



A GUIDE TO PREPARING AN AGRICULTURAL MECHANIZATION STRATEGY

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EXECUTIVE SUMMARY

In many parts of the world, agricultural mechanization has made a significant contribution to agricultural and rural development. Levels of production have increased, soil and water conservation measures constructed, the profitability of farming improved, the quality of rural life enhanced, and developments in the industrial and service sectors stimulated.

In some countries, however, farm power and equipment have failed to realise their potential. In part, this may be attributed to the inappropriate selection and use of certain mechanized inputs. It is also due to the piecemeal approach adopted by governments and donors to encourage mechanization without reviewing the agricultural engineering sector in its entirety. If key components were not in place, inputs were frequently not available, or were poorly maintained and operated below capacity. Consequently, mechanization has often become a burden to national budgets and the farming community, leading to financial losses and restricted agricultural production, as well as environmental degradation.

With the urgent need to increase food production in the next few decades, both to match the growth in global population and to reduce malnutrition, it is essential to ensure agricultural mechanization does not act as a constraint on any initiatives to stimulate production.

The purpose of an Agricultural Mechanization Strategy (AMS) is to create a policy, institutional and market environment in which farmers and other end-users have the choice of farm power and equipment suited to their needs within a sustainable delivery and support system. It covers the manufacture, distribution and operation of all types of tools, implements, machines and equipment for agricultural land development, farm production, harvesting and post-harvest activities. It addresses the needs of all end-users of farm machinery and equipment, such as small family operated farms, commercial farm businesses, farmers' organizations, irrigation groups, contractors, government departments, rural transport operators and primary food processors.

This guide sets out the framework for preparing an AMS; it is not intended to be prescriptive but rather to guide and assist people through the process of preparing a strategy. Each country has its own characteristics (in terms of resource base, structure of economy, policy objectives, cultures and customs) which will be reflected in the formulation of the strategy.

Stakeholders in Strategy Preparation

Stakeholders in the AMS cover a broad cross section of the agricultural, industrial and institutional community, both in terms of their activities and size of businesses. Interested parties range from individual smallholders and blacksmiths, to financiers and senior government representatives. The strategy is prepared in close association with these groups and discussion workshops enable all interested parties to contribute to the debate. Support may be formalised by establishing a steering committee with responsibility for overseeing strategy preparation.

Prior to preparing a strategy, there needs to be sufficient political will and support from both the private and public sectors to participate in the formulation process. There should be broad consensus that an AMS would be relevant to the needs of the country in general and the agricultural sector in particular. Key stakeholders should be prepared to act on its recommendations. There also needs to be skilled personnel and sufficient funds to prepare the strategy, producing results in a time frame that is reasonable.

The timing also has to be right with regard to developments in other sectors. Whilst there may be some argument for agricultural mechanization to lead the way with regard to strategy formulation, the initiative may be severely hampered if there are significant weaknesses in other sectors of the economy. Thus it is essential that developments in the agricultural engineering sector are complementary to, and move in step with, developments elsewhere.

Activities of Strategy Preparation

The preparation of the strategy consists of two distinct activities: data collection, analysis and interpretation; and the formulation of the strategy. A systems approach is adopted to review the agricultural engineering sector, addressing the major farming systems, agricultural mechanization, farm machinery and equipment manufacturing, importing and distribution systems. Explicit attention is paid to the influence of existing policies and supporting institutions to determine whether they promote sound mechanization. The findings and their implications for the strategy are summarised in a tabular format.

These findings provide the framework within which the strategy is formulated. Future scenarios for the economy, demographic characteristics, and the agricultural sector are extrapolated over a five year period. Farm power and equipment requirements are determined and their potential sourcing identified.

When formulating the strategy specific attention is paid to the roles of government and the private sector. It is recognized that farmers and other end-users are looking for the widest choice of appropriate farm tools, machinery and equipment at affordable prices, as well as access to spare parts and maintenance services. They may also require information to assist in their choice, legislation to protect them from commercial exploitation, and credit to facilitate their purchases. Similarly, the agricultural machinery industry requires a competitive commercial environment in which manufacturing, importing, distribution and repairs businesses can develop profitably, free from any unfair competition from the state.

Recommendations are made regarding policies and institutions, and are supported, where necessary, by programmes and projects. This information is summarised in a strategy table.

Strategy Implementation

The task of strategy formulation and implementation is a dynamic on-going process. As the economy develops and farming systems change, farm power needs will change. Moreover, government policies will adjust to reflect new circumstances and development philosophies. New programmes and projects will need to be identified, and new ways of incorporating farm power into broader development projects will have to be developed. Thus the strategy will need to be monitored regularly and revised to reflect key changes in the economic, policy and institutional environment.

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GLOSSARY OF TERMS

Agricultural engineering sector: covers the manufacture, import, distribution, repair and maintenance, and use of agricultural tools, implements, machinery and equipment in association with human, animal or engine power sources. Supporting activities, such as research, education and training, extension, credit, product testing and evaluation, and consumer protection are also addressed.

Agricultural mechanization: the process of utilising different combination of power, tools and equipment for production purposes over time. Farming systems typically move from hand tool technologies, to the selective use of draught animals or tractors for certain operations. The ability to mechanize is determined in part by the nature of the operation, as well as other technical, financial, economic, social and environmental considerations.

Farm power: the application of power to agricultural production from human, animal and mechanical sources.

Strategy: the process by which a sector moves from an existing state to a future (or desired) state.

LIST OF ABBREVIATIONS

AMS	Agricultural Mechanization Strategy
AGSE	Agricultural Engineering Branch
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
NGO	Non Governmental Organization
RRA	Rapid Rural Appraisal
R and D	Research and Development

1. INTRODUCTION

1.1 The Need for an Agricultural Mechanization Strategy

On the eve of the twenty first century, concerns about the ability of the world to feed itself are as real as ever. With the population forecast to almost double within the next two decades, not only does agricultural production have to match this growth in demand but also address the needs of 840 million people presently suffering from chronic malnutrition.

Farm power and equipment are associated with all stages of agricultural production, from preparing land and applying seeds and fertilizers, to weeding, harvesting and transporting produce. The three principal sources of power are people, draught animals and engine-driven machinery. The appropriate choice and use of machinery and equipment influences the area under cultivation, the timeliness of operations, and the effective use of other inputs.

In many parts of the world, agricultural mechanization has made a significant contribution to agricultural and rural development. Levels of production have increased, soil and water conservation measures constructed, the profitability of farming improved, the quality of rural life enhanced, and developments in the industrial and service sectors stimulated.

In some countries, however, farm power and equipment have failed to realise their potential. In part, this may be attributed to the inappropriate selection and use of certain mechanized inputs: for example, the use of tractors and heavy machinery has often been encouraged by subsidies. It is also due to the piecemeal approach adopted by governments and donors to encourage mechanization without reviewing the agricultural engineering sector in its entirety. If key components were not in place, such as repair and maintenance services or industrial extension and training, inputs were frequently not available, or were poorly maintained and operated below capacity. Consequently, mechanization has often become a burden to national budgets and the farming community, leading to financial losses and restricted agricultural production, as well as environmental degradation.

The drive to increase food production will make significant demands on farm power resources. Thus it is essential to ensure agricultural mechanization does not act as a constraint on any initiatives to increase food production and achieve food security at both the household and national level.

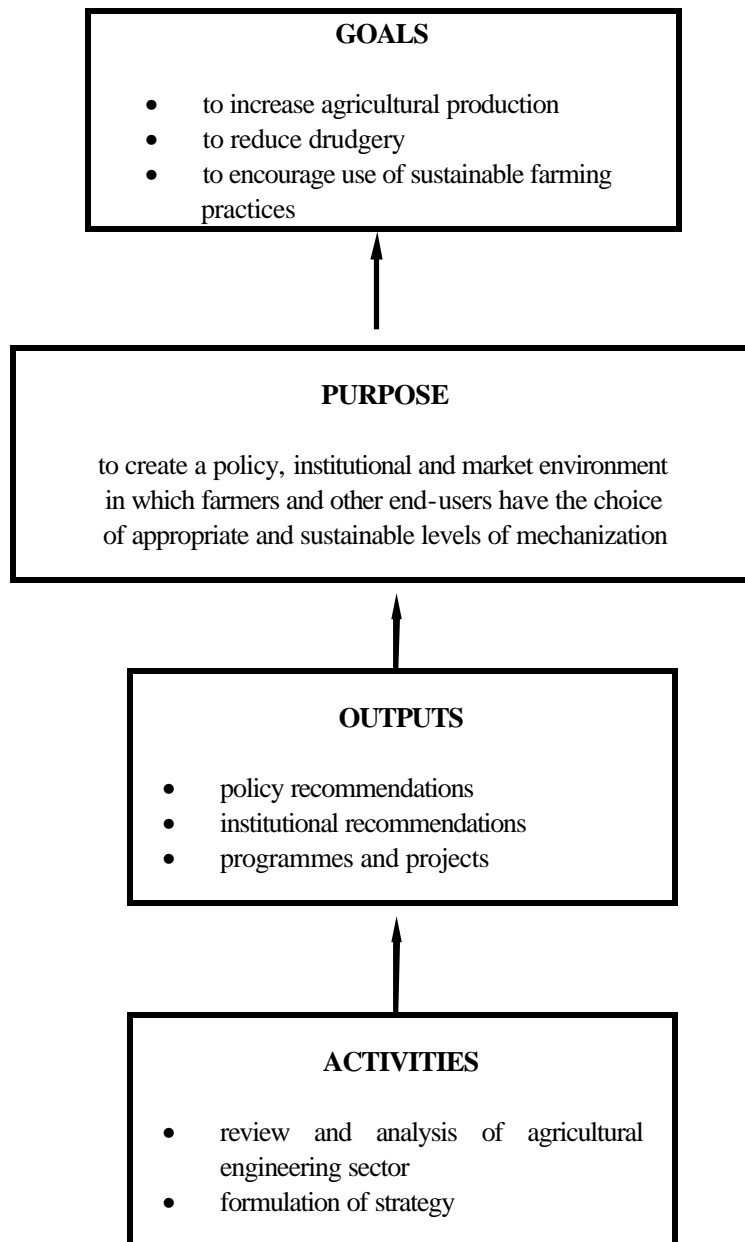
An Agricultural Mechanization Strategy (AMS) adopts a holistic approach to supporting and developing agricultural mechanization. It covers the manufacture, distribution and operation of all types of tools, implements, machines and equipment for agricultural land development, farm production, harvesting and post-harvest activities.

Strategy preparation considers: the use of inputs at the farm level; their sourcing through imports or local manufacture; the infrastructure for their distribution, repair and maintenance; institutional support and the policy environment.

1.2 Purpose of a Strategy

The purpose of an Agricultural Mechanization Strategy is to create a policy, institutional and market environment in which farmers and other end-users have the choice of farm power and equipment suited to their needs within a sustainable delivery and support system (Diagram 1.1). 'Farmers and others' refer to all end-users of farm machinery and equipment, such as small family operated farms, commercial farm businesses, farmers' organizations, irrigation groups, contractors, government departments, rural transport operators and primary food processors.

Diagram 1.1: AMS in the Project Framework



This purpose will, in turn, contribute to the wider *goal* of increasing agricultural production by cultivating new areas or farming existing areas more productively, reducing the drudgery associated with farm operations, and facilitating the adoption of sustainable farming practices.

Activities which are central to preparing a strategy for agricultural mechanization include:

- reviewing the performance of the economy and identifying future scenarios with regard to the role of the agricultural sector;
- identifying existing and future use of farm power and equipment in farming systems;
- determining the current status and potential of the manufacturing and distribution systems; and
- reviewing supporting institutions and the policy environment.

The *outputs* of strategy formulation include a suite of policy and institutional recommendations supported, when necessary, by programmes and projects. These outputs do not remain static; during the on-going process of implementation, the recommendations are monitored and revised in the light of changing circumstances.

1.3 Purpose of the Guide

This guide sets out the framework for preparing an AMS following a process approach. The principal steps in strategy preparation are discussed, the key techniques described, and supporting documents noted.

The document is not intended to be prescriptive but rather to guide and assist people through the process of preparing a strategy. Each country has its own characteristics (in terms of resource base, structure of economy, policy objectives, cultures and customs) which will be reflected in the formulation of the strategy.

The guide will be of interest to those planning and preparing strategies. The level of detail pursued in each area is not exhaustive since it is assumed the strategy team will have recourse to the specialist skills required. Other FAO publications which provide supporting information are noted in the bibliography.

Whilst this guide has been prepared specifically with reference to the agricultural sector, it could be adapted to examine and support the engineering component in other natural resource sectors, such as forestry and fisheries.

1.4 Structure of the Guide

Chapter 2 describes the main stages in strategy preparation and identifies those individuals and groups participating at each stage. A systems approach is used to identify the main components of the agricultural engineering sector in chapter 3; the key features which should be addressed during data collection are discussed.

The core activities of strategy preparation are presented in chapter 4: predicting future scenarios, identifying the implications for farm power requirements, and determining how they may be sourced.

Chapter 5 completes the preparation process by reviewing strategy documentation, the procedure for presenting the findings, and the move towards implementation.

Checklists are included at the two most important stages in the process, identifying the pre-conditions which should be in place prior to the first national workshop (chapter 2) and reviewing the whole AMS process at the conclusion of the second national workshop (chapter 5).

The agricultural engineering sector summary - strategy table, which provides the rationale and recommendations of the strategy, is developed in two parts: at the end of the review of the sector (chapter 3) and on completion of strategy formulation (chapter 4). Examples of completed tables are presented in the appendices.

A bibliography of supporting FAO documentation is presented in chapter 6.

2. PROCEDURES FOR PREPARING A STRATEGY

This chapter discusses the main steps in preparing a strategy and the key participants associated with these activities. It identifies the pre-conditions which should be in place prior to commencing this process.

2.1 Process Approach

Much experience has been gained by FAO about the process of preparing Agricultural Mechanization Strategies during the last two decades. The approach has evolved over that period, principally reflecting changes in the development philosophies of beneficiary countries and the donor community. Initially studies followed a fairly uniform approach based broadly around centrally planned economies; hence strategies were formulated within a

pre-determined policy framework. This was justified on the grounds that government established policies within which strategy formulators had to work; it was not part of their role to suggest policy changes. The methodology focused on the collection of very detailed information about the sector.

With the rapid political and economic changes of the late 1980s and early 1990s, it was recognized that a more flexible approach was required. Firstly, the methodology has to be expedient, both in terms of resources and time. Thus the establishment of a database is no longer the backbone of the strategy. Secondly, strategy formulators now explicitly consider the policy environment: they identify any conflicts in existing policies and suggest alternatives that will be conducive to sustainable agricultural mechanization. If policies remain unjustifiably biased for or against mechanization, it is highly unlikely that a workable strategy can be formulated. Thirdly, more emphasis is placed on creating opportunities for the private sector to participate in developing the agricultural engineering sector.

2.2 Key Stages in Strategy Preparation

The procedure for AMS preparation is evolutionary rather than a blueprint approach. It progresses through a number of stages, the exact number of which will vary depending on local circumstances (Diagram 2.1). The principal ones are discussed below.

The process commences when there is a *perceived need* to address agricultural mechanization issues in the country. Either an individual or a small group will act as the catalyst for strategy preparation. In order to support their case, background papers are prepared reviewing, in general terms, the current status of the agricultural engineering sector and identifying any problems, constraints and opportunities.

The second step is to gain the support of key decision makers. This may be achieved by organizing a small workshop specifically to address agricultural mechanization; the discussion would be initiated by presenting the background papers. Alternatively it may be possible to present the case for AMS preparation at an existing forum. Regardless of the route chosen, at the end of this stage there should be *broad consensus* that an Agricultural Mechanization Strategy would be relevant to the needs of the country in general and specifically to agriculture. However, if agricultural mechanization does not emerge as a priority issue at present, it may be appropriate to postpone the preparation of the strategy until other issues have been addressed.

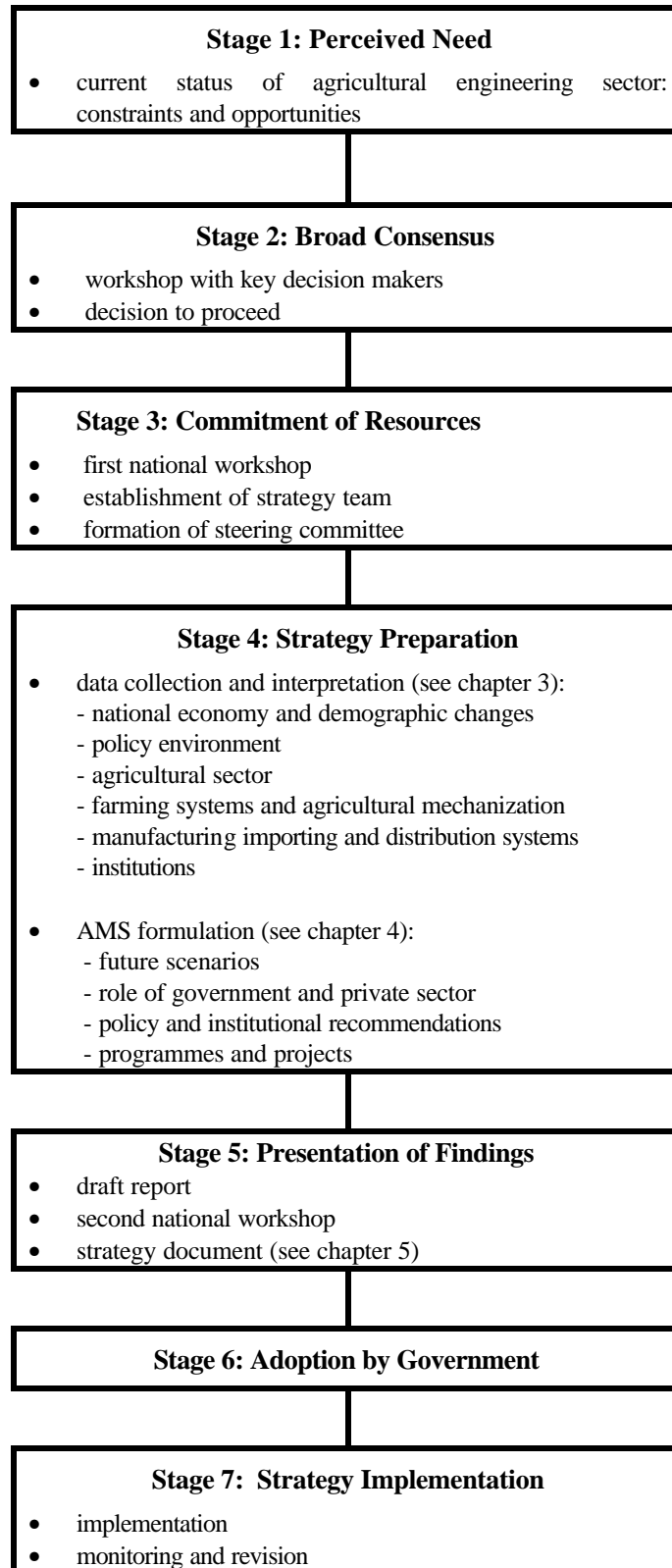
The first national workshop draws together all interested parties from the agricultural engineering sector. Participative methods, using techniques such as Objectives Oriented Project Planning, can be used with the participants to place agricultural mechanization issues in a broad perspective. If they are convinced that agricultural mechanization would be best addressed through an AMS, the output of this stage is to secure the *commitment of resources*. The strategy team should be established, the steering committee appointed, funds allocated, and a plan of action drawn up.

The *preparation of the strategy* consists of two distinct activities: data collection, analysis and interpretation; and the formulation of the strategy. A systems approach is adopted to review the agricultural mechanization. Existing policies and institutions are reviewed to determine whether they promote sound mechanization. This stage typically takes between six to eight weeks.

These findings provide the framework within which the strategy is formulated. Future scenarios for the economy, demographic characteristics, and the agricultural sector are extrapolated over a five year period. The implications for farm power and equipment requirements are determined and their potential sourcing identified. Specific attention is paid to the roles of government and the private sector. Recommendations are made regarding policies and institutions, and are supported, where necessary, by programmes and projects.

The strategy is circulated in a draft format, seeking the views and opinions of stakeholders. The *findings* are presented at a second national workshop involving all interested government and private sector organizations. The document may be revised in the light of these discussions before being submitted for subsequent government action.

Diagram 2.1: Key Stages in Strategy Preparation



The **adoption** of the recommendations by government will vary between countries. In some, the strategy may be formally incorporated into the policy framework; in others it may result in specific actions to implement recommendations.

Once formulated, a strategy does not remain static; rather it is a dynamic on-going process. During **implementation** it will need to be monitored regularly and revised to take into account key changes in the economic, policy and institutional environment.

2.3 Stakeholders in Strategy Preparation

Strategy preparation requires a **multidisciplinary team** with analytical skills and experience of macro and micro economics, farming systems, agricultural engineering, manufacturing, business and enterprise development, policy and institutional reviews, and the private sector. The team size may range from two key staff (ideally an agricultural engineer and an agricultural economist supported by a series of specialist short term inputs), to four to six members providing comprehensive coverage of the key areas of expertise.

Stakeholders in the AMS cover a broad cross section of the agricultural, industrial and institutional community, both in terms of their activities and size of businesses (Box 2.1). The strategy should be prepared in close association with these groups; the process will only be effective if there is consensus and commitment amongst the stakeholders to act upon the findings.

Discussion workshops are held throughout the preparation process to enable all interested parties to contribute to the debate. They may participate at the outset of the enquiry to help formulate ideas and generate a level of support for the study; they may confirm the interpretation of current events and the vision of the future; and they may provide feedback on the findings and recommendations.

Box 2.1: AMS Stakeholders		
<ul style="list-style-type: none"> • smallholder farmers • commercial farmers • farming organizations • irrigation groups • crop processors • rural transporters 	<ul style="list-style-type: none"> • importers • manufacturers • blacksmiths • distributors • machinery support services • contractors 	<ul style="list-style-type: none"> • financiers • government and NGOs: <ul style="list-style-type: none"> - extension workers - researchers - trainers - policy makers

The support may be formalised by establishing a **steering committee** with responsibility for overseeing strategy preparation. Committee members would include senior representatives from relevant ministries, such as Agriculture and Industry, and the private sector. The committee can also provide the vital link between strategy preparation and the on-going activities of implementation.

Regular consultation and dialogue with **decision makers** can help with the interpretation of existing policies and confirmation of future scenarios. If they have the opportunity to comment on the draft findings it may strengthen their support for subsequent action.

2.4 When to Proceed

Before deciding whether to commence with the first national workshop it is important to consider the pre-conditions which should be in place. A checklist is presented in Box 2.2. If several of the answers to the checklist are negative, then it may be expedient to reconsider whether it is appropriate, at this time, to proceed with the national workshop.

In particular, there needs to be sufficient political will and support from both the private and public sectors to participate in the formulation process. They should also be prepared to act on its recommendations. There also needs to be skilled personnel and sufficient funds to prepare the strategy, producing results in a time frame that is reasonable.

The timing also has to be right with regard to developments in other sectors. Whilst there may be some argument for agricultural mechanization to lead the way with regard to strategy formulation, the initiative may be severely hampered if there are significant weaknesses in other sectors of the economy. Thus it is essential that

Box 2.2: Checklist Prior to First National Workshop

- Is there broad consensus that bottlenecks and constraints exist within the agricultural engineering sector and they hinder the development of the agricultural sector?
- Are there skilled personnel in government and/or the private sector to join the strategy team?
Will they be released from other duties in order to participate fully in the activities required?
Will there be any opportunities for developing in-country capabilities in strategy formulation?
- Will there be sufficient funds to support strategy preparation activities?
- If external assistance is required, is it likely to be forthcoming?
- Will the broader community perceive agricultural engineering to be sufficiently important to justify attending the discussion workshops? Will they be able to participate in a full and open exchange of views at the workshops?
- Will the members of the steering committee represent a broad cross section of the agricultural engineering sector?
- Will there be the political will to implement the recommendations of strategy?

developments in the agricultural engineering sector are complementary to, and move in step with, developments elsewhere.

3. AGRICULTURAL ENGINEERING SECTOR

This chapter identifies the main components of the agricultural engineering sector which are reviewed during strategy preparation. This provides the basis for formulating the strategy (chapter 4). The chapter concludes with a short review of information collection methods.

3.1 Framework for Reviewing Agricultural Mechanization

Strategy formulation adopts a systems approach to reviewing agricultural mechanization in the context of the agricultural engineering sector and emphasizes the linkages between the key components (Diagram 3.1). Activities in the manufacturing and retailing of agricultural machinery and equipment are determined, to a large extent, by the profitability of the farming system. In turn, this is influenced by the domestic and international markets for farm products. If markets are buoyant, farmers may respond by changing cropping patterns and requiring different complements of tools and machinery. The manufacturing sector responds to this stimulus. *Thus the process of*

agricultural mechanization in a market economy is mainly demand-led, both at the farm level and at the point of manufacture.

Occasionally, there are situations where the process is supply-led. Under certain circumstances this can be appropriate; for example, when an inventor introduces a new tool or machine to the market. In contrast, setting manufacturing production targets or recommending levels of mechanization without due attention to market forces often results in the misuse of resources.

In addition to the key components of the system, explicit attention is paid to the influence of the policy environment and the role of supporting institutions. Whilst policies in the agricultural sector may make specific reference to agricultural mechanization, fiscal, trade and industry policies can have indirect implications. For example, trade policy may be aiming to place greater reliance on earning foreign exchange, thereby stimulating the production of export crops; alternatively, industry policy may provide support for local manufacturing, including the production of agricultural tools and equipment. Any conflicts in existing policies should be identified since it is highly unlikely that a workable strategy can be formulated if policies remain biased against mechanization. Similarly, distortions in favour of mechanization should also be identified and their implications for establishing a sustainable agricultural mechanization system examined.

A host of private commercial, Non Governmental Organization (NGO) and public sector bodies are associated with the agricultural engineering sector. They provide access to training, extension, research and credit. The extent to which they fulfil their functions effectively should be determined.

These points are discussed in more detail below.

3.2 National Economy

Working with broad aggregates, it is possible to comment on the performance of the economy. If an economy is relatively homogeneous this can be done at the national level; however, if there are significant differences between regions of the economy then disaggregated data may be more appropriate.

Key indicators include the rate of growth, per capita income, levels of unemployment and rates of inflation (Box 3.1). In order to make a meaningful interpretation it is useful if data are available for several years.

Box 3.1: Key Indicators of Economic Performance

- **Gross Domestic Product (GDP):** total GDP (preferably real GDP since it is expressed in constant prices, thereby removing the effects of inflation) and GDP per capita
- **Economic growth:** annual percentage increase in GDP
- **Unemployment:** percentage of total labour force
- **Wage rates:** average wage for agricultural, rural non-farm and urban employees
- **Inflation:** annual percentage rate
- **Trade:** balance of payments and value of domestic currency
- **International debt:** debt servicing
- **Population:** total population disaggregated by age, sex and residence (rural/urban) and annual growth rate
- **Human development:** life expectancy, nutrition, calorific intake, health, literacy

The performance of the economy and the development of the agricultural sector are closely related. If the economy is buoyant there may be opportunities for farm mechanization: labour may become scarce due to the development of non-farm sectors of the economy, wage rates will rise and people will be encouraged to move from farming into other occupations. Similarly, agricultural products may command higher prices in the market place due to the growing urban population. If a proportion of the population becomes more affluent, they make

seek a more varied diet. Under these conditions farmers will find it profitable to introduce new forms of technology. In contrast, during periods of economic stagnation characterised by high rates of unemployment and low wage rates, there is little incentive for people to leave farming and little opportunity to introduce new tools and equipment into farming systems. High rates of inflation also seriously disrupt economic activity.

The performance of an economy may also be reviewed from an international perspective, by examining the balance of trade and the value of the domestic currency. If there is a trading imbalance and access to foreign exchange is limited, this has implications for importing raw materials, machinery and spare parts for agricultural tools and equipment. Similarly, high levels of international debt servicing will constrain other economic activities.

Demographic data provide insights into future pressures on the economy. A young population with a significant proportion under the age of 15 indicates there will be a rapid expansion of the workforce during the next ten year period. If it will not be possible to absorb this additional labour in farming or other income generating activities in rural areas, many will migrate to the cities. As the proportion of the total population residing in urban areas increases, greater demand is placed on the agricultural community to produce marketable surpluses.

Indicators reflecting the general well being of the population should also be considered. Increased longevity, reduced morbidity, improved diets and increased literacy rates - all are indicators of human development which are not captured by purely economic data. Their relevance with regard to agricultural mechanization is in terms of labour availability and productivity, and their capacity to accept new ideas.

3.3 Policy Environment

At the macro level, governments typically pursue four development *goals*: income growth, equity and income distribution, employment generation, and the promotion of some notion of sustainability. Individual goals are quantified through a range of *objectives*, such as the elimination of poverty, achieving national food security, or achieving greater self sufficiency in manufactured goods. *Policies* are used to achieve the specified objectives, and may be formulated and implemented at both macro and sectoral levels.

A review of a range of government documents provides insights into aspects of the policy environment relevant to agricultural mechanization. The macro economic framework defines the planning rules, procedures and regulations regarding foreign exchange, trade, pricing, taxes, subsidies, quotas, and tariffs. The scope of the analysis is not just confined to agriculture and industry since many other sectoral policies, such as trade, energy, employment and transport, also have implications for the manufacture and use of farm machinery and equipment. Possible information sources include: national medium and long term development plans, annual sectoral development plans, public and parliamentary speeches and statements, and provincial government policies, where relevant.

The purpose of the policy review is to develop an understanding of the following:

- what the government expects to achieve;
- how the government plans to go about it and the time frame for achievement;
- which national resources are to be mobilized and what mechanisms are to be adopted to promote their efficient allocation;
- what role is to be fulfilled by the private sector; and
- where, when and how the government's policies impinge on agriculture, in general, and agricultural mechanization, in particular.

The last decade has witnessed a significant shift in many countries towards market economies. Economies have been deregulated, state owned industries privatized, and government intervention significantly reduced. Despite this move to free markets, some level of government intervention is inevitable. There will be a continuing role in facilitating open and fair competition whilst providing adequate protection for consumers and workers. There will also be opportunities for direct interventions when the market proves to be an unsuitable delivery mechanism, such as installing rural water supplies or targeted social programmes.

3.4 Role of Agriculture

Agriculture will be the mainstay of most economies in which there is an interest in formulating an AMS. It is usually the principal source of national output and the main employer (Box 3.2). The net contribution to foreign exchange earnings will depend on the nature and value of exports. Agriculture also plays a role in supporting the development of an agro-industrial food processing sector.

Box 3.2: Key Indicators of the Agricultural Sector

- **GDP by sector:** percentage contribution of agriculture relative to industry and services
- **Employment by sector:** percentage engaged in agriculture relative to industry and services
- **Trade:** value of agricultural exports and imports as a percentage of total
- **Food self sufficiency:** proportion of total food consumed which is produced domestically
- **Farm gate prices:** movements in prices for main products sold by farmers
- **Frequency of cultivation:** length of fallow periods of cultivable areas
- **Access to markets:** flow of goods and information between farming community and market centres

In countries where there is a stated commitment to meeting basic food needs from their own resources, it is relevant to consider the food self sufficiency ratio. This gives an indication of the current pressure to produce food to satisfy the domestic market. Insights to future sources of growth in agricultural production may be determined by the frequency with which the land is cultivated at present. With the drive to increase food production, fallow periods will be reduced, cultivation practices changed, and investments in land improvement undertaken.

3.5 Farming Systems and Agricultural Mechanization

The structure of farming systems is central to the analysis of agricultural mechanization. The pattern of production, the ownership of resources, participation by household members in farming, gender division of labour, and the profitability of farm enterprises influences the range and scope of agricultural mechanization.

Farming systems need to be classified on a basis which accurately reflects the agricultural sector and is relevant to the use of farm power and equipment. Possible classification criteria include agro-ecological zones, crop/livestock production systems, principal sources of farm power, farm size and land tenure. The level of analysis should not be unduly complicated but sufficient to identify groups of farmers with similar resource endowments and patterns of utilization, whilst facing common constraints and development potentials. The information used for classification should be relatively easily available and reliable.

Once the criteria for classification have been established, basic statistics for each farming system are collected (Box 3.3). This covers both household and farm data since the household is the core of the farming system. It is here that goals are established, food and cash requirements are determined, labour is allocated, and crop and livestock production systems are designed. Whilst it will not be possible to conduct a full survey of all farming systems in the time available, it is essential to ensure the principal ones are considered.

In the context of preparing an AMS, specific attention is paid to establishing the existing status of agricultural mechanization. Constraints in the production system, particularly those caused by failures in the agricultural engineering sector, are noted and their underlying causes identified. For example, uncertainties regarding legal title to land can inhibit on-farm investments in soil and water conservation structures or farm buildings. Any specific assistance by government or others to encourage or directly support the use of certain types of machinery or equipment is reviewed.

Box 3.3: Characteristics of Farming Systems

- **Number of holdings in each farming system**
- **Average farm size** : total area, area cultivated, length of fallow
- **Dominant crop/livestock production systems** : types of crops/livestock and production methods
- **Use of inputs**: traditional, alternative (e.g. seeds, organic and inorganic fertilizers, agro-chemicals)
- **Use of farm power and equipment**: inventories of farm tools and equipment by power source
- **Labour**: family, hired, exchange, tasks performed by age and gender, labour costs
- **Crop and livestock budgets**: gross margins per enterprise
- **Machinery and equipment costs**: purchase price, replacement rate, repair and maintenance costs, hire charges, contractor charges, government schemes
- **Land tenure**: owner, tenant, communal, state
- **Household characteristics**: family size, composition by age and sex, labour availability, migration, goals, preferences, decision making, traditions
- **Performance of tasks by family members**: household duties, subsistence food crops, cash crops, livestock, storage, marketing, off-farm activities
- **Household income** : farm and non-farm sources, average farm income, average household income

An example of the type of data collected is presented in Appendix I. The layout can be adapted for use in the field: whilst the three headings would remain the same, the detail would differ, reflecting different farming systems and different production constraints.

3.6 Other End-Users

Whilst the principal users of farm machinery and equipment are farm businesses, it is important to recognize the interface between agricultural engineering and other sectors of the economy. Other end-users include government departments engaged in public works (such as soil and water conservation), farm machinery contractors and private hire services, and forestry businesses. They may face constraints which are attributable to weaknesses in the agricultural engineering sector.

Alternatively, farmers' decisions regarding farm power or machinery may be influenced by non-agricultural considerations. For example, if a decision to purchase a tractor is based partly on an ability to establish a rural transport service, the quality of the roads and location of markets will determine the profitability of this choice.

3.7 Agricultural Machinery Industry

The scale and activities of the agricultural machinery industry varies substantially between countries. At one end of the spectrum, local manufacturing is dominated by blacksmiths and craftsmen producing a limited range of hand tools and animal drawn implements. These countries rely mainly on imports to meet their farm machinery needs. In the middle, a reasonable range of farm machinery is manufactured locally and those items which cannot be manufactured are imported. At the other extreme, countries are self sufficient in machinery manufacture and may also export some items.

The distribution network also varies: some countries benefit from comprehensive sales, repairs and maintenance services whilst in other regions, poor delivery and backup services frustrate the timely and sustained use of machinery and equipment.

The level of analysis will depend on the size of the industry and level of complexity of a country's economy (Box 3.4). If large scale manufacturers and importers are limited in number, it may be possible to describe them

individually. However, this would not be practical in countries with many large and medium sized manufacturers. Specific initiatives by government to support the agricultural machinery industry are reviewed.

Box 3 4: Characteristics of the Agricultural Machinery Industry

- **Importers:** volume of imports of finished goods, goods in a partially knocked down state and raw materials
- **Manufacturers:** range, quality and quantity of hand tools, machinery, equipment and spare parts produced by blacksmiths, local craftsmen, commercial manufacturers, joint ventures, technical skills of manufacturers and employees
- **Machinery distributors:** number and location of dealerships, marketing arrangements
- **Maintenance and repair services:** number and location of facilities, links with manufacturers, source of spare parts, adequacy of service
- **Fuel and lubricants:** availability, quality
- **Draught animals:** breeders, trainers, veterinary services, animal feed
- **Government assistance to agricultural machinery industry**

In countries where draught animals are a major source of farm power, the infrastructure for animal breeding, training, health and nutrition should also be reviewed.

The objectives of the review are to determine:

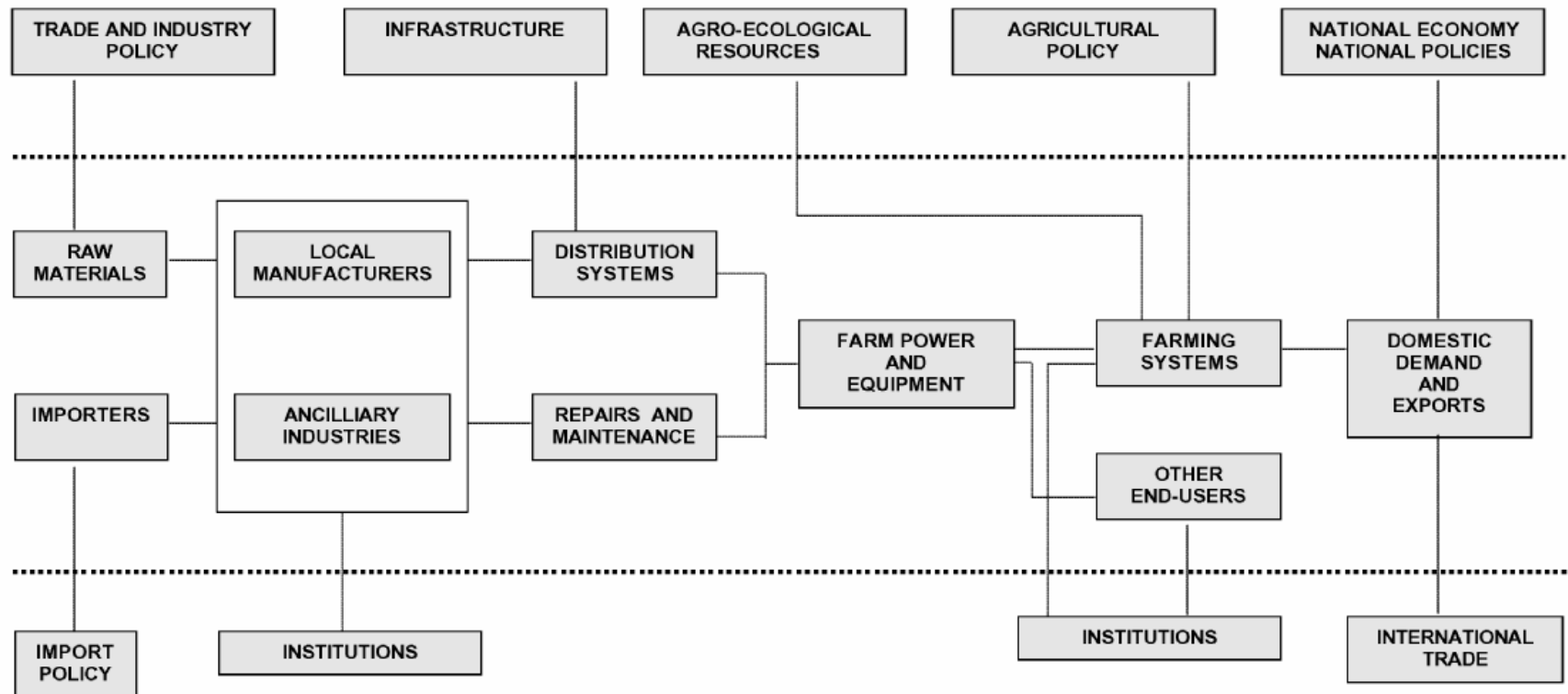
- the current manufacturing and distribution capacity of the industry;
- any slack in the current system, which might allow for a rapid increase in production;
- possible constraints to the expansion of production, including the acquisition of raw materials, equipment and manufacturing designs;
- training, research, credit and extension needs; and
- weaknesses in repair and maintenance services.

An example of the data collected is presented in Appendix II. Again this may be adapted in practice to reflect different structures of the agricultural machinery industry.

3.8 Institutions

The various institutions associated with the agricultural and manufacturing sectors, particularly with regard to agricultural mechanization, are identified and their principal activities determined (Box 3.5). These activities may be undertaken by private commercial, NGOs and public sector bodies.

Diagram 3.1: Agricultural Engineering Sector



Box 3.5: Institutional Review

- **Extension:** structure, number of staff and their qualifications, services provided, contact with target groups (farmers, manufacturers, distributors, blacksmiths), budgets and development plans
- **Education and Training:** programmes, curricula, target groups, participants, staff, facilities, budgets and development plans
- **Credit:** formal and informal sources, use of credit, terms, duration, collateral requirements, rates of repayment
- **Research and development:** specialist institutions, universities, independent bodies: programmes, activities, staff, facilities, dissemination methods, links with beneficiary groups, budgets and development plans
- **Machinery testing and evaluation:** testing procedures and certification
- **Consumer protection:** legislation, information dissemination, credit protection

The review should identify any major institutional constraints which limit the performance of the agriculture at present or may inhibit future initiatives. Any institutional strengths which may facilitate strategy implementation should also be noted.

3.9 Information Collection

It is important to keep the collection methods appropriate to the task in hand: the overriding objective is to collect sufficient information to prepare a strategy within a reasonable period of time.

The starting point is to collect and review existing information which may be available, for example, from government departments, research organizations, national associations and NGOs. These secondary data provide the broad parameters within which the agricultural engineering sector operates.

In order to identify and understand the needs of the farming and manufacturing sectors in more detail, it is necessary to work with those communities. Whilst there will be insufficient time to conduct a full and detailed survey, informal data collection methods such as Rapid Rural Appraisal (RRA) techniques can be very effective. The sampling frame should cover all major classifications, particularly within the farming and manufacturing sectors. Case studies can be used to provide detailed insights of specific points of interest.

Primary data may also fill in gaps in the information base and validate existing data. As with all data collection exercises, information collected from different sources should be cross-checked for consistency and adjusted if necessary.

3.10 Summary

At the completion of the review of the agricultural engineering sector, it is useful to summarize the main findings and consider their implications for the strategy. The key questions to address are listed in Box 3.6; the results may be presented in tabular format, highlighting the strategy implications. An example of a completed summary table is presented in Appendix III.

Box 3.6: Agricultural Engineering Sector Summary

Policy Review

- Do agricultural policy instruments influence the use of farm power and equipment?
- Do industrial policy instruments influence the local manufacture of farm machinery and equipment?
- Do trade policy instruments influence the importation of farm machinery and equipment?
- Do fiscal policy instruments influence the manufacture or use of farm machinery and equipment?

Farming Systems

- Does the existing level of agricultural mechanization restrict agricultural production?
- Does the existing level of agricultural mechanization restrict the performance of household tasks?
- Does the existing level of agricultural mechanization perpetuate drudgery and poverty amongst the farming community?
- Does the existing level of agricultural mechanization have any adverse environmental impacts?

Agricultural Machinery Industry

- Does the local manufacturing industry meet the needs of the farming community?
- Does the local manufacturing industry have export potential?
- Do the imports of farm machinery and equipment meet the needs of the farming community?
- Do the distribution, repair and maintenance services support the efficient use of farm machinery and equipment?

Institutions

- Are there adequate credit facilities for local manufacturers, importers, distributors and farmers?
- Is there adequate training for manufacturers, distributors and farmers regarding the production, operation and maintenance of farm hand tools, farm machinery and equipment?
- Do the extension services provide adequate support for manufacturing, operating and maintaining farm hand tools, farm machinery and equipment?
- Is there adequate training and extension support for using draught animals?
- Do publicly funded research and development projects in agricultural mechanization focus on priority needs?
- Do manufacturers, importers and farmers have access to sufficient market information to make informed choices?
- Is there adequate protection for consumers from poor or illegal business practices?

4. STRATEGY FORMULATION

This chapter focuses on the formulation of the strategy to create the environment in which agricultural mechanization will develop from the existing situation to a future (or desired) state. Ultimately the strength of the strategy depends on the correct interpretation of present events, as well as the concept and identification of future scenarios. The latter are generated with reference to the national economy, the agricultural sector, farm power and equipment requirements, and the manufacturing and distribution system.

The strategy is formulated, paying specific attention to the roles of government and the private sector. The output is a suite of policy and institutional recommendations, supported by programmes and projects, when appropriate.

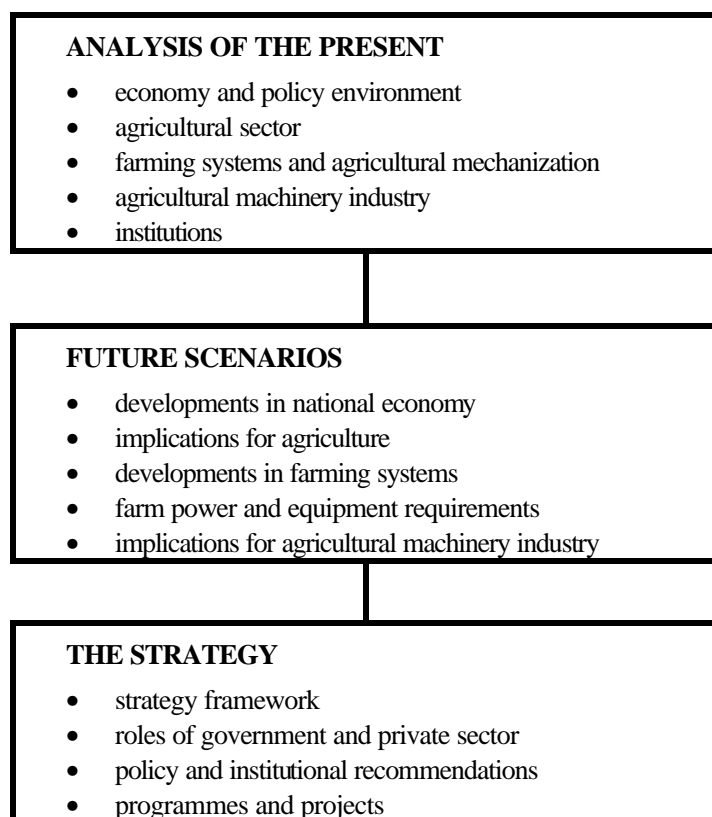
4.1 Overview of the Formulation Process

Initially, the strategy team must be familiar with the present: what are the principal farming systems; use of farm power, tools and equipment; and performance of tasks (Diagram 4.1). Are farm businesses meeting their expectations: are they realising their potential or do they face constraints and perceive opportunities are being missed? Similarly, what are the current activities of the manufacturing and distribution system: are there weaknesses or opportunities in the local manufacture and importation of farm machinery and equipment, or in their distribution, repair and maintenance? These points were addressed during the review of the agricultural engineering sector described in chapter 3.

Next, the strategy team must establish a vision of the future. Development plans set out broad statements of intent, supported by various policy initiatives. However, the actual position will evolve as the result of: the interaction between the performance of the economy, both at national and international levels; changes in the composition and residence of the population; and exogenous events. Each development scenario will have implications for the agricultural sector and, in turn, for farm power and equipment requirements.

Finally, how will these future mechanization requirements be fulfilled? What will be the roles of government and the private sector? Initiatives may be required to support the development of the manufacturing and distribution system, and strengthen the role of supporting institutions. Whilst some recommendations may be addressed at the policy level, perhaps requiring specific changes in legislation, others may be implemented through programmes and projects.

Diagram 4.1: Stages in Strategy Formulation



4.2 Future Scenarios

4.2.1 *Developments in the National Economy*

Based on the performance of the economy in recent years, coupled with statements regarding development goals and objectives, it is possible to determine the general course the economy will follow during the next five years. By and large, trends tend to be fairly stable in the medium term, with the exception of exogenous shocks to the system.

The latter may provide a window of opportunity for economic development (for example, if export prices rise) or may disrupt local activity (through drought, political instability or an unexpected rise in import prices).

Policy statements may make specific reference to the role envisaged for agriculture, in terms of export earnings and/or import substitution, securing food self sufficiency, poverty alleviation, and employment generation. Similarly, the local manufacturing base may have a role in import substitution, employment generation and human resource development

Demographic changes are central to the analysis. A high population growth rate indicates a growing demand for food. If this is coupled with a proportionally higher growth rate in urban areas (often fuelled by rural-urban migration) then even greater demands will be placed on the agricultural sector. Meanwhile, despite high birth rates, the productive capacity of the agricultural population may be threatened by malnutrition and illness, particularly AIDS, and migration of the young.

There are four key issues to be addressed by the agricultural sector (Box 4.1).

Box 4.1: Implications for the Agricultural Sector

- will the agricultural population be able to meet their own food needs?
- will the agricultural sector be able to meet the food needs of a growing urban population?
- will the agricultural sector be able to produce cash crops to either generate or save foreign exchange, or support the development of agro-industries?
- will the agricultural sector be able to shed labour or provide employment opportunities at a rate which makes best use of the nation's human resources?

4.2.2 *Developments in Farming Systems*

How will the farming systems respond to these demands?

The first step is to understand how the farming systems are likely to evolve over next five years. Factors which may influence the distribution of holdings between the farming systems are listed in Box 4.2; their influences may be experienced equally across all farming systems or skewed in certain directions. For example, if farming becomes more profitable, there may be a move from smaller holdings towards more commercially viable enterprises. Alternatively, the subsistence sector may experience continued growth, struggling to absorb a growing population

Box 4.2: Factors Influencing the Distribution of Holdings

- population growth
- changes in land tenure
- cultural and social factors
- relative profitability of farming versus other employment opportunities
- infrastructure developments

with limited non-farm employment opportunities; as a result, holdings become fragmented and the area cultivated per person decreases. Changes in land tenure may also affect the distribution of holdings.

The needs of the subsistence sector will be somewhat different. Their primary concern will be to ensure their households remain intact and they are able to meet their own food requirements. Particularly vulnerable groups are single and female headed households. If they are facing the challenges of reduced household size and declining labour productivity, they may be looking for less labour intensive cropping patterns, and labour saving technologies and practices.

Some smallholders may be able to bridge the gap between subsistence and commercial production but may require support, such as changes in land ownership and access to credit, to enable them to do so.

Due regard should be paid to the impact of increased production on the environment. Intensive cultivation methods may destroy the soil structure, irrigated areas may become saline, and agro-chemicals may pollute groundwater supplies. However, environmental measures may also be part of the solution: some new lands will require conservation measures, such as terracing, in order to be brought into sustainable cultivation.

What will be the farm power requirements under these different scenarios?

4.2.3 Farm Power and Equipment Requirements

The demand for farm power and equipment stems from four sources (Box 4.3). Regardless of any drive to increase production there will be an annual demand for tools and equipment to maintain the existing stock intact. Thus it is important during the review of the sector to identify the productive life of equipment and their replacement rates.

Box 4 3: Sources of Demand for Farm Power and Equipment

- replacement demand to maintain existing stock
- increase in demand due to growth in number of farm businesses
- adoption of mechanization inputs
- substitution demand to replace traditional power sources

Any move to increase total production will require additional farm power: to prepare larger areas, to bring marginal lands into production, to adopt more intensive cultivation methods, and to harvest, transport and process greater volumes of output. This demand may be supplemented by a growth in the number of farm holdings.

It may be possible to meet some of these additional demands from existing resources which are underutilised at present. For example, the introduction of double cropping or new cropping patterns may enable labour, draught animals or tractors to be more fully utilised throughout the year. Alternatively, resources may be redeployed: for example by withdrawing labour from activities outside the farm such as schooling or off-farm employment, or reducing time spent on household tasks. However, there will be trade-offs and the returns from agricultural production have to be set against the benefits foregone. Tasks may be reallocated between household members, overriding the traditional performance of tasks by gender or age.

In many instances it will be necessary to introduce additional power and equipment into the production system. This may be achieved through individual or group purchase, or hire. There may be opportunities for exchanging labour or equipment but this will be of limited benefit if households are operating similar farming systems.

In addition to considering the total stock of tools and equipment, it is also relevant to consider equipment design. Improved designs can both reduce environmental impacts of more intensive farming methods and also improve operator productivity and yields. An understanding of the conditions under which farmers adopt new technologies is central to the analysis of future scenarios (Box 4.4).

In some farming systems, producers have to introduce substitute power sources due to a decline in the availability or productivity of their traditional sources. Migration, long term malnutrition and illness all take their toll with regard to household productivity. Similarly, any sustained decline in the health and productivity of draught animals may force farmers to use new sources of power. Alternatively, they may seek labour saving solutions to keep their households intact, such as adopting less intensive production methods or cropping patterns, or reducing time spent on household tasks.

In summary, farmers and other end-users are looking for the widest choice of appropriate farm tools, machinery and equipment at affordable prices, as well as access to spare parts and maintenance services. They may also require information to assist in their choice, legislation to protect them from commercial exploitation, and credit to facilitate their purchases.

Box 4.4: Factors Influencing Farmers' Decisions to Adopt New Technologies

- **Technical performance:** work rates, implications for cropping and livestock systems, scale of production, impact on yields, complementary technologies
- **Financial returns:** gross margins, break-even analysis, returns from hiring machine/contractor versus ownership, individual or group ownership, sources of finance
- **Social implications:** total labour requirement with new technology, division of tasks between household members (by age and gender), division of tasks between family, hired and exchange labour, impact on quality of life
- **Environmental implications:** timeliness of operations, impact on soil structures, use of natural resources (water), cultivation of marginal lands
- **Machinery support services:** ability of existing infrastructure to maintain and repair new technologies, access to spare parts, technical information and advice, training

4.2.4 Implications for Agricultural Machinery Industry

The next step is to consider how the agricultural manufacturing industry will evolve during this period. Will it be growing at a pace to respond to the changing demands of the agricultural sector? Will it be developing export capabilities and displacing imports, or will imports be an important source for meeting any shortfall between demand and supply?

The sectoral review conducted in chapter 3 provides information about the current capacity of the manufacturing sector and its scope for expansion. Growth rates will be influenced by the state of the national economy, the development of infrastructure and ancillary industries, improved communications, skills acquisition, and the profitability of sales of agricultural machinery and equipment. The absence of a thriving agricultural machinery industry can often be traced back to a lack of profitability in one or more of the groups operating in the sector.

In summary, the agricultural machinery industry requires a competitive commercial environment in which manufacturing, importing, distribution and repair businesses can develop profitably, free from any unfair competition from the state.

4.3 The Strategy

4.3.1 Strategy Framework

Estimates for the demand for, and supply of, farm power and equipment are drawn together to provide the framework for formulating the strategy. Farm power and equipment requirements for the duration of the strategy are aggregated and compared to current levels of use. Incremental demand is then estimated on an annual basis.

Levels of output from local manufacturing coupled with imports are determined for the strategy period. If it is likely that the required level of supply in a sustainable delivery system will not be achieved, various strategy options will be considered.

The depth of the strategy will reflect these findings. There may be circumstances where projected demand will broadly be fulfilled; hence the strategy would focus on ensuring the agricultural engineering sector continues to function efficiently and fairly. In other circumstances, there may be a significant gap between projected demand and supply; thus the strategy would need to be more comprehensive to address fundamental imbalances in the sector.

4.3.2 The Roles of Government and the Private Sector

The principal role for government is to provide the conditions for a largely self sustaining development of the agricultural engineering sector within a policy of minimum direct intervention. The purpose of any interventions should be clearly identified and should fall within the framework of the AMS, and explicit attention should be paid to the effects of other policies on the level and use of engineering inputs in agriculture.

With the widespread move towards market economies, the new challenge is to formulate and implement policies and strategies which lead to government intervention in a consistent and efficient manner. Policies must be aimed at removing the most damaging forms of market failure and leaving market forces to operate where they can be effective in promoting both growth and rural poverty alleviation.

Thus the continued use of many of traditional forms of intervention will be uncertain in the medium term. Already exchange rate regulations have been lifted in many countries thereby facilitating the exchange of currencies at their market value (rather than being overvalued). In contrast, the continued use of taxes or subsidies distort the way in which either inputs are used or outputs are generated. Whilst this may be desirable in the short term (for example, if subsidies encourage the use of selected inputs), they are usually not sustainable in the long term. Similarly, the future role of government in providing agricultural extension is uncertain; many governments do not have the resources to continue to provide free extension services to all farmers.

Nevertheless, areas remain in which there is broad support for government involvement (Box 4.5). Large scale infrastructure investments (such as irrigation), agricultural marketing infrastructure, selected research and development (R and D), and education and training are considered important and legitimate areas for support. Government will have a continuing role in ensuring consumers have access to market information and adequate protection against illegal business practices.

If the government has traditionally played a central role in the agricultural engineering sector and private businesses have been largely discouraged, it will take time for entrepreneurs to come forward and fill the gap. Under these circumstances, the development of a fledgling private sector will require programmes and institutional support over the medium term. Capital will need to be mobilised, business skills strengthened, and an infrastructure developed.

Box 4.5: Possible Roles for Government

- health and safety
- labour law
- training
- industrial extension
- product R and D
- manufacturing designs
- manufacturing standards
- machinery testing
- licensing
- credit
- business promotion and development
- market information
- identification of regional trading partners

4.3.3 Policy and Institutional Recommendations

Existing policies and institutions need to be reviewed to determine how they are likely to influence the proposed strategy. The strategy team may suggest improvements and formulate alternatives to support the implementation of the strategy.

Where the findings indicate that development will be enhanced by a modification to policy or institutions, the impacts of at least two alternative options should be prepared: namely, the best option within the current policy and institutional environment, and what could be achieved if the environment was modified. However, it must be recognized that the ultimate decision to implement such changes rests with the government and, in some cases, may require fundamental changes to legislation.

4.3.4 Programmes and Projects

The formulation of an agricultural mechanization strategy usually includes the identification and preliminary formulation of supporting programmes and projects. These may be specifically oriented towards farm power and equipment or define components that can be incorporated into other agricultural development projects.

The key items and issues are detailed in the strategy document in order to provide guidance for subsequent project formulation. Where relevant, implementation of each project should be coordinated with other projects in the programme and with complementary projects in other development programmes.

4.3.5 Strategy Table

The key elements of the strategy can be summarised by addressing four questions (Box 4.6). An example of the details of strategy findings and strategy actions is presented in Appendix IV. In the final strategy document, the tables presented in Appendices III and IV are combined to form the agricultural engineering sector summary - strategy table.

Box 4.6: Strategy Questions

- What quantity and quality of farm hand tools, machinery, equipment and draught animals will be required over the next five years?
- How will they be supplied?
- How will they be distributed?
- How will they be sustained?

5. PRESENTATION OF STRATEGY AND IMPLEMENTATION

This chapter concludes the strategy preparation process. It discusses a proposed format for the strategy document, mechanisms for reviewing the findings, and the initial steps towards strategy implementation.

5.1 Strategy Documentation

Whilst there is no prescribed format for the layout of the strategy document, the following approach is recommended:

- the *executive summary* setting out briefly the main findings and recommendations. The agricultural engineering sector summary - strategy table provides a comprehensive summary of the main issues raised during strategy preparation. The executive summary should be concise and self contained;
- the *main report* concentrating on the analysis of the current situation, the projection of future scenarios, and the identification of the means by which the future is to be achieved. Detailed descriptions of the current situation are presented in the appendices, along with project profiles. The main report should be brief, providing a ready reference to the main features of the strategy; and
- the *appendices* presenting the essential information and analyses used for reaching the conclusions discussed in the main text. Each appendix is self contained and may be presented as a discussion paper at the second national workshop.

A suggested list of contents for the main report is presented in Box 5.1.

Box 5.1: Headings for Strategy Report

EXECUTIVE SUMMARY

1. INTRODUCTION

2. AGRICULTURAL ENGINEERING SECTOR

- 2.1 National Economy
- 2.2 Policy Environment
- 2.3 Role of Agriculture
- 2.4 Farming Systems and Agricultural
Mechanization
- 2.5 Other End-Users
- 2.6 Agricultural Machinery Industry
- 2.7 Institutions

3. FUTURE SCENARIOS

- 3.1 Developments in the National Economy
- 3.2 Developments in Farming Systems
- 3.3 Farm Power and Equipment
Requirements
- 3.4 Implications for Agricultural Machinery
Industry

4. STRATEGY

- 4.1 Strategy Framework
- 4.2 Roles of Government and Private Sector
- 4.3 Policy and Institutional
Recommendations
- 4.4 Programmes and Projects
- 4.5 Timetable and Review

APPENDICES

5.2 Review of Strategy

There are two mechanisms for reviewing the strategy. First, the draft document should be circulated for comment at the earliest opportunity to the widest possible audience, particularly amongst those who provided information during the preparation process. Second, the national workshop should be used to encourage comment and discussion, rather than solely as a forum for the formal presentation of the findings and proposals.

By the end of the workshop, typically lasting two days, the participants and the steering committee are expected to accept the draft strategy, probably with revisions, and to propose its adoption by government. This does not mean that all agree with every aspect of the strategy; some differences of opinion will be inevitable. Mechanisms should be set in place to oversee strategy implementation. Tasks may be assigned to specific individuals and a timetable set for achieving major targets. If responsibility for monitoring progress is placed with the steering committee, its

Box 5.2: Checklist Prior to Completion of Strategy Formulation

- Has there been the opportunity for the views from all key players in the agricultural engineering sector to be heard during strategy formulation?
- Have they had the opportunity to express their opinions regarding the future scenarios identified and recommendations of strategy formulation?
- Has the interpretation of the policy environment been discussed with the appropriate authorities?
- Are there any policy inconsistencies or institutional constraints which will make implementation of the AMS ineffective unless acted upon?
- Have policy makers been party to the preparation of the strategy? Are they willing and committed to act on the recommendations?
- Who is perceived to own the strategy document?
- Will implementation of AMS require complementary activities in other sectors and, if so, will they be likely to be forthcoming?
- Have linkages been identified with other development or planning initiatives?
- Has the preparation team operated effectively, keeping on schedule and within budget?
- Has the steering committee provided timely guidance and advice?
- Has a mechanism been set in place to see through strategy implementation, including provision for monitoring and any revisions?

location and line of authority need to be clearly established.

Final adoption of the strategy ultimately depends on the government. Hence it is important to secure the support of key decision makers at the outset of strategy preparation and to maintain close links with them throughout the process.

5.3 Steps Towards Implementation

Immediately after the workshop the document should be revised to incorporate the agreed changes and the final report submitted to the government. It is only if the findings are acted upon successfully that the exercise has been worthwhile (see Box 5.2).

Important decisions will be required regarding the final acceptance of the strategy: how it is to be implemented, what funding is required, and what are the potential funding agencies for specific programmes and projects? One way to facilitate implementation is to identify linkages with other development initiatives, where appropriate. Aspects of the strategy recommendations may be incorporated in other programmes or projects, such as sustainable agriculture or rural transport.

It must be recognized that strategy formulation and implementation is a dynamic process. As the economy develops and farming systems change, farm power needs will change. Moreover, government policies will adjust to reflect new circumstances and development philosophies. New programmes and projects will need to be identified, and new ways of incorporating farm power into broader development projects will have to be developed. Thus the strategy will need to be monitored regularly and revised to reflect key changes in the economic, policy and institutional environment.

6. BIBLIOGRAPHY

The following FAO documents provide additional guidance and insights relevant to strategy preparation.

Farming Systems

Bishop C (1995) *Farm Power Considerations in Farming Systems in Sub Saharn Africa*, Agricultural Engineering Service and Farm Management and Production Economics Service Occasional Paper, Rome: FAO

Bishop C (1995) *Farm Power: An Essential Input for Crop Production*, Agricultural Engineering Service AGSE Occasional Paper, Rome: FAO

FAO (1994) *Farming Systems Development*, A participatory approach to helping small-scale farmers, FAO-Sweden Farming Systems Programme in Eastern and Southern Africa, Rome: FAO

Agricultural Engineering Sector

FAO (1990) *Agricultural engineering in development: selection of mechanization inputs*, FAO Agricultural Services Bulletin 84, Rome: FAO

FAO (1990) *Agricultural engineering in development: guidelines for mechanization systems and machinery rehabilitation programmes*, FAO Agricultural Services Bulletin 85, Rome: FAO

FAO (1992) *Agricultural engineering in development: human resource development - training and education programmes*, FAO Agricultural Services Bulletin 92, Rome: FAO

FAO (1997) *Gender and Agricultural Engineering: Key Issues*, Agricultural Engineering Service AGSE Occasional Paper, Rome: FAO

Inns F M (1995) *Selection, testing and evaluation of agricultural machines and equipment, Theory*, FAO Agricultural Services Bulletin 115, Rome: FAO

Limbrey R F S (1994) *Agricultural Machinery Distributors, Importers and Dealers, Their role, management and operation*, Agricultural Engineering Service AGSE Occasional Paper, Rome: FAO

Strategy Considerations

Boussard J-M (1992) *The impact of structural adjustment on smallholders*, FAO Economic and Social Development Paper 103, Rome: FAO

Simalenga T E (Ed) (1997) *Farm Mechanization and Strategy Formulation in East and Southern Africa*, Proceedings of FAO/Farmesa Regional Workshop, Arusha October 1996, Harare: FAO

Smith L D and Thomson A M (1991) *The role of public and private sector agents in the food and agricultural sectors of developing countries*, FAO Economic and Social Development Paper 105, Rome: FAO

Thomson A and Terpend N (1993) *Promoting private sector involvement in agricultural marketing in Africa*, FAO Agricultural Services Bulletin 106, Rome: FAO

Data Collection Methods

Davis-Case D (1990) *The Community's Toolbox, The idea, methods and tools for participatory assessment, monitoring and evaluation in community forestry*, Community Forestry Field Manual 2, Rome: FAO

Dixon J M, Hall M, Hardaker J B and Vyas V S (1994) *Farm and community information use for agricultural programmes and policies*, FAO Farm Systems Management Series 8, Rome: FAO

Norman D W, Worman F D, Siebert J D and Modiakgotla E (1995) *The farming systems approach to development and appropriate technology generation*, FAO Farm Systems Management Series 10, Rome: FAO

**APPENDIX I FARMING SYSTEMS AND FARM POWER CONSTRAINTS:
AN EXAMPLE**

FARMING SYSTEMS	EXISTING FARM POWER AND EQUIPMENT	PRODUCTION CONSTRAINTS
subsistence - traditional crops for household consumption	<ul style="list-style-type: none"> • limited range of hand tools • family labour • very occasionally exchange labour with neighbours or relatives 	<ul style="list-style-type: none"> • late planting due to shortage of labour • women have limited time for farming due to labour-intensive household tasks
small-scale, emergent - principally producing for domestic use but occasionally market small surplus	<ul style="list-style-type: none"> • full range of hand tools • family labour • occasionally hire labour or DAP 	<ul style="list-style-type: none"> • unable to do second weeding due to labour shortages • limited use of soil erosion practices due to uncertainty regarding land tenure
peri-urban farmers, located on urban fringe with access to part time off-farm work	<ul style="list-style-type: none"> • full range of hand tools • family labour and hired labour • own tractor and implements • hire out tractor and implements 	<ul style="list-style-type: none"> • use of mechanized inputs not always appropriate since decisions not constrained by farm profitability
medium scale, commercial producer	<ul style="list-style-type: none"> • full range of hand tools • family labour and hired labour • own draught animals and implements • hire out draught animals + implements • small scale primary processing equipment 	<ul style="list-style-type: none"> • spare parts for animal drawn implements not always available
large scale, commercial producer	<ul style="list-style-type: none"> • full range of hand tools • hire labour • own tractor and implements • hire out tractor + implements • small scale primary processing equipment 	<ul style="list-style-type: none"> • tractor spares unreliable • repair services of variable quality • lack of information regarding new machinery • subsidized government tractor hire threatens private services
estate	<ul style="list-style-type: none"> • full range of hand tools • hire labour • own tractor and implements • large scale primary processing equipment • full repair and maintenance services on site 	<ul style="list-style-type: none"> • spare parts for machinery not always available • lack of information regarding new machinery • mandatory testing of new machinery causes delays

APPENDIX II - AGRICULTURAL MACHINERY INDUSTRY: AN EXAMPLE OF PRODUCTION CONSTRAINTS AND OPPORTUNITIES

INDUSTRY	CHARACTERISTICS	CONSTRAINTS	OPPORTUNITIES
importers	<ul style="list-style-type: none"> sector is dominated by a few well established businesses all imports of machinery arrive fully assembled 	<ul style="list-style-type: none"> traditionally enjoyed preferential access to foreign exchange for machinery imports now have to compete with other sectors for foreign exchange 	<ul style="list-style-type: none"> examine possibility of importing goods in partially knocked down state own dealer network with well equipped workshop facilities and trained staff
blacksmiths	<ul style="list-style-type: none"> numerous throughout country produce limited range of hand tools and some animal drawn implements quality variable 	<ul style="list-style-type: none"> difficulties buying raw materials use scrap metal when available very limited production facilities 	<ul style="list-style-type: none"> regular contact with end-users skills developed by training courses support of industrial extension service
small scale manufacturers	<ul style="list-style-type: none"> batch production of standard hand tools and animal drawn implements 	<ul style="list-style-type: none"> no distribution network lack credit to improve production facilities and equipment 	<ul style="list-style-type: none"> potential to upgrade range of products to meet local needs
medium scale manufacturers	<ul style="list-style-type: none"> full complement of tools and animal drawn implements manufacture some equipment driven by imported engines sited in main manufacturing towns 	<ul style="list-style-type: none"> limited distribution network limited contact with farmers and other end-users 	<ul style="list-style-type: none"> rehabilitate manufacturing equipment examine opportunities for joint venture agreements
large scale manufacturers	<ul style="list-style-type: none"> full complement of tools and animal drawn implements manufacture some equipment driven by imported engines manufacture some implements drawn by tractors sited in main manufacturing towns 	<ul style="list-style-type: none"> shortage of working capital restricted access to new designs weak links with outlying distributors due to poor communications network delays in marketing new products due to machinery testing and certification procedures 	<ul style="list-style-type: none"> regional export potential good access to raw materials skilled workforce good links with ancillary industries
manufacturers of spare parts and accessories	<ul style="list-style-type: none"> limited range of products variable quality sited in main manufacturing towns 	<ul style="list-style-type: none"> market dominated by imported items limited distribution network 	<ul style="list-style-type: none"> develop wider product range to support engine-powered machinery
distributors	<ul style="list-style-type: none"> located at principal market centres 	<ul style="list-style-type: none"> shortage of working capital carry limited stocks delays in receiving new products 	<ul style="list-style-type: none"> act as intermediary between end-users and manufacturers

maintenance and repair services	<ul style="list-style-type: none">• sparsely scattered in rural areas	<ul style="list-style-type: none">• limited capabilities of workshops• supplies of spare parts unreliable• limited technical information to support new products	<ul style="list-style-type: none">• improve quality of work by staff training
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APPENDIX III AGRICULTURAL ENGINEERING SECTOR SUMMARY: AN EXAMPLE

REVIEW	FINDINGS	STRATEGY IMPLICATIONS
POLICY		
Do agricultural policy instruments influence the use of farm power and equipment?	<ul style="list-style-type: none"> • subsidised tractor hire scheme has encouraged reliance on tractors for land preparation 	<ul style="list-style-type: none"> • subsidy not sustainable • poor performance of service • planting delayed for many farmers
Do industrial policy instruments influence the local manufacture of farm machinery and equipment?	<ul style="list-style-type: none"> • no special incentives available to assist manufacturing 	<ul style="list-style-type: none"> • see agricultural machinery industry section below
Do trade policy instruments influence the importation of farm machinery and equipment?	<ul style="list-style-type: none"> • tractors imported at concessionary rates • spare parts imported at full duty 	<ul style="list-style-type: none"> • repair and maintenance services struggle to get spare parts
Do fiscal policy instruments influence the manufacture or use of farm machinery and equipment?	<ul style="list-style-type: none"> • subsidised fuel reduces operating costs of engine-driven machinery • manufacturing tools imported with full duty 	<ul style="list-style-type: none"> • subsidy may be withdrawn • examine impact if manufacturing tools imported at concessionary rates
FARMING SYSTEMS		
Does the existing level of agricultural mechanization restrict agricultural development?	<ul style="list-style-type: none"> • most power sources fully utilised at present • farm power constraints restrict land preparation and weeding 	<ul style="list-style-type: none"> • any increase in production will require additional power sources • examine alternative weeding systems
Does the existing level of agricultural mechanization restrict the performance of household tasks?	<ul style="list-style-type: none"> • women give priority to household tasks; hence they struggle to meet all their farming commitments 	<ul style="list-style-type: none"> • identify opportunities to reduce labour intensive tasks in the home (e.g. food preparation)
Does the existing level of agricultural mechanization perpetuate drudgery and poverty amongst the farming community?	<ul style="list-style-type: none"> • opportunities for off-farm work often occur at busiest times of farming year, thereby delaying completion of own farming tasks 	<ul style="list-style-type: none"> • identify alternative employment opportunities which complement farming calendar
Does the existing level of agricultural mechanization have any adverse environmental impacts?	<ul style="list-style-type: none"> • labour shortages restrict construction of soil conservation structures • poorly designed sprayers cause environmental and operator pollution 	<ul style="list-style-type: none"> • identify and address farm power requirements of soil conservation structures • improve design of spraying equipment

APPENDIX III (continued)

REVIEW	FINDINGS	STRATEGY IMPLICATIONS
AGRICULTURAL MACHINERY INDUSTRY		
Does the local manufacturing industry meet the needs of the farming community?	<ul style="list-style-type: none"> • produces full range of hand tools • limited range of animal drawn implements and engine-driven machinery 	<ul style="list-style-type: none"> • examine opportunity to extend range of implements
Does the local manufacturing industry have any export potential?	<ul style="list-style-type: none"> • none at present 	<ul style="list-style-type: none"> • conduct market research into possibility of developing regional capability for producing farm implements
Do the imports of farm machinery and equipment meet the needs of the farming community?	<ul style="list-style-type: none"> • mixed fleet of tractors and engines imported in past • difficult to resource spare parts 	<ul style="list-style-type: none"> • some rationalization may be appropriate
Do the distribution, repair and maintenance services hinder the efficient use of farm machinery and equipment?	<ul style="list-style-type: none"> • limited services away from principal centres • technical repair skills variable 	<ul style="list-style-type: none"> • identify ways in which network can be extended • review industrial training programmes
INSTITUTIONS		
Are there adequate credit facilities for local manufacturers, importers, distributors and farmers?	<ul style="list-style-type: none"> • facilities limited in manufacturing sector 	<ul style="list-style-type: none"> • examine opportunities for extending credit facilities to manufacturers
Is there adequate training for manufacturers, distributors, dealers and farmers regarding production, operation and maintenance of farm tools, machinery and equipment?	<ul style="list-style-type: none"> • skills variable at rural level, particularly with regard to engine-driven technologies 	<ul style="list-style-type: none"> • review industrial training programmes
Do the extension services provide adequate support for manufacturing, operating and maintaining farm tools, machinery and equipment?	<ul style="list-style-type: none"> • limited support for blacksmiths and small scale manufacturers • dealership staff provide most support for engine-driven technologies 	<ul style="list-style-type: none"> • identify ways to strengthen industrial extension service
Is there adequate training and support for the use of draught animals?	<ul style="list-style-type: none"> • poor operator skills in working with draught animals 	<ul style="list-style-type: none"> • review extension service skills in working with draught animals
Do publicly funded R and D projects in agricultural mechanization focus on priority needs?	<ul style="list-style-type: none"> • research stations have introduced some on-farm research but priorities often determined by research staff 	<ul style="list-style-type: none"> • identify opportunities to establish closer links between research staff and end-users
Do manufacturers, importers and farmers have access to sufficient market information to make informed choices?	<ul style="list-style-type: none"> • limited information available in rural areas • machinery testing delays new products entering market 	<ul style="list-style-type: none"> • examine ways to improve information flows • review testing procedures
Is there adequate protection for consumers from poor or illegal business practices?	<ul style="list-style-type: none"> • limited production guarantees • existing legislation offers limited protection 	<ul style="list-style-type: none"> • review quality standards • review legislative framework

APPENDIX IV STRATEGY TABLE: AN EXAMPLE

STRATEGY QUESTIONS	STRATEGY FINDINGS	STRATEGY ACTIONS
<p>What quantity and quality of farm hand tools, machinery, equipment and draught animals will be required over the next five years?</p>	<ul style="list-style-type: none"> • hand tools: increase in demand due to growth in number of small holdings • draught animals: increase in demand as farmers switch from hand to animal power • animal drawn implements: as above • stationary engines: small increase due to expansion of irrigated area; rapid growth in maize mills • tractors: limited increase because existing fleet not fully utilized 	<p>AMS:</p> <ul style="list-style-type: none"> • credit: flexible collateral arrangements for smallholders, contractors, machinery groups and primary food processors; • product information: regarding complex machinery + equipment • research: labour saving cropping patterns and technologies for households <p>Other:</p> <ul style="list-style-type: none"> • improve availability of other farm inputs • data collection: identify power requirements under different cropping systems and management practices
<p>How will they be supplied?</p>	<ul style="list-style-type: none"> • hand tools and animal drawn implements: local manufacturers • draught animals: local breeders • stationary engines: imported for locally manufactured equipment • tractors: imported • tractor-drawn implements: increase local manufacturing component 	<p>AMS:</p> <ul style="list-style-type: none"> • credit: blacksmiths for materials; small and medium scale manufacturers for production facilities and equipment; large scale manufacturers for working capital • research and design: improve access to new designs for large scale manufacturers • voluntary machinery testing to rationalise imported fleet <p>Other:</p> <ul style="list-style-type: none"> • improve flow of raw materials to rural areas

APPENDIX IV (continued)

STRATEGY QUESTIONS	STRATEGY FINDINGS	STRATEGY ACTIONS
How will they be distributed?	<ul style="list-style-type: none"> • blacksmiths sell direct to end-users • weak links between other manufacturers and end-users • dealership network covers engine-driven technologies 	<p>AMS:</p> <ul style="list-style-type: none"> • establish linkages between local manufacturers and distributors • credit: to enable dealerships to become established <p>Other:</p> <ul style="list-style-type: none"> • improve communications network in rural areas
How will they be sustained?	<ul style="list-style-type: none"> • hand and animal drawn implements serviced by blacksmiths • repair and maintenance workshops to service engine-driven equipment • veterinary services and animal feed suppliers for draught animals 	<p>AMS:</p> <ul style="list-style-type: none"> • training: farmers in use of engine-driven technologies; extension staff in animal nutrition; repair and maintenance staff in workshop skills • credit: working capital for workshops <p>Other:</p> <ul style="list-style-type: none"> • improve flow of spare parts to rural areas