental environment: Rather large-sized, well fed oxen, only two of which are required to till a smooth-surfaced large, flat field, free of stones and stumps. Such conditions are very rarely found on peasant farms in Tanzania and as such, the experiments can only provide optimal results, impossible to achieve in the relevant peasant environment - as the experience with so many other controlled, isolated experiments under favourable conditions has shown. Such experiments consume time, effort and scarce funds to produce largely inapplicable results.

There is no need to achieve the most favourable 'optimal' results and there is no need to start from scratch all over again. But if peasant agriculture is to benefit from the Tanzanian research institutes, there is one imperative, i.e. to start from what is already there: peasant farming. Although everybody might agree, the results have too often been inapplicable as we have seen above. An adaptive research programme involves a thorough understanding and acceptance of the integrated nature and often alternative processes of farming methods and management decisions within and between peasant households operating under differing micro-local conditions (e.g. field sloping, stone and weed problems, size and weakness of oxen, seed quality, etc.).

The idea of using only two oxen is extremely good. If two
smaller, weak oxen could be experimented with, the results would be even more applicable. A reduced 'optimum' has to be accepted. Another interesting merit of the UAC tool carrier is that it combines a tilling toolbar with an ox-cart which may in due time make it popular among peasants and - totally viewed - make it a cheap general purpose labourer, from which one or two persons can drop seeds through a simple funnel seed drilling device as indicated above. The drawback of such an implement is its heaviness for tilling operations which require on lifting and steering clear of stones and stumps. Thus, its applicability is for the time being limited.

Moreover, the idea of using a simple and durable wooden frame and wheels is sound, if costs can be reduced comparable to an iron framed toolbar and if it can be repaired and produced by village artisans. The two latter points have to be welltested and tried out in the villages. Finally, a more simple way of constructing wooden wheels (without spokes) should be tried out along the lines of the AATP ox-cart (see section 8.3 above).

The idea of using wood for every detail should however not over-ride considerations of durability, strength, construction time and ability of village artisans, although it may improve the good property of flexibility required for slow movement over rough surface. Despite its heavy appearance - which made one observer note 'that it looked like a medieval attack machine' - the UAC tool carrier might under proper adaptive research conditions contain the embryo of a future multipurpose labourer.

In the meantime, comparable experiments should be undertaken at Uyole with the proposed 'Sine' prototype to enable design and technical specifications for production at the Mbeya factory. Since Uyole is oriented towards and capable of doing proper trial work on cropped fields, and since TAMTU is oriented towards metal work design, there is an obvious case for close cooperation and achievement of hopefully fruitful results which can be further tested at ox-training centres in villages and applied to batch production by the Mbeya factory and UFI.

8.10 THE SINE-HOUE TOOL FRAME

The 'Sine' tool frame is shown in two versions below (copied

Manufactured by
Ploughs & Allied Products Ltd
PO Box 467
KISUMU
Kenya

Telephone: Kisumu 40512

Ploughs & Allied Products are making the Sine-House tool-frame of Senegalese design, and are able to manufacture the whole frame from locally available materials. In the last year they produced more than 100 units.

Price: (ex-works) Kshg. 1200/00 ($160.00)
(as at 1.7.80)

Manufactured by:
SISCONA
(factory
BP 3214 at Pout)

DAKAR
Senegal

Telephone: Pout 81096, 81136

Overall operational weight: 30-45 kg. (dependent on tools)

Price: (ex-works) (as at 1.1.80)

1. Basic equipment (frame with 'Canadian' tines) 23,912 CFA ($112.00)
2. Full equipment (except seeder) approximately 69,500 CFA ($326.00)
3. 2x2 row seed drill 82,830 CFA ($294.00)

The Kisumu version has the merit of skids and (perhaps too sophisticatedly shaped) weeding sweeps (below left), while the groundnut lifter with a two-skid attachment (below right) and the rake (or harrow?) would not seem to have general priority in Tanzania. Furthermore, the Kisumu version omits the middle cross bar for a total of 5 tines, thus reducing draught power requirements. Somewhat broader, symetrical and flat-side sweep blades might be a better design for weeding intercropped fields.

To my knowledge, the 'Sine' has not yet been tested and is unavailable in Tanzania despite the fact that it has over the years through experimental tests and adoption by peasants, become the most widely used ox-drawn multipurpose toolbar in Africa (mainly Senegal, the Gambia and Upper Volta where comprehensive ox-powered mechanization has progressed the most).
If at all possible, sets of equipment from Kisumu and Dakar should be imported for testing and modification to suit Tanzanian conditions. (For further discussion of the 'Sine', see Section 7.3).

8.11 THE ETHIOPIAN ARD

Although the African Scratch Plough or 'Ard' can for several reasons be considered one of the most appropriate implements for animal draught on small peasant farms, particularly under arid to semi-arid conditions, its diffusion in Subsaharan Africa has mainly been limited to Ethiopia where it has been widespread in the Mediterranean and still is in the Middle East and India, although the steel-made mouldboard plough is gaining ground here.

More limited use of the ard has also been reported from Sudan, Northern Nigeria and some West Sahelian countries. I am not fully aware of the reasons why it has not spread out from Ethiopia and North Africa, but one of them must be the desert preventing direct, permanent contact between the peasants to the north and south. During the colonial period and until very recently, the scratch plough has wrongly been considered an inferior implement to the European invented mouldboard plough. Until around some 1,500 years ago when the climate in Western Europe was less humid and forest fallow cultivation was common, the ard was also the proto-plough used here.

The Ethiopian ard - like most other non-steel and unimproved ones - is made of a long, curved, wooden draw-beam, at the bottom of which a long wooden handle pierces through, fixed at a slant angle, and extends into a blunt spearhead-like iron tip. From this tip two narrow wooden boards or skids, one on either side of the plough head, extend back to the bottom of the beam to give operation stability and ploughing depth (on average some 12 - 15 cm). The head of the draw-beam has an attachment which is tied to the shoulder yoke. The plough is steered and operated with only one hand, the other holding the whip to urge the oxen. Only two oxen and one person are thus required to operate the ard.
The picture and description above refer to a local plough from the Chilalo Agricultural Development Unit (CADU) Arussi Region. There are probably different versions of the ard from other areas in Ethiopia, including a number of versions from India.

By contrast with the mouldboard plough, the Ethiopian ard does not cut the soil but rather pushes its way through without inverting or overturning the topsoil. The furrow has the shape of an equilateral triangle and the angle between the equal legs becomes smaller the more the plough works on its point. The plough used in the CADU trials (referred to below) gave an average working width of 23 cm in heavy, sticky clay soils (CADU 1970:6). Ploughing with the local plough could be performed earlier than mouldboard ploughing which had to await sufficient rains for softening the soil. This in turn gave problems with soil-sticking on the mouldboard and share. 'If the demand of complete turning of the tilth is dropped out, it is possible to take the furrow deeper in relation to the breadth' (CADU 1969: 14).

The ard can, more easily than any other implement, be used on stony fields with fallow stumps. Its versatility refers to the fact that the ard is used both as a primary and secondary tillage implement55). It is effective for breaking up fallow land, requiring two ploughings with the second in cross-direc-
tion. When the soil is sufficiently moist the third ploughing will break clods and prepare the seed bed. The fourth ploughing is used for seed covering, for which operation it is however not very suitable since seed covering depth varies to a great extent, resulting in uneven seed germination and lower yields than if two harrowings, one for seed bed preparation and one for seed covering had been used (CADU 1970: 9). The plant emergence was faster and more uniform the lighter the harrows used had been (CADU 1969: 12).

The results of a number of replicated trials, undertaken by CADU to compare the tilling effects of the indigenous plough with a number of different steel mouldboard ploughs, harrows and the Ariana toolbar, are presented below:

"From the experience so far gathered it can be stated that the indigenous wooden plough has some advantages:

1. It is cheap (Eth. $ 6 - 8) and available locally.
2. It is versatile.
3. The pullpower demand of the plough is suitable for a pair of oxen of the type available.
4. The plough is easy to operate.
5. Deviations from the straightforward driving directions can be allowed.
6. The weeding effect of the plough before planting seems to be good.
7. The plough leaves the mulch on the surface. This might be important, especially under semi-arid climate conditions, for water conservation and protection against erosion.

The disadvantages of the wooden plough so far known are:

1. The method is time consuming. If four ploughings are substituted with one ploughing with mouldboard plough and 3 harrowings it will mean a saving of ox-and manpower with at least 50 %.
2. The wooden plough cannot be used for mechanical weed control in grain crops after planting." (CADU 1969: 6).

All the advantages listed are rather important and it can be added that the plough is simple enough to enable copying and production by the average Tanzanian village blacksmith and wood artisan based on locally available material. The plough is so light that it can be carried on the shoulder. No support infrastructure is necessary for making the plough available, once a
number of local specific suitable prototypes have been developed.

The results of the local plough trials presented above are of interest to Tanzania, especially to the central semi-arid areas and to areas with hard pan soils (both of which often coincide). With relatively low draught-power requirements, early (if not even pre-rain) breaking of the hard crust should be possible. This would leave a rough erosion-protective surface for better water penetration and moisture conservation, thus enabling earlier planting which in most years - depending on rainfall distribution - would improve yields, provided that subsequent tilling and weeding is properly done. Further, it is now generally agreed upon that soil inversion is a disadvantage in semi-arid areas, because it does not leave the thin humus layer in the top soil. The leaving of mulch on the surface also prevents the capping impact of raindrops.

The final interesting point is the possibility of increasing the working depth of the ard, probably by strengthening it and raising the sideskids. The question is whether this would enable deep ploughing or some intermediate level of subsoiling with the pull of 4 oxen. Subsoiling after some years of cultivation in semi-arid areas can be of considerable merit in aiding water infiltration and root/plant development. So far this can only be done with a tractor-powered strong chisel plough.

Further attention should also be drawn to the disadvantages of the Ethiopian ard mentioned above. The time-consuming method relates to the fact that two primary tilling operations have to be done because the plough usually leaves unploughed land, probably because the oxen are not guided by a person. In addition, one ploughing is needed for seed bed preparation and one for covering broadcast seeds. The third tilling for seed bed preparation and the fourth for seed covering, when required, can however be substituted with more efficient and timesaving harrowing. Nevertheless the time required for the two first ploughings might still be longer than if a mouldboard plough was used. However this constraint can be offset by allowance for earlier and more beneficial ploughing with the ard.
The fact that the ard leaves a surface layer of mulch of uprooted weeds on the soil serves the purpose of building up soil moisture content during the early rains before planting. This effect of hindering evaporation will be reduced with harrowing for seed bed preparation but at a time when the young plants can start to utilize moisture. Broad, light harrows with adjustable spike teeth for seed bed row-harrowing could be a solution to this problem and should be experimented with (see Section 8.6).

The question now is whether the ard is suitable for humid upland areas. It might be more effective than the mouldboard plough in breaking fallow land with tough sod. But one important disadvantage is that it is unable to plough weeds into the soil to serve as green manure. Similarly it is unable to plough in farmyard manure which needs to be covered by soil under tropical conditions to reduce loss of nutrients, and this problem applies both to humid and semi-arid areas, and to the use of tined implements. However, the present use of mouldboard ploughing for also covering farmyard manure is likely to be limited, although it might hopefully become more important in the future. This question also needs further investigation.

As regards the problem of inter-row weeding, it should be possible to make different attachable tine points for the ard, one of them a broad bladed sweep blade for weeding, allowing for one or two weeding passes within one row depending on row width. In India, traditional double-row weeding is performed by attaching two steerable ard-like implements to a broad yoke, drawn by two oxen. Such a method of inter-row weeding does not even require exact row-width most easily ensured by introducing a furrow opener in the system of cultivation. The ard would thus seem to constitute the most easy means of introducing inter-row weeding in Tanzania since it does not have to be associated with a complex of changes in cultivation practices.

To sum up, given the low technology shelf in Tanzania and the semi-arid conditions in large parts of the country, where most of the cattle population is found, where rural poverty is most
serious and where the supportive infrastructure is least de-
veloped, there is a strong case for trying to introduce the
ard if well conducted adaptive experimental research shows po-
sitive results. Despite its simple appearance the ard is an
appropriate, multipurpose tillage implement which requires on-
ly two oxen and one person to operate and which enables true
local production at very low cost. TAMTU, Oyole Agricultural
Centre and ox-training centres should start to test the imple-
ment, a few of which could be imported from Ethiopia at low
cost. Some of them should be given to rural craftsmen for co-
pying, and experimental oriented peasants should also be allow-
ed to test the implement. This should be done in conjunction
with the development and propagation of a simple, light wooden
harrow, which can reduce the tilling operations of the ard and
increase the efficiency of seed bed preparation and seed cover-
ing.

There might be resistance to the introduction of the ard by
some peasants and by educated government technocrats on the
grounds, that the ard by all appearances seems like a too
simple 'undeveloped' implement and would seem to represent a
step backwards from the steel mouldboard plough. However, what
matters in peasant oriented technological development is not
the appearance of technological superiority but rather simple-
ness, lightness, cheapness, ease of operation, adaptability
and agronomic appropriateness which is particularly crucial in
semi-arid areas.

It will take time for the peasants to adopt the ard since they
are used to the mouldboard plough. A further problem is that
the ard should be promoted together with a light, possibly
wooden harrow which also can be produced in the villages. The
ard should not be promoted as the only alternative to the
mouldboard plough but rather as a complementary or new imple-
ment which might gain ground. It would constitute a very cheap
option for the poorer households by comparison with the mould-
board plough. Given the present shortage of mouldboard ploughs
and the crying demand for ploughs, the time would seem ripe for
introduction of the ard, and immediate action should be taken.
Recommendations about introducing the ard were already put for-
ward by Beeney (1975: 25) but so far, nothing has happened de-
spite the cheapness and appropriateness of such an undertak-
ing.
CHAPTER NINE

9. THE DEVELOPMENT OF COMPREHENSIVE ANIMAL TRACTION:
SUMMARY AND DISCUSSION OF THE MAIN PROBLEMS AND PROSPECTS

9.1 INTRODUCTION

During the 1970s, Tanzanian government policies on agricultural mechanization have been rather incoherent, if not contradictory. The need to develop animal traction has been stressed over and again by the political leadership. Yet financial resources have been concentrated on the foreign exchange demanding and capital intensive state farm sector running at considerable economic losses while the very basis of the national economy, the peasant sector, has been relatively starved of directly productive financial support. This pattern could only be sustained with the financial support of foreign donors. In addition, a continued string of failures of village tractor mechanization schemes has amounted to a series of costly mistakes.

On the other hand very limited funds and efforts have been directed to the promotion of animal traction. Ox-cultivation has until today continued to rely solely on the use of the single-furrow mouldboard plough and the availability of this plough for purchase in the regions has declined together with a growing scarcity of associated spares. TAMTU, set up to develop a comprehensive range of equipment, remained in a state of neglect and most of its implements are inappropriate.

There is now a growing interest in animal traction, both internationally and in Tanzania. The installed capacity for producing ox-implements has been increased and TAMTU has been reorganized. Regions like Arusha, Mara, Iringa and Mbeya are giving more priority to animal traction and this interest can also be observed among some foreign donors - though not among the influential World Bank and USAID.

The main reasons for these changes must be sought in what appears like a production crisis in the peasant sector, the lack of foreign exchange and the national economic crisis which has
made further tractor adventures an unlikely proposition in the near future. But to what extent a coherent policy and sufficient appropriate support at all levels of the state apparatus can develop with respect to animal tradition remains to be seen.

This chapter is an attempt to follow up on issues partly left unanswered in the previous chapters and to discuss the development perspectives of some of the most crucial problems related to the further development of ox-mechanization, i.e. the problem of land-use in the context of villagization and the problem of unequal access to the most crucial productive forces, draught oxen and labour power. A summary outline is provided on the need for selective priorities in the choice of implements and on the need for adaptive experimental research so as to avoid a continuation of the past failures of inappropriate technology.

9.2 INTENSIFICATION WITH VILLAGIZATION AND EXTENSIFICATION WITH OX-CULTIVATION

The general economic and political conditions and the pattern of land-use brought about by villagization are of crucial importance to the development of comprehensive animal traction. First of all, villagization has brought about drastic changes in settlement and land-use patterns. Settlement has been concentrated, often on poor water-shed land following roads.

Local population densities have at least been effectively doubled if not trebled in many areas, walking distances to fields have increased and extensive forms of bush and grass-fallow systems, ensuring natural fertility restoration without input costs and at low labour intensities, have given way to permanent systems of annual cropping. The field pattern around the villages is more contiguous, severe shortages of grazing have developed and grazing can now mainly be undertaken in village frontier areas far away. Cattle keeping has in effect been further separated from crop cultivation and the potential for organic crop - animal integration through the use of manure, ley farming and production of fodder crops has been hampered.
Villagization has imposed new labour constraints and more exhaustive pressures on the land and its vegetative resources (plant nutrients, bushland browsed by goats and trees for firewood). These changes, unless counteracted with other means, will mean yield reductions and a further decline in labour productivity. The basis for achieving high labour productivity — which is one of the overriding principles of production in peasant economies characterized by a complex of hand tools and critical dependence on human power (cf. section 2.4) — has effectively been undermined at the expense of the political objective of providing social services and infrastructure. The concentration of population, however, did facilitate state interventionist policies of administrative management and control, which have been attempted as a measure to control and extract more surplus out of the peasant sector.

Village tractor mechanization which could have been a means of increasing labour productivity, has utterly failed and the necessary conditions for tractor mechanization are not there, although the block farm layout was probably seen as one of the means for tractor mechanization. Most of the government resources, efforts and man power that were oriented towards raising peasant productive capacity, have been spent on the promotion of the bio-chemical package. While some of the more appropriate seed varieties have been adopted in many areas, the use of fertilizer on the whole (with a few regional and high value crop exceptions) remains a problem which is not easily overcome for a whole range of reasons (see section 7.4). Apart from these, the use of fertilizer is a costly — and far from always profitable — land and labour intensive technology which may easily impose new labour constraints (extra work for the application of fertilizer and for weeding).

As analysed by Frank Ellis there have been "rapidly increasing transfers of financial surplus between peasants and the state in Tanzania during the period 1970 to 1980" ... and ... "the basic process of Tanzania's political economy during the 1970s was the impoverishment of the rural economy to the end of supporting a proliferating state and parastatal bureaucracy" (Ellis 1982b, cf. section 6.3 above). The Tanzanian peasantry has been subordinated to the depressed conditions of the pro-
ductivity/surplus squeeze (cf. section 2.4 above).

As such the objective conditions for the further adoption and development of ox-cultivation are indeed the very opposite of those boom-like conditions under which ox-cultivation spread during the 1950s (i.e. profitable cash crops, savings from wage income and migrant labour, taking advantage of extensive cultivation in a wide land frontier, improved infrastructural and marketing facilities, cf. section 3.5 and Chapt. 4).

Yet, despite these depressed and very different conditions at present, there is a strong and perhaps even growing demand for ox-ploughs. Part of this demand is obviously a result of the declining output and availability of ox-ploughs in Tanzania, and part of it is due to the decline in tractor cultivation and exorbitant rates for hiring tractor services. The decline in tractor cultivation and transport has in fact accorded animal traction a good chance in areas where it had previously declined in importance or had not even started.

However, there is evidence to suggest that villagization and related economic changes have in fact created a new demand for animal traction, partly because of the adverse conditions referred to above. The decline in shifting agriculture and fallow land, increased problems of traditional forms of manuring, and the decline in soil fertility and yields together with deteriorating terms of trade has necessitated the cultivation of larger acreages just to maintain output. Extension of the cultivated acreage has taken place at the expense of grazing land, and many households have got access to more land for cultivation, mostly as a result of more equitable land distribution in the villages and partly as a result of attempts to impose minimum acreages upon households.

To this more equitable redistribution of land can be added a general decline in off-farm employment, local agricultural wage labour and migrant labour because of a depressed economy, official discouragement of peasant employed wage labour, attempts to control migration from the villages and a depressed plantation economy (cf. sisal). More young men and women would seem to have no alternative but to stay on and farm, if they are not
involved in all sorts of petty businesses and black marketing. Households in their early phases of the family development cycle do experience even greater labour constraints than those generally imposed by villagization.

The changes in land-use, increased labour constraints and relative changes in crop price levels and marketing opportunities have furthermore brought about changes in the relative proportions of crops grown. The relative importance of maize has at least grown in many regions, at the expense of wheat, rice (?), finger millet, cotton and tobacco, and thus also at the expense of relatively more intensive methods of land preparation and planting (i.e. intensive seed bed preparation, thinning, transplanting, ridging, mound cultivation, fertilizer application)\textsuperscript{56}.

Now, the cultivation of larger acreages with a less nutrient and labour demanding crop like maize is facilitated by means of ox-ploughing so as to overcome the peak labour constraint in the first and second cultivation of larger acreages. To the extent that marginal lands with short rainfall seasons are increasingly put under cultivation, this would also create a demand for ox-ploughs so as to cultivate large acreages fast.

As analysed in sections 3.5 and 5.2, the main advantage of ox-ploughing was to enable fast land preparation (despite late ploughing), extend cultivated acreages and/or overcome labour constraints in land preparation and increase the productivity of labour. Ox-ploughing was in the 1950s and 1960s blamed for leading to extensive cultivation methods, i.e. inferior flat cultivation, poor planting and weeding, and low yields. The colonial government tried to discourage and limit ox-ploughing, but ox-ploughs could be purchased in increasing numbers during that period.

It almost seems as if villagization and the last decade of government policies have turned history upside down. The poor effects, for which ox-ploughing was once blamed, have now been provided as de facto conditions through villagization and state intervention, apparently facilitating a demand for ploughs. Ox-ploughing is encouraged in political rhetoric, but no ploughs are available for purchase, and there may well have been a de-
cline in ox-ploughed acreage over the last several years.

The question now is where the purchasing power for ox-ploughs comes from if the peasants have been economically squeezed? First of all the demand and purchasing power would tend to be found among the more well-off sections of the peasantry, most likely those who have cattle, access to draught oxen and who can easily realize cash through sale of stock at the present very high livestock prices. Secondly, the drastic increase in black-marketing might provide more ready cash which cannot be spent on the usual consumer goods for which there is a serious shortage. Thirdly, there would now tend to be better possibilities for hiring out ox-teams at profitable rates, and attempts to invest in ploughs rather than land improvement would be made.

Now, we have a situation where villagization has created a demand for and a growing interest in ox-ploughing. To the extent that this is the case it constitutes the potentially most dynamic factor for the further development of animal traction. But the further expansion of ox-ploughing in the same extensive way as hitherto has its limits. The labour peaks will be shifted to and be increased in weeding, women will be more overburdened, yields will remain low or be further depressed, and manuring of crops and transport of produce (mainly women activities) will remain a problem. Extensive plough cultivation will expand at the expense of grazing areas, oxen will get weaker, ploughing and planting consequently delayed with lower yields etc. These are, if you want, the worst thinkable long-term effects.

Before it comes to that, a number of households, especially those with livestock, would have moved out and settled more or less permanently in the land frontier where they can continue to cultivate and graze in an extensive way. The herd available for manure production and draught purposes in the villages will be further reduced. Households without cattle have less to lose and might stay on in the villages - especially to the extent that there are advantages to be gained from the economic and social service infrastructure - however without the means to raise yields and labour productivity apart from fertilizer.
In fact this would represent a partial reversion to previous patterns of land-use and settlement with the larger cattle owning households taking advantage of the frontier areas. The development of seasonal cultivation and grazing settlements and permanent satellite villages in the frontier areas are already signs of this trend, but the question is to what extent it can relieve pressure on the land in the village areas. De-villagization and a reversion to extensive systems of land-use would in any case constitute the cheapest way of raising yields and labour productivity, but the advantages of villagization would be defeated.

Villagization has imposed more intensive land-use and the need for manuring of crops and animal traction to relieve increased constraints in transport and land preparation. At the same time the need for closer crop-animal integration has been made more difficult because of grazing shortages, crop-animal separation, and a too dense settlement pattern. The vesting of rights to allocate land in village governments, including in some places orders to resettle people several times, has involved a loss of security in landholdings and the loss of incentive to improve land holdings and build up fertility through the application of farmyard manure, tree planting, ley farming etc. The layout of village land-use with separate block farms, village government fields and scattered individual plots creates unnecessary fragmentation and transportation problems.

If the objective is to develop mixed farming through crop-animal integration, the most feasible holding pattern is to have homesteads situated in the centre of a sufficiently large holding which allows for controlled ley or fallow farming, and land for supplementary fodder production in addition to cash and food crop acreages. This would involve a more dispersed settlement pattern, smaller villages and increased distances to social service centres. Clearly, mixed farming is a very long-term proposition which involves new higher land and labour intensities which have to be overcome.

In the meantime, research work, material support and democratic political discussion could be started as regards how villagers could themselves reorganize land-use and settlement so as
to enable improvements in the production process. The state neither has the technical expertise nor the planning and implementation capacity to rework land-use and village layout. The experience of villagization clearly shows that. But the state could work out and explain the overall objectives and should make legal and political allowance for changes in those cases where a majority of villagers themselves feel the need to implement changes in land-use.

The objectives would involve allowance for contiguous individual holdings including land for grazing fallows, perhaps in some areas reserving areas for communal grazing, starting up adaptive experimental research on peasant farms to gain insight into the problems of labour constraints, cultivation practices, seed varieties, fertilizer use, application of farm-yard manure, green manuring and fodder production for seasonal supplementary feeding of draught oxen. The basic premise must be that most peasants understand these problems better than the government.

9.3 SELECTIVE PRIORITIES AND ADAPTIVE EXPERIMENTAL RESEARCH FOR COMPREHENSIVE ANIMAL TRACTION

As discussed in the previous section, villagization has created a growing need for mouldboard ploughs and attempts have been made by the government to increase the industrial capacity for the production of ploughs from UFI and the Mbeya factory. Although mouldboard ploughing is not necessarily the best technical and agronomic solution in many plough areas, this still has to be more firmly established through experimental adaptive research with other implements. For lack of better alternatives, the demand for mouldboard ploughs should obviously be met. In this respect it is important that sales and stocks in the regions and requests for ploughs are continuously monitored so as to facilitate proper distribution to areas most in need and so as to get indications of demand. In the present situation of shortage it can be considered a malpractice to promote ox-cultivation in areas where peasants are basically uninterested.

In any event, the planned production of disc harrows in Mbeya should stop. They are in all respects inappropriate and pro-
duction capacity could be better utilized on producing light ploughs, not larger heavy ones. It cannot be sufficiently stressed that the main objective must be to produce simple, light, cheap and durable implements with as low draught power requirements as possible. The present constraints of peasant farming must override ideas about trying to achieve a potential optimum.

The use of the single-furrow mouldboard plough has its problems and limitations: high draught power requirements (4 oxen), poor weed inversion, undesirable soil inversion in semi-arid areas, land extensive cultivation, the creation of new weeding bottlenecks, low yields etc. Although it is still possible by means of mouldboard ploughing and extensive cultivation to produce a higher total output (despite lower yields) at a higher return to labour than is the case in hoe cultivation, continued sole dependence on this plough would further reduce grazing areas and hamper the gradual transition to more intensive, yield improving systems of land-use. The most serious constraints are now weeding and transport, both of which increase the work load of already overburdened women. Ox-carting is furthermore one of the preconditions for intensified application of farmyard manure on crops and for relieving increased transport constraints imposed as a result of villagization and increased field homestead distances.

There is an urgent need to start up an effective programme on adaptive experimental research in order to test and develop appropriate inter-row weeding equipment and much cheaper ox-carts.

As regards inter-row weeding two possibilities are

1. to test the 'Sine Houe' toolbar, the most widely adopted toolbar in Africa, to which can be attached a mouldboard plough share, a ridger, tines for land preparation and inter-row weeding.

2. to adapt modifications on the Tanzanian mouldboard plough so that weeding tines and possibly a light ridger share can be attached to it.
But to the extent that batch or mass production of implements has to be carried out in workshops and factories there is a limit to the range of implements which can be produced, and this limit applies to the capacity for experimental design and test work as well. This limit has become even more acute with Tanzania's economic crisis. There is a need to make compromises and apply selective priorities. But at the same time, selection and standardization of design must involve the scope for flexibility and versatility, including the possibility for modifying designs locally.

Thus, rather than trying to promote a row seeder which can neither work nor be afforded under present conditions, a better alternative is to design a simple wooden furrow opener which can ensure equal row width for inter-row weeding and which can be produced and modified in villages. Similarly, simple and light wooden harrows for seed bed preparation and clod crushing should be experimented with. Finally, adaptive experimental research should be undertaken to test the Ethiopian ard as an appropriate prospect for poor peasants and semi-arid areas (see sections 8.6, 8.7 and 8.11).

If selected comprehensive ox-mechanization is to be given a real chance, it is of the utmost importance that as many implements as possible, including ox-carts, can be produced and repaired in villages or rural small-scale industrial workshops (with welding equipment for making frames and modifications for steel implements). Decentralization is necessary to allow for local modifications, to create linkages between the craft and small-scale industrial sector and the peasant sector and to avoid dependence on irregular or low supply from the parastatal sector.

CAMTEC (Centre for Agricultural Mechanization and Applied Rural Technology, newly established in Arusha and an amalgamation of TAMTU and AATP), UAC (Uyole Agricultural Centre at Mbeya) and possibly some of the other research stations like Ukiriguru at Mwanza would be well positioned to undertake the above-mentioned adaptive experimental research programmes. In addition, there is a strong case for involving private voluntary organizations, missions and ox-training centres in the work. (See section 8.2).
9.4 THE PROBLEM OF UNEQUAL ACCESS TO DRAUGHT OXEN AND LABOUR POWER

This section is mainly concerned with the relations of production within the peasant sector, i.e. the forms of access to and control of the productive forces (cattle and draught oxen, implements, and labour power), and to what extent these forms may determine or limit the development of comprehensive animal traction.

We have already noted that the availability of draught oxen is one of the most important constraints on developing comprehensive animal traction. The weakness of draught oxen, which may well increase in the future as a result of further grazing shortage, necessitates the use of four oxen for mouldboard ploughing. It is quite common in many areas that only some 40 to 50 percent of households own cattle and many of these do not even have 4 oxen to be used as draught animals. The use of cows as draught animals, although possible according to Uyole Agricultural Centre experiments, is at present a quite unlikely prospect, since their use would mean a reduction in milk yields and calving rates which would in all likelihood be unacceptable to the cattle owners, the men, and to their women whose responsibility it is to feed their children.\(^{57}\)

The unequal ownership of cattle might well have become more visible over the years. In many areas like Arusha, Singida and Iringa there has been a gradual reduction in migrant labour and more young men remain in the villages. Most of the cattle and draught oxen will tend to be held by older, large, polygamous and well-established households while young households, most short of labour and means of cash, are without these means.

The 'traditional' extended families have thus had the means to adopt ox-cultivation, and studies from The Gambia, Nigeria, and Tanzania have shown these extended families to be the main adopters of animal traction. However, young monogamous households, experiencing a greater problem of labour constraints, constitute a large group of potential and interested adopters. As long as their children are small (below 5 years of age) or
attend school, their problem is how to get labour to herd cattle. Keeping only a few heads of cattle for milk and draught purposes would mean that the capacity of herding labour would be seriously underutilized unless forms of coope-
ration between a number of households in livestock herding are undertaken. This form of neighbour cooperation in herding used to be well-known in many livestock areas, but it may well be on the decline due to growing individualization.

The need for ox-cultivation is established by the fact that on the whole fairly expensive hiring of ox-teams, as well as customary borrowing of draught oxen and/or ploughs, is very com-
mon. To the extent that ox-ploughing has tended to displace the use of hired wage labour for hoeing and to the extent that it continues to compete favourably with the use of hired wage labour, the hiring and renting of ox-teams will increase, while at the same time constituting an incentive for indivi-
dual acquisition of these means. Strong forces militate against the purchase of these means, i.e. the high prices of ploughs and especially the high cost of oxen and the problem of grazing which reduces herd growth. If oxen were to be stall-fed, the real costs (including those of labour and oppor-
tunity costs of using land for fodder crops rather than food or cash crops) would even be higher.

The already high meat and cattle prices, which are likely to rise relatively to food crop prices, consequently compete strongly against the purchasing and keeping of oxen for draught purposes. This problem could partly be solved by timely re-
placement of draught animals through sales in the market. If the oxen were fed supplementary fodder and gained weight over their working life span, and if cattle market prices did re-
fect the costs of keeping these animals including their live weight and quality - which was not the case during the 1970s at least - then the profitability of draught oxen would be ensur-
ed. But the problem of access to and costly purchase of draught oxen remains.

As discussed in section 7.4 there seems to be no immediate need to maintain a credit system for the purchase of ox-ploughs. But if it is an objective to extend animal traction to non-ow-
ners of cattle, then the question of credit for draught oxen has to be dealt with. Space does not allow for a discussion of this intricate problem. Suffice it to say here, that the best possibility would be to extend credit to small groups of 3 - 4 households which of necessity would have to cooperate on the use of draught oxen, at the same time as they could then better utilize the capacity of ox-carts and implements.

Credit should not be extended to villages as such since an aggregation of so many households does not constitute a productive and social basis for cooperating around a small-scale type of technology. Besides, the indebtedness of villages because of past forms of credit, and the imposition of unpopular forms of so-called cooperation on communal fields - the product of which is outside the control of most villagers and very often not accounted for - has created a lot of resentment.

The other social problem involved in the development of comprehensive animal traction is conditioned by the sexual division of labour and the fact that women do not have control over the ox technology and especially over draught oxen. The question is whether the male heads of households feel the need and incentive to adopt inter-row cultivators for weeding and ox-carts for transport. These activities mainly fall upon women.

As pointed out, the main reason for the lack of adoption of these implements is unavailability and inappropriateness. But a few households do use ox-carts and in some areas, men use the mouldboard plough for inter-row weeding. As in the case of The Gambia, where comprehensive ox-mechanization has progressed the furthest, inter-row weeding, ridging and ox-carting constitute means of relieving women of their work burden. Again this issue needs further study in Tanzania. For instance, would men by means of inter-row cultivators start to take over at least part of the weeding activities? (Not the whole task since in-row weeding between the plants would still have to be done with the hoe, lest check row planting is introduced allowing access by ox-weeders in both directions). If so, how would this affect the sexual control over the product? Will comprehensive animal traction be limited to cash crops?
Ox-carting is a necessary means for transporting sufficient quantities of manure to the fields. Collection, transporting and spreading of manure is in many places strictly a female task. Would men agree to undertake the task of transporting and spreading of manure?

A more general question is whether women have possibilities of acquiring, working with and controlling ox-technology? In Tarime we have seen how women do operate the ox-teams but the ownership and control of these still remain with the men. If male-controlled comprehensive animal traction develops, what are the effects for women in terms of control over the product? Would they become further marginalized as regards control over the means of production and the product? If so, how would this affect the relative levels of cash crop and subsistence production as well as the welfare of the family and especially the children? These questions need further study.

A final note of caution must now be made in conclusion: The development and possible adoption of appropriate implements for comprehensive ox-mechanization is not on its own going to mean a productive 'take-off' for those areas which are involved. It does provide one of the necessary means for increasing the productivity of labour at the same time as it provides one of the means for establishing linkages between the peasant sector, the rural craft sector and the industrial means of production sector, linkages which are a necessary basis for the development of self-contained national accumulation.

Without a balanced appropriate approach towards supporting the livestock sector, the rural craft sector, the marketing infrastructure, availability of necessary consumer goods and other means of production (not least hoes), and without securing terms of trade which provide an incentive for peasant production, ox-mechanization will have little impact. Finally it cannot be sufficiently stressed that the development of comprehensive animal traction will in any case involve a long painstaking trial and error process which will take decades rather than years.
Both of these possibilities should be worked on simultaneously. For the more detailed technical recommendations on these and on making a cheaper, more appropriate ox-cart see sections 7.3, 8.3 and 8.10. This adaptive experimental research programme involves two levels of work which must be closely integrated and coordinated:

1. Farming systems research to identify major constraints, and adaptive testing of implements on individual peasant farms.

2. Adaptive design and testing work at research stations simulating peasant farming conditions.

The basic premise is that it is easier and potentially more productive to adapt technology to peasant farming than it is to transform peasant farming to inappropriate technology. One sign of appropriateness is that the technology is actually adopted. There have hardly been any sales of TAMTU implements like the double-furrow plough, the ridger, the rectangular spike-tooth harrow and the single row seeder. They are all too heavy and too expensive and there is neither a sufficiently high technology shelf nor crucial labour constraints to warrant production of double-furrow ploughs, mechanical planters and fertilizer drills.

There seems to have been a tendency in design work to draw uncritically on European concepts of design and technical efficiency of implements and to go for optimum solutions which can never be realized under peasant farming conditions.

There is a great variety of peasant farming systems and agro-economic zones in Tanzania which necessitates local specific solutions to technological problems and constraints. But even within one village there is great variability between households in such factors as economic and technological capacity, labour availability, cropping patterns, cultivation practices, access to and condition of draught animals etc. These differences would seem to call for a range of implements which would suit not only the country-wide or regional differences in agro-ecological and farming systems conditions, but also individual household differences.
Notes

1. Ethiopia is not accounted for. Here, an indigenous type of scratch plough or 'Ard' has been in use for more than one thousand years.

2. It may well be that there is an overweight of agricultural engineers who indulge more in fancy designs than trying to learn about the farming systems and who dream of designing their own piece of technology.

3. Some examples are found in the seminar proceedings by the Commonwealth Secretariat 1977 and 1979 a) + b). The proceedings also contain a number of very useful papers, and the work by the Secretariat on appropriate technology issues is commendable.

4. The classification of land-use systems and the stages of intensification used below is mainly based on Boserup (1965): The Conditions of Agricultural Growth.

5. Falling average returns to labour or average output per unit of labour time.

6. The problems of the Sahel provides a well-known example of this process under marginal land and rainfall conditions. Land degradation in some of the former feudal areas of the Ethiopian Highlands was a consequence of heavy surplus extraction (personal communication with Professor Mesfin Wolde Mariam). For a historical analysis of the same problem in colonial Tanganyika, see Sway 1980. For stagnation at a higher level with high population densities, see Ludwig 1968, Brewin & Lunan 1956 and Friedrich 1968. For an analysis seeking to combine all the main factors involved, see Kjaerby, 1980b.

7. For a more elaborate analysis, see Kjaerby 1980b:69, and Bernstein 1979:427.

8. For a more detailed account of the factors involved, see Kjaerby 1979b.


12. Ruttenberg (1964:183) refers to ordinances regulating the use of ox-ploughs already during the 1920s and 1930s. Restrictive regulations were also applied in Nigeria (Tiffen 1976).


16. Rotenhan’s study on Sukumaland showed a 60 per cent degree of farm commercialization on plough holdings in Shinyanga compared with some 45 percent in two hoe regions (see Table 2 in Chapter Three).

17. Singida is one of the most important ploughing regions in Tanzania today, and as referred to above, the number of ox-ploughs was high already in the 1950s. The charismatic Native Authority chief in Singida between 1925–39, Mgeni, actively encouraged the use of ploughs. H.K. Schneider (1970), in his monograph on the Wahi Wanyaturu based on field work in the late 1950’s, does not make any mention whatsoever of the plough. In fact he makes great effort to explain away the changes in the area brought about by labour migration, livestock sales, etc. (cf. Chapter 2, 5, 9). Even M.Jellicoe’s work does not describe plough cultivation among the Nyaturu, and we have been unable to obtain other evidence. We only know that 26,585 ploughs were recorded for Singida region between 1976 and 1978 (FAO/Kilimo 1980:7), representing the fourth highest regional number of ploughs in Tanzania.

18. Of the 77 interviewed in Ngamanga and Katygongole villages, 34 farmers had neither ploughs nor bullocks, 16 had ploughs only, 5 had bullocks only and 22 had both ploughs and bullocks (ibid:27). In Katygongole 26 out of 47 had no cattle (ibid:84). It may appear paradoxical that many households have only ploughs, while others possess only bullocks. The phenomenon is well-known in all ploughing areas of Tanzania. Owners of only draught oxen have been unable to get hold of a new plough or repair an old one, due to the severe, general shortage of ploughs, spares and draw-chains. Owners of only ploughs have lost or been forced to sell their oxen. In flood-prone Kyela where the climate is bad for cattle, the high rate of mortality of cattle and bullocks is a particularly serious problem.

19. In Sukumaland and other places, late ploughing is often noted to be a result of too weak oxen just at the onset of the rains ending a period of dry season grazing shortage. But late ploughing can also be a conscious method of reducing the subsequent weeding burden! "... 'farmers in certain parts of Sukumaland have found it useful to delay ox plowing, and therefore sowing, until the first crop of weeds has germinated" (de Wilde 1967, Vol. 1: 101). The weed crop is ploughed in and thus acts as a green manure. A similar technique is used by wheat growers using tractors in North Tanzania.

Staggered planting, weeding and harvesting is applied to overcome labour bottlenecks. This may partly be a way of minimizing risk at the expense of optimal yields where the cultivation season is long enough to allow for it. It has also been reported that part of the sown acreage may be left to weed invasion and that part of the cotton crop may even be left unharvested in the field (ibid). This might be due less to risk factors than to high cost or shortage of wage labour or to shortage of family labour or both.
20. "The average stock owner in Masawa has almost four times the number of livestock units as his equivalent in Usmao (Kwinba) and "the present return to capital invested in livestock is high, particularly in terms of returns to labour involved in herding" (Collinson 1972:31).


22. This rate is very low compared to a rate of around shs. 200/- for the same period in Hanang district where the number of tractors is much higher.

23. This is the case in Hanang district; and in irrigated paddy production in Usangu Plains, Mbeya district, with a rate of 50 shs. per acre for both tractor and ox-ploughing (Branner Jespersen 1973:66).

24. Personal communication with Eva Tobisson.

25. The problem is that labour input is invariably expressed in man-days or man-hours, and labour units in man equivalents. There is no way one can distinguish between women-days and man-days, although this is of extreme importance for an understanding of the constraints of the economy, especially so where women face labour peak crises.

26. Apparently, women might even find men owning ox technology attractive: "In fact young men at the marriage age will first strive to acquire at least a pair of oxen and one ox-plough before he could make his mind to settle as a family man. According to one villager it is always possible to win a girl of one's choice if he already has a pair of oxen and a plough" (Mlambo & Nnko 1982:11).


33. Singh (1977: 22) referring to Clayton (1972: 27). It is a question whether Clayton's estimate is not overly optimistic and whether such a high number of ploughs was at all available for purchase. By 1974, UFI had a virtual monopoly in plough production and imports were restricted.

34. FAO Mission Report, 1975; Beeney, 1975; Singh, 1977; Dagg, 1978. There might well be more recent UNDP/FAO, World Bank, etc. evaluations which I have not seen.

36. In the case of Tanzania we must add both parastatal ranch and dairy schemes (see Raikes, 1981).

37. For an excellent theoretical critique of this narrow and wrong assumption, see M. Wuyts (1979): On the Question of Mechanization of Mozambican Agriculture Today: Some Theoretical Comments.

38. Rather, the state farm sector generally runs at a loss. For the livestock sector development budget, Phil Raikes estimates the parastatal sector to have absorbed in the region of 70 percent of total funds while it only holds 1-2 percent of the national cattle herd. (Personal communication).

39. The most appalling case I know of is that of the largest farmer and business tycoon in Arusha - and possibly in Tanzania - who in 1979 reportedly got a whole batch of 30 new tractors consigned for Arusha Region - whilst already owning around 100 tractors - in addition to buying up large stocks of fuel which was rationed at the time (personal communication with settlers and officials). Most of his some 50,000 acres of cultivated land is grown in seed beans for export.

40. Personal communication with Juhani Koponen, translating a feature article in a Finnish newspaper.

41. TRDB (1981): Notes on 1981/82 TRDB Lending Budget. Total bank lending potential was T.Shs. 480,220,000 while approved lending was 183,600,000.

42. In the early 1960's TAMTU tested a 'Chinese Single Furrow Plough', possibly not the same as the one produced by UFI. Test conclusion: Too weak and not suitable for Tanzanian soils (TAMTU Test Report No. 2/64/65/A4, June/July/65.


44. P.J. Northwood worked for a number of years in the 1960's for the Tanzanian Ministry of Agriculture and pioneered research on chisel and till cultivation techniques at Tengeru Research Station in Arusha. At that time the ministry was reportedly not interested in his research on soil and moisture conservation techniques, in contrast to the settlers who have now widely adopted the recommended chisel tined implements (personal observation and communication with Phil Raikes). The latter method also saves energy per cultivated acre, a very important point. The effect produced by such chisel points as duckfeet and weeding sweeps mounted on ox-drawn tool-frames is, however, not new to Tanzanian soils. The short-handled weeding hoe, which is used to undercut weeds horizontally, produces more or less the same effect.

45. The body of literature on agronomic and technical problems is overwhelming, but see Beeney 1975; Commonwealth Secretariat 1977, 1979 a,b,c; FAO 1969; FAO 1972, Matthews & Pullen 1975; Gibbon 1981; Starkey 1981. For other references see Kjaerby 1982b.
46. The 'arina' toolbar, also from SISCOMA, is supposedly being manufactured at UFI (?) and has reportedly been tested at Dept. of Engineering, Faculty of Agriculture, Morogoro. The 'ariana' is considerably more expensive and too sophisticated (e.g. wheels) for Tanzanian conditions of peasant farming.

47. In fact, there are indications that the weight of cattle is on the decline in Tanzania. The average live weight of cattle, most of these oxen, received by the single largest buyer, Tanganyika Packers Ltd. (TPL) has declined from 249 kilos in 1965 to 160 kilos in 1976/77. One important reason for this is that Tanzania Livestock Marketing Company (TLMC) has paid too low prices at auctions without price grading for quality, and that the heavier cattle apparently went to private buyers paying better prices (Kjaerby 1979: 111, and Marketing Development Bureau (1977:8): "Price Policy Recommendations for the 1978/79 Agricultural Price Review. Annex 12 : Livestock"

Ministry of Agriculture, Dar es Salaam.

Even so, the shortage of grazing has over the years become an increasing problem, not least as a consequence of villagization, and also because of expanded cultivation as a consequence of villagization, and also because of expanded cultivation as a consequence of population growth. To start stall-feeding of oxen does involve a whole range of changes in the land-use and farm management system not likely to come about soon (cf. above Section 2.5).

Moreover, 'draft animals fed on produced fodder are not an efficient source of energy supply. The mechanical energy supplied by them is probably only some 3-5 percent of the energy contained in the fodder they consume' (Boverup 1981: 49, referring to C. Cipolla (1962): The Economic History of World Population. Hammondsworth, Penguin). This low rate of energy conversion should, however, not be taken at face value, since it depends on the type of fodder crop and its return to labour and other types of energy involved in procuring it. Returns from the animals in terms of milk, meat, hides, etc. have to be included as well to get a comprehensive economic calculation of their utility quite apart from their social importance. Partial stall-feeding of oxen during the short working season on the foliage of fodder trees like 'leucaena', grown at the homestead, involves very little labour and energy consumption and should be tried out (see National Academy of Sciences (1977): Leucaena: Promising Forage and Tree Crop for the Tropics. Washington D.C.).

48. For the 1979/80 season, Hanang District agricultural office estimated its demand for ox-ploughs to be 2,065 with 6-700 ploughs for each of the three most important ploughing divisions. The figures might be high but they do correspond to the mentioned requests from one division in Iringa. The high demand is a result of the decline in and exorbitant cost of tractor ploughing.
49. Hanang District Agricultural Report, General File D.20/1, Vol. II, 1979. For the 1978/79 season, there were plans to increase the number of villages to 50. I have myself been a participant in this programme and can testify to the report. Since the participants had to take the full package to be allowed a plot in the blockfarm, the fertilizer was simply thrown away or dug into a hole. Most of those who tried had their crops burned. The extension advice differed for every extension officer. Some told us to cover the fertilizer, others to put it on top of the soil. There is no sufficient expertise from the government, and peasants decided to throw the fertilizer away. After 1978, no villages ordered fertilizer (personal communication with informed peasant). Though some peasants have complained about the hybrid seeds (622) the composite and the insecticides have on the whole been well received.


51. This would first of all involve the supply of cheap, appropriate ox-carts and in some places - depending on villagers' (sometimes conflicting) interests - possibly a change in settlement and village land-use layout, allowing for a higher number of smaller villages with a view towards a more integrated system of grazing and cropped acreage (ley farming), as well as the provision of appropriate fodder crops, planted near the homestead. Such a system - which would take years to develop - does not depend on seasonal inputs with a high foreign exchange component.

52. It is being tried in Machakos in Kenya but I do not know the results (personal communication with D. Gibbon). David Gibbon (School of Development Studies, University of East Anglia, Norwich NR4 7TJ) has a long practical and theoretical experience with oxenization in a number of African countries. He is a very resourceful person who can be consulted for contact with relevant projects and for ideas and practical solutions.

53. Despite this sensible statement there have nevertheless been a few individuals in Sukumaland who have bought it. There are always a few enterprising and experimental minded individuals around with enough money to try out fancy equipment. Their experiences are extremely useful but their marginal interests cannot constitute the basis for either mass production, or spot production as in the case of the 2-furrow plough.

55. In FAO (1972): "The Employment of Draught Animals in Agriculture" it is stated (p. 83) that ....'it should be remembered that the true ard is considered a secondary tillage type implement'. This is incorrect. The ard is both a primary and a secondary tillage implement.

56. For an excellent account of the combined expansion of maize production and ox-ploughing at the expense of fallow systems and intensive finger millet mound cultivation on the Ufipa Plateau in Rukwa Region as a result of villagization, see Collinson, Croon and Mkindi (1980).

57. Ownership of donkeys - most commonly found in Northern Tanzania - is even further limited to relative few households. They can be borrowed or hired and are used mainly as pack animals and probably only very few are used as draught animals. The advantage of using donkeys for draught purposes is that they are more easy to train and are more able to remember their training skills than oxen; the disadvantage is that donkeys are weaker.
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