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Agricultural Mechanization in Sub Saharan Africa:

Guidelines for preparing a strategy

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Agricultural Mechanization in Sub-Saharan Africa *Guidelines for preparing a strategy*

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FOREWORD

The production of food in developing countries is generally very labour intensive particularly in smallholder agriculture. The manual work carried out by farmers and their families is very arduous and time consuming and in many countries this is a major constraint to increasing agricultural production. Also, the day to day drudgery of farming is a major contributory factor in the migration of people, particularly young people, from the rural countryside to the prospect of a better life in towns and cities.

Farm production can be substantially increased through the use of mechanical technologies which are both labour saving and directly increase yields and production. Inputs of hard labour by farmers and their families can be substantially reduced if they have access to a carefully selected use of tools, machines, and equipment. The labour released can be used for other productive activities. The use of improved mechanical technologies can also have a direct impact on yields and area under production. Such technological interventions are commonly referred to as agricultural mechanization. In a rural context the term also extends to cover other closely related small scale activities such as the primary processing of agricultural products, on-farm storage, and the delivery of irrigation water.

Within the term ***"mechanization"*** there is a large number of possibilities and technologies for farmers to choose from. These range from choosing between the different sources of additional farm power to selecting from the various other production enhancing mechanical technologies available. A judicious choice from amongst these is crucial for farmers to achieve optimum profitability from their businesses and to attain an acceptable quality of life for themselves and their families. There is now also the realization and acceptance that the choice of mechanical technologies to be used can also have a major impact on the environment; only the use of technologies which have a positive effect can be sustainable over the long term. This sets a major challenge for all those involved in mechanization; planners, advisors, manufacturers, service providers, practitioners and farmers. It is therefore important that governments should identify the correct strategies for increasing mechanization in their countries with particular emphasis on increased production, farmers' livelihoods, and environmentally sustainable options.

One of the major mandates of FAO is to assist member states to make their input supply and food production chains more effective and efficient and at the same time provide farmers with improved livelihoods. The goal is

clear: to increase sustainable food production. The effective and sustainable use of increased levels of mechanization is one of the most important means of achieving this.

But what is required to best achieve this? This document outlines why and how a strategy on mechanization can make a major contribution to the achievement of the goal of increasing levels of agricultural production and improving the livelihoods of farmers. These guidelines on the development and formulation of a *sustainable* agricultural mechanisation strategy form part of FAO's approach on sustainable production intensification.

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The development of these Guidelines originates from the early 1990's when interest was expressed by several countries in Asia, Eastern Europe and Africa for assistance from FAO for the development of plans for the expansion of mechanization. In the case of Eastern European countries advice was requested on how to privatize the public sector mechanization services. In response to these requests the Agricultural Engineering Service (AGSE) of FAO developed some guiding principles for the assistance to be provided. Subsequently, field work was conducted in several countries from which a mechanization strategy was formulated for each. From this experience, in 1997 AGSE produced more detailed guidelines on strategy formulation. The author of these was Clare Bishop, a consultant who had been involved in the formulation of several of the country studies. Overall guidance and supervision during this period was provided by Lawrence Clarke, Chief of the Agricultural Engineering Service.

Since then, based on this first version of the Guide, a number of AMS formulation exercises were carried out mainly with FAO TCP funds. The main focus for these studies was on countries in sub-Saharan Africa (Benin, Burkina Faso, Cameroon, Democratic Republic of the Congo, Guinea, Malawi, Mali, Niger, Sudan, Tanzania). In these countries, teams of local experts under the supervision and guidance of a senior consultant, collected data and prepared detailed reports on strategies to be followed for the adoption and wider expansion of mechanization. Acknowledgements must be given to these national experts who contributed to the great overall wealth of knowledge on how mechanization is to be expanded and sustainably adopted.

In 2008, a second version of the AMS Guide was prepared based on experiences of the Mali Formulation Exercise and this French version has been further refined and produced in English leading to this finalized document. So many experts have contributed both directly and indirectly to bring these guidelines to this present state that it would be impossible to name each individual. Never-the-less our thanks go to all of these anonymous contributors. The overall supervision for this document has been the responsibility of Josef Kienzle, Agricultural Engineer, Plant Production and Protection Division. Brian Jackson, FAO Consultant, joined the authors for the proof reading tasks and Magda Morales formatted the document for printing. Thanks also go out to the contributors and reviewers from many different countries.

INTRODUCTION

This guide is published during a crucial period when most African countries are taking steps to modernize their agriculture. Improving the performance of the agriculture sector has become one of the important challenges to be faced in the context of fighting malnutrition, illness, poverty, and unemployment. Furthermore, in recent years, the situation has been aggravated by very high food commodity prices on the world market. This has significantly increased the number of people in poverty in many countries. As a result, progress in human development has been slowed down, and the danger of failing to deliver the Millennium Development Goals (MDG), especially MDG1[1], is all too evident.

In Africa, particularly in those countries south of the Sahara (SSA), there is a great potential to increase agricultural production, however, the realization of this potential will require high levels of commitment and resources. At the same time, due consideration will have to be given to ecological and climatic considerations. This requires a rational and responsible approach to the choice of cropping systems and crop production inputs. One of the most important of these inputs is the development and use of increased levels of farm power and appropriate mechanization techniques.

In the developed world, maintaining existing levels of agricultural production would be impossible without mechanization. In many parts of the developing world, the use of increased levels of mechanization is already making a significant contribution to agricultural and rural development. In recent years, by means of development programmes and other incentives, governments of many African countries have been encouraging farmers to make increasing use of agricultural machinery. Unfortunately, these efforts have mostly failed to have much impact on overall production, and there is now a realization that the acceptance and greater utilization of agricultural machinery is still below what had been projected.

Several reasons are behind this but in particular it is now realized that the manner in which structural adjustment programmes were undertaken throughout the 1980s had a major impact on the expansion and use of farm mechanization. The underlying reason for this was a failure to understand the effect of structural adjustment on the agricultural tools and machinery markets particularly for those items that were imported. Furthermore, the respective roles of the government and private sectors were not clearly defined: Governments withdrew from activities in farm mechanization with the expectation that the private sector would step in and take over. But in most

[1] MDG1 – The Eradication of Extreme Poverty and Hunger

cases this did not happen and the expansion in the use of mechanization in agriculture in many countries entered a period of decline. This has been largely due to a failure to put in place an effective political and economic environment as well as implementing effective programmes to support the emergence and development of the private sector. This decline has had an adverse effect on the development of agricultural mechanization in general and the emergence of the private sector in particular. It has certainly had an adverse effect on the overall development of agriculture.

Unfortunately, a dominant factor in this has been the fragmented, sometimes contradictory, and uncoordinated approach adopted by governments and donors when measures were taken to encourage mechanization. Instead of taking a holistic approach, isolated and stand alone measures have often been taken, when in reality, every stakeholder – institutional as well as the private sector - has a role to play.

Increased agricultural production and improved rural livelihoods cannot be achieved without the adoption and use of increased levels of farm power and mechanization. However, agricultural mechanization is not quite as straightforward an input as fertilizer or seed; in order for farmers to have access to farm tools, machinery and equipment, there needs to be in place a whole complex system of manufacture, importation, retail outlets, support, provision of spare parts - the so-called supply chain - as well as the availability of advice and guidance for farmers. Therefore the development and use of mechanization as an input to agriculture is a complex and long term process and calls for a correspondingly long term, consistent effort.

As a first step, one of the most important tools and an essential part of the process is the formulation of a strategy as to how increased, sustainable levels of mechanization can be brought about without subsidies and without distortions. The strategy should provide a framework of how to make decisions on the allocation of resources, address challenges, and take advantage of opportunities that arise. It should be a structured, but flexible, participatory process which leads to the definition of a coherent plan of achievable actions and programmes.

For over twenty years, FAO has assisted many countries in Africa and Asia to elaborate their own agricultural mechanization strategies (AMS). The approach evolved under the influence of changes occurring in the development philosophies of individual countries, FAO members, and financial institutions. Niger, Democratic Republic of the Congo, Cameroun, Morocco and Sudan, are some examples in Africa where strategies have recently been formulated. These projects have created opportunities for in-depth analyses and discussions, and have resulted in clear objectives being set and action plans formulated. A sound platform has emerged on which the respective countries can now take action.

This present guide is prepared from a compilation of many documents published by FAO in this domain and is a guide to the process of formulating an agricultural mechanization strategy. The aims are:

- To raise awareness of the main constraints which hinder the development of agricultural mechanization and especially those hindering the development of the private sector;
- To provide approaches and methodology for a comprehensive and inclusive agricultural mechanization strategic planning process;
- To raise the awareness of politicians and decision makers of the need to develop a strategic plan for the development of agricultural mechanization.

The guide is divided into six chapters:

Chapter One defines and clarifies concepts. It presents definitions and principles and demystifies terminologies related to agricultural mechanization. It clarifies what is meant by the term "strategy" and demonstrates that agricultural mechanization is not a narrow engineering discipline but is an important sector to be viewed in a much broader context. Any analysis of agricultural mechanization has to take into account not just the technical and engineering aspects but also the connections and inter-dependencies with other sectors and their place in the farm tools and machinery supply chain as a whole.

Chapter Two presents an overview of the current situation of agricultural mechanization in SSA. In this chapter the main issues and constraints found in the agricultural mechanization sector are emphasized. The issues are many and varied and range from technological problems to economic and commercial issues and to the demand and supply aspects of agricultural mechanization. They are all inter-related and have, in the past, led to the development of inter-related negative factors which can explain the stagnation in adoption and growth of agricultural mechanization. On the demand side of agricultural mechanization; it is clear that the output from many farming systems remains very low. This is due to many negative factors which result in low farm incomes and therefore leads to a low capacity by farmers to invest. On the supply side too, it can also be observed that the farm machinery commercial sector has been unwilling to invest and become involved as suppliers. This has been due to several negative factors but particularly the unfavourable business environment, unfair competition, lack of an enabling policy environment and issues of governance. This chapter identifies and describes these negative factors and describes how these may be overcome so that agricultural mechanization can fulfil its potential as a vital input into agricultural production.

Chapter Three covers elements of the fundamental requirements for the development of agricultural mechanization. The chapter provides recommendations on issues of demand for mechanization. It is aimed at farmers, suppliers of mechanization inputs and supporting institutions. Evidence is provided that demonstrates why a strategic approach is vital for the development of agricultural mechanization. The chapter demonstrates that the development of agricultural mechanization is a complex task that involves many different components and that the development and adoption

of mechanization as an effective input to enhance agricultural production and human development is therefore a long term process.

Chapter Four sets out the methods and tools that can be used once the idea to conduct an AMS formulation project has been accepted. It outlines organizational tools and describes the main stages in strategy preparation. The formulation of a strategy requires the use of effective methods, procedures, and rules. This chapter provides ideas on how a project should be prepared and what are the main steps. The role of the project team during the collection and analysis of data stages is clarified and the role of the stakeholders at participatory workshops is defined. The use of tools such as SWOT analysis and Log-Frame matrix analysis is outlined.

Chapter Five presents the first of two critical parts of formulating a mechanization strategy; to identify and describe the existing situation of mechanization in a country. Guidance is provided on how the current situation of agricultural mechanisation can be defined and how it is achieved by focussing on the identification of the relevant information to be collected and the kind of analysis to be carried out. Emphasis is placed on the importance of maintaining a holistic approach taking into account not only the engineering sector but also other aspects related to farming systems such as the economy, the institutional framework and the environment. Finally it explains the importance of participatory workshops where a SWOT analysis might be utilized.

Chapter Six This final chapter focuses on the final steps in the formulation of a strategy for mechanization; a strategy that will lead to the creation of an enabling environment in which agricultural mechanization can freely develop. The first step in the formulation process is a definition and analysis of the existing situation (covered in chapter five). The second part of the strategy process is to define an ideal future situation; a situation in which the mechanization sector contributes to the overall development of agriculture in the country but which will also contribute to improving farm incomes and living standards. This chapter deals with how this future situation can be identified and defined. Emphasis is given to the individual roles of the public and the private sectors and how they interact with each other. It describes how the preparation of the strategy should be completed by reviewing strategy documentation, the procedure for presenting the findings, and implementation. The outcome is a framework of policy and institutional recommendations, supported by programmes and projects where appropriate. An example of a strategy framework is given.

This guide aims to be a valuable reference and is intended for use by politicians, decision makers, officials and experts involved in the agricultural sector in general and in agricultural mechanization in particular. However, it must be pointed out that it can never be a complete substitute for sound common sense; each country has its own individual characteristics and each study will need to be customized to fit these characteristics.

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CHAPTER 1

Agricultural mechanization strategy formulation: Definitions and principles

1.1 INTRODUCTION

Agricultural mechanization is a very broad field in which numerous factors have to be considered. It is a cross-cutting term that includes several disciplines. In addition to agriculture, it includes many economic aspects. It involves many different stakeholders coming from a whole range of sections of society; the smallest farmer can have an interest and be involved but so can very large private and public sector companies and organizations. Across this wide spectrum of interests, there is a necessity for a common understanding of the terminologies and concepts used. It is also desirable for the layperson to understand these terms and concepts.

This first chapter serves as an introduction to this guide and sets out the general context of agricultural mechanization by defining principles and clarifying definitions. It also explains patterns of agricultural mechanization, its evolution, and the notion of sustainable development of mechanization. Finally, it clarifies the concepts of strategic planning and the way it should be approached.

1.2 SOME TERMINOLOGY USED IN AGRICULTURAL MECHANIZATION

1.2.1 Agricultural mechanization

According to FAO (Clarke, 1997), the term *"Agricultural mechanization"* generally refers to the application of tools, implements, and powered machinery as inputs to achieve agricultural production. In general three sources of power are used in agriculture; manual, animal and motorized (fossil fuel and electric).

The term covers the manufacture, distribution, maintenance, repair, management, and utilization of agricultural tools, implements, and machines. It applies to agricultural land development, crop production, harvesting, and preparation for storage, on-farm processing and rural transport.

Agricultural mechanization is often associated solely with tractors and sophisticated agricultural machinery – so called "tractorization". ***In reality, particularly in developing countries, the term covers all levels of technology from the simplest and most basic (hand tools) to the most sophisticated and powerful.*** What is very important is that the technology involved meets

the real needs of farmers and can be used efficiently and effectively and is financially viable. In other words, increasing levels of mechanization doesn't necessarily mean big investments in tractors and machinery, but involves shifting to an alternative combination of the use of land, capital and labour, which results in improved farm incomes either through increased output or through reduced costs, or through a combination of both. Additional other, non-monetary benefits such as a reduction in the drudgery of farm work must also be considered.

Although agricultural mechanization is an essential input for agricultural production, it is difficult to place it alongside other inputs. It is not a single input like seed and fertilizer, but rather a series of production tools which are used in almost all phases of production. In almost any agricultural production system, the annual expenditure on mechanized inputs (tools, implements and machines), greatly exceeds the individual costs of other single inputs such as agrochemicals and seeds. Cost components of mechanization include labour, animal costs, and running costs of tools and machines (fuel, repairs, depreciation, and interest). Farm machine and tool use, in contrast with other inputs such as seed, fertilizer, and chemicals, requires an initial capital investment. Engine driven machines such as tractors and stationary machinery require fuel, servicing, and maintenance. Animals used for draught (pulling) purposes require fodder and veterinary services. Therefore the use of mechanization can involve many different stakeholders and include technical, economic, and social aspects. Environmental issues also have to be considered.

1.2.2 The different levels of agricultural mechanization

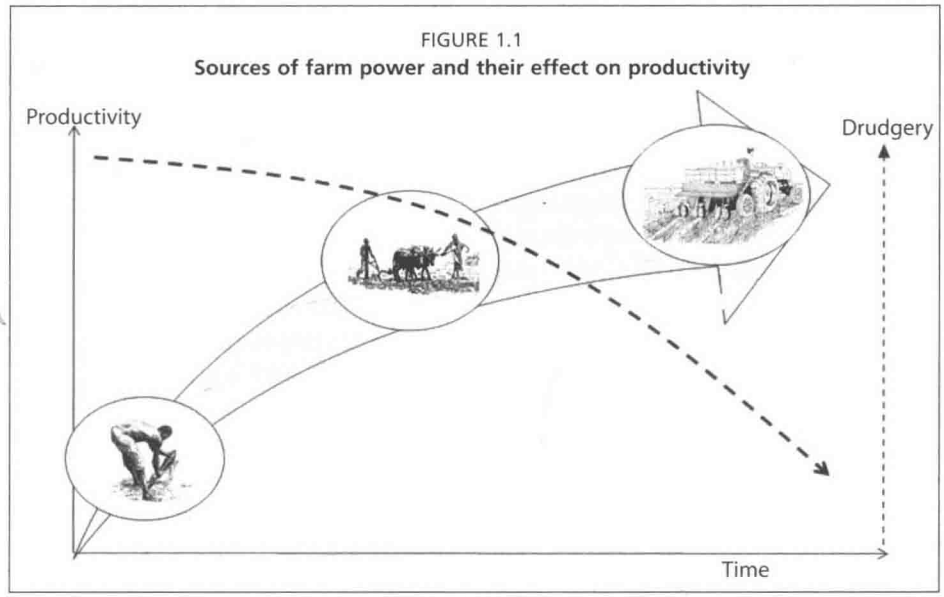
Mechanization based on human power sources

Manual technology (the use of hand tools and manually powered machines) relies upon human beings as the source of power ("muscle power"). There is a very wide array of tools and hand machines used in agriculture. This includes hand tools such as machetes, hoes, spades, forks, axes, knives, but also machines such as manually powered winnowers and seed drills. These are technologically simple and can be designed and made locally in small quantities by artisans (blacksmiths) and small workshops. They may also be mass produced and sold through shops. Hand tools are generally multi-purpose tools and may be used for several operations related to crop production and agro processing.

Hand tools are relatively easy to manufacture and use, as well as easy to maintain and to repair. They also offer the advantage that they are inexpensive and accepted socially. However, their use demands very high levels of human effort which limits what can be achieved in production terms. In terms of area to be cultivated, the use of hand tools puts a limitation on the area that can be cultivated by one person (Figure 1.1). Within this overall limitation, the amount of time it takes to accomplish various farming operations will nevertheless vary widely according to considerations such as the crop, soil

type, soil moisture, optimum seeding dates and desired quality of work. The amount of work a human can deliver is influenced by nutrition and health. Climatic conditions also play a significant role; in particular high ambient temperatures and humidity drastically reduce human work capacity.

FIGURE 1.1
Sources of farm power and their effect on productivity



Currently, hand tool technology constitutes the most widespread mechanization level within small-scale farmers in sub-Saharan Africa and some estimates even show that the use of manual tools is increasing in Africa whereas their use is decreasing in Asia.

Animal power based mechanization

Animals are used extensively as a source of power in agriculture. The potential draught power of animals varies greatly according to the type of animal. The main animals used for work purposes are horses, oxen, mules, donkeys and camels. Their size, nutrition, state of health and general condition at the time of use are key factors determining the amount of work they are capable of carrying out. For equines (horses, donkeys, and mules) and camels the optimum pulling force is about 12 percent to 15 percent of body weight. The working speed for most draught animals when working at optimum pull is about 3½ km/hr (Ashburner *et al.*, 2009).

It is strongly recommended that animals which are adapted to the local conditions be used as they generally exhibit a greater resistance to local diseases. High temperature and humidity greatly reduce the work output of animals. Animals need to be trained for work purposes and it takes about a year for them to attain maximum performance.

There is considerable evidence to show that by replacing and augmenting human power with animal traction, the total cultivated area can be expanded and labour productivity increased (Figure 1.1). The rate of work achieved by work animals varies considerably but can be from 5 to 20 times greater than manual labour. Land preparation is particularly power intensive and huge increases in production can be achieved by replacing hand hoes with animal drawn ploughs. For crop production, the main implements used with animals are the plough and trailer. More recently, technological advances have led to the development and manufacture of other types of animal draught equipment such as seeders and mowers; however, primary tillage and transport still remain by far the main operations carried out by work animals. Animal power can also be used for other operations such as pumping, milling, and road construction.

The use of animals as a source of power provides economic gains not only for farmers but also for the local economy. Local businesses benefit from the use of draught animals both on the support side (retailing, manufacturing, and servicing of implements) as well as the processing, marketing and sale of surplus agricultural products. For the national economy, the requirement for foreign currency is generally small or non-existent. Animals and trailers also provide local transport facilities in rural areas. Another major economic benefit for farmers who switch to using animal draught is that it releases them and their family to carry out additional, income generating activities.

One of the main problems in using draught animals in many developing countries is the often poor condition of the animals at the end of the dry season. Yet this is the time when, in conventional farming systems, the first ploughing is undertaken, and which is the most arduous of all the tasks for the animals. Most farmers rely solely on grazing for animal feed during the off-season. This is the time when grasses and other fodder plants have dried out and are least nutritious and least plentiful. As a consequence the animals lose condition and weight and are more susceptible to diseases which seriously reduce their work capacity. If farmers are to keep their animals in peak condition then supplementary fodder must be given before and during the work season. However, if productive land needs to be specifically set aside for this, then the food producing capacity of the farm will be reduced.

Another problem with using animals for work purposes is the common perception that their use is archaic and backward. This is in contrast to tractors and other large machinery which are viewed as progressive and modern. These are generally opinions and perceptions held by ill-informed commentators which are formed without knowing or taking into consideration all prevailing factors and conditions. Unfortunately, and to the detriment of increasing the use of animal power, tractors and other advanced machinery have been used as political tools both by donors from industrialized countries as well as politicians from recipient nations who argue that continuing to promote the use of work animals indicates a lack of development.