Centre Technique de Coopération Agricole et Rurale ACP-UE
Technical Centre for Agricultural and Rural Cooperation ACP-EU
CTA

# Mechanisation of agricultural work in sub-Saharan Africa

## Proposals for integration of mechanisation in sustainable rural development strategies

*Study report*



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*March 1997*

**Technical Centre for Agricultural and Rural Cooperation (ACP-EU)**

The Technical Centre for Agricultural and Rural Cooperation (CTA) was established in 1983 under the Lomé Convention between the African, Caribbean and Pacific (ACP) States and the European Union Member States.

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# Summary

The study gives an overview of past and current experience, together with a brief description of the most common techniques, and identifies the determining factors in the development of agricultural mechanisation in sub-Saharan Africa. A number of recommendations are made with a view to improving the integration of mechanisation in rural development strategies. These are addressed to governments, private operators, donors and NGOs.

On small and medium-sized farms, the use of engine-powered field equipment (four-wheel and single-axle tractors, combines, etc.) is rare, whether individually or collectively owned, or hired from service companies. Public enterprises have been a failure, and have considerably hindered the emergence of private services. *Tied bilateral aid* has failed to reach its target (farmers), whilst disrupting local import/distribution/maintenance channels on a long-term basis. The performance of *national companies manufacturing* and assembling farm machinery, set up with outside capital and know-how during the 1960s and 1970s, was disappointing; they monopolised aid resources to the detriment of the craft sector and informal SMEs manufacturing farm equipment and parts.

On the other hand, if the increase in the numbers of draught animals and tools acquired by farmers is any indication, the development of *draught animal cultivation* is one of the notable successes of past policy. However, in some areas where it has been used for some decades, the technology seems to have reached a plateau or even begun to decline in technical quality. Furthermore, experiments in *local manufacture*, setting up blacksmith shops and improving local know-how, are particularly encouraging (e.g. blacksmiths' association in Mali, small companies such as the SOMATA and the AAMA, etc.).

*Access to markets* and changes in *population density* determine how farm land is exploited and the technical feasibility of mechanisation, which can accelerate the processes of soil over-exploitation/degradation in heavily populated areas. *Resource conservation* demands not only the *controlled use* of mechanisation but also the reform of *land laws* ensuring farmers life interest in land they have invested in. Population movements and the development of non-agricultural sectors are too limited to alter the availability and cost – which is still low in Africa – of rural labour and have a limited impact on mechanisation which will, therefore, involve only energy-intensive activities for some time to come.

The *political and macroeconomic environment* determines to a large extent the capacity of farms to sell their produce and thus to invest in mechanised techniques. The priority for governments is thus to create a favourable environment for technological progress: investment security, the organisation of markets for farm produce, infrastructure, product prices guaranteeing a stable and adequate income, the value of money, consistent customs tariffs, etc.

Governments must also encourage the establishment of professional organisations (for farmers, craftspeople and agricultural machinery contractors), train their senior staff and take responsibility for the functions vital for development so long as the latter are not in a position to do so, i.e. for some time yet. These functions include i) primary and secondary technical education, the training of mechanics, specialist craft workers, engineers and agricultural engineering contractors; ii) information, extension and research; iii) support to local manufacture. To this end, it is essential to strengthen centres of expertise in mechanisation.

The support for institutional reform and integrated local development provided by donors and NGOs must be better coordinated. For local mechanisation projects to succeed and their impact to be sustainable account must be taken of land law problems and support given to a range of operators supplying the services needed for development. One of the greatest challenges to animal traction programmes is that of disseminating intensive management methods for draught animals.

Existing animal traction networks must be strengthened and open up to the range of mechanical techniques, both pre- and post-harvest, and energy sources.

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# Introduction

The study follows on from the conclusions and recommendations drawn up during the meeting of the Committee for Regional Agricultural Information Programmes and Strategies (CRAIPS) for Central Africa, held in Bujumbura (Burundi) from 8 to 10 February 1993. Participants at that meeting stressed the importance of mechanising farm work as a factor in increasing productivity. However, mechanisation does not seem to take a high priority in agricultural development strategies in Africa, although 80% of agricultural tasks are still done by hand and slightly less than 20% using animal traction.

"Agricultural mechanisation" is used here in the broadest sense of the term. Studies made by the World Bank (Binswanger et al., 1988) define it as a process involving:

- the use in agriculture of methods calling on larger amounts of mechanical energy;
- the development, use and management of a pool of mechanical equipment for land clearing, water control, cultivation, maintenance, storage and primary processing of agricultural produce;
- the use of manual and animal-drawn tools and machines with internal combustion engines or electrical motors and their accessories.

The scope of this study is, however, confined to the mechanisation of field work and transport. It will therefore tackle the adoption and use of innovative manual tools, draught animal cultivation and engine-driven equipment, in the fields and for transport purposes.

According to the terms of reference, the aims of the study are

- to identify the most appropriate means of raising the awareness of the various operators (small farmers, policy-makers and research managers) regarding the contribution of mechanisation to agricultural development,
- to suggest activities at national or regional level to promote the mechanisation of small and medium-sized farms,

throughout the regions of western, central, eastern and southern Africa.

## Why mechanise?

Farmers have strong reasons for wanting to mechanise their activities: to produce more for the same amount of work and/or to increase the area they cultivate; to respond to excessive demand for labour and reduce its arduousness; and to keep to the farming calendar. However, they are selective in mechanising activities, making choices in accordance with their resources and the constraints they face, which vary depending on their access to labour and their level of basic equipment. Governments and donors list the same reasons for supporting the development of mechanisation, along with others such as: improving the living conditions of rural people or certain social groups;

organising production (e.g. collective tractor fleets); or indeed simply promoting technological progress. All too often, the cost and advantages of these approaches are not measured against or compared with other approaches, which would not necessarily involve investing in mechanisation. The failure, in particular, to take account of training needs and investment profitability has in some instances led to a waste of tax-payers' money.

## Content of the report

On the basis of a study of past and ongoing experience (Chapter 1) and an inventory of mechanised techniques in Africa (Chapter 2), the first section of the document puts forward a typology of factors determining the development of mechanisation (Chapter 3). The second section contains recommendations relating to strategies for the *sustainable development* of mechanisation, which are consistent with *rural development policies* (concepts defined in Chapter 4). These recommendations are addressed to governments (Chapter 5), private sector operators (Chapter 6), donors and NGOs (Chapter 7) and also concern mechanisation networks in Africa (Chapter 8).

# First section:
# analysis

# 1. Lessons learned from past and current experience

## 1.1 The failure of public sector engine-driven farm equipment services (tractor hire services)

In the 1960s and 1970s, many African countries, particularly in the English-speaking part of the continent, set up companies to manage tractor and equipment pools with the worthy objective of solving the mechanisation problems faced by small farmers, primarily those relating to soil preparation and transport. An assessment of 20 public sector programmes of this type was conducted by Seager and Fieldson (1984, quoted by Binswanger et al., 1988):

*"None of these programmes was able to provide the intended services without suffering heavy losses and most of them failed altogether. The high cost of the companies is connected with (...) the absence of economies of scale resulting from the use of large tractor fleets, (...) lack of staff motivation regarding efficiency, (...) low rate of use of the machinery, (...) difficulties competing with private contractors, or (...) when private contractors are not making profits, public companies suffer even more substantial losses".*

## 1.2 The weak development of motorised equipment under individual, company or collective ownership

### Individual ownership

Motorisation on the basis of individual ownership has developed only in large landholdings (estates set up before independence, some of which became State farms), particularly in East and southern Africa:

- single axle tractors are virtually unheard of outside projects and research stations;
- government service-providing enterprises loaning conventional tractors have practically all disappeared (cf. Chapter 1.1) and private enterprises are finding it difficult to take over;
- the CFD (French development fund) stopped financing so-called "intermediate motorisation" pilot projects in 1992 (more than 1,500 28 hp tractors designed for cotton production were sold to producers in West Africa and Cameroon).

The devaluation of national currencies connected with structural adjustment has pushed up the price of motorised equipment and every other type of imported equipment. As the rise in prices paid to producers has been less marked, investment in motorisation has become increasingly difficult.

The following figures illustrate current constraints on the development of motorisation:
- in Guinea, whereas in 1984, 24 tonnes of paddy rice were required to acquire a 50 hp tractor with a plough, sprayer and trailer, 150 were needed in 1995;
- in Tanzania, in 1985, 83 tonnes of maize were needed to purchase a 70 hp tractor with the same tools, but 400 in 1995.

### Groups

Attempts have been made to remedy the failures of public enterprises by promoting agricultural machinery sharing rings and other forms of farmer group. The main types of group are involved in the use of tractors, mills and rice shellers by women's groups. In most cases, for communities without the cohesion or skills to manage a particularly costly production tool, sharing ring type associations have been recommended and subsidised. With certain exceptions, the establishment of groups of equipment users is only viable if the size of a group does not exceed that of the family unit.

### Problems with the emergence of private service companies

While the failure of State companies providing tractor-hire services (see above) obstructed the emergence of private companies – through competition – it has not stopped them altogether. Small-sized enterprises start up regularly, economic climate permitting, generally when price increases on the world market or domestic measures improve the profitability of national agricultural commodities marketing chains[1]. Demand from farmers then focuses on ploughing and transport, or more rarely on secondary soil tillage and, in the case of cereals, on threshing, hulling and milling.

In general, there are no checks on the development of cultivation services, which presents risks in terms of soil conservation. To avoid breakage problems on soils still containing stumps, tillage is usually done with disc ploughs; this work is of poor agronomic quality and can lead to erosion. Government and donors should inform and train the owners and operators of these private tractor fleets and above all the service users regarding the risks of using tractors in the fields.

## 1.3 The adverse effects of tied bilateral aid and donated equipment

Most African countries have witnessed the failure of tied bilateral aid, which consists of supplying or selling equipment manufactured in the donor country. Senegal provides a telling example of this (Mbengue). One of the primary reasons for failure lies in the

[1] This point does not refer to private tractor fleets belonging to farms set up on the large landholdings mentioned above, which may also provide services.

growing incompatibility between products manufactured in donor countries – particularly European countries – and African production conditions, and the fact that it is impossible to maintain or supply spare parts for machinery imported in small quantities. Bulk purchases made to equip State agencies or farmer groups and imposed by the administration, lead to the management problems mentioned above. This was the case for operation *Rattrapage Paddy,* which imported 1,400 tractors and their accessory equipment into Madagascar between 1973 and 1979 (Rabezandrina).

Furthermore, although donations and purchases of equipment negotiated between governments, and purchases of machinery within the framework of projects do allow for significant price reductions, they rarely match the demand and financial capacity of farmers. Calls for tender may be drawn up by brilliant experts, but the choice of supplier (or the absence of competitive procedures in that choice) can lead to the import of inappropriate equipment or brands not found in the country and for which no spare parts are available. In addition, the mechanisms for selling and allocating equipment imported in this way, in the recipient country, are rarely monitored and can result in misappropriation and inequalities. The beneficiaries of the purchases are generally individuals who are already receiving support, and the poor farmers who by rights should gain the most from such aid are left out.

These programmes can also result in the counterproductive deployment of government mechanisation departments, which have other important tasks to perform. For example, during a programme to import several hundred tractors, the government may ask its agricultural engineering department to handle the transit of the vehicles and accessories, their sale, credit organisation and even the management of spare parts and the establishment of repair units. The workload involved can be excessive and go beyond the usual scope of a department used to dealing with inventories, surveys, research and training.

## 1.4 Overly centralised national manufacture, detrimental to the craft sector

Past policies focused on setting up national companies to manufacture or assemble agricultural machinery. This was the idea behind the SISCOMA in Senegal, the SMECMA in Mali, the CNEA in Burkina Faso, the SIDEMA in Madagascar and the UFI and others in Tanzania, all of which benefited from the injection of outside know-how and capital. These enterprises should have gained from the adjustments and devaluations which gave local manufactures an advantage over imports. However, agricultural engineering now amounts to less than 25% of the activities of SISMAR (SISCOMA before privatisation), while the Tanzanian companies are bankrupt for lack of capital and as a result of the rise in interest rates. The CNEA received an exceptional order for 30,000 ploughs financed by an Austrian development cooperation programme, whereas it had been producing an average of 10,000 to 15,000 tools per year for the previous 15 years. In

addition, local companies involved in assembling tractors and complex equipment all went under; their only advantage was the saving made on freight costs, but they were unable to overcome assembly problems and, in particular, difficulties linked to the cost of spare parts, all of which were imported.

These enterprises had a monopoly on government attention and resources at least until the beginning of the 1980s and were the main suppliers to agricultural development companies. When these companies, their only clients, went bankrupt (cf. the example of the ONCAD in Senegal, or the case of the cooperative unions in Tanzania), these enterprises went down with them.

All agricultural machinery manufacturers - craftspeople, small and medium-sized industries, including those mentioned above – suffer from the under-development of the mechanical and metal working manufacturing sector in their respective countries. The absence of a local steel production sector, coupled with ill-suited customs duties and tax systems, drives up the cost of materials[2]. In addition, when craftspeople, technicians and engineers trained in the construction and maintenance of agricultural machinery often seek employment in other more buoyant sectors – such as transport – where job opportunities and salaries are greater than in agriculture.

## 1.5 Supply that could mask real demand from farmers

A great deal of machinery invented in Africa for draught animal cultivation, the processing of products and by-products, transport, pumping and storage, has not found buyers. All too often, supply takes precedence over real demand from farmers, owing to the interventionist, vertical organisation of research and extension services. Research has played a dominant role in developing and disseminating agricultural machinery, and also in allocating development resources. A telling example is that of the CNRA in Senegal, which was the main agronomic research station in West Africa (Bordet, 1988).

It is easy, with hindsight, to point up the limited impact of this research work and to demonstrate that it was directly inspired by the history of agricultural development in Europe[3]. Sales of machinery involved a very restricted range of simple or lightweight equipment which had been developed in the early 1960s. The bulk of the equipment recommended by research was geared towards intensification, which did not occur since the availability of land and the low cost of labour encouraged farmers to adopt extensive strategies. The principles dear to European agronomists concerning the

[2] Zimbabwe (along with South Africa) is an isolated case, being seemingly the only African country to exploit steel and coal resources. The difficulties of the national iron and steel company (ZISCO) weigh heavily on the Zimbabwean mechanical and metal working sector however. Certain Zimbabwean companies (Zimplow, Bulawayo Steel Products) seem to be the only private companies of industrial dimensions in sub-Saharan African that are still manufacturing equipment suitable for small farms.

[3] As land and labour were scarce, mechanisation with a view to increasing yield per hectare was the only way to increase farm productivity.

integration of cropping and livestock (manure production and ploughing in, ley farming, stabling, making use of by-products, etc.) are adopted by farmers only when population pressures and a short supply of arable land make them unavoidable and when land and common grazing rights do not prevent them from benefiting from their efforts.

## 1.6 Success with clear limits: the development of draught animal cultivation

The expansion of draught animal cultivation is undoubtedly the most notable success of African mechanisation policies over the last 50 years. Although the expansion is difficult to quantify, Havard (et al., 1996) estimates that numbers of draught animals in 11 French-speaking African countries (the CFA zone and Guinea) rose from 339,000 in 1960 to more than 1.8 million in 1995. In the same countries and over the same period, the stock of animal traction equipment rose from 345,000 to 2.3 million.

However, it would seem that a ceiling has been reached and, in some countries, draught animal cultivation is even on the decline. While it is true that the numbers of draught animals are rising, the quality of draught animal cultivation techniques is deteriorating (poor animal training, nutrition and health, teams driven by two or three people, inefficient yokes, poorly maintained or badly adjusted tools). This deterioration may be the result of:

- difficulties maintaining and passing on know-how among farmers;
- a lack of integration between cropping and livestock activities, limiting opportunities for keeping animals on community farm land and feeding and caring for them properly;
- the disappearance of mechanisation services or the reduction in their advisory capacities, both in government and development agencies;
- an unfavourable trend in the ratio between product prices and equipment prices.

The decline is not generalised, however. A differentiation can be made between "good" arable/livestock farmers, who have been able to master the techniques, because agriculture is a profitable activity for them, and the masses of farmers who remain poor in unproductive systems.

In some cases, animal numbers and stocks of equipment are stagnating, owing to the short supply or disappearance of uncultivated land, swallowed up by expanding farms, and also because all the farms likely to equip themselves have done so (e.g. Fouta in Guinea, the groundnut-growing basin in Senegal, southern Mali, western Burkina Faso).

## 1.7 Encouraging signs in small-scale and semi-industrial manufacturing

Smithing and small-scale iron and steel metallurgy are age-old practices in Africa. In some areas such as the Upper Niger region, some blacksmiths had little difficulty in copying the models imported during the colonial period, in particular the first animal-drawn ploughs. Equipment manufactured in the craft sector is of inferior quality to industrially-produced items but cheaper and thus better suited to the financial capacity of most farmers. Traditional blacksmiths and craftspeople were put at a particular disadvantage by the above-mentioned centralised construction policies and particularly by the monopoly on channels set up with development companies. Craftspeople, however, still manufacture parts and complete sets of equipment (manual tools, ploughs, harrows, cart platforms, wheelbarrows, etc.), although, unlike national enterprises, they have no access to such large-scale preferential channels for the purchase of materials, financing or knowledge transfer.

There have been programmes to train blacksmiths since the 1970s; some have tried to integrate blacksmiths gradually within the maintenance networks for mass-produced equipment. In some cases, training activities have led to blacksmiths taking over manufacture totally or partially. The example of the blacksmiths trained by the CMDT (Malian textile development company) is a notable success story. This remains an exception however; craft associations come up against the individual nature of the activity and the reluctance of craftspeople to specialise in certain products to complement other craftspeople, when the market in which they are selling is not growing appreciably.

Mention should also be made of the establishment of small and medium-sized enterprises, based on local and/or imported know-how and simple technology, bringing previously imported components into local production. The SOMATA, set up with support from the Belgian NGO ACT and the Guinean NGO RGTA in Kindia (Guinea), and the AAMA, set up with assistance from the IMAG-DLO using Dutch financing in Niono (Mali), have proved remarkably successful. Favourable conditions have enabled them to sell their production: in the case of the SOMATA, the CFDT's relaunch of cotton-growing in Guinea and the revival of rice production linked to the privatisation of some of the services of the Office du Niger.

# 2. Current status of technology

## Stocks

Up until about 10 years ago, mechanisation services had sufficient resources to conduct surveys on farmers' equipment and to have an approximate idea of stocks of equipment and draught animals. In the absence of reliable data, it is becoming difficult to measure quantitative and qualitative developments in mechanisation. Havard (et al., 1996) has, however, suggested chronological series of inventories for 11 French-speaking countries: see Chapter 1.6 above.

## Equipment and techniques

The level of equipment owned by farmers depends on the product grown and the state of the commercial channels linked to that product. For example, equipment specific to cotton (sprayers) and groundnuts (lifting ploughs, depodding machines and shellers) is more widespread than that used in similar operations relating to cereals.

- Despite its arduous nature, **manual cultivation** is still practised on the vast majority of farms. The extreme diversity of the tools used has already been described in many illustrated works. Blacksmiths and a small number of industrial enterprises have added more recently-introduced tools - axes, picks, weeders, sickles, shovels and maize shellers – to their traditional manufactures (daba hoes of all types, hilaires, angady (spades), kayendos, cutters, etc.). Imports, particularly from Asian countries, still account for the bulk of the former tools and for the totality of tools such as sprayers. Only a small proportion of manual tools are, however, imported, since the diversity of locally manufactured equipment provides a better response to user demand. The use of a tool that appears simple can lead to a radical change in the production process. For example, in harvesting rice, if a sickle is used rather than a knife, it is necessary to adopt varieties that mature at the same time, as with the sickle, unlike the knife, the panicles cannot be selected on the basis of ripeness. However, some farmers may customarily prefer to sow heterogeneous varieties as a safeguard against climatic risks. In addition, whereas the knife allows short-stemmed panicles to be harvested – and the harvest may then be stored in that condition – the sickle cuts long stalks, making it necessary to transport larger quantities of material, a heavy operation, and to thresh before storing, thus altering the storage method (observations made in Gambia).
- In the case of **draught animal cultivation**, the most commonly used tools, in descending order, are: multi-purpose cultivators, ploughs, carts and precision planters (Havard, 1996), all manufactured locally. The plough is the basic tool for systems that enjoy good rainfall (over 800mm per year), as the duration of the cycle allows

ploughing and the fight against weeds demands it. Planters and multi-purpose cultivators are the essential equipment in areas with low rain fall (less than 800mm), since rapid superficial cultivation and even direct planting are necessary to sow quickly, the prerequisite for a minimum yield. Depending on the area, multi-purpose cultivators are used for weeding/hoeing and lifting groundnuts (in the Senegalese groundnut-growing basin), or for weeding and ridging (north Cameroon, Chad).

- The other draught animal cultivation tools are much less widespread, with the exception of certain areas: harrows (irrigated cropping in Mali), single-purpose hoes and ridgers, lifters (in Senegal), a few seed drills for rice. One note-worthy local feature is the "maresha", a very cheap ard plough used for thousands of years and easily manufactured by village blacksmiths; it is used almost universally in Ethiopia. Paradoxically, the ard or swing plough is rarely used in the rest of sub-Saharan Africa, despite its obvious advantages for areas with inadequate rainfall and no heavy draught animals. At this level, mention should also be made of the lack of mechanical equipment to harvest cereals (mowers), owing to the absence of animals with sufficient traction power and the specific characteristics of African cereals.
- In the case of **motorised cultivation,** which concerns large farms and agricultural contractors, the equipment is used is standard: tractors, trailers, ploughs and disc harrows, able to work in all ground conditions (e.g. in the presence of stones or stumps) without too many breakages. It is interesting, however, to point out the (promising) attempts at motorisation on small farms in Ethiopia, which hire combine harvesters from private enterprises.

## Animals and livestock farming systems

After manual labour, animals constitute the main source of energy for agricultural work in Africa; the following are used in decreasing order of importance: cattle, and, in areas not affected by trypanosomiasis, donkeys, horses and mules.

Donkeys, which are numerous in semi-arid areas (they account for 30% of draught animals in Ethiopia), are inexpensive, hardy, easy to keep and stolen less frequently than cattle. Donkeys can work light soils. Their main disadvantage (and this applies to horses as well) is that they cannot be fattened up for sale. They are not very powerful (rarely weighing over 150kg, whereas a horse may weigh up to 300kg) and thus have limited draught capacity. Horses, much less numerous than donkeys, are used for riding and for drawing carts. Mules are even less common. In most countries, horses, which socially are considered luxury animals not to be put to work in the fields like oxen, are more difficult to keep; they are used in as draught animals mainly in Senegal. In Mali, Burkina Faso and Niger only donkeys are used in harness. In areas with less than 400mm rainfall, people generally transport goods on their backs. In semi-arid areas (400-800mm rainfall), donkeys (and horses in Senegal) and carts are used for sowing and hoeing/weeding.

*Cattle*: zebu cattle are the most powerful, but it is very unusual for them to weigh more than 500kg; the small N'dama bulls, the only draught animals available in areas affected by trypanosomiasis, are even lighter (less than 300kg) than other species. The use of draught cattle has by no means met the standards recommended by researchers in the 1960s:

- where cattle rearing is a traditional activity, the practice of entrusting animals to herders during the dry season has a negative effect on their training and their nutrition at the beginning of the rainy season, the very time they should, on the contrary, be receiving special care and feeding;
- when farmers stop receiving advice, there can be some decline in animal training practices: harness which causes injuries; two drivers, whereas in countries with ancient traditions in draught animal cultivation, it is common for the team to be driven by one person;
- practices such as stabling cattle, managing cropping residues and organic manuring are rare[4]; these methods are adopted by farmers only when they are obliged by population pressure and the short supply of arable land, and only when customary law permits; even in situations of very heavy demand on land, land laws and grazing rights can prohibit the implementation of such methods, as in Lesotho for example (Bordet, 1994);
- with the exception of Madagascar, the use of cattle to draw carts is uncommon, in spite of the advantages, which include keeping animals on the farm throughout the year and selling or using a transport service for products of all types; the high cost of carts is one explanation, but cultural resistance may also be a factor;
- on the other hand, despite the fact that horses and donkeys cannot be fattened for sale, the rapid increase in their use in certain regions (Senegal) may be explained by the fact that these animals provide greater transport services than cattle and are quick and suitable for light work (sowing, weeding/hoeing) on sandy soils. However, in most parts of Africa, cattle are the only option for health reasons (trypanosomiasis).

[4] With the exception of certain highlands (Kenya) or the cotton-growing region of southern Mali where 75% of farms use manure (CFDT, 1993)

# 3. Typology of critical factors in the development of mechanisation

The determining factors in the development of mechanisation fall into two major categories: micro-factors (of an economic, social and technical nature at farm or community level) and macro-factors (of an economic or political nature or relating to the overall dynamics of agricultural production systems at provincial or country level). The former are most readily invoked to explain the slow development of mechanisation in Africa. These factors include a lack of financial resources, credit, technical know-how and education on the part of producers, the small-size and dispersion of farms and an excess of cheap labour. They are certainly valid, and are confirmed by anyone directly involved with African farming, but they are conditioned to a large extent by the macro-factors which can be seen as the really critical factors in the development of mechanisation.

## 3.1 Microeconomic and social factors

The primary condition for the sustainable development of mechanisation is the possibility for farms to accumulate savings and capital by means of their agricultural activity. The fact that most African farms lack financial resources is obvious but it stems from causes related to macroeconomic and infrastructure policies: access to markets is poor, price instability discourages those who would like to produce to sell surpluses and agricultural product prices are too low for savings to be made.

It is true that schooling, technical training and agricultural extension are often inadequate – varying from one country to another. However, whereas fleets of complex transport vehicles (buses and taxes) are often maintained with prodigious ingenuity, agricultural machinery, for the most part simple and inexpensive, is less well maintained. Mechanics trained to repair or manufacture agricultural equipment often prefer to work in the transport sector or others. The reasons may lie in the high profitability of transport activities (owing to the shortage of roads and vehicles) and the low profitability of agricultural activities, owing to the fact that agriculture is a low priority in economic policy.

The small size and dispersion of farms and surplus cheap labour undoubtedly hinder the development of mechanisation, but these factors are the result of the dynamics of the production systems, and of a relationship to land and its management that is to a large extent determined by market access and population density (see analysis below).

## 3.2 Macroeconomic and political factors

There is reason to believe that the most critical factor affecting agriculture, not only in terms of the development of mechanisation but also, more generally, of technical progress in rural areas, is the political and economic environment.

Farmers (and other private operators involved in the development of mechanisation) will only invest in their own training or expensive equipment if they find good reasons for doing so in their immediate environment, such as:

- investment security, i.e. guarantee of a return;
- organised markets for agricultural products, ensuring outlets for surpluses; roads and market places facilitating commercial exchanges;
- attractive or at least stable or relatively predictable, selling prices for their products, as well as reasonably low purchase prices for equipment.

These parameters do, of course, depend on government attitudes regarding:

- taxation and equality before the law;
- infrastructure policy in rural areas;
- agricultural income policy;
- hence customs policy on agricultural products, and also inputs;
- hence economic policy and, in particular, the value of money.

These aspects are discussed in detail in Chapter 5.1 below.

By reducing national budgets, structural adjustment has obliged governments to redefine their stance in these fields and, in particular, to cease all types of subsidy. Adjustment programmes have, however, avoided issues relating to the protection of farmers' income and the financing of their productive investments.

Analysis of the real impact of subsidies, not only on farmers' equipment, but also on the agricultural engineering sector, is needed to define the conditions under which they can be useful, without creating distortions amongst the parties involved.

The success of any credit operation, be it commercial, cooperative or institutional, depends on the above-mentioned parameters. All too often, credit is cited as an essential factor, and it is forgotten that it can be repaid only once the borrowers are working with stable markets. Credit granted by cotton companies is, to our knowledge, the only form of equipment financing for small farmers in Africa that works – although not without problems relating to group guarantees – as the companies are able to recover loans without too much risk, by deducting their due from the payment for the harvest[5].

[5] Yet this reimbursement in kind is only possible owing to the purchasing monopoly enjoyed by the cotton companies, a monopoly criticised by certain donors.

## 3.3 Dynamics of production systems

It is worthwhile recalling some of the conditions that led to the expansion of mechanisation and explain its current limitations, and taking them into account when drawing up future strategies.

### Market access, demographic growth and the nature of production systems

As Pingali (and Bigot, Binswanger, 1987) showed on the basis of the work of Boserup, market access and demographic growth are the main determining factors in agricultural intensification[6] and thus, in particular, in the move from manual to draught animal or motorised cultivation. Therefore, mechanisation is unlikely to develop in areas with low population density where fallow systems are the most profitable (in terms of labour productivity) and where stumps (or the high cost of stump removal) prevent the use of animal- or tractor-drawn tools. There are population density and intensification thresholds, which vary in accordance with local conditions (nature of soil, rainfall, length of rainy season, etc.), beyond which farmers will opt naturally for animal draught power because it reduces their labour requirements. Conversely, below these thresholds, attempts to encourage mechanisation are likely to fail. In many situations in Africa, land availability and the low cost of labour have encouraged farmers to adopt extensive strategies (minimising the quantity of labour and inputs per unit area), explaining the difficulties encountered by research and extension services in persuading them to adopt intensive agricultural methods and equipment. However, there are large variations in population density and resources within individual countries and provinces, which make it necessary to adjust development activities accordingly. In addition, migratory movements can quickly transform the demographic situation within very few years (see below).

No single strategy can therefore be applied to a country as a whole, but a range of strategies are required to reflect market access conditions and population density in each region.

### Technical know-how of farmers, yields and input use

It is not the adoption of animal draught power or motorisation that leads to intensification and sedentarisation in agriculture, but the contrary; intensification is governed above all by market access and increases in population density (Pingali et al.). Ploughs are impractical unless forest or shrubby plant mass has given way to grass cover from which stumps have been at least partially removed.

Changing to mechanised ploughing or planting does not necessarily imply increased yield per unit area, and is motivated by other advantages such as area expansion and

[6] Intensification is here defined as moving from cropping systems with forest or shrubby fallow to annual or multiple cropping systems.

labour savings in soil management and weeding. Intensified use of inputs (fertilisers, improved seeds and pesticides) per unit area is unrelated to the degree of mechanisation. However, such practice is necessary to reach the productivity levels that free up financing to purchase equipment and animals[7].

### Mechanisation and soil conservation

A change to short fallow systems with low levels of nutrient replacement – a necessary accompaniment to mechanisation – makes the use of mineral and organic fertilisers essential. It is worrying to observe that this rarely happens. Pingali (et al.) notes that the use of organic manure is linked above all to land shortages. It is used when land becomes scarce, i.e. when the degradation process is well underway as a result of over exploitation. Many authors (Piéri, Béroud, Chavatte and Bordet, 1996) have observed the deterioration – loss initially of fertility and then of structure – of savannah soils, in areas that have developed substantially over the last 30 years, in cotton and groundnut-growing areas for instance. It is precisely these areas that have experienced the greatest increase in draught animal cultivation in Africa as a result of their market integration and also good conditions at the outset: the low cost of stump removal, the absence of trypanosomiasis and the presence of livestock. The mechanisation of ploughing is helping to speed up the degradation process, as in the absence of adequate replenishment of minerals and organic matter it allows more land to be cultivated and fallow periods to be reduced. However, the main cause of the deterioration lies in migratory movements and the nature of land laws: these community lands attract migrants from less-favoured neighbouring areas who, as population density increases, clear increasingly marginal land until the area is saturated and the possibilities of restoring fertility by fallowing are reduced or even destroyed.

It would appear that the dynamics governing these community lands are generating a downward spiral. Initially, market access allows for genuine accumulation and productive investment among the most long-standing occupants. The new arrivals attempt to accumulate in the same way, the first few succeed, but the last to arrive inevitably fail. If nothing is done, degradation resulting from overuse will be the inevitable outcome of cultivating any potential farm land. Unfortunately, it is likely that this spiral will accompany every agricultural development process in Africa so long as land laws do not give farmers greater responsibility for maintaining soil fertility, i.e. greater rights and guarantees that they will reap the benefit of any land improvement work they may undertake.

One practical recommendation must thus be made to the mechanisation departments: *any attempts to promote mechanisation – particularly for ploughing, given that it*

[7] This is why the cotton companies in the CFA franc zone made credit and advice to farmers on adopting animal draught power conditional on taking advice on cotton-growing techniques (varieties, densities, insecticide treatments, etc.).

*is inadvisable to promote land clearance – must be accompanied by the promotion of measures to reconstitute soil fertility and combat erosion, and thus action to reform land laws.*

## The relationship between mechanisation and migration

It is worth noting that investment in mechanical equipment, to replace manual labour, will only be profitable and thus possible if labour becomes scarce and thus too expensive, and the production system exceeds the minimum productivity/profitability thresholds – which vary depending on the type of mechanisation – to generate financing. In Europe, the development of mechanisation over the course of the 19th century occurred in situations where small farmers were encouraged to migrate elsewhere as a result of very inegalitarian land laws or the creation of urban or industrial employment; this rural exodus made way for the establishment of large-scale farms and led to a labour shortage, conditions that encouraged the replacement of labour with other forms of energy. Two important conclusions may be drawn from these observations:

- for African agricultural systems to reach the minimum productivity thresholds that allow mechanisation to be financed, other technical innovations (fertilisers, seeds, pesticides, cultivation methods, water control, etc.) must be adopted;
- conditions in Africa are not those of 19th century Europe; opportunities for migration to other continents are virtually non-existent, while industrial or other non-farm employment opportunities are restricted by the weak growth of non-agricultural sectors[8]. The only option for poor farmers in densely populated areas is to migrate into sparsely populated areas, where conditions are difficult (trypanosomiasis or endemic diseases, etc.) and/or which have inadequate market access. Opportunities for saving and investment remain limited.

Binswanger (et al., 1988) has shown that historically in both African and European farming systems, mechanisation has begun with the most energy-intensive tasks (ploughing, soil management, pumping, threshing, milling/shelling, etc.) i.e. the most demanding. On the other hand, the tasks which require the greatest precision (sowing, weeding, treatments and harvesting) are the last to be mechanised. There is reason to suppose that *if the productivity of traditional African farming systems remains this low and favourable conditions for migration and growth in non-agricultural sectors are not established, mechanisation will long be restricted to the most energy-intensive work.*

[8] It is unrealistic to believe that growth in the agricultural sector can engender growth in other sectors of the economy. Historically, in developed countries, the opposite has generally applied.

## 3.4 Factors in the development of animal traction

The development of animal traction is related to the extent of livestock integration in production systems. The development of meat markets and, in the highlands, markets for dairy produce have contributed to the increased use of cattle as a source of draught power. The chance to fatten up cattle while using their draught power or to obtain dairy produce represents an additional source of profit for farmers and a good reason for using draught animals. The benefits of using draught animals, in addition to the energy supplied, are the same as those generated by integrating cropping and livestock farming activities: stabling, using cropping by-products to feed livestock and produce manure, ploughing in organic manure, ley farming to regenerate fertility, etc.

The management of draught animals usually poses more problems than the distribution of traction equipment. National livestock departments have an important role to play in promoting animal draught power. They should promote and/or organise markets for cattle farming products: meat, dairy products, and also manure. They should also pay greater attention in their programmes to draught animal management. Campaigns to improve care and nutrition should make a priority of targeting these animals, encouraging settlement (guaranteeing productivity) in preference to extensive livestock systems[9]. The success of efforts to integrate draught animals into arable farming, whilst related to changes in agricultural systems – which cannot easily be controlled – , also depends on land law reform. This last aspect is critical in any strategy designed to promote animal traction.

## 3.5 Factors in the development of motorisation

The use of motorised equipment (four- and two-wheel tractors, engine-driven machines, combines and motor pumps) for farm work is dependent on highly profitable production systems, integrated within commercial marketing circuits. It is most likely to develop in peri-urban intensive gardening belts: large-scale cropping areas not too far from urban centres, roads and tracks, where the crops grown have a high market value and forwarding costs to urban markets are low.

Transport using tractors can help to reduce the isolation of areas which are poorly served by tracks; but it is profitable and competitive with other forms of transport only when there are large distances to cover cross-country. Over short distances, the use of animal-drawn carts, should it develop, would be less costly. On tracks and surfaced roads, trucks and light vehicles are more profitable.

Currency devaluations push up the cost of imported equipment (see Chapter 1.2). In traditional rainfed cropping systems (maize, upland rice, sorghum, millet, groundnut

[9] which, in comparison, are greater consumers of biomass.

and cotton) on small and medium-sized farms, the prospects for the sustainable development of motorisation are limited given the low level of returns from farming, including cotton-growing. Motorisation will develop in hydromorphic (flooded) areas if water control techniques are developed (compartmentalisation of fields and drainage), to pave the way for productivity gains and the proper use of field machinery.

# Second section: recommendations

Over the last 10 years, the economic environment in African countries has changed as a result of structural adjustment. Currency devaluations have helped to revive certain types of local agricultural production and should also give a boost to local equipment manufacture, but they push up the cost of imported equipment. National budgetary restrictions have had a grave impact on the government departments involved in developing mechanisation. Finally, donors or at least the main one, the World Bank, prefer to finance institutional and economic policy reforms over local or regional integrated rural development programmes. These new constraints and opportunities, and this new form of resource allocation between the private and public sectors demand a new definition for the role of the various operators and, in particular, government mechanisation strategies.

# 4. Conceptual framework

A clear overview of rural development policies is required to understand the role played by mechanisation in the development process. In addition, definitions are required for the sustainable development of mechanisation and the objectives that should underpin government mechanisation strategies. The following definitions are intended to give a better understanding of where mechanisation belongs in the development process, with a view to defining the respective roles of the various economic operators.

## National development policies

It is up to African society, through the various representation systems, to give substance to the notion of development and define development objectives. Listed below are three types of agricultural policy objective, which should form the backbone of mechanisation strategy:

- Economic growth objectives: increasing production and value added, organising agricultural markets, improving the balance of payments, reducing imports, increasing exports, improving product quality, satisfying consumers, providing stable supplies of goods at low prices, etc.
- Social objectives relating to redistribution, equality and organisation: ensuring equal access to resources, training and inputs; securing a satisfactory income and lifestyle for agricultural households; combating unemployment, poverty and malnutrition; improving the position of women and disadvantaged social groups in rural areas; etc.
- Objectives relating to environmental protection: maintaining stocks of flora and fauna, maintaining soil fertility and plant cover, etc.

## The sustainable development of mechanisation

The notion of sustainability relates to the potential to reproduce productive systems in the long-term. It covers two aspects, one physical and the other economic:

- The conservation of the natural resources (plant cover, soil and water resources) on which agricultural activity depends. The development of mechanisation is sustainable if it does not contribute towards the degradation of such resources.
- The potential to reproduce the economic mechanisms governing production systems. An agricultural production system is economically sustainable if the farmers and the other operators with whom they trade gain enough income from their activity to be able to continue it. Likewise, a form of mechanisation is economically sustainable only if farmers can purchase or hire and maintain the equipment at market prices and purchase new equipment when it reaches the end of its economic life.

This definition of sustainability presupposes the existence of a market, a place where goods and services are traded and prices are set. It opposes the concept of administered prices i.e. prices set by the State. The prices paid by farmers to acquire or repair equipment or obtain credit determine the profitability of their activities, as they in turn make a living for the craftspeople, sellers, repairers, credit agencies and service providers with whom they trade.

## Mechanisation strategies

Mechanisation is not an end in itself, but a means of development. The objective of mechanisation strategies is not to develop mechanisation, but to use agricultural mechanisation in the best possible way to achieve development goals. Binswanger (et al., 1988) however, showed that most developing countries have tended to pursue policies aimed at speeding up the development of mechanisation and motorisation in particular. These countries have underestimated the difficulties involved in sustainable mechanisation and given in to the confused notion held by many operators that one single aspect of technical progress (the sight of tractors in fields) is tantamount to real progress (economic growth and the well-being of rural communities).

Mechanisation strategies must promote the least costly combination of measures to achieve development objectives, and their costs and benefits should be compared with those of measures not involving mechanisation. For instance, mechanisation is just one way of increasing farm productivity, to be compared against the improved use of fertilisers, more appropriate varieties, better technical skills on the part of farmers and so on.

The best foundation for a mechanisation strategy is undoubtedly the first of the agricultural policy objectives mentioned above. More specifically, this involves improving farm access to markets (by transporting and processing products) and then increasing farm productivity (using less costly and more effective cultivation methods), to offer a better response to consumer demand and stand up to competition from imported products. This aim should not conflict with the social and natural resource conservation objectives. In other words, governments must ensure that the development of mechanisation does not contribute towards natural resource degradation or generate unemployment or inequality in rural areas[10]. In particular, governments must take care to safeguard the common interest, by protecting communities from the occasionally damaging behaviour of certain operators. The use mechanisation to gain control over land that is already subject to tenure rights held by rural communities, or to overexploit land must not be tolerated.

[10] Development has always generated social divergence; it is inevitable and can have a negative social impact. Whether or not this impact can be offset by the creation of new wealth (through growth) and its redistribution (through social policies) is another debate for African societies.

A description has already been given (Ch. 1) of situations where governments – along with donors – have justified pro-mechanisation measures in terms of the need for redistribution (making labour less arduous, improving the lifestyle of rural people, etc.) and community organisation (group motorisation initiatives). In the past, government attitudes have fluctuated between a genuine desire to help farmers and disadvantaged groups and measures designed to attract voters and organise rural societies. Even with the best possible intentions, this approach can represent a cost to the community, with no real advantages for the supposed beneficiaries. The sustainable establishment of mechanisation is possible only when individuals or groups have management and financing capacity, something which past measures have failed to take sufficiently into account. When these conditions are not met, it is unrealistic to seek equality and redistribution by means which involve investment in cultivation equipment. Land law reform, along with public investment in child and adult education, sanitation, health, water supply, byways and roads, make a more lasting and equitable mark.

## Mechanisation as a complement to other factors in agricultural production

The development of mechanisation is a component of agricultural development that is indissociable from the dynamics of economic growth and monetisation and the increase in farm trade. Farmers see investment in mechanisation as an investment opportunity to be compared with other opportunities. Mechanisation is one factor in agricultural production that logically must be used in conjunction with other production factors (fertilisers, seeds, pesticides, water, soil and labour). We have already seen that mechanisation can be financed only when production systems have reached certain minimum productivity and profitability thresholds, which require the use of technical innovations other than mechanisation. It is worthwhile repeating that mechanisation is not an end in itself, but a means of development.

## The specific role of mechanisation among agricultural production factors

Mechanisation is a means, however, that deserves particular attention in the preparation of development strategies, given the:

- impact it has on land-use management and soil conservation;
- impact it has on employment and income distribution in rural areas;
- radical impact it has on farm productivity;
- the particular conditions necessary for its adoption; unlike fertilisers and pesticides, it is an indivisible factor which poses particular financing problems;
- potential for its use outside the farm plot: machinery can be used for transport, draught animals for purposes other than traction; this means taking a broader look

at livestock farming systems, markets for animal products and the problems of integrating arable and livestock farming.

## Defining the respective roles of governments and the private sector

The sustainable development of mechanisation depends on the existence of markets where prices regulate the supply and demand of equipment. The organisation of competitive markets, with a transparent fiscal and legal framework for business, can make a greater contribution to regulating the economy and allocating resources effectively than direct voluntarist intervention by governments.

However, this does not imply that any government attempt to act and safeguard the public interest is doomed. On the contrary, there is a new need for genuine public activism, based on a better understanding of reality. Governments need competent, efficient mechanisation departments, commensurate with the resources at their disposal, to conduct those activities vital to the development of mechanisation that are not attractive to private investors. These activities are the basis for a redistribution of roles between the State and the private sector.

*The State should leave the private sector to manufacture, import and distribute agricultural equipment;* equally, it should not try to take the place of farmers and private entrepreneurs in producing agricultural commodities, or directly managing stocks of agricultural equipment available for hire. It is a recognised fact (cf. Chapter 1.1) that the private sector can perform these roles at a lower cost to users and the community than government departments.

*The primary role of the State is to create the right political and economic environment for private initiative*: establishing a positive and transparent tax and legal framework, providing for investment security, organising marketing channels and competition, setting up the right pricing policy, customs tariffs, infrastructure, etc. (cf. Chapter 5.1 below).

*In addition, the State must support the expansion of the agricultural engineering sector and undertake activities such as training, education, advisory services, extension and research into agricultural machinery and mechanisation (c.f. Chapter 5.2).*

# 5. Priorities for government action: strategic aspects

Each African country has its own set of obstacles to the development of mechanisation and no single type of strategy could address that diversity. Chapter 3 outlined the critical factors in the expansion of mechanisation, to be taken into account by development planners when preparing mechanisation strategies. A number of priority activities are listed below, but though overall they may apply, their order of importance must be adapted to each national and regional situation.

## 5.1 Creating a favourable political and economic environment

Binswanger has shown that the pace of the development of mechanisation may depend more on economic policy measures than on direct government intervention promoting mechanisation. The top priority for government action in Africa is to establish a political and economic environment facilitating investment. The following recommendations refer to the development of agricultural technology as a whole and go beyond the framework of mechanisation strategy. However, their influence on its success is such that they deserve mention.

***Investment security.*** Farmers and companies supplying agricultural equipment will invest if they have guarantees that they can make money and plan their future business. Political stability, a legal framework and executive power providing that security are essential. One aspect in particular of agricultural investment security is assured access to land and its usufruct; in many cases, land laws do not allow this.

***Organised, competitive agricultural product marketing channels.*** Organised, competitive, commercial channels contribute towards a stable and reassuring environment. Market information, the relative predictability of prices, and above all the certainty of finding – or better, choosing – a purchaser for products, enable farmers to organise production, predict income and thus save, invest and borrow. For example, cotton marketing channels in West Africa guaranteed an outlet for cotton and credit availability. Conversely, the fact that in most of the West African coastal countries the grain market is poorly organised, owing to the oligopoly of certain operators over markets, may partly explain the low level of investment in rice production in these coastal areas. *One of the State's primary roles should be to promote and regulate competition on markets for products, inputs and agricultural equipment.*

***Infrastructure.*** Without a physical infrastructure (roads, marketplaces), economic activity cannot develop. Agricultural development and thus that of mechanisation occur in areas which are well served with roads and marketplaces enabling ordinary commercial activity.

***Agricultural income policy.*** *Low farming incomes and cheap labour obstruct the development of mechanisation.* Binswanger and Cleaver both stress the need to adopt agricultural product pricing policies that are "less unfavourable" to farmers. Reducing customs tariffs and opening up to the world food product market, policies advocated by international institutions, benefit urban consumers but penalise agricultural producers. Africa does not have comparative advantages over other continents in the production and trade of staple foods (grain in particular). Opening the borders too far could condemn small African producers of grain and grain substitutes to a vicious circle of poverty and income stagnating at very low levels preventing investment. *The low cost of labour diminishes the profitability of investing in mechanisation, limiting it to the activities requiring the most energy.*

***The value of money and customs tariffs on agricultural inputs and equipment.*** The local manufacture of agricultural equipment and spare parts has not benefited appreciably from devaluation, as tax systems and customs duties have not been adapted accordingly and perhaps because the cost structure of local manufacturing is still dominated by imported items, made dearer by devaluation. Many countries have set inconsistent customs tariffs: higher customs duties for spare parts than finished equipment, discouraging equipment maintenance; higher duties on raw materials than finished products, penalising local construction[11]; varying levels of duty depending on types of equipment or input (fertilisers and equipment for animal or motorised traction), creating bias in favour of the use of a particular production factor, leading in turn to poor resource allocation; high duties aimed at protecting one or more local company whose production costs are too high in relation to imports, to the detriment of the end users. Therefore, *governments must establish reasonably low, homogeneous customs tariffs for all inputs, materials and parts used in agricultural production and metal and mechanical works, including the manufacture of agricultural equipment.*

It will be noted that many countries only partially meet the conditions listed above. Development policy reforms must accompany, or indeed precede, the definition of mechanisation strategies.

## 5.2 Reorganising government departments

Practical recommendations on the organisation of mechanisation development departments must be based on an analysis of their circumstances. Their budgets have been cut severely since the beginning of the structural adjustment phase. The following broad aspects are suggested as priorities.

[11] Ferrous materials for mechanical construction are often over-taxed; imports of these materials for use in building (to reinforce concrete) represent substantial budget revenue; it is difficult for customs departments to separate iron for concrete and steel for the construction of agricultural machinery; however, these duties harm the entire mechanical and metal working sector and not only agricultural machinery.

## Training

Governments are responsible for providing training in mechanical technology at all levels: primary- and secondary-level technical education, training for agricultural technicians and engineers, mechanics, qualified workers and mechanical engineers. However, they do not have the monopoly here; religious associations and some NGOs have demonstrated their ability to train technicians using models which could provide inspiration for institutional training courses. The critical factors for training in agricultural engineering and mechanisation (i.e. training on using machinery in agricultural systems) are:

- the emergence of a scientific and technical culture that values both local and outside knowledge and uses any concepts or theories that provide an understanding of local reality (including those applied by farmers, which are sometimes simpler and more meaningful than imported concepts);
- a higher profile for learning techniques related to animal traction and, in particular, those related to animal management and the manufacture and maintenance of tools, which are often neglected in favour of motorised equipment;
- a match between training and job opportunities; many training courses still focus on public sector employment, although opportunities there are shrinking at the same rate as public spending; hence the need to train more entrepreneurs with the potential to generate their own employment; training should include aspects such as business and cost management in small enterprises;
- training to teach technicians and engineers to understand and solve farmers' problems; to find the necessary information and exploit or circulate it; to take the initiative without waiting for State support or a career in the civil service.

## Advice – information – extension – research

The choice of energy sources and types of equipment is essentially a matter for farmers; but the choice must be informed and farmers need ready access to training and information services on new techniques. Institutional research has been criticised (Binswanger, 1988) for its inability to produce tangible results and existing extension services must win back farmers' confidence. The response to demand for technology must involve new participatory processes, while overall approaches (e.g. the Training and Visit system) must be based on sound local experience (management advice, participatory research, local NGO initiatives, etc.) which provide a better understanding of demand and enhance the skills of extension staff.

For that reason, governments departments will definitely continue to need at least a small number of staff skilled in mechanisation to perform the following functions:

- enabling farmers to express management constraints and demand for equipment;
- ascertaining the constraints on the manufacture, import and distribution of farm machinery;

- collecting and disseminating information on techniques; training extension workers;
- assessing the impact of various forms of mechanisation on the environment;
- measuring the impact of mechanisation on employment and working conditions, with particular regard to disadvantaged groups (women, children and landless farmers), and suggesting the necessary measures;
- more generally, advising governments on mechanisation strategies, including aspects of overall policy, such as customs duties, market competition and the tax system for businesses, which influence supply and demand for agricultural equipment.

Opinion is divided as to whether research and extension should be a matter for the civil service or devolved to the private sector and producers' associations[12]. The establishment of organisations representing producers is a precondition for such devolution (see Chapter 6). The process will be slow, since it implies financial resources and skills that African farmers have yet to acquire. Governments will, for a long time, have to provide support in the form of finance and training for the managers of trade associations.

In many countries, it would be worthwhile concentrating research, information and extension activities relating to mechanisation and those designed to promote agricultural engineering companies within the same administrative unit, to form a skills centre for mechanisation. These activities are often scattered among departments which do not have the necessary critical mass to take action themselves. However, whether new structures are created or old ones retained, they must be reorganised into *interprofessional* structures as soon as possible, i.e. placed under the joint responsibility of governments and associations of farmers and equipment manufacturers.

### Support for the local manufacture of agricultural equipment

*Governments must support the development of cottage industries, SMEs (small and medium-sized enterprises) and local agricultural engineering industries.* To this end, they should also foster the emergence of national mechanical and metal working sectors, supplying materials, small parts (nut and bolt works, etc.) and know-how, while setting lower customs tariffs for these components, in order not to penalise end users.

Governments should encourage the establishment of enterprises with local capital, recognise the value of local know-how and encourage the acquisition of outside know-how. They should encourage the formation of representative trade associations in the field of agricultural engineering like those for farmers. They should recognise the informal sector and examine the reasons for many entrepreneurs confining themselves to it, with a view to finding solutions.

The quest for import substitutes must not result in a return to the large-scale projects (cf. Chapter 1.4) and protectionism of the past. Competition must be organised between

[12] This can be a matter for debate within an individual institution. See note on page 23.

all enterprises involved with agricultural engineering (manufacturing as well as distribution and import companies). Governments should encourage cottage industry workshops to modernise and expand. The growth of such workshops goes hand in hand with differentiation and specialisation, and the natural outcome is increased productivity.

Donations, purchases of equipment negotiated between governments and international tendering are prejudicial to local import, construction and distribution sectors unless they themselves are involved. Governments should negotiate aid in such a way as to strengthen those sectors rather than setting up unfair competition against them. Governments do not generally have the skills necessary to construct agricultural machinery and import and distribute it, manage stocks of spare parts or provide a good maintenance service, and must encourage the private sector to acquire them.

# 6. The role of private operators: farmers, craftspeople, traders and local NGOS

## The place of direct stakeholders and local NGOs in national strategies

Farmers have their own development strategies. In the final analysis, it is they who choose whether or not to invest and decide on the source of energy and type of equipment that will give them the best service. The criteria for making the decision are so numerous and vary so much from one place to another that it is inconceivable that anyone other than the farmer could take the decision or that it should be taken on a universal basis by a government agency, however competent and informed it may be. More generally, the decisions of direct stakeholders – farmers, manufacturers and distributors of equipment – are rational, i.e. they are aimed at optimising the resources available in their environment to achieve their objectives (saving, investing, improving their standard of living or surviving). In the past, overly interventionist approaches have often failed to take this logic into account.

Future mechanisation strategies should reflect a degree of consensus between the public authorities and private stakeholders, to depend on consultation and shared responsibility. *The direct stakeholders must organise themselves into professional structures,* to ensure that they are represented at government level and that measures are implemented. Despite the efforts made, farmer representation and participation in decision-making in Africa are still underdeveloped concepts. The same is true for craftspeople and traders, particularly those in the agricultural engineering sector. If, before deciding to invest massively in one or other mechanisation programme, governments were to offer farmers responsibility not only for the management, but also for the cost of the operation, it is clear that the nature of the operations would be altered and that farmers would express genuine demands – for information, training and financial assistance – which are otherwise impossible to divine.

## Farmer associations managing mechanisation

The potential of producer groups to disseminate innovations or cover the cost of investment in mechanisation should not be overestimated. It is always worth checking that there are individuals within groups with the technical training and ability to take on collective responsibilities. If not, individual volunteers should be the first to adopt the innovations; dissemination of the innovations will be easier if they are representative of the group and/or hold an influential social position.

In the same way, the experience of agricultural equipment loans granted by cotton companies shows that borrower groups must be kept small and their composition socially homogeneous to ensure the members of the groups share the same objectives and interests.

## Craft associations and SMEs in the agricultural engineering sector

Craftspeople and SMEs in the agricultural engineering sector would gain from setting up specific associations to defend their interests and to highlight their potential contribution to the national economy. The development of local agricultural machinery manufacturing could in fact generate:

- currency savings and a greater contribution to the growth of local value added than had the same quantities of equipment been imported, hence more local jobs, greater purchasing power and more wealth distributed within the country;
- a better match between supply and demand for machinery because of the proximity of suppliers and users; a village blacksmith or a small regional enterprise is better placed than a foreign manufacturer to be aware of the technical (soil, water, plants, etc.) and economic factors that will determine the form, weight and price of the tool a farmer needs;
- greater sustainability of investment in mechanisation, as a result of the local availability of spare parts and better maintenance, as when knowledge of how to construct equipment exists in a country, knowledge of how to keep it in good condition will follow.

These companies should put pressure on the government to create a healthy economic environment (cf. Chapter 5.1), so that they can invest to increase productivity. When productivity gains are made within a competitive framework, they result in reduced selling prices; the end users – the farmers – are then the first to benefit. Companies should also argue for access to training (in technical, accounting and business skills) and credit, but should be able to create their own training and financing facilities, without expecting too much from the State, as is the case for some chambers of commerce and industry, in other sectors (e.g. in Zimbabwe).

However, the obstacles to such developments cannot be ignored:

- the low purchasing power of their customers, the farmers, when they are not marketing their products through organised channels;
- difficulties in accumulating capital particular to African enterprises (savings culture, the need to redistribute among the family or clan);
- the informal nature of the craft sector and the refusal of entrepreneurs to move into formal circuits, possibly to avoid tax liabilities;
- the difficulty and cost of obtaining supplies of materials, a problem shared by all companies in the mechanical and metal working sector, in the absence of a local iron and steel industry.

Manufacturing standardisation should not be an objective for a sector in the process of establishing itself. On the contrary, diversity in manufactured products should be encouraged, to respond to the diversity of demand from users.

# 7. The role of donors and international NGOS

## The variety of past attitudes

Donors and international NGOs differ in their approaches depending on their own analyses of constraints and the resources at their disposal. International organisations favour institution building and economic policy reform and regional integrated rural development programmes are becoming increasingly rare and tend to focus on specific aspects (e.g. developing marketing channels or supporting the private sector) or work on a smaller geographical scale. The differences in analysis and lack of co-ordination between donors are striking. While the choice of one form of support over another may be based on the need to use limited resources (most often where NGOs are concerned), opportunities for complementary action and exchanges of experience between projects and programmes in the same country are often missed, owing to a lack of coordination between private and public operators. National networks should facilitate such exchanges.

The strategic proposals of the World Bank are worth studying in detail. The proposals concerning mechanisation vary from one study to another depending on the writers' interest in the subject. Binswanger (et al. 1988, page 70) puts forward a number of specific recommendations:

- using loan programmes within the framework of structural adjustment to reduce the distortions in national policies that are prejudicial to mechanising the majority of farms (inappropriate customs tariffs, interest subsidies, over-valuation of exchange rates) and to promote pricing policies and marketing organisation measures that are less unfavourable to agriculture;
- reviewing policy regarding loans involving a large mechanisation component;
- continuing to finance projects promoting animal draught power (blacksmith training, credit and veterinary services), but resisting demands for land reclamation and public enterprises providing mechanised services;
- selecting loans to develop a national agricultural engineering industry on the basis of a thorough knowledge of local conditions (access to foreign currency and high quality materials, patents, the training of qualified mechanics, private sector research and a review of policy relating to the mechanical engineering industry).

Cleaver ("A strategy to develop agriculture in Sub-Saharan Africa and a focus for the World Bank", 1993) favours:

- a favourable environment for private farming and for agricultural marketing, processing and credits;
- technological advancement in farms and enterprises (mechanisation is mentioned once; cf. note below);
- the development of farmer organisations and their empowerment;

- infrastructure, links between town and country, roads, education and health in rural areas;
- natural resource management and increased security of tenure rights[13].

## Guidelines for designing programmes

Donors can help governments to define appropriate strategies and take part in their implementation. The strategic balance between i) regulatory measures of an economic nature, ii) institutional support measures and iii) decentralised support programmes for the private sector and local NGOs varies from one donor to another and from one country to another. It is not possible in this study to mention all the types of activity donors should support. Some of them have yet to be invented – this requires imagination – and, above all, priorities for action must be defined on the basis of the real situation in each country or province.

A number of suggestions regarding the place of mechanisation in development programmes/projects are given below. These proposals may help to define integrated development activities at local level, financed by willing donors. They can also be used as guidelines for agricultural development services at the same level:

1. Mechanisation programmes/projects should form part of integrated activities taking account of land tenure problems and seeking to ensure sustainable development, through conservative community land management. They should facilitate the control and maintenance of soil fertility and contribute to improved fodder resource management, protection from grazing to prevent erosion, reafforestation and bush fire control.
2. In most African countries and given the current state of agricultural product markets, farmers cannot invest in mechanisation unless they enjoy a set of services including input and equipment supply, credit, technical advice, training and organised marketing of crop and animal products. Mechanisation programmes will not achieve their objectives unless they are part of programmes supporting agricultural production and livestock farming which sustain the development of such services.
3. Rather than being provided by the programmes themselves, the services should preferably be sub-contracted to private operators or other specialised projects whose

[13] Cleaver makes very little reference to the role of mechanisation in development, except on page 76: "Governments should have a facilitating role; to ensure that the regulatory environment does not discourage private sector participation in farm input supply and to provide advice through the extension service to farmers(...) Government research and extension services, along with private voluntary organisations, should be active in developing prototypes of inputs and investment goods (better seed varieties, new hand tools, animal-drawn equipment), etc." This should be compared with Binswanger (1988), page 71: "Public sector research (into mechanisation), both in industrialised and developing countries, has not always succeeded in inventing machinery likely to be adopted on a wide scale. The private sector is better placed in this regard and Bank projects designed to improve public sector research need not include major elements of agricultural mechanisation." The same author highlights the bias against animal draught power in education and extension programmes: "Credit and veterinary services should be made available to farmers. Where animal draught power has been used for a long time (...), agricultural credit, research and extension projects seem to be one way of ensuring it is not put at a disadvantage".

presence and effectiveness in the programmes' domains are recognised. The programmes should facilitate the emergence of such operators. To that end, the application of real prices for services supplied by projects to small farmers should be the rule and subsidies the exception.

4. The animal traction components of projects should seek to integrate the management of draught oxen with agricultural activities, i.e. stabling, supplementary feeding and proper use of harvest residues, and attempt to demonstrate that this form of management is more productive and makes better use of natural resources than extensive herd management.
5. The integration of cropping and animal husbandry should be among the objectives of every agricultural development programme, whenever the two activities are possible; such programmes should encourage likely candidates; animal draught power is one aspect of this. Livestock farming support programmes should encourage livestock farmers wishing to engage in cropping activities and make recommendations on animal health monitoring and business plans for the use of draught animals; agricultural production support programmes should encourage farmers to take up sedentary livestock farming activities.
6. Credit for the purchase of equipment is unlikely to be repaid unless farmers have stable incomes, i.e. they can sell their production on good terms. Credit for the purchase of a pair of oxen should be restricted to areas where livestock farming is not traditional and it should be subject to strict conditions to avoid oxen running wild. In areas where cattle-rearing is traditional, credit for oxen is often misappropriated. It is difficult to control loans to ensure that they are restricted to people who do not already own oxen.

# 8. Proposals for regional and multi-lateral programmes

## 8.1 Training activities

### i) Training national staff in their own countries

Work must begin on restructuring national mechanisation services, without waiting for a more precise analysis of the state of agricultural development services or a reform of agricultural policies. It is proposed that national training courses (of one to three weeks) should be organised for the staff who are to train the extension and/or education service personnel. These courses would deal with some of the tasks that the services should perform and which all too often are neglected, such as:

- assessing farmer demand, monitoring equipment stocks and using participatory survey methods;
- understanding manufacturers' constraints;
- monitoring import and distribution circuits, tax systems and customs tariffs and advising governments in these areas;
- defining mechanisation strategies.

The people responsible for leading these training sessions would be chosen on the basis of the quality of the work they have already done in one or other of these fields.

### ii) International subject-based workshops with resource persons

Workshops could be organised for a limited number of specialists recognised in their respective countries, to deal with a limited number of subjects at a modest cost. The aim of these workshops would be to exchange information and methods generated by practical experience in specific areas, such as:

- the role of tax systems and customs duties in the development of local construction of agricultural equipment, taking the informal sector into account;
- the construction of agricultural machinery by cottage industries and the organisation of blacksmiths into producer groups;
- the cost-effectiveness of mechanisation following economic and monetary adjustment;
- the design of mechanisation activities within development programmes, with particular regard to animal draught power and the integration of cropping and livestock farming;
- methods involving information and advice on mechanisation and agricultural extension (i.e. Training and Visit, management advice);
- trade in agricultural equipment and term loans.

These workshops would be led by one or two resource persons, also chosen for the relevance of their work, and would be preceded by work prepared in advance by each participant in his or her own country.

## 8.2 Information and communication

Networks whose aim is to promote the exchange of information on agricultural mechanisation in Africa are well known (Starkey, 1992; Mrema, 1992). The main networks are shown in the box below. They are having difficulties because:

- their correspondents are based mainly in government agencies, victim to budget cuts, sometimes without support from their supervisory bodies;
- frequently, a correspondent or network leader takes a job unrelated to the topic on which they have been working, diminishing returns for the network, unless they can be taken on by a project with external funding;
- organising regional conferences to allow network members to meet is expensive.

Under the circumstances, members of European technical centres who have been able to retain financing and a few engineering chairs with permanent tenure at African universities seem to be the most assiduous participants at meetings and the only ones who have witnessed the development of mechanisation in the long term. However, the direct stakeholders, those with most to say, are poorly represented in these networks as they are not usually organised in their own countries into groups able to get their point of view across and make their needs known.

### Present and past networks

The NAMA, Network for Agricultural Mechanisation in Africa, led by G. Mrema, published several newsletters between 1992 and 1994. Initially, the NAMA received support from the Commonwealth Secretariat, and subsequently from GTZ and GATE, but seems to have ceased functioning.

There are three animal traction networks in Africa, of which P. Starkey is the kingpin:

- ROATA – Réseau Ouest-Africain de la Traction Animale
- ATNESA – Animal Traction Network for Eastern and Southern Africa
- SANAT – Southern Africa Network on Animal Traction

Two societies of agricultural engineers are being or have recently been set up in East Africa on the initiative of a dynamic group of Tanzanian engineers:

- SEASAE – Southern and Eastern Africa Society of Agricultural Engineers
- TSAE – Tanzanian Society of Agricultural Engineers, which publishes its proceedings annually

In 1972, the FAO set up the WAICENT (World Agricultural Information Centre) which, in addition to a great deal of data on agricultural production, holds the Directory

of Agricultural Engineering Institutions. It is a useful list although it does not yet reflect the great diversity of national agencies involved in mechanisation. This directory is accessible by electronic mail (Internet).

The ITDG (Intermediate Technology Development Group, London) and GRET (Groupe de Recherche et d'Echange Technologique, Paris) publish the "Tools for Agriculture" guide, with CTA support, which provides a list of manufacturers of agricultural equipment for small and medium-sized farms throughout the world, thus completing the inventory of institutions produced by the FAO. However, some of the references require substantial updating (false information includes prototypes presented as widely distributed equipment and dealers passing as manufacturers)

The ACEMA (Association euro-africaine des centres d'etude du machinisme agricole) was set up in 1985 to identify the needs of agricultural engineering research centres; put them in touch with each other; monitor changes in demand and the dissemination of equipment in the field; and ensure the circulation of information collected through ongoing projects. As such projects became increasingly rare, its existence could no longer be justified. The last meeting of the ACEMA was held in Brussels in 1990. Since then, the ACEMA has virtually disappeared, a victim of the deteriorating working conditions of its members and a lack of interest on the part of donors.

The ARCEDEM (African Regional Centre for Engineering, Design and Manufacturing), in Nigeria, does not seem to have any noteworthy networking activities.

## Proposals to strengthen existing networks

The best future prospects for existing networks lie in the widespread adoption of E-mail systems and conferences, which would enable them to achieve their primary objective – circulating information – at a lower cost. One of the priorities in developing networks is thus to help those individuals or institutions that have the potential to become lasting focal points for the circulation of information and organisation of activities to set themselves up with computer equipment and modems.

Meetings in the field are still necessary, however, as digital information is not sufficient: skills are passed on more quickly using demonstrations, pictures and words. Therefore, in addition to circulating information, the role of networks must also be to organise workshops for small numbers (to limit costs) on specific topics on which recognised experts would be invited to share their skills (e.g. workshops on trade in farm equipment, the organisation of blacksmiths into producer groups, term loans, etc.).

If these networks are to have an impact on development and the information they transfer is to be meaningful, direct stakeholders (farmers, craftspeople and SMEs) must be involved. It is therefore essential that international networks be based on the prior establishment of national networks bringing together not only institutions but also

representatives of the private sector, including farmers. The organisation of farmers and the agricultural engineering trades into national networks is currently lagging behind the establishment of international networks.

It would be helpful if the networks concerning animal traction in Africa, the most dynamic, opened up to mechanical technology in general, as it is based on identical approaches and know-how (including motorisation, pumping, primary processing of products and even storage techniques). In spite of the criticism directed against it, motorised equipment and other forms of energy can, under certain circumstances, represent a lasting solution to the constraints faced by farmers.

While the prospects for developing electronic mail systems remain limited and even after E-mail is widely adopted (simplifying dissemination), the relaunch of a quarterly newsletter on agricultural mechanisation is particularly recommended. It should echo the former MAT (Machinisme Agricole Tropical) journal published by CIRAD-CEEMAT, or the NAMA network newsletter, and would provide a forum for exchanging information on: initiatives and projects; who is doing what; interim reports; abstracts of more detailed publications; publicity for seminars and conferences; etc. The newsletter's readership would be engineers, and also economists, sociologists, representatives of African and European professional organisations and local NGOs. It should be written to be accessible to non-specialists, avoiding jargon of any of the disciplines. Its administration could be organised on a rotating basis (changing every 12 or 24 months) by the mechanisation centres with sufficiently well organised publication resources. CTA could finance all or part of the publishing and distribution costs of the newsletter and its translation from English into French or vice versa.

In addition, the issues raised in this document, in particular those concerning the sustainability of agricultural development, need to be brought into the public arena, to reach a wider audience than policy-makers alone. To this end, it would be worthwhile preparing articles for circulation in the local press and programmes for local radio and television stations.

## 8.3 Research

The work done by the FAO/AGSE over the last few years should be supplemented and taken further by means of studies on mechanisation strategies in African countries facing problems in managing mechanisation and through an exchange of views on the concepts and results of such studies, most of which are summarised in this document. The African countries whose strategies have recently been studied are: Ghana, Guinea, Kenya, Lesotho, Malawi, Sudan and Zaire. Others (Burkina Faso and Zimbabwe) are in the process of drawing up strategies and are requesting support.

This study, which deals with one of the aspects of *technological progress* in rural Africa, the mechanisation of cultivation, ought to be supplemented with studies on the

mechanisation of all agricultural work (pumping, post-harvest processing, drying and storage), and other aspects of technological progress: the use of fertilisers, seeds, irrigation and hydro-agricultural schemes, pesticides and so on. This would provide an overall view of techniques, the conditions for their adoption by farmers and their complementary roles in development. Such a study would enable the social aspects of technological progress in rural Africa to be examined in more depth and better understood.

# List of abbreviations

| | |
|---|---|
| AAMA | Atelier d'assemblage de matériel agricole |
| ACT | Association de coopération technique |
| AEI | Agricultural Engineering Institute (Zimbabwe) |
| AFC | Agriculture Finance Corporation (Zimbabwe) |
| AGSE | Agricultural engineering sub-division of the FAO |
| AMS | Agricultural Mechanisation Section (Tanzania) |
| APICOMA | Atelier pilote de construction mécanique (METSS) |
| ARCOMA | Atelier régional de construction mécanique (MARA) |
| ATAS | Agents techniques agricoles spécialisés |
| ATNESA | Animal Traction Network for Eastern and Southern Africa |
| BEPC | Brevet élémentaire du premier cycle |
| CAMARTEC | Center for Agricultural Machinery and Rural Technology (Tanzania) |
| CAP | Centre agricole polytechnique (Matourkou, Burkina Faso) |
| CEFP | Centre d'évaluation et de formation professionnel (MFP) |
| CFD | Caisse française de développement |
| CFDT | Compagnie française pour le développement des textiles |
| CFU | Commercial Farmers' Union (Zimbabwe) |
| CIDA | Canadian International Development Agency |
| CIRAD | Centre de coopération internationale en recherche agronomique pour le développement |
| CNCA | Caisse nationale de crédit agricole |
| CNEA | Centre national d'équipement agricole (MARA) |
| CNPAR | Centre national de perfectionnement des artisans ruraux |
| CRDB | Cooperative and Rural Development Bank (Tanzania) |
| CRPA | Centre régional de promotion agropastoral |
| DIMA | Direction des intrants et de la mécanisation agricole du MARA |
| CU | Cooperative Unions (Tanzania) |
| DVA | Direction de la vulgarisation agricole du MARA |
| EDF | European Development Fund |
| EIER | Ecole inter-États d'ingénieurs de l'équipement rural |
| ERP | Economic Recovery Programme |
| ESAP | Economic Structural Adjustment programme |
| FAO | Organisation des Nations-unies pour l'alimentation et l'agriculture |
| GV | Groupements villageois |
| GNP | Gross National Product |
| GPC | Groupements de producteurs de coton |
| IDR | Institut de développement rural de Bobodioulasso (MESSRS) (Burkina Faso) |

| | |
|---|---|
| IMAG-DLO | Instituut voor Milieu- en Agritechniek; Dienst Landbouwkundig Onderzoek |
| INERA | Institut d'études et de recherches agricoles, MESSRS (Burkina Faso) |
| MARA | Ministère de l'agriculture et des ressources animales (Burkina Faso) |
| MEE | Ministère de l'environnement et de l'eau (Burkina Faso) |
| MESSRS | Ministère des enseignements secondaire et supérieur et de la recherche scientifique |
| METSS | Ministère de l'emploi, du travail et de la sécurité sociale (Burkina Faso) |
| MICA | Ministère du commerce, de l'industrie et de l'artisanat (Burkina Faso) |
| MFP | Ministère de la fonction publique (Burkina Faso) |
| MoA | Ministry of Agriculture |
| OFNACER | Office national de commercialisation des céréales (Burkina Faso) |
| ONG | Organisation non gouvernementale |
| OSEO | Oeuvre suisse d'insertion ouvrière |
| PAMA | Projet d'appui à la mécanisation agricole (DIMA) (Burkina Faso) |
| PASA | Programme d'ajustement du secteur agricole |
| PCT | Programme de coopération technique |
| PRSAP | Projet de renforcement des services d'appui aux producteurs (World Bank) |
| RDF | Regional Development Fund |
| SEASAE | Southern and Eastern Africa Society of Agricultural Engineers |
| SMA | Service de mécanisation agricole (DIMA) (Burkina Faso) |
| SME | Small and medium-sized entreprises |
| SFU | Service de formation des utilisateurs (DIMA) (Burkina Faso) |
| SOFITEX | Société burkinabé des fibres textiles (Burkina Faso) |
| SOMATA | Société de construction de matériels de traction animale |
| SUA | Sokoine University of Agriculture (Tanzania) |
| TAD-AP | Tanzanian Association of Draft Animal Power |
| TEMDO | Tanzanian Engineering Manufacturing and Design organization |
| TMTA | Tanzanian Motor Traders Association |
| TS | Technicien supérieur |
| TSAE | Tanzanian Society of Agricultural Engineers |
| EU | European Union |
| UFI | Ubonfo Farm Implements |
| USAID | Agence des États-Unis d'Amérique pour le développement international |
| ZFU | Zimbabwe Farmers' Union |
| ZSAE | Zimbabwean Society of Agricultural Engineers |
| ZZK | Zana Za Kilimo (Agricultural Farm Implements) |

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## List of primary documents prepared for the study

1. *La mécanisation des travaux agricoles en Afrique, Rapport de la première phase de l'étude,* Bordet, D., April 1996, 27 pp., annexes,15 pp.
2. *La mécanisation des travaux agricoles en Afrique, Rapport de la deuxième phase de l'étude,* Bordet, D., June 1996, 50 pp., annexes, 44 pp.
3. *La mécanisation des travaux agricoles en Afrique, Rapport de synthèse.* Bordet, D., July 1996, 36 pp., annexes, 20 pp.
4. *La mécanisation des travaux agricoles en Afrique. Rapport de synthèse.* Bordet, D., October 1996, 18 pp., annexes, 75 pp.
5. *La mécanisation des travaux agricoles en Afrique. Annexes au rapport de synthèse.* Bordet, D.,January 1997, 68 pp.

This document takes the form of an annex to the final report and summarises primary documents 1 and 2 and the parts of documents 3 and 4 which were not retained in the report. It is summarised as follows:

- A.I : Termes de référence de l'étude
- A.II : Évolution des stratégies de mécanisation
- A.III : Les contraintes au développement de la motorisation
- A.IV : Étude documentaire : les relations entre mécanisation, gestion foncière et conservation des sols
- A.V : Estimation (Havard) des effectifs d'animaux de trait et de matériels de culture attelée dans 11 pays francophones
- A.VI : Le modèle de développement de la culture attelée propre aux sociétés cotonnières
- A.VII : Étude documentaire : le Sénégal
- A.VIII : Étude documentaire : le Soudan
- A.IX : Étude documentaire : le Ghana
- A.X : Étude documentaire : le Malawi
- A.XI : Étude documentaire : le Lesotho
- A.XII : Étude documentaire : la Guinée
- A.XIII : Compte rendu de visites au Burkina Faso (1-10 mai 1996)
- A.XIV : Compte rendu de visites au Zimbabwe (13-20 mai 1996)
- A.XV : Compte rendu de visites en Tanzanie (21-29 mai 1996).

6. *Étude de la mécanisation agricole en Afrique, Première phase,* Rabezandrina, Prof. R., April 1996, 38 pp.
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8. *Étude de la mécanisation agricole en Afrique, 2ème phase de l'étude, Synthèse des visites effectuées par les consultants,* Rabezandrina, Prof. R., July 1996, 55 pp.

9. *Étude de la mécanisation agricole en Afrique,* Rabezandrina, Prof., October 1996, 30 pp.

10. *La mécanisation des travaux Agricoles en Afrique, Rapport de synthèse,* FAO-AGSE, December 1996, 17 pp.