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FOOD ENGINEERING
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Agricultural mechanization in Mali and Ghana: strategies, experiences and lessons for sustained impacts

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Agricultural mechanization in Mali and Ghana: strategies, experiences and lessons for sustained impacts

by
Mathias Fru Fonteh
FAO Consultant

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2010

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List of abbreviations

AESD	Agricultural Engineering Services Directorate
AGSE-FAO	Agricultural Engineering Service
AGST-FAO	Agricultural and Food Engineering Technologies Service (formerly AGSE)
AMCs	Agricultural Mechanization Centres
AMS	Agricultural Mechanization Strategy
APCAM	Assemblée Permanente des Chambres d'Agriculture du Mali
APEJ	Agence pour la Promotion de l'Emploi des Jeunes
ASAE	American Society of Agricultural Engineers
CAADP	Comprehensive Africa Agriculture Development Programme
Cap-Net	Capacity Building Network for Integrated Water Resources Management
CEEMA	Centre d'Expérimentation et d'Enseignement du Machinisme Agricole
CIGR	Commission Internationale pour le Génie Rural
CILSS	Comite Permanent Inter-Etats de Lutte Contre la Sécheresse dans le Sahel
CPS	Cellule de Planification et de Statistique
DAP	draught animal power
DNA	Direction Nationale de l'Agriculture
DNAER	Direction Nationale de l'Aménagement et de l'Equipement Rural
DNGR	Direction Nationale du Génie Rural
DNPIA	Direction Nationale des Productions et des Industries Animal
DNSI	Direction Nationale de la Statistique et de l'informatique
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization of the United Nations
FASDEP	Food and Agriculture Sector Development Policy
FCFA	West African Franc
FEWS NET	Famine Early Warning Systems Network
GDP	gross domestic product
GIDA	Ghana Irrigation Development Authority
GPRS	Growth and Poverty Reduction Strategy
GWP:	Global Water Partnership Organization
hp	horsepower
IWRM	Integrated Water Resources Management
MA	Ministry of Agriculture
MCA	Millennium Challenge Account
MDAs	Ministries, Departments and Agencies
MiDA	Millennium Development Authority
MoFA	Ministry of Food and Agriculture
NDPC	National Development Planning Commission
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organization
ON	Office du Niger
PDES	Programme de Développement Economique et Social
SRID	Statistics Research and Information Directorate
SSA	sub-Saharan Africa
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization

Preface

FAO has been assisting member states for over two decades to formulate strategies and implement action plans in order to develop agricultural mechanization. This was particularly important in the earlier years, as at that time the disappointing results of many mechanization schemes had led to the abandonment of the same. Efforts had reverted to focusing on improved hand tools, promotion of draught animal technologies and development of rural workshops, among others. Today, the agricultural development policies are turning full swing and many countries have, either unilaterally or with donor assistance, returned to the importation of substantial quantities of motorized equipment, including two- and four-wheel tractors.

Mali and Ghana, two African countries that are adopting this approach, have been chosen for an in-depth study of their mechanization activities. They are similar in that they are both in West Africa and also in the sense that both have previously attempted mechanization schemes based on motorized equipment. They differ in that Mali formulated an Agricultural Mechanization Strategy (AMS) in 2002 whereas Ghana, although having undertaken diagnostics of the situation on two recent occasions, never formulated such a strategy.

The case studies allow an assessment of the impact achieved together with observations concerning their relative success. In this way, the document complements two others in this series, the first studies the supply chains for agricultural equipment (Sims and Kienzle, 2009) and the second presents a more historical review of some of the earlier mechanization schemes in Africa (Ashburner and Kienzle, 2009).

Executive summary

Most African countries have economies strongly dominated by the agricultural sector. In some countries, agriculture generates up to 50 percent of the gross domestic product (GDP), contributes over 80 percent of trade in value and more than 50 percent of raw materials to industries. It provides employment for the majority of Africa's people, and yet Africa is the only region in the world where agricultural productivity is largely stagnant. Yields of maize and other staple cereals have typically remained at about 1 000 kg/ha, which is about a third of the average achieved in Asia and Latin America. In addition, poor post-harvest handling, storage and processing methods lead to high losses. Despite the importance of agriculture to most African economies, and despite low productivity, investment in agriculture is still very low.

One of the major constraints to the expansion and modernization of production is the low level of engineering technology inputs into agriculture. Farm power in African agriculture, especially sub-Saharan Africa (SSA), relies on human muscle power and is based on operations that depend on the hoe and other hand tools. It has been estimated that using only hand hoes, a farmer can only prepare about 0.5 ha for planting per season. For farmers to earn a living from agriculture, they cannot count only on hand-tool technologies. Investment in mechanization has only taken place on large commercial farms or through government schemes. In the past, most government established tractor-hire schemes failed regardless of whether the intention was to serve small-scale farmers or large mechanized agricultural projects. This contributed to the currently prevailing lack of confidence in the benefits that can be gained from mechanization in Africa.

One of the major reasons put forward for the lack of effectiveness of these efforts to mechanize in Africa has been the fragmented approach to mechanization issues. Formulation of national Agricultural Mechanization Strategies (AMSs) and plans for their implementation are now seen as the solution. In most African countries, no serious planning for sustainable mechanization has taken place. FAO has started to support a number of governments in the development of suitable national AMSs, and some countries have planned and implemented national AMSs on their own. FAO continues to receive requests from member countries on how to plan and implement successful AMSs, and it was therefore thought necessary to review two of the existing approaches; Mali and Ghana, as an input into FAO's guidelines.

To formulate an effective strategy, a holistic approach is required that includes private sector involvement, profitability considerations, and the creation of an enabling environment with clear roles for both public and private sector. The various activities involved in the formulation of a strategy can be grouped into three phases: (i) situation analysis; (ii) development of the strategy; and (iii) adoption of the strategy. The impacts of a strategy on mechanization should be a reduction in drudgery, increases in production, an increase in farmers' incomes, creation of employment and an increase in the standards of living of rural communities. However, an enabling environment needs to be created before mechanization can develop, expand and make an impact. The two countries looked at, Mali and Ghana, have both involved themselves in formulating a strategy on mechanization. The results are examined to see whether the original objectives have been achieved. In both instances the countries are still deciding on an overall way forward.

Mali has made noticeable progress in agricultural mechanization mainly because of the enormous potential for draught animals, the available agricultural land and the efforts of the state in collaboration with many development partners. Despite this, mechanization has not been coherent and accessible to most farmers. The provision of required agricultural technology to farmers is still considered low with only 35 percent of farmers having some form of mechanization technology. One of the major constraints has been the lack of a comprehensive vision in agricultural mechanization; hence the fragmented approach. In 2002, an FAO supported AMS was elaborated. The specific objectives were to: (i) improve food security through increased production per unit area and increase in area

cultivated; (ii) reduce the drudgery of women by developing and producing appropriate agricultural equipment; (iii) promote employment in rural areas through the production of agricultural equipment and provision of various associated services; and (iv) increase the income of the private sector involved in the provision of agricultural mechanization technologies.

The formulation was carried out in two phases: The first was a situation analysis to diagnose the strengths and weaknesses of the sector and was carried out in a participatory manner. The results of this analysis revealed that there were three major problems hampering the development of agricultural mechanization in Mali. These were: (i) farmers are not adequately equipped with agricultural equipment; (ii) difficulties of producers, importers and distributors of agricultural equipment to sell their products; and (iii) absence of a coherent agricultural mechanization policy. The second phase was the elaboration of the strategy and identification of feasible programmes and projects. At this stage, the roles of the three stakeholder groups were identified: farmers, the state, and the private sector equipment and service providers. Finally the strategy formulated a programme incorporating projects involving: (i) tax breaks and legislation to reduce the production cost of agricultural equipment; (ii) a strengthening of repair and maintenance services; (iii) development of a national commercial network to supply agricultural equipment including local production and importation; and (iv) encouragement of the creation of small enterprises to offer agricultural mechanization services. Although completed in 2002, by June 2009 the strategy had still not been formally adopted. The reasons for this are mainly political and basically because of changing agricultural policy perspectives. Without a clear agricultural policy it is difficult to settle on a mechanization strategy. Even so, despite the non-adoption, the strategy still forms the base reference document as concerns agricultural mechanization in Mali.

In the intervening period, a number of actions have been realized, which could be considered as implementation of some of the projects identified in the action plan, although not exactly as these were envisaged. Two programmes were proposed in the AMS. These formed part of the action needed to create an enabling environment. The first was to provide support to Government institutions in charge of agricultural mechanization. In response to this, a division was created and a system for coordination, monitoring and evaluation of mechanization is now in place. The second programme was to improve the supply of equipment to farmers. As a result, more agricultural equipment is now available in Mali either through importation or local manufacture. A problem that persists is the low purchasing power of farmers.

To address these issues an agricultural fund has been created to guarantee loans to farmers, many financial systems have been decentralized, and a network for the production and sales of draught animals has been created. As far as the reduction in drudgery is concerned, available data demonstrates that numbers of farm equipment increased after the elaboration of the AMS although not across all types of equipment. There are indications that farmers' access to mechanization equipment is increasing and hence this could have an impact on reducing the drudgery in agriculture. Extensive data on agricultural production is provided in the report, but apart from a few exceptions, no general overall benefit from the increasing mechanization could be determined. Overall average cereal production increased by 11 percent in the period 2003 to 2007. Increased mechanization is supposed to have contributed to this increase. Labour productivity has not significantly increased except in one or two specific geographic areas. Yields of major crops have also not shown any general increase that can be directly attributed to increased mechanization, again with the exception of one or two specific geographic areas.

In Ghana, no complete AMS has ever been developed although some early FAO reports from 1993/94 encompassed some aspects of mechanization strategy. The current umbrella policy document that guides agricultural mechanization in Ghana is the Second Growth and Poverty Reduction Strategy (GPRS II). This document covers all sectors including agriculture and looks to a better business and investment environment leading to improved agriculture-led growth. The priorities of GPRS II are: macroeconomic stability, accelerated private sector-led growth, vigorous human resource development, and good governance and social responsibility. The goal is to implement policies that will enhance and sustain economic stability. These include: prudent fiscal policies, a flexible monetary policy that ensures stable prices, stable exchange rates and affordable credits to the private sector.

The national vision in Ghana for the food and agriculture sector is a modernized agriculture culminating in a structurally transformed economy and resulting in food security, employment opportunities and reduced poverty. It is to be realized through a value-added chain approach. To achieve the goals of GPRS II, agriculture had to grow at an annual rate of 6 percent over 4 years. This implies a modernization of agriculture. In 2005, it was noted that there were nine critical issues that need to be addressed. These were: (i) reform of land acquisition and property rights; (ii) accelerating the development of irrigation; (iii) improving access to credit and inputs for agriculture; (iv) promoting selective crop development; (v) modernizing livestock production; (vi) improving access to mechanized agriculture; (vii) improving access to extension services; (viii) developing infrastructure for aquaculture; and (ix) restoring degraded environments. In GPRS II it is also stated that the strategy is to promote increased mechanization in large-scale agriculture but also with an emphasis on the development and use of small-scale technologies.

Under the GPRS II the Ministry of Food and Agriculture (MoFA) developed the Second Food and Agriculture Sector Development Policy (FASDP), which outlines the goals of the agricultural sector. It also developed a 3-year strategy for the different individual aspects for the period 2007–2009. This became the official agricultural policy document for Ghana. The components of the policy include: food security and emergency preparedness; improved growth in incomes and stability; sustainable management of land and environment; and application of science and technology in food and agriculture development. The MoFA has identified four groups of stakeholders for the implementation of the agricultural policy: the State; the private sector and civil society; development partners; and other Ministries, Departments and Agencies. The GPRS provides a national coordinated development framework in which agricultural mechanization is an important component and for which suitable policies to support the implementation of mechanization policies have been put in place. It clearly identifies the roles of the public and private sectors where the role of the state is seen primarily as a facilitator and the role of the private sector is as an equipment and service provider. Appropriate policies are in place for this. This is conducive to the successful elaboration and implementation of a strategy.

The objective for agricultural mechanization is to facilitate access by farmers and agroprocessors to mechanized services at affordable cost. To achieve this the following strategy was adopted: (i) collaboration with the private sector to build capacity to supply machinery and equipment; (ii) promotion of machinery for use along the value chain (storage, agro-processing machinery, transport); (iii) intensification of the use of animal traction; (iv) facilitation of the establishment of mechanization services; (v) promotion of local assembly of tractors and manufacture of processing equipment; and (vi) development of human capacity in agricultural machinery management, operations and maintenance.

Under the Ministry, the Agricultural Engineering Services Directorate (AESD) determined that the following general strategies should be developed: (i) establishment of agricultural research institutes; (ii) local manufacture; (iii) human resource development; (iv) irrigation development; (v) soil and water conservation measures; (vi) post-harvest technology development; (vii) extension; and (viii) finance. In order to meet policy objectives, the Directorate determined that about 40 000 tractors were required and it took a decision to import these. This was based on the perception that the private sector was reluctant to supply tractors and implements to farmers because of the high cost of agricultural machines compared to purchasing power of the farmers and the reluctance of commercial banks to lend to the agricultural sector. The Directorate formulated a comprehensive plan for the purchase by farmers of agricultural machinery that is based on state ownership until the farmer has paid off the subsidized price. Agricultural machinery centres were also set up to provide services to farmers. These are run by the private sector, which is required to pay for the machinery.

During the implementation of GPRS I from 2003 to 2005, farmers' access to mechanized tillage and access to processing equipment improved. The creation of agricultural mechanization centres has contributed to improving the access of farmers to agricultural mechanization technologies, and there is agreement from various data sources that farmers' access to mechanical power has increased over the last few years. This can be attributed to the increasingly favourable enabling environment regarding agricultural mechanization. There is also increased activity in the manufacturing and assembly of farm tractors and machinery, which is an indication that the enabling environment is favourable for suppliers of the technology.

Not withstanding this, agricultural production per farmer has hardly changed in the period since 1991. However, overall agricultural productivity has been increasing steadily from a low in 1997 to a high in 2004. Production of staple foods has been increasing steadily since 1997, and in the course of a decade production increased by 45 percent. This steady increase in food production can be attributed to the comprehensive agricultural policies in place in which agricultural mechanization is an important aspect. Data indicates that the agricultural sector has been experiencing growth over the last decade with an average growth rate of about 4.7 percent per year and that, during the implementation of the FASDEP initiative, growth in the agricultural sector increased with the cocoa subsector registering the highest growth. For cereals, the productivity of farmers is about 36 percent higher than the average of SSA. However, average yields are still far short of the average yields in Asia and Latin America. A reduction in post-harvest losses has also contributed to the increased availability of food.

The following major constraints were identified in both Mali and Ghana: (i) poor access of farmers to mechanization technologies; (ii) lack of skilled tractor operators; (iii) poor commercialization of agricultural produce (no guaranteed markets, low market prices, etc.); (iv) poor availability of spare parts because suppliers are concentrated in the major towns of Bamako and Accra; (v) farmers usually do not consider agriculture as a business but as a way of life; and (vi) the existing land tenure system. In Mali, there is consensus among all stakeholders that enough agricultural equipment is available in the market. In Ghana, however, stakeholders have concluded that agricultural equipment is not easy to acquire. A major constraint to increased mechanization for farmers in both countries is poor access to mechanization technologies. This is the result of the high cost of mechanization inputs, the low purchasing power of the majority of farmers to acquire them and the poor access to loans by farmers. In Ghana, lack of skilled tractor operators is considered to be one of the reasons why Government supported mechanization schemes failed in the past. Other constraints in Ghana include little commercialization of agricultural products, poor availability of spares, and the existing land tenure system.

Several factors contributing to success or failure of agricultural mechanization have been identified. In Mali there have been delays in the adoption of the AMS, which was completed seven years ago. With the implementation of new agricultural policies and programmes, the mechanization strategy is now an integral part of national development strategy even though it has not been formally adopted. Also, many projects in many sectors are complementary to the AMS and include: infrastructure, developing the private sector, good governance, education and health, economic growth and regional integration. Even though the mechanization strategy has not been formally adopted, it is still considered the reference document used for planning in agricultural mechanization and has contributed to raising awareness on the importance of improving the productivity of farmers. Mechanization has been generally more successful in Mali for crops with a good market price and with a ready market and may suggest that mechanization strategies should be focused on a few strategic crops within each country in a subregion and subregional trade encouraged. In Mali, the Government is involved in the provision of some mechanization services (tractors and implements, power tillers, etc.) to farmers whereas this should be the role of the private sector. This may end up in a failure, as has been the case previously.

In Ghana, several strengths have been recognized in the approach to promoting agricultural mechanization. The approach to mechanization focuses on selected commodities based on comparative and competitive advantage, which implies that the emphasis is on farming as a business. Agricultural mechanization in Ghana, even without a formal strategy having been adopted, is being carried out as an integral part of the national development process. Policies affecting mechanization stem from national policies and have been engrained into the various work plans of national institutions. In addition, because the national policy is to stimulate agriculture-led growth, many complementing policies that enhance agricultural production and productivity were put in place simultaneously. As a result, growth in productivity has been steady and sustained. Ghana already has a relatively good infrastructure, numerous training institutions in agricultural engineering (four public universities, one private university and four polytechnics), a good extension service and a fairly well staffed Agricultural Engineering Services Directorate. However, some weaknesses were identified in the

approach: a lack of a strategy has meant that some stakeholders have been omitted from the planning and implementation stages, especially farmers and private-sector equipment and service providers. A detailed diagnosis of the problems confronting farmers and private-sector equipment and service providers still needs to be carried out. The Ghanaian approach to agricultural mechanization for now is essentially top-down. Also, the Government is involved in the provision of some mechanization services. This should be the role of the private sector.One of the main constraints encountered in both countries was the lack of data to determine the long-term impacts of mechanization. Where data existed, it was generally not very reliable. Data collection should therefore be an important aspect of a strategy and calls for monitoring and evaluation of the implementation of the strategy. First indications are that progress in increased production and productivity has been steadier in Ghana. In Mali, production has been increasing but productivity has been constant. Ghanaian farmers are more productive than their Malian counterparts.

Although production has increased in both countries, a major issue is whether agricultural mechanization can be profitable without subsidies. In both Mali and Ghana different opinions were expressed. Not surprisingly, there is agreement that agricultural mechanization is only profitable for financially viable crops. In Ghana, the conclusion by the Agricultural Engineering Services Directorate is that agricultural mechanization is not profitable without subsidies. In Mali, the State view is that equipment purchased with loans from commercial banks with high interest cannot be profitable and that mechanization needs to be subsidized with concessionary interest rates. However, some researchers have a different view. Studies have concluded that agricultural mechanization is currently profitable in Ghana without subsidies; a view shared by the private sector in Ghana. In Mali, the confederation of Chambers of Agriculture has concluded that for crops with a good market value and with a ready market mechanization is profitable but that the most serious handicap is access to loans and the high interest rates charged by the commercial banks. This view is also shared by farmers and private-sector equipment suppliers in Ghana. In Ghana and Mali, the public sector provides some mechanization technologies (tractors and implements, power tillers, etc.) to farmers. Although this should be the role of the private sector, it is justified by the fact that farmers have difficulties to obtain loans. The intention of the State is to stimulate demand. Concerns exist about the sustainability of subsidized mechanization.

The recommendations are several. A strategy exercise is best carried out at the start of the mandate of a new political administration in a country. This increases chances for adoption and implementation. The strategy should only be prepared when there are policies in place outlining a broad national-development strategy including agriculture and that a mechanization strategy should fit into the context of an overall agricultural- development strategy. Implementation of the strategy should focus on the entire food chain and not just on land preparation. Political will and commitment at the highest possible level are very important for the elaboration, adoption and implementation of an AMS. FAO should assist at the highest possible level. Political will and commitment are also very important to place mechanization high on the agenda, raise awareness and drive the mechanization process. Implementation of a plan of action requires a considerable amount of resources and it is desirable to identify and involve development partners during the elaboration of the strategy; FAO may not be the only one involved in keeping the issue alive. In general, farmers are willing to pay for agricultural equipment but need loans at more favourable interest rates than those currently offered by commercial banks. Stakeholders conclude that the development of a flexible sustainable financing mechanism with preferential interest rates for loans for the acquisition of equipment is the key to the successful implementation of an AMS.

Within subregions in each country, the implementation of the strategy should initially focus on a few easily marketable and profitable strategic crops. Without a ready market to absorb increased production, mechanization is not sustainable. In cases where the private sector is weak, or the farmers have a poor purchasing power, and have difficulties to obtain loans, the state should be involved in the provision of services to farmers. Ghana is a country where the elaboration of a strategy has very good chances of success and which could be emulated by other countries. This is because the strategy would fit into a national development scheme, which is currently being implemented. FAO should consider providing financial and technical support for this to be achieved.

Acknowledgements

This study would not have taken place without the collaboration of many persons whom I would now like to acknowledge. I am indeed very grateful for the logistic support provided by FAO offices in Mali and Ghana. Special thanks go to: Marie Bernadette Traore-Sissoko in Bamako and Elsaid Yeboah in Accra; my FAO field contacts, who were responsible for organizing the meetings with various stakeholders and providing logistics support in the field.

The data collection for this assignment in Mali and Ghana was successfully carried out thanks to the constant support and collaboration of the Direction Nationale du Génie Rural (DNGR) of the Ministry of Agriculture (MA) in Mali, and the Agricultural Engineering Services Directorate (AESD) of the MA in Ghana. I am very indebted to Hantle Diarra of the DNGR, and Gamel Nuhu Ahmed of the AESD who went beyond the call of duty, abandoned their normal duties to ensure I had unlimited access to all the available information as concerns agricultural mechanization, facilitated meetings with the various stakeholders and personally accompanied me in all the visits during and outside office hours.

I wish to say thank you to all the stakeholders in Mali and Ghana, who took time off their very busy schedules to meet with me. I do hope the time spent was not in vain and that this document will lead all of us to take a new look at agricultural mechanization to ensure food security in Africa. The productive meetings with stakeholders were facilitated by ideas obtained from a questionnaire prepared by Professor Ajaga Nji, of the University of Dschang, in Cameroon. I am grateful for his insight and advice.

Finally I wish to thank the staff of the AGST at FAO headquarters in Rome for the opportunity to carry out this assignment. Special thanks go to Josef Kienzle for his supervision, orientation and comments, to Claudia Bastar for all the administrative and logistic support from Rome. I very much appreciate the time taken by Divine Njie, Alexandra Rottger, John Ashburner and Lawrence Clarke to thoroughly review this document and for their invaluable comments that greatly contributed to improve its quality. Special thanks go to Larissa D'Aquilio for coordinating the final review and publishing process, and to Fabio Ricci for the desktop publishing.

Chapter 1
Introduction

1.1 BACKGROUND

Agricultural mechanization can be defined as the economic application of engineering technology to enhance the effectiveness and productivity of human labour. FAO and UNIDO (2008) concluded that agricultural mechanization aims at reducing human drudgery, increasing yields through better timeliness of operations because of the availability of more power, bringing more land under cultivation, providing agriculture-led industrialization and markets for rural economic growth, and ultimately improving the standard of living of farmers. The technology can be applied to aspects of agriculture such as: land preparation, weeding, harvesting, pest control, irrigation and drainage, transportation and crop processing and storage. Tractors of various types and sizes may be involved while animal and human power are also important, as are other forms of internal combustion engines, electric motors, solar power and other methods of energy conversion. Levels and types of technologies need to be compatible with local, agronomic, socio-economic, environmental and industrial conditions.

Most African countries have an economy strongly dominated by the agricultural sector. In some countries, agriculture generates up to 50 percent of the gross domestic product (GDP), and contributes over 80 percent of trade in value and more than 50 percent of raw materials to industries (FAO and UNIDO, 2008). It provides employment for the majority of Africa's people. Despite this domination, investment in the sector is still grossly low in most African countries. Furthermore, it is widely documented that 30 to 40 percent of agricultural produce in Africa is lost because of poor post-harvest handling, storage and processing methods.

In addition, Africa is the only region in the world where agricultural productivity is largely stagnant. Yields of maize and other staple cereals have typically remained at about 1 000 kg/ha, which is about a third of the average achieved in Asia and Latin America (Table 1). In the years ahead, global warming is expected to seriously exacerbate the current constraints on African farmers.

TABLE 1
How Africa compares with other developing regions

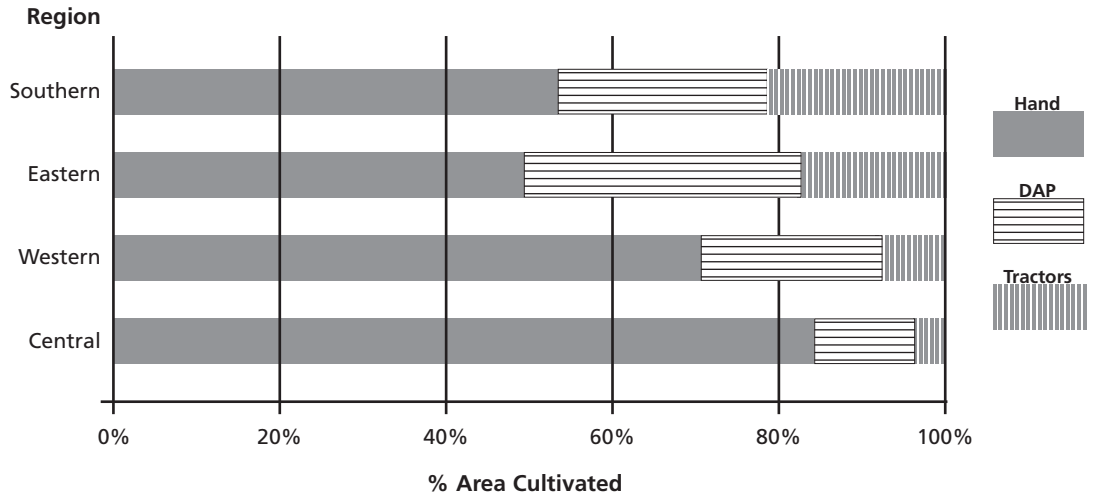
Region	Cereal yield kg/ha	Fertilizer use kg/ha	Irrigation percentage of arable land	Tractors per 1 000 ha
Africa[1]	1 040	13	5	28
Average of 9 selected countries[2]	3 348	208	38	241

Source: The World Bank (2007) as cited by FAO and UNIDO (2008).

Based on the above, there is therefore a high potential for lateral expansion of the agricultural sector at all levels. According to FAO and UNIDO (2008), the low level of engineering technology inputs in agriculture is as one of the main constraints hindering the modernization of agriculture and food production systems in Africa. Farm power in African agriculture, especially sub-Saharan Africa (SSA), relies to an overwhelming extent on human muscle power, based on operations that depend on the hoe and other hand tools as shown in Figure 1. Such tools have implicit limitations in terms of energy and operational output in a tropical environment.

[1] Africa less Egypt and Mauritius.
[2] Bangladesh, Brazil, China, India, Korean Rep., Pakistan, Philippines, Thailand, Viet Nam.

FIGURE 1
Percentage use of different sources of power in agriculuture in four regions in Africa



Source: Adapted from FAO (2001) as cited by Shetto (2007).

Giles (1975) as cited by Arnon (1981), concluded that for mechanization to be effective, the average aggregate yield of major crops should be at least 2.5 tonnes/ha and determined that the available power to the farmer should be at least 0.5 hp/ha. Man as a power unit produces only about 0.01 horsepower of continuous output and is therefore not worth much as a primary source of power (Barger *et al*., 1963). With only a hand hoe, Boshoff and Minto (1975) concluded that across the African continent, only about 0.5 ha could be prepared for planting. Based on the above, for man to earn a living from agriculture as an economic activity, he cannot count on hand tool technologies alone.

According to FAO and UNIDO (2008), past efforts to mechanize African agriculture have produced mixed results. Compared with other regions, Africa has not had the large-scale investment in agricultural infrastructure, such as irrigation or other inputs needed to intensify crop production. This is partly because Africa is fragmented into relatively small countries, unlike countries such as Brazil, India, or China. Investment in mechanization has been limited to large commercial farms or government schemes. In many cases where governments established tractor hire schemes to serve small-scale farmers, planning was very short term, and management was poorly trained and poorly supported. Such schemes, though relatively few across the continent, failed miserably, denting the image of agricultural mechanization in general.

FAO and UNIDO (2008) concluded that one of the major reasons for the disappointing performance and low contribution of mechanization to agricultural development in Africa has been the fragmented approach to mechanization issues. This can be attributed to poor planning by government agencies and over-reliance on unpredictable or unsuitable, one-off, aid-in-kind or other external mechanization inputs. Lack of teamwork or coordination within and between government departments and inherent competition with private sector business initiatives in mechanization services have not helped the situation. Formulation of national agricultural mechanization strategic and implementation plans is now seen as the solution, where a holistic approach is used and specifically includes private sector involvement, economic profitability and creation of an enabling environment with clear roles for both public and private sector stakeholders.

In most African countries, no serious planning for sustainable mechanization has taken place. In many cases where mechanization has made a positive contribution to agricultural development, it has been by chance, and not by careful project or program design. FAO has supported a number of governments in the development of suitable national Agricultural Mechanization Strategies (AMSs) and policies over the last couple of years. The last guidelines for the formulation of a mechanization strategy were published in 1988 as AGS Bulletin 45 (Gifford, 1988). FAO visions have changed since then towards a more integrated approach. Some countries have planned and implemented national AMSs without support from agencies such as FAO. Because FAO continues to receive requests from member countries on how to plan and implement successful agricultural mechanization strategies, it is necessary to review the elaboration and implementation of mechanization strategies in a number of countries to be used as input into revised guidelines for the elaboration and implementation of mechanization.

This study did so for two countries: Mali and Ghana. In Mali, with the support of FAO, a national mechanization policy was formulated in 2002. In Ghana, no complete AMS has been developed but a government-led program has imported thousands of tractors since the year 2004 to accelerate the adoption of mechanization technologies by Ghanaian farmers. This second initiative did not involve FAO. The approach in Ghana is being carried out within the framework of the Food and Agriculture Sector Development Policy (FASDEP), which itself is part of the national Growth and Poverty Reduction Strategy (GPRS). The aim of the GPRS is to stimulate economic growth in Ghana through a Green Revolution. This calls for increasing the agricultural productivity and production.

1.2 AIMS AND OBJECTIVES

The aim of this study was to analyse and evaluate the two mechanization approaches in Mali and Ghana with regard to whether their set objectives have been achieved. The specific objectives of the study were to:

- Determine the background information of the two approaches.
- Find out the key elements of each approach.
- Establish the roles and responsibilities of the public and private sectors.
- Determine the long-term quantifiable and qualitative results of intervention, as far as these can be ascertained.
- Analyse the factors that led to success or failure (difficulties) in each case.

1.3 METHODOLOGY

In order to analyse agricultural mechanization in Mali and Ghana, data were collected from a combination of primary and secondary sources. These data were collected in the two countries over a two-week period from 27 October to 9 November 2008. Primary data were collected from stakeholders of the agricultural mechanization subsector in both countries in the course of interviews. These stakeholders included relevant government staff who have been involved in the planning, implementation, monitoring and evaluation of mechanization in each country, private sector actors, research and training institutions, civil society, parastatal organizations, and professional organizations. Secondary data were obtained in the field in the two countries from official publications, published articles, as well as from publications available on Internet, from private collections and from FAO publications. During the write up of this document, updates up to June 2009 were obtained from the DNGR in Mali and from the AESD in Ghana.

Chapter 2
FAO guidelines for mechanization strategy formulation

2.1 AGRICULTURAL MECHANIZATION PLANNING

Early development plans in many countries were simply based on a list of projects where the government proposed spending its financial resources (Gifford, 1988). The focus was on economic development and hence planning was dominated by economists. Development planning has generally evolved from this level, but for agricultural mechanization in most developing countries it has largely remained in the "list of projects phase" of planning. The top-down approach is usually used in which the state defines the policies, and other stakeholders simply have to implement.

Africa in general has not witnessed significant sustained agricultural growth, which could be used as the basis for agriculture-led industrialization. This is because of the low productivity and production of the agricultural sector. Agricultural mechanization is a very important element to increased agricultural productivity and production with a dwindling percentage of the population engaged in agriculture. However, in Africa agricultural mechanization in general has not delivered the desired results and as concluded by FAO and UNIDO (2008), this could be attributed mainly to poor planning, fragmented approach to mechanization, emphasis on farming for poverty alleviation and lack of sustained political will. According to Rijk (1999), the introduction of agricultural mechanization is a complex process and should be carried out within the framework of an AMS. The aim of an AMS is to create a policy, institutional and market environment in which farmers have the choice of farm power and equipment suited to their needs within a sustainable delivery and support system. This is just what is required in most African nations to improve mechanization planning. The AMS strives to create an institutional framework that brings together all key stakeholders in a bid to increase the adoption of agricultural mechanization technologies.

Agricultural mechanization is just one of the "inputs" that needs to be mobilized to meet national development objectives and is therefore not an end in itself (Gifford, 1988). The formulation of an AMS should therefore be an integral part of a national development planning process and should be determined from short-, medium- and long-term national development objectives such as: self-sufficiency in food crops, generation of foreign exchange, reducing rural exodus and agriculture-led industrialization. Preferably, mechanization technology should be considered in the context of an agricultural technology strategy (Rijk, 1999). The AMS cannot be dissociated from other sectors if it is to be successfully implemented. Success of the AMS will depend on: social and economic stability, infrastructural development, utilities, fiscal policies, human resources etc.

2.2 PRINCIPLES OF AMS FORMULATION

For successful agricultural mechanization planning and implementation, a holistic approach should be used that should specifically include private sector involvement, economic profitability and creation of an enabling environment with clear roles for both public and private sector stakeholders (FAO and UNIDO, 2008). The above implies a number of notions:

- Holistic Principle: There are many disciplines involved in the agricultural mechanization process. These include: economics, agricultural engineering, sociology, agronomy, policy formulation and development planning. The formulation of an AMS should therefore be based on a multidisciplinary and participatory approach wherein no discipline dominates to the exclusion of others. The participatory approach will ensure that the interests and judgement of all who are knowledgeable and concerned are taken into consideration. This is a requirement for the building of consensus, stakeholder ownership and for successful implementation. The participatory approach is desirable especially with the disengagement of the state and with privatization. Three main groups of stakeholders can be identified. These are: a) the farmers who use the technology, b) private sector equipment and service providers to the farmers, and c) the state. Mechanization would only be successful if the actions of these three groups are coordinated.

- Public-Private Partnership: The AMS should clearly define the roles of the private sector and that of the state. The private sector should have the role of providing the technology, services and spare parts to the farmers. Meanwhile, the state should be a facilitator through the creation of the enabling environment. The creation of an enabling environment involves: establishing an appropriate institutional framework; implementing policies (exchange rates, prices, land ownership and tenure); providing infrastructure, extension services, research, education and training; and raising awareness. Rijk (1999) recommends that government should not actively get involved in the supply and repairs of agricultural mechanization technology but that this should be left in the hands of the private sector.

- Economic Profitability: Farmers will only mechanize if this will result in increased or maintained incomes. This is the driving force for the adoption of mechanization technologies. The cornerstone of an AMS should therefore be farming as a business enterprise and not simply for poverty alleviation. Farming operations that are not profitable are very unlikely going to be mechanized because there will be no revenue to pay for mechanization technology. Similarly, the private sector will only provide services if the operation is profitable. Clarke (1997) concluded that the end users and the suppliers will only play their roles if each one makes a livelihood from their business.

- Mechanization is Demand-driven: Ultimately, it is the farmer who will decide what technology to use, from whom and how to use it. Hence farmers are the most important stakeholders because they are the primary drivers of the mechanization process.

2.3 GUIDELINES FOR AMS FORMULATION

One of the first issues to decide upon is who will be in charge of formulating the AMS and developing a work plan for the process. A multidisciplinary project team should be put in place consisting of the following core disciplines: agricultural mechanization/engineering, agricultural economist, institutional development and specialist in the elaboration of an AMS. A national coordinator should also be designated by the Ministry in charge of Agriculture to head the project team that would be responsible for the day-to-day management of the process.

In order to facilitate coordination, guide the process and mobilize political will and commitment across sectors and interest groups, a steering committee should be put in place by the government.

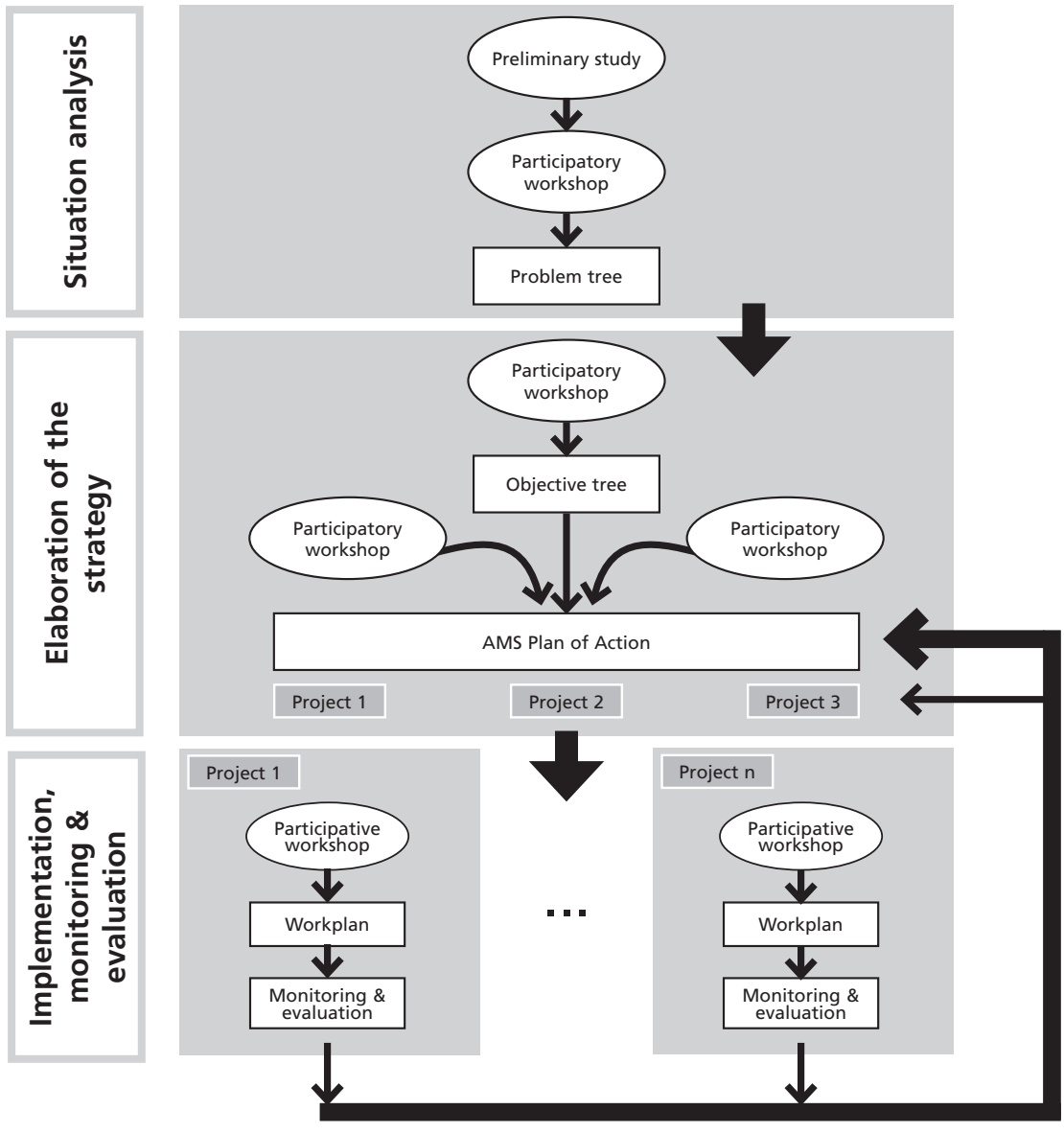
The committee should bring together stakeholders from the various relevant sectors. The committee should be formed by the Ministry in charge of Agriculture, after a stakeholder analysis has been carried out under the supervision of the project team.

According to Houmy (2008), the various activities involved in the formulation of an AMS can be regrouped into basically three phases. These are:

- Situation analysis.
- Development of the strategy.
- Adoption of the AMS.

Figure 2 illustrates some of these phases and is considered to be the latest FAO vision in the elaboration, implementation, monitoring and evaluation of an AMS. Figure 2 does not include the adoption phase, which is very important if the AMS is to be implemented and hence this would need to be included.

FIGURE 2
Cycle for the elaboration of an AMS



Source: Houmy (2008).

2.3.1 Situation analysis phase

The aim of this phase is to conduct a diagnostic analysis of the agricultural mechanization sub-sector in the country to identify the strengths and weaknesses of the subsector. This phase comprises two parts: the preliminary study and a diagnostic part. The preliminary study is based on secondary data, interviews and observations. The following types of information will generally be required:

- General information on the country (physical and demographic data, economy, policy environment, importance of the private sector).
- The agricultural production and mechanization systems (agricultural production characteristics, main crops, livestock production, labour, factors of production, and different mechanization options, i.e. human, animal and mechanical power).
- Supply of agricultural mechanization technology (producers, importers, distributors, availability of repair services).
- The enabling environment (extension service, training institutions in agricultural mechanization, research, testing and certification of machines, basic infrastructure, fiscal policies, availability of credit, monitoring and evaluation, legislation and other services).

The comprehensiveness of an AMS depends on the amount and quality of available secondary data. This is usually a problem in many developing countries where up-to-date data are often limited. In such cases, it is advisable to start with simple strategies, identify data collection as a constraint to be tackled as part of the AMS, and as more data become available, to refine the strategy. The elaboration, adoption and implementation of an AMS should therefore be an iterative process.

Following the preliminary study carried out usually by consultants, the diagnostic analysis then follows. Here, the information collected from the preliminary study is analysed in a participatory manner by the various stakeholders in order to determine the constraints to agricultural mechanization. The outcome of this second part of the situation analysis is the elaboration of the problem tree identifying the causes and effects of the various constraints to the enhancement of agricultural mechanization.

2.3.2 Development of the strategy

This phase should also be carried out in a participatory manner as well. Based on the constraints identified during the situation analysis phase, objectives are defined that present the desirable situation to be attained in future. Numerous objectives are likely going to be determined but these would have to be prioritized. Here agricultural mechanization options for attaining the priority objectives are identified based on established criteria and strategies selected in a participatory manner. The broad areas to be addressed should be the demand for and supply of agricultural mechanization technology, and the enabling environment.

Based on this, a plan of action is elaborated consisting of mechanization programmes with projects. The programmes could conveniently be based on overcoming the constraints affecting the three main groups of stakeholders namely: farmers, private sector equipment and service providers, and the state as a facilitator. The strategy should identify the roles of the three key groups of stakeholders.

2.3.3 ADOPTION OF THE AMS

This phase is intended to be a transition between the elaboration of the strategy and the implementation. During this phase, advocacy for the strategy should be carried out towards key national institutions and development partners, and the strategy should be formally adopted at the highest possible level to give it a fair chance to be implemented.

2.3.4 IMPLEMENTATION

The elaboration of an AMS is an important step in the development of agricultural mechanization, but this has no value unless the plan of action in the strategy is translated into implemented projects. Once the strategy has been adopted, the various programmes and projects would need to be fully developed with a work plan and budget. The objectives here are to:

- Describe the activities to be carried out.
- Give the time frame for implementation.
- Indicate the required resources, the expected results, and the verifiable and quantifiable indicators of progress.

The elaboration of the work plan for the various projects should also be carried out in a participatory manner and should include the project team, policy makers, development partners and resource persons, as need be.

The mechanization of agriculture is a dynamic process and the approach for doing so needs to be reviewed as the situation changes on the ground. As a strategy is implemented, more accurate data will become available, and hence it would then be possible to refine the strategy later. This requires that the process should be monitored and evaluated to provide inputs to revisit the strategy.

Chapter 3
Physical and socio-economic environments

3.1 MALI

According to the Direction Nationale de la Statistique et de l'informatique (DNSI, 2006), Mali is a vast landlocked nation with a surface area of 1 241 231 km^2 located between latitude 10° and 25° north, and longitude 4° east and 12° west. It is bounded in the north by Algeria, in the west by Mauritania, Senegal in the southwest, Niger in the east, and the Republic of Guinea, Côte d'Ivoire and Burkina Faso in the south. The estimated population in 2006 was 12 051 021 with a population density of 9.7 persons/km^2 and an annual rate of growth in the population of 2.7 percent.

Administratively the country is divided into eight Regions and one District, which is the capital Bamako. These regions are: Kayes, Koulikoro, Sikasso, Ségou, Mopti, Tombouctou, Gao and Kidal. The climate in the north is of the desert type, which affects about 50 percent of the country. The climate is of the Sahelien type in the centre and Sudan savanna type in the south. The annual rainfall varies from less then 200 mm in the north to about 300 mm in the centre to more than 1 300 mm in the south. There are five agro-ecological zones namely: the Sahara, Sahel, Sudan Savanna, Sudan-Guinean and the Delta.

Information from DNA *et al. (*2007) indicates that cereals are the most cultivated crops in Mali, accounting for about 72 percent of the cultivated area. Millet and sorghum are the most cultivated cereal accounting for 75 percent of the cereals produced. Millet alone accounts for 50 percent of the area allocated to cereals. Cereals are produced mainly in Ségou, Mopti, Koulikoro, Sikasso and Kayes with 27, 22, 18, 17, and 8 percent of the cereal area, respectively. Rice is cultivated mainly in the Region of Mopti, Ségou and Koulikoro. Cotton is the main industrial crop followed by groundnuts with Sikasso the primary zone of the production of industrial crops.

Concerning inputs, improved seeds are used on only a small fraction of the cultivated area, ranging from 1 to 10 percent for all crops cultivated. Industrial crops are an exception where about 88 percent of the cultivated area is with improved seeds. The use of improved seeds is relatively high in Sikasso (38 percent of the area) and Koulikoro (17 percent) because of the dominance of cotton in these two regions. Nationally, only about 20 percent of farming units take loans. Most are in kind in the form of farming inputs. Sikasso, Koulikoro and Ségou are the regions with the highest numbers of beneficiaries of loans with respectively 50, 18 and 16 percent of the total loans contracted. Loans for farm equipment are very small (2 percent of total loans contracted).

During the 2004–2005 farming season, the agricultural population was estimated at 8 912 459 distributed within 1 374 215 households (DNA *et al*., 2007). The average size of household was 6.5 persons and varied from a minimum of 5.8 in the Mopti Region to a maximum of 9 in the District of Bamako. The agricultural population was concentrated within four regions: Koulikoro (18.9 percent), Mopti (17.7 percent), Sikasso (16.4 percent) and Ségou (15.4 percent). According to the same source, the number of farms was estimated at 805 194 with three regions, Mopti, Koulikoro and Ségou, accounting for just over half of the farms in the country. The national average size of farms was 4.7 ha. Farms are registered agricultural enterprises with the administrative authorities in the lands register. They could be operated by an individual, a group, or by one or more households.

3.2 GHANA

Ghana is a West African nation located between latitude 4° 44' N and 11° 11' N and longitude 3 ° 11' W and 1° 11' E, with a total land area of 238 539 km^2, and a coastline of 550 km in the southern border (SRID-MoFA, 2007). It is bounded in the east by Togo, in the west by Côte d'Ivoire, in the north by Burkina Faso and in the south by the Atlantic Ocean. In 2006, the area under cultivation was estimated at 6 904 000 ha, which was about 29 percent of the total land area. The average rate of growth of the population is estimated to be about 2.7 percent a year and The World Bank Group (2008) estimated the population in 2007 to be 23.5 million.

Administratively the country is divided into ten regions namely: Northern, Brong-Ahafo, Ashanti, Western, Volta, Eastern, Upper West, Central, Upper East and the Greater Accra regions. The regions are further divided into districts, which in 2006 numbered 170 (Ghanadistricts, 2006). SRID-MoFA (2007) indicated that annual average temperatures range from 26.1 ºC in places near the coast to 28.9 ºC in the extreme north. The topography is predominantly undulating, with slopes less than 1 percent. The rainfall varies from an annual value of 2 200 mm in the rain-forest zone to about 800 mm in the coastal zone. There are five main agro-ecological zones. These are: Rain Forest, Deciduous Forest, Transitional Zone, Coastal Savanna and Northern Savanna (Guinea and Sudan Savanna).

The principal agricultural products are:

- Industrial crops: cocoa, oil-palm, coconut, coffee, cotton, tobacco, kola.
- Starchy staples: cassava, cocoyam, yam, plantain.
- Cereals: maize, rice, millet, sorghum.
- Fruits and vegetables: pineapple, citrus, banana, cashew, pawpaw, mangoes, tomatoes, pepper, okra, garden eggs, onions and others.

MoFA (2007) characterizes the agricultural sector in Ghana as predominantly practised on smallholder, family-operated farms using rudimentary technology to produce about 80 percent of Ghana's total agricultural output. It is estimated that about 2.74 million households operate a farm or keep livestock. About 90 percent of farm holdings are less than 2 ha in size. Larger-scale farms and plantations produce mainly oil-palm, rubber and coconut, and to a lesser extent, maize, rice and pineapples. Agricultural production is generally dependent on rainfall, although an estimated 6 000 farm enterprises nationwide practised irrigation of various types in 1999. In 2002, the total area under formal irrigation was around 11 000 ha whereas the potential area – including inland valleys – that could be developed for irrigation is estimated at 500 000 ha. The Ghana Irrigation Development Authority (GIDA) in 2000 identified 32 000 ha of underdeveloped inland valleys throughout the country that could benefit from moisture improvement technologies for food production.

Ghana produces 51 percent of its cereal needs, 60 percent of fish requirements, 50 percent of meat and less than 30 percent of the raw materials needed for agrobased industries. Production of roots, tubers and vegetables such as tomatoes and onions, the most widely used staple food crops, is rather erratic and vacillates between scarcity, sufficiency and glut, depending on the vagaries of the weather.

Chapter 4
Approach to agricultural mechanization in Mali

4.1 BACKGROUND

Mali is one of the countries in the West African subregion that has made noticeable progress in agricultural mechanization (MA-SG, 2008). This has come about because of a number of reasons: enormous potential in draught animals, available agricultural land and the considerable efforts of the state in collaboration with many development partners to enhance mechanization. Despite this, mechanization has not been coherent and accessible to the most disadvantaged farmers. In addition, provision of required agricultural technology to farmers is still considered low with only 35 percent of farmers considered to be equipped with the desirable agricultural mechanization technology. One of the major constraints has been the lack of a comprehensive vision in agricultural mechanization and hence the fragmented approach.

Conscious of these problems, the Malian Government requested the technical and financial assistance of FAO. This culminated in a project titled "Appui a la définition d'une politique nationale de mécanisation agricole: Mali" (FAO, 2003). An accord was signed on January 2001 between FAO and the Malian Government for US$145 000. The aim was to define a national mechanization policy, and to formulate a strategy in a participatory manner. MA-SG (2008) report that the aims of the strategy were to:

- Improve food security through increased production per unit area, increase in the area cultivated and the respect of agricultural calendars.
- Reduce the drudgery of women by developing and producing appropriate agricultural equipment.
- Promote employment in rural areas through the production of agricultural equipment and provision of various associated services.
- Increase the income of the private sector involved in the provision of agricultural mechanization technologies.

The project ended on 31 December 2002 with the elaboration of a national mechanization strategy and a plan of action. This was submitted to the Malian Government for adoption and implementation.

4.2 KEY ELEMENTS OF THE STRATEGY FORMULATION

The elaboration was carried out in two phases following the FAO vision presented in Section 2.3. The first was the situation analysis phase in order to diagnose the strengths and weaknesses of the sector so that a strategy could be put in place to build on the strengths and overcome the weaknesses. During the first phase, a stakeholder analysis was also carried out. The preliminary study was carried out by consultants, and a participatory national workshop convened of various stakeholders to identify the major problems confronting the sector.

The results of the situation analysis revealed that there were three major problems hampering the development of agricultural mechanization in Mali (Houmy, 2002). These are:

- Farmers are not adequately equipped with agricultural equipment. This was attributed to inadequate supply of mechanized equipment, lack of animal-powered implements in some areas, the high cost of mechanization inputs/agricultural equipment and the low purchasing power of the farmers.
- Difficulties of producers, importers and distributors of agricultural equipment to sell their products. This is attributed to poor quality of products of some local producers, high price of imported raw materials for production, and also the lack of affordable loans by farmers. Discussions with key stakeholders indicated that farmers are prepared to pay for agricultural equipment but need loans at favorable interest rates than those obtained from commercial banks. The development of a sustainable financing mechanism at preferential rates for the acquisition of equipment has been concluded to be the key to the success of the implementation of an AMS.
- Absence of a coherent agricultural mechanization policy.

The second phase was the elaboration of the strategy and identification of feasible projects based on the outcome of the first phase. This was also carried out in a participatory manner with stakeholders from all the regions represented. The strategy emanating from the workshop was refined by a group of consultants who participated in the workshop and submitted to the steering committee of the project for finalization.

A holistic approach was used because experience has shown that agricultural mechanization cannot be successful when implemented in isolation from other sectors. The approach was also participative in recognition of the numerous advantages of this approach. This was also in line with new policy orientations of the government of disengagement and privatization in the sector. Because many stakeholders are involved from various sectors and disciplines, there needs to be a mechanism for effective coordination of the process. For Mali, a national coordinator responsible for the day-to-day management of the project was designated by the Ministry in charge of Agriculture. A multidisciplinary project team consisting of national consultants was recruited to work under the supervision of the national project coordinator. The team comprised the following specialists: agronomist, agricultural economist, agricultural engineer, sociologist and a specialist on institutional/policy matters. From the stakeholder analysis, farmers, private sector equipment and service providers, and policy makers were identified to form a steering committee. Their role was to provide direction to the project, approve work plans and methodologies, and to monitor the progress of the elaboration of the AMS.

4.3 ROLES AND RESPONSIBILITIES OF STAKEHOLDERS

The stakeholder analysis recognized the importance of three major groups that have to work together to ensure success. These are the farmers, the private sector equipment and service providers, and the state. Each group has a different role to play and represents different interests. For sustainable mechanization, the roles of each of these groups should be clearly defined and there should be good coordination so that their actions are complementary.

4.3.1 Farmers

Farmers are the users of agricultural mechanization technology. According to Houmy (2008), the ideal situation is for farmers to have sufficient training and knowledge, have access to appropriate equipment of good quality at an affordable price and to operate under a favorable production environment. This implies: availability of information to farmers to be able to make informed decisions; provision of appropriate financing mechanisms for the acquisition of equipment based on the socio-economic situation of the farmers; availability of equipment, spares and repair services nearby. By favourable production environment we refer to good agricultural water management infrastructure to provide the optimum soil-water conditions for crops and appropriate land tenure systems that encourage mechanization, and accessible markets with fair prices for their produce.

It was noted that farmers would only invest in agricultural mechanization if this would increase profitability of their operations. The Malian strategy therefore addresses the various issues affecting farmers in a program with five projects, namely:

- Provision of loan guarantees to farmers through the creation of an agricultural financing fund.
- Increase access to loans through the development of an appropriate loan mechanism in line with the socio-economic realities of the various regions of the country and the type of crops grown.
- Provision of incentives to encourage mechanized agriculture through the importation and the assembly of tractors.
- Support farmers in the creation of associations at various levels for the sale and maintenance of agricultural equipment.
- Creation of a network for the sale of draught animals.

4.3.2 The state

Previously, the state was involved in the production, transformation and commercialization of agricultural inputs but this has now been left to the private sector as prescribed by the Law on the Orientation of Agriculture (République du Mali, 2006). The state was represented by ministries, development partners and non-governmental organizations (NGOs) and was responsible for the creation of an enabling environment that would enhance agricultural mechanization. The state therefore played a facilitating role. To achieve this goal, the state should have the capacity to define adequate policies, coordinate the actions of the multitude of stakeholders, and be able to analyse, support, monitor and evaluate various actions in the domain using institutional arrangement and appropriate economic instruments. To this end, the Malian strategy sought to strengthen structures that would support the promotion of mechanization, develop basic infrastructure and put in place economic instruments to facilitate the process. The strategy had an action plan with the following projects to enhance the facilitating role of the state:

- Strengthen the capacity of state institutions in charge of mechanization to be able to: coordinate actions in the domain, implement the strategy and monitor and evaluate the progress of agricultural mechanization.
- Develop a research and extension program in agricultural mechanization through provision of adequate infrastructure and manpower to carry out research, and the dissemination of the results.
- Strengthen the training programmes in agricultural mechanization through the provision of adequate resources to existing institutions for them to respond better to the needs of the sector.
- Strengthen the Centre d'Expérimentation et d'Enseignement du Machinisme Agricole (CEEMA) at Samanko to be a centre for testing and certification of agricultural equipment.
- Strengthen institutions in the dissemination of agricultural mechanization technologies.

4.3.3 Private sector equipment and service providers

With the disengagement of the state in the production, transformation and commercialization of agricultural products, the private sector has an even greater role to play than before. The agricultural mechanization private sector is represented by local equipment producers, importers of equipment, suppliers and service providers of spares and repairs. This sector should be dynamic and is called upon to provide farmers with equipment and services required in agricultural mechanization in a sustainable manner. To be effective, these equipment and service providers need to have well-trained personnel in order to produce or supply quality equipment, adequate resources to operate in a competitive environment and be profitable. The state can help by creating an enabling environment by improving access to capital goods and raw materials and also through fiscal incentives.

The private sector in Mali produces a wide range of equipment but has problems of selling them for various reasons. The strategy therefore envisages a program with the following projects:

- Reduction in the production cost of agricultural equipment using tax breaks and legislation.
- Strengthen the system for repairs and maintenance of agricultural equipment.
- Develop a national commercial network to supply agricultural equipment. This would include local production, and importation and distribution of equipment.
- Encourage the creation of small enterprises to offer agricultural mechanization services with a view to strengthening the network of service providers to better respond to the needs of the sector.

4.4 STATUS OF IMPLEMENTATION

The AMS for Mali was completed in December 2002 and was expected to be adopted by the state so that the implementation phase could begin. Up to June 2009, i.e. more than seven years after the completion of the strategy, it was still to be adopted. However, despite the non-adoption, the AMS is still the reference document as concerns agricultural mechanization policy in Mali. Without the formal adoption, however, it has not been possible to allocate funds in the state budget for the implementations of projects envisaged in the plan of action. Discussions with various stakeholders in Mali revealed various reasons presented below for the delay in adopting the AMS.

With the advent of multiparty politics, policy makers in Mali now have a very short-term view with an eye on the next elections. Hence they are not keen to implement strategies or programmes with medium- to long-term goals that may be achieved when they might no longer be in power. After completion of the strategy in 2002, a new president of the country was elected in 2003. The change was accompanied by a different political vision, which focused on short-term goals. Because mechanization has medium- to long-term goals not usually consistent with the short-term goals of politicians, adopting and implementing strategy was delayed.

In the meantime, politically correct actions had to be taken to respond to pressing demands to resolve food production problems. A political decision was therefore taken to import 400 tractors from India and also to construct a tractor assembly plant in Mali. This was more "visible" and more politically expedient than implementing the AMS. Up to December 2008 there were no after-sales services for these tractors because the assembly plant that was supposed to provide these services was not yet operational. After one year in the field without adequate after sales services, some estimates are that more than 20 percent of the imported tractors are not in operating condition because of lack of spare parts and poor maintenance.

An unsuccessful attempt was made in 2005 to have the Malian Council of Ministers approve the strategy. The reason for the non-adoption of the strategy then was that there was a need to have a national agricultural policy developed before a mechanization strategy could be adopted. The strategy would therefore fall within a broader national policy. This was done in the form of the 2006 Law on Orientation of Agriculture (République du Mali, 2006).

The strategy was presented again to the Council of Ministers in 2007 but was not adopted. It was recommended that new developments in the agricultural sector should be integrated into the strategy. These included the project for the importation of 400 tractors from India, the setting up of an assembly plant for tractors and the President of the Republic's initiative for 2007–2012 called Programme de Développement Economique et Social (PDES). The aim of the PDES is to transform Mali into a prosperous state through a Green Revolution. Modernization and intensification of agriculture are the cornerstones of the initiative for which 20 percent of the state budget will be allocated to (Toure, 2007). The PDES envisages the provision of 1.2 million sets of equipment for draught animal, 3 000 tractors, 1 000 power tillers, 10 000 pumps, 10 000 pieces of equipment for post-harvest operations and the development of 103 000 ha of irrigated land by the end of 2012.

All these developments where incorporated in the updated AMS, which is now in line with other national policies and strategies such as: the strategic framework for growth and poverty reduction and the rural development master plan (Diarra, 2008). The current strategy dated March 2008 has a plan of action for the period 2008–2012 and hence this might need to be shifted again because the

AMS is still to be adopted, let alone implemented. The feeling of stakeholders now is that the stage is now set for the strategy to be adopted.

Other contributing factors for the non-adoption of the strategy were institutional instability/changes and insufficient human resources in the unit in charge of agricultural mechanization. In 2002 when the strategy was completed, agricultural mechanization was the responsibility of a service in the Direction Nationale de l'Aménagement et de l'Equipement Rural (DNAER) under the Ministry of Rural Development. The service was very poorly staffed and had only one engineer, two technicians and one state agent in the national directorate, and a technician in each regional office. Institutionally, agricultural mechanization did not have enough clout to mobilize political will and commitment to speed up the adoption of the elaborated strategy. Some time after the elaboration of the AMS, new institutional changes where effected, which placed agricultural mechanization in the Ministry of Agriculture (MA) under the Direction Nationale du Génie Rural (DNGR) as a division. In addition, since the strategy was developed, there have been four ministers in charge of agriculture. Institutional instability of the ministry in charge of agricultural mechanization has therefore contributed to the delay in the adoption of the strategy by the Malian Government.

Chapter 5
Approach to agricultural mechanization in Ghana

5.1 BACKGROUND

Ghana does not yet have an AMS. It has however been recognized by the Ministry of Food and Agriculture (MoFA) that earlier attempts at mechanizing agriculture in Ghana had a number of constraints and were not as successful as desired. One identified problem was that mechanization did not follow a holistic approach with the involvement of the various stakeholders outside the agricultural sector such as finance, economic planning, industry, education, science and technology, labour and employment, universities, and research institutes. The various sectors have made important contributions over the years in the development of agricultural mechanization but not in a coordinated fashion and hence the actions have not been very effective.

AGSE-FAO (1994) reports that an attempt to elaborate an AMS for Ghana was made by FAO in 1993. This was made in the final days of an FAO administered project financed by the Italian Government called Agricultural Mechanization for Food Production in the Afram Plains (GCP/GHA/024/ITA) from 1987 to 1993. As the large-scale mechanization project was winding down, it became clear that the project had failed to provide a model for mechanization in Ghana. It was therefore concluded that a mechanization strategy was needed. For three-and-a-half weeks in May 1994, a consultant carried out a mission in Ghana with this in mind, with the technical assistance of an FAO officer and the close collaboration of the Agricultural Engineering Services Directorate (AESD) of the MoFA. The mission visited a number of towns, held discussions with key stakeholders in government and NGOs took part in a workshop of mainly agricultural engineers and made proposals of future government strategy on agricultural mechanization.

Based on the holistic approach currently recommended by FAO on the elaboration of an AMS, the outcome of the mission cited above can hardly be considered as an AMS strategy for Ghana. It, however, could be considered as a preliminary situation analysis of the agricultural mechanization subsector. Unfortunately, the situation has changed much since then and if an AMS is to be elaborated, an updated situation analysis will be needed to reflect the current picture. However, it would be useful for lessons learned from the Afram Plains project to be incorporated into the AMS.

The promotion of agricultural mechanization in Ghana is currently the responsibility of two entities within MoFA. These are: the AESD and the GIDA (Boamah, 2006). The roles of the AESD include: initiation and formulation of policies and programmes, coordination, monitoring and evaluation of agricultural engineering programmes and projects, and the provision of technical backstopping to the District and Regional Directorate of Agriculture and to stakeholders in the agricultural engineering industry. The AESD has four units, each headed by an assistant director. These are:

- Soil & Water Engineering Unit, which focuses on physical aspects of soil conservation such as the use of contour bunds. It also carries out training of operators in ploughing and soil conservation.
- Rural Technology Information Unit, which links farmers to technology producers and suppliers and has a database of local and imported technology for various operations.
- Post-Harvest and Power Unit, which focuses on the reduction of post-harvest losses and the use of renewable energy sources in agriculture.

- Farm Power, Machinery and Transportation Unit, which is involved in testing equipment and recommends if government should acquire them for farmers. The Unit does the same for private suppliers but in a free market, the unit does not have the power to prevent a supplier with a bad product from selling the equipment in the market. Equipments are tested in four agro-ecological zones and the unit has an adaptive training centre.

GIDA on the other hand is responsible for the development, facilitation, and promotion of the use of surface and groundwater resources for agricultural production. The focus is on both small-scale farmers as well as medium- to large-scale commercial farmers growing high-value crops through public-private partnerships.

5.2 KEY ELEMENTS OF APPROACH

5.2.1 Policy environment

The current umbrella policy document that guides agricultural mechanization in Ghana is the Second Growth and Poverty Reduction Strategy (GPRS II) for the period 2006–2009. This is a national policy document that covers all sectors including agriculture. It is an official/adopted working document of the government and was elaborated in a participatory manner. In order to stimulate growth and reduce poverty, the business and investment environment needs to be improved for agriculture-led growth (NDPC, 2005). This calls for modernizing agriculture. To achieve the goals of GPRS II, agriculture needs to grow at an annual rate of 6 percent over 4 years. This is intended to build on the results of GPRS I, in which progress was recorded in the agricultural sector. NDPC (2005) noted that there were nine critical issues that need to be addressed for agriculture to lead the economic growth in Ghana. These were:

- Reform to land acquisition and property rights.
- Accelerating the provision of irrigation infrastructure.
- Enhancing access to credit and inputs for agriculture.
- Promoting selective crop development.
- Modernizing livestock development.
- Improving access to mechanized agriculture.
- Increasing access to extension services.
- Provision of infrastructure for aquaculture.
- Restoration of degraded environments.

As relates to mechanization, the strategy stated in the GPRS II is to promote increased mechanization in large-scale agriculture, with emphasis also on the development and use of small-scale technologies that target especially women in the areas of tillage, storage and processing.

From this national policy document, which covers all sectors, MoFA elaborated the Second Food and Agriculture Sector Development Policy (FASDEP II), which outlines the goal of the sector and also elaborated a 3-year strategy for various aspects in MoFA for the period 2007–2009. FASDEP II is therefore the current official agricultural policy document for Ghana. It was elaborated in a participatory manner. It is the outcome of a consultative process that began with inputs from inter-ministerial teams working on different areas of intervention (MoFA, 2007). Inputs of thematic groups were consolidated into an initial draft that was revised on the basis of comments from MoFA and its development partners, and from stakeholders at a sector review workshop. The second draft was then distributed widely and consultations held at regional workshops to seek the views of a wider cross-section of stakeholders. The components in FASDEP II include: food security and emergency preparedness, improved growth in incomes and stability, sustainable management of land and environment, and application of science and technology in food and agriculture development.

The national vision for the food and agriculture sector is a modernized agriculture culminating in a structurally transformed economy and evident in food security, employment opportunities and reduced poverty (MoFA, 2007). The vision for the food and agriculture sector is also linked to the Comprehensive Africa Agriculture Development Program (CAADP) of the New Partnership for Africa's Development (NEPAD).

According to MoFA (2007), a value-chain approach to agricultural development will be adopted with value addition and market access given more attention in FASDEP II. In the short- to medium-term, selected commodities will be targeted based on comparative and competitive advantage for food security and for income diversification. A major research effort will be pursued to promote the commercialization of selected indigenous agricultural commodities as a strategy for poverty reduction. Partnership with other Ministries, Departments and Agencies (MDAs) and private sector for improved response to the sector policies will be pursued. FASDEP II prescribes greater devolution of responsibilities to the regional and district levels in order to increase stakeholder participation.

Also according to MoFA (2007), the objective for agricultural mechanization in FASDEP II is to facilitate access of farmers and agroprocessors to mechanized services at affordable cost. To achieve this objective the following strategy was adopted:

- Collaboration with the private sector to build capacity, and companies to produce and/or assemble appropriate agricultural machinery, tools and equipment locally.
- Promote small-scale multipurpose machinery along the value chain, including farm-level storage facilities, appropriate agroprocessing machinery/equipment and intermediate means of transport.
- Intensify use of animal traction through the establishment of animal traction centres.
- Facilitate the establishment of mechanization services provision centres and machinery hire-purchase and lease schemes that have adequate backup of spare parts for all machinery and equipment.
- Promote local assembly of tractors and encourage adaptation and local fabrication of processing equipment.
- Develop human capacity in agricultural machinery management, operations and maintenance with the public and private sectors.

It is recognized that the successful implementation of FASDEP II depends on many sectors outside MoFA (MoFA, 2007). Concerted action would therefore be required on the part of the Government of Ghana as a whole. The key considerations in the implementation will be efficient allocation of resources, strengthening linkages between stakeholders and coordinating their activities. The responsibility of coordination in most cases lies in the hands of MoFA.

In line with the FASDEP II, the AESD has elaborated a draft agricultural mechanization policy. The policy aims at modernizing agriculture to increase agricultural production by making available appropriate agricultural engineering technologies that will ensure adequate supply of food and raw materials for all Ghanaians, local industries, and for export, consistent with environmental conservation practices and safety measures (Mahama, 2007; AESD, 2008a). The objectives are to support agricultural development in Ghana through increased agricultural productivity, minimization and/or removal of drudgery and empowering farmers to earn more and live comfortably, thereby raising the overall standard of living in rural Ghana, and lead to a decline in the rural-urban drift of youths. The implementation of this policy should be multidisciplinary in content with agricultural mechanization and irrigation playing leading roles.

According to the AESD (2008a), the following general strategies should be developed and pursued:

- Local manufacture of agricultural equipment and machinery.
- Establishment of agricultural research institutes.
- Soil and water conservation measures.
- Post-harvest technology development.
- Extension.
- Finance.
- Irrigation development.
- Human resource development.

The draft agricultural engineering/mechanization policy has been elaborated primarily by the state with some stakeholder participation from the academia. What is now required is more extensive participation of other stakeholders especially the farmers and the private sector to diagnose and prioritize the major constraints to agricultural mechanization in Ghana, and agree on strategies and a work plan to minimize these constraints. Based on the actions already taken within the context of the GPRS and FASDEP, the finalization, adoption and implementation of the strategy would be very easily carried out. This is because there is a very high level of political commitment and the last two governments in Ghana have shown a great deal of political will/commitment to modernizing agriculture. This has generated a great deal of interest in the sector. In addition, the AESD has a high profile with the required manpower to carry through the process, and the AMS would fall neatly within the adopted and implemented national development policies. Ghana is therefore a country where FAO support in the elaboration of an AMS has very good chances of being a success story. The AMS will create the environment for better coordination in the agricultural mechanization subsector, mobilize more stakeholders in the private sector, and end users in the planning that will facilitate the implementation of the AMS.

The AESD has determined that Ghanaian farmers need tractors of up to 70 hp and that Ghana needs to have about 40 000 tractors to be able to cultivate all the land that can be mechanized. This came about because AESD estimated the tractor to farmer ratio was 1:1800 and desired to bring it down to 1:900. In order to meet the objectives of agricultural mechanization in FASDEP II, AESD took a decision to import tractors. This was included in their work plan and budgets, and passed through parliament successfully and hence the AESD started ordering tractors. The adoption by parliament of the proposal by the AESD to import tractors was facilitated by the fact that the government at the time came into power with a willingness to support the acquisition of tractors. In addition, agricultural modernization was high on the political agenda of all political parties. This was because the message had gone out from the extension services that timely land preparation in rainfed agriculture is very necessary for improved productivity. Hence there is need for more power and mechanization technologies.

The AESD took the decision to supply the tractors to farmers because of the private sector's reluctance to do business with farmers. This is in turn caused by the high cost of agricultural machines and implements (compared to purchasing power of the farmers), which most farmers are unable to afford. Second, commercial banks are very reluctant to loan to borrowers in the agricultural sector because it is considered to be highly risky. The AESD therefore concluded that the only way forward was for the state to supply tractors to farmers at subsidized costs and to give concessionary conditions for the repayment of the loans. The AESD decision is in line with the findings of Twum (2002), which concluded from a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis that the most significant barrier to enhanced agricultural mechanization in Ghana was the limited access to credit by farmers. African Agriculture (2008) quoting the Statesman newspaper indicates that the problem of access of farmers to credit is getting worse. In 1998, about 9.7 percent of bank loans were directed to the agricultural sector. By the year 2006, this had dropped dramatically to only 4.3 percent.

5.2.2 Procedure for the acquisition of tractors

To buy tractors, the AESD produces the required specification and requests for tenders from the market for suppliers and selects the best offer. This is usually based on price, but after-sales service plans are also considered. The supplier is then requested to provide a sample for rigorous testing. It is following this approach that the following brands of tractors have been ordered: Mahindra, Farmtrac, and John Deere.

For private owners, a tractor with a set of implements (trailer and plough) is supplied at 66 percent of the total cost. The tractors and equipment are imported tax free, and the government bears costs related to handling at the ports, which amount to a discount of 33 percent. The owner makes a down payment of 30 percent of the discount price of the equipment and contracts to complete payment within 3 years without interest. Tractor owners are also expected to use their tractors to provide services to other farmers. The tractors and equipment remain the property of the state until complete

repayment when the farmer becomes the owner. The tractors are given out by the AESD with the understanding that they would be used for agricultural purposes only. This is monitored to ensure this is the case by having applications for tractors approved at local levels. Applicants who are experienced tractor operators have an added advantage.

Because many farmers cannot meet the conditions to acquire their own tractors, the government decided to create Agricultural Mechanization Centres (AMCs), which provide services to farmers. The AMCs are strategically located in areas with a need for mechanization. In the past, centres owned by the state failed partly because of low tractor usage. In the current scheme the government has partnered with the private sector to operate these AMCs. Each centre is provided with eight tractors, a set of implements, a trailer, a pump operated by the tractor power take off shaft, a tractor operated milling mill, etc. The idea is that the centres should have work or activities throughout the year (i.e. from ploughing, planting, harvesting, transportation and milling) so as to maximize the use of tractors to be profitable. More equipment are expected to complete the set of equipment as they become available, e.g. seed drills and fertilizer applicators.

In November 2008, there were 11 AMCs. With the importation of additional tractors and implements, by June 2009 a total of 65 AMCs had been created. It is envisaged that within the next 3–4 years, there should be at least one AMC in each of the 170 districts of Ghana.

The private sector is responsible for day-to-day management of the AMCs while the state provides equipment on loan and free training of operators. For the creation of AMCs, the private sector entrepreneurs pay 10 percent of the value of the equipment (because the total cost for eight tractors and accessories is high) and contracts to pay the balance over a 5-year period, interest free. These equipment remain the property of the state until complete payment when the private sector partner becomes the owner. Some AMCs have inherited facilities of past government mechanization centres for which they pay rents. Others located in areas without such facilities have had to develop their own facilities.

Many, farmers, civil servants and private entrepreneurs are interested in acquiring equipment from the state for farming but they cannot all be supplied. It is estimated that only about 40 percent of the demand is being satisfied. This is an indication that the mechanization business is profitable in Ghana. Some farmers who cannot obtain tractors from the state buy from private dealers on a cash basis mainly, as it is difficult to obtain loans for the purchase of farm equipment.

During the period 2004–2006, 1 000 Farmtrac tractors from India were ordered by the AESD and supplied to farmers. For 2007–2009 the target is to order 3 000 tractors. The target is therefore that by the end of 2009, 4 000 tractors should have been supplied to farmers. As of November 2008, 1 430 tractors had been supplied during the 2007–2009 period, bringing the total since 2004 to 2 430.

5.2.3 Sustainability of tractor importation

Financial resources for the purchase of tractors in Ghana have come from the Highly Indebted Poor Country (HIPC) funds and from the Millennium Challenge Account. It is hoped that the money will serve to create a revolving fund so that as farmers pay back the loans they have received, more tractors will be ordered and supplied to other farmers. The challenge is to ensure that these loans are repaid.

Twum (2002) indicated that the profitability of tractorized commercial farming in Ghana was poor because of low domestic prices of farm produce and high costs of mechanized services. He indicated there was a need for the establishment of minimum guarantee prices for local staples to enable farmers to pay for mechanization technologies. Recent studies by Mahama *et al*. (2007) now indicate that mechanization in Ghana based on tractor power is profitable even without subsidies. This suggests that local market prices for agricultural products have increased or there are readily available export markets with fair prices for the farmers products.

As concerns after sales services for imported tractors, there are accredited agents for all makes of tractors supplied by the AESD for the provision of spares and carrying out repairs. As part of the agreement to supply tractors to the AESD, the agents have to open satellite workshops so as to be able to serve the farmers effectively. Also, manufacturers selected to supply tractors have to train Ghanaian technicians at their headquarters so these technicians can assist in local training on return.

5.3 ROLES AND RESPONSIBILITIES OF STAKEHOLDERS

The material presented under this sub-section was obtained from MoFA (2007), which identified four groups of stakeholders in the implementation of the Ghanaian agricultural policy. The draft agricultural mechanization policy recognizes the need for the state to be a facilitator, and for the private sector to be a supplier of technology and services. These stakeholders are presented in turn below.

5.3.1 The state

The mission of the state, represented by MoFA, is to promote sustainable agriculture and thriving agribusiness through research and technology development, effective extension and other support services to farmers, processors and traders for improved livelihood. In line with this mission and as the lead ministry, the roles of MoFA are:

- Policy analysis and formulation.
- Monitoring and evaluation of policy implementation.
- Advising cabinet on laws required to regulate agricultural activities in order to protect all stakeholders and the environment.
- Coordination and harmonization of policies and sector activities with other MDAs.
- Facilitation of public-private dialogue and partnerships.
- Advocacy of sector interests locally and internationally.
- Facilitation of capacity building of the sector's human resources.
- Facilitation of research and technology development.
- Facilitation of the linkage between agriculture and industry.
- Facilitation of the integration of cross-cutting issues such as gender equality into the work of the MA.
- Facilitation of international trade and domestic marketing of agricultural commodities.
- Provision and facilitation of agricultural service delivery. It was with this in mind that the AESD decided to import and distribute tractors to farmers.
- Coordination of the enforcement of regulations.
- Coordination of Development Partners' development policies and activities with the sector policies and activities.

MoFA requires the support and collaboration of all MDAs, as well as stakeholders in civil society, in the implementation of FASDEP II. MoFA engages partners through a platform on which all parties agree on:

- Shared objectives.
- Common prioritization of objectives and, where necessary, joint planning.
- Building synergies between parties.
- Developing mechanisms to assess success and make adjustments.

This platform functions at the national level for interministerial coordination, through to the regional and district levels where agriculture directorates will partner with the private sector and civil society organizations to address various issues. At the national level, the National Development Planning Commission (NDPC) plays an oversight role, with MoFA playing a strong advocacy and monitoring role. The Regional Coordinating Councils and MoFA directorates in the regions and districts play similar roles at the regional and district levels.

5.3.2 Private sector and civil society organizations

The role of this group of stakeholders is to:

- Participate in policy dialogue to ensure that their interests are reflected.
- Invest in productive activities in the sector.
- Ensure that commercialization is balanced with social responsibility and environmental sustainability.
- Support training and skills improvement of the sector's human resources.
- Participate in research and utilize results.
- Disseminate good agricultural practices.
- Comply with laws and regulations.
- Partner with the government in sector development.

Some private sector stakeholders interviewed were asked whether the government is competing with them by supplying tractors at below market value indicated they were not bothered by this. This is because they anticipate they would make money from the after-sales services over the life of the tractor and that the state is simply creating a bigger market for their after-sales services.

5.3.3 Development partners

Their roles in the implementation of FASDEP II are:

- Contribute financial and technical resources to support the achievement of sector objectives within the parameters of the prevailing policy framework.
- Continue to seek new opportunities to harmonize and align their assistance according to the Government's Harmonization Action Plan.
- Engage constructively in on-going policy dialogue on all policies relevant to agriculture and related sectors.
- Participate in and support sector monitoring and evaluation efforts.
- Facilitate government management of financial and technical assistance.
- Participate in and support sector monitoring and evaluation efforts.

5.3.4 Other Ministries, Departments and Agencies (MDAs)

Other MDAs are expected to ensure that their policies and programmes are consistent with FASDEP II. MDAs partner with MoFA in sector development through:

- Participation in sector policy development, planning and review.
- Research.
- Human resource development.
- Implementation of cross-sectoral activities.
- Monitoring and evaluating relevant development indicators and providing information to MoFA.

Chapter 6
Impacts of agricultural mechanization approach in Mali

Agricultural mechanization strives to reduce drudgery in agriculture, increase production as a result of increased productivity per unit area or increase in area cultivated. The ultimate goal is to increase the income of farmers, create jobs and increase the standard of living of the rural population. The impacts of mechanizing agriculture will therefore be examined with the above in mind. Before the benefits of mechanization can be obtained, there needs to be an enabling environment in which the roles of the major stakeholders are clearly defined and their actions coordinated. Consequently, indicators of a better environment and coordination would be considered as impacts.

6.1 ENABLING ENVIRONMENT

Although the AMS in Mali has not been formally adopted, it is still considered the reference document in agricultural mechanization. A number of actions have been realized, which could be considered as implementation of some of the projects envisaged in the action plan although not exactly as were envisaged. These can be classified under the following two programmes proposed in the AMS:

Program 1
Support to government institutions in charge of agricultural mechanization

- A division of agricultural mechanization has been created with two services.
- There is now a mechanism in place for the coordination of agricultural mechanization.
- A system for monitoring and evaluation of mechanization is now in place. This is carried out by the Cellule de Planification et de Statistique (CPS) and the Direction Nationale du Génie Rural (DNGR) both of the MA.

Program 2
Improve the supply of equipment to farmers

Agricultural equipment is available in Mali either through importation or local manufacture. The local manufacture of equipment is flourishing especially in the cotton-growing areas where raw materials for the fabrication of implements are imported by the Cotton Development Authority and hence artisans have access to good quality materials. In the cotton-growing areas, all farmers own draught animals and implements all locally made. With the assembly of tractors in Mali by two companies, availability of tractors will be less of a problem. The problem that persists is the inability of farmers to acquire them because of the low purchasing power of the majority of them. To address these issues:

- As envisaged in the 2006 Law of Orientation of Agriculture, an agricultural fund has been created to guarantee loans to farmers. Mobilization of resources is now going on for the fund to go operational.
- Many financial systems have been decentralized to be closer to farmers to improve access to credit.
- A network for the production and sales of draught animals has been created.

6.2 REDUCED DRUDGERY (LEVEL OF MECHANIZATION)

Table 2 shows the distribution of farm equipment in Mali in the various regions in the year 2000. Dembele, R (2001) indicated that about 70 percent of the tractors were used for cotton and rice cultivation, which are profitable activities. Eighty-three percent of power tillers were found in the Ségou Region and used mainly for rice cultivation in the zone supervised by a parastatal called Office du Niger (ON).

Table 3 gives the average number of various types of farm equipment in Mali during the period 1997–2002 and 2002–2007. The data suggest that the provision of agricultural equipment is across the food chain and not limited to primary cultivation. The table serves as a basis for quantifying the impact of reduced drudgery. Average values were used to take into consideration annual fluctuations and hence considered only trends. The table shows that across the board, the number of farm equipment increased after the elaboration of the AMS. Table 3 indicates that the increase in draught animal power (DAP) has been very slight. This could be attributed to the fact that DAP is used mainly in zones where farmers are organized and supervised by parastatals, and have access to credits to acquire the technology. This is the case in the cotton- and rice-growing areas where farmers using DAP are concentrated. Increase in the use of DAP therefore comes mainly from increases in the cultivated area. Farmers cultivating local staples have little or no access to credits to acquire DAP and their crops are considered unprofitable to justify the use of the technology.

From Table 3, the biggest percentage increases were in the number of tractors and power tillers. The importation of 400 tractors by the state greatly contributed to this increase. Of the 400 tractors imported by the state, 100 were supplied to youths through the Agence de Promotion de Emploi de Jeune (APEJ) to support the provision of services to farmers. The market values of the tractors were as follows: 70 hp tractors (7 million FCFA); 50 hp (7 million FCFA) and the 39 hp tractor at 6 million FCFA. These tractors were supplied to farmers and youths with a discount of 25 percent and given interest free loans payable in 10 years.

Two tractor assembly plants have been constructed in Sikasso and Samanko. The plant in Sikasso is a private venture by the Chinese to produce 29 hp tractors, while the plant at Samanko is a joint venture between the Malian Government (49 percent shares) and an Indian company

TABLE 2
Distribution of farm equipment in Mali and by region in 2000

Type of equipment/ number of draught animals	Koulikoro	Kayes	Sikasso	Ségou	Mopti	Gao	Tombouctou	Kidal	Total
Animal traction									
Multiculteurs	74 694	3 047	175 559	49 598	68		144	12	**303 122**
Ploughs	17 878	3 315	198 035	92 774	33 280	151	159		**345 592**
Planters	4 641	4 009	75 007	13 270	34				**96 961**
Houes (asine)		2 637	8 128	2154	412				**13 331**
Harrows	183	152	2 925	2 537		3			**5 800**
Animal drawn carts	28 931		110 601	64 275	23 431	39	2		**227 279**
Number of draught animals	142 952	44 951	493 440	220 069	124 939	214			**1 026 565**
Mechanized									
Tractors	14	28	464	205	12				**723**
Power tillers		4	34	188					**226**
Ploughs			226	36					**262**
Harrows				629					**629**
Shellers			216	934	69				**1 219**
Threshers	30	1	116	647	18	18			**830**
Grinding mills	145			429	29		42		**645**
Mechanically powered pumps		123		80	700	2 287	456		**3 646**

Source: Dembele, R. (2001)

TABLE 3
Evolution of the number of various types of equipment in Mali before and after the elaboration of the AMS

Type of equipment/power source	Number of equipment		Numeric increase	Percentage increase
	1997–2002	2002–2007		
Animal traction				
Ploughs	346 024	348 048	2 024	0.6
Houes asines	13 046	13 846	800	6.1
Multiculteur	234 608	236 608	2 000	0.9
Planters	96 361	97 561	1 200	1.2
Animal drawn carts	227 276	229 279	2 003	0.9
Draught animals	1 079 000	1 081 000	2 000	0.2
Mechanized				
Tractors with implements	743	1 300	557	75.0
Power tillers	226	310	84	37.2
Threshers	850	924	74	8.7
Grinding mills	540	703	163	30.2
Shellers	960	1 238	278	29.0
Motorized pumps	2 946	3 646	700	23.8
Multifunctional platforms	150	520	370	246.7

Source: Adapted from Diarra (2008)

TABLE 4
The distribution of various power sources used for land preparation in various regions of Mali in 2005

Regions	Type of power source and percentage use per region					
	Manual	Animal traction	Mechanized	Partly animal traction and mechanized	Partly manual and animal traction	Partly manual and mechanized
Kayes	31.58	52.68	3.11	0.32	12.31	0.01
Koulikoro	17.96	64.47	1.13	0.08	16.34	0.02
Sikasso	12.86	83.16	0.34	0.04	3.58	0.02
Ségou	3.78	91.94	0.18		4.10	
Mopti	48.59	43.95	0.33	0.06	7.07	
Tombouctou	86.36	11.90	0.48	0.00	1.26	
Gao	78.02	18.89	0.01	0.03	3.05	
Kidal						
Bamako	22.52	26.46	35.24	1.63	6.50	7.65
National Weighted Average	**17.00**	**71.98**	**0.94**	**0.09**	**9.93**	**0.06**

Source: DNA *et al.* (2007)

with a majority share of 51 percent. The Samanko plant is now operational and produces 39 hp, 50 hp and 70 hp tractors. As of June 2009, the production was about 50 tractors per month. These tractors are sold at the market value prices indicated above.

Reports from Mali indicate that 250 more tractors have been added to the fleet of Malian tractors since November 2008. Fifty of these were acquired by the state from the Samanko Assembly plant and supplied to farmers at subsidized rates while 200 others were imported from Russia by a private concern for the production of 1 000 ha of oil plants for vegetable oil production. The above indicates that access to mechanization equipment is increasing and hence this could have an impact on reducing the drudgery in agriculture.

Table 4 presents the distribution of various power sources used for land preparation in various regions of Mali in the year 2005. Animal traction and mechanical power are used mostly for land preparation while other farm operations are still essentially done manually. The data indicate that compared to the aggregate values for the various subregions in SSA, the exclusive use of

mechanical power in Mali is still very low (less than 1 percent whereas the region with the least usage is central Africa, with a percentage of 4). However, only about 17 percent of farmers use muscle power for primary cultivation while the majority of Malian farmers (72 percent) use intermediate animal power technology. Hence the majority of farmers have gone beyond using human muscle power for land preparation. The percentage use of animal power in Mali is much higher than the average usage for any of the subregions in SSA as shown on Figure 1. In Mali, however, there are still very marked regional variations. In Ségou for example, less than 4 percent of farmers still use human power for primary cultivation while in Sikasso it is about 13 percent. On the other hand, in Gao and Tombouctou regions, most farmers still use human power for primary cultivation.

6.3 AGRICULTURAL PRODUCTION AND PRODUCTIVITY

Figure 3 gives an indication of the evolution of food production in Mali from 1996 to 2007 for cereals and a three-year moving average trend. The index presented is simply a relative increase to the base period where the average production of cereals in 1996–1997 was 100, for maize, millet, rice and sorghum. For fonio and wheat the base period was 2001–2002 for which the index was taken as 100. The data indicate that cereal production has been increasing although not steadily. Analysis of the data on food production indicates that between the year 1997 and 2002, the average annual increase in cereal production in Mali was about 4 percent. During the period 2003–2007, this increased to about 11 percent. This increase can be attributed in part to the increasing level of mechanization.

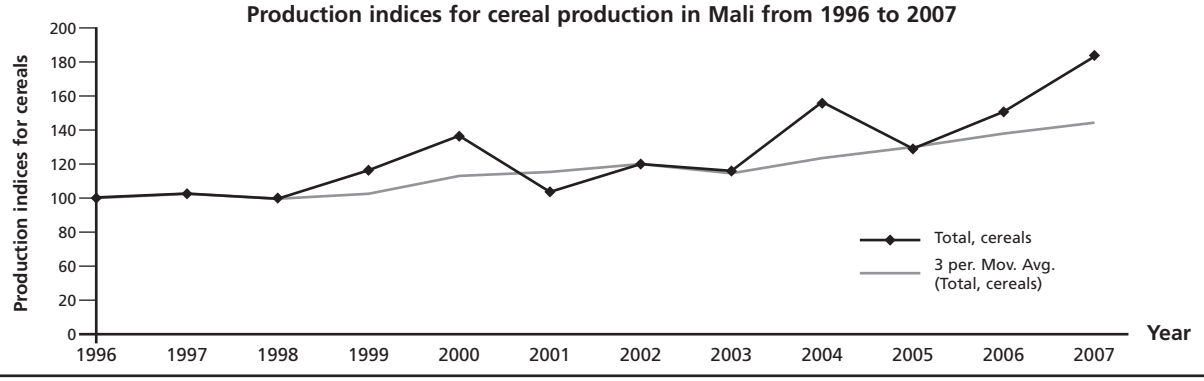
Data on the number of agricultural tractors in use obtained from the FAOSTAT database (FAO, 2006), which is obtained from official data submitted by member countries to FAO, had no relation to the information collected on the ground. As a result, information on tractor use intensity could not be determined with a reasonable degree of certainty.

Figure 4 shows the most recent data of agricultural labour productivity for Mali from 1991 to 2003. Productivity increased significantly up to 1996 and has essentially been constant since then at about 1 ha/farmer. The reasons for the increases up to 1996 are not evident and it would be interesting to investigate this to find out why. Although production has been increasing, the productivity of farmers has remained fairly constant since 1996, despite the increase in the number of mechanization technologies. This is because of the increasing number of the agricultural population. Data from FAOSTAT indicate that although the percentage of the population engaged in agriculture is reducing, the actual number of persons is increasing at a rate of about 1.5 percent per year. As a result, the increase in the number of mechanization technologies has not translated into noticeable changes in the productivity of farmers.

Figure 5 gives an indication of the productivity of Malian farmers from 1996 to 2004 in terms of the added value per capita in constant 2000 US$. It would be expected that the productivity would be increasing steadily if there is sustained action that enhances agricultural productivity. Figure 5 suggests that this is not the case because it has been essentially constant. This can be attributed to the fact that without the adoption and implementation of the well thought out AMS, interventions have been patchy and uncoordinated within and between government departments.

Table 5 shows the productivity of Malian farmers in 2005 in terms of the average size of land cultivated per farm. Because the labour force on a farm could be provided by an individual, one or more households or a group of farmers, determining the labour productivity is rather difficult. The national average size of farms for Mali is 4.72 ha but there are very important regional variations that could be attributed to the level of mechanization. Farmers in Sikasso and Ségou regions, which have the highest numbers of tractors, power tillers and a high percentage of soil cultivation carried out by draught animals, also have the highest productivity of 7.5 and 6.7 ha/farm respectively. This is followed by Koulikoro and Mopti, which rely on DAP for a good proportion of their energy for land preparation. In Tombouctou and Gao, where primary cultivation is mostly with hand tools, the farm sizes are small. Bamako has the smallest size of farms probably because of the scarcity of land around the capital city. Table 5 therefore indicates that mechanization has contributed to the increase in productivity in some regions.

FIGURE 3
Production indices for cereal production in Mali from 1996 to 2007

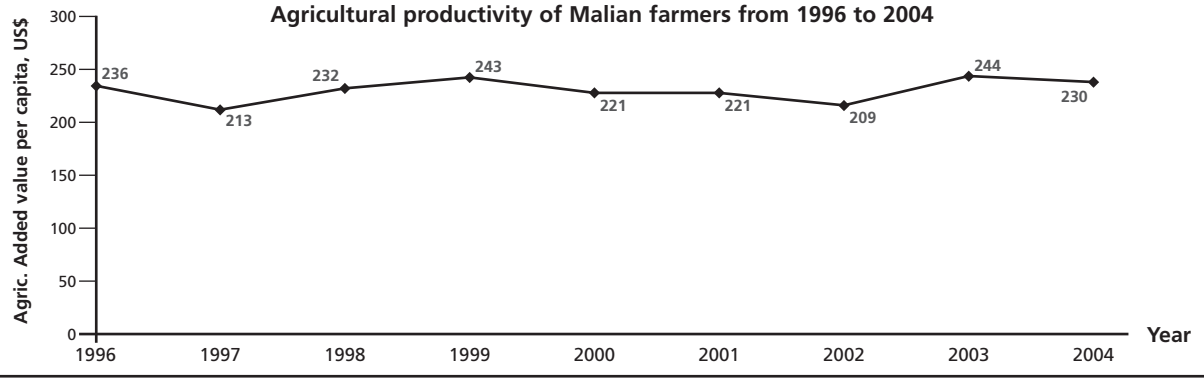


Source: Compiled from CPS-MA (2006); CPS-MA (2007) for 2006–2007 data; and Tongola *et al.* (2008) for 2007 data.

FIGURE 4
Evolution of agricultural labour productivity in Mali from 1991 to 2003

Source: Adapted from FAO (2006).

FIGURE 5
Agricultural productivity of Malian farmers from 1996 to 2004



Source: Adapted from The World Bank Group (2008) and FAO (2006).

TABLE 5
Indicators of the agricultural productivity of Malian farming units in various regions for various crops in 2005

Type of crops	Average area cultivated, ha/farm enterprise in various regions								Weighted average area per crop
	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Bamako	
Cereals	2.12	3.62	4.19	5.43	3.36	1.69	1.54	0.94	**3.44**
Legumes	0.94	1.62	0.99	2.15	1.98	0.21	1.06	0.34	**1.52**
Industrial crops	2.83	2.80	3.40	2.31	0.61			1.93	**3.00**
Tubers	0.23	0.30	0.47	0.24	0.10	0.16		0.01	**0.34**
Other crops	0.14	0.26	0.14	0.35	0.32	0.17	0.03	0.25	**0.25**
Average per region	**2.81**	**5.38**	**7.50**	**6.74**	**4.22**	**1.70**	**1.56**	**0.89**	**4.72**

Note The average area/farm enterprise is not the average of the data on the table. This is because the farm enterprises usually cultivate more than one crop.

Source: Adapted from DNA *et al.* (2007)

Table 6 presents the average yields of cereals in kg/ha for various regions of Mali for the period 1995–2000, 2005–2006 and the 2007–2008 farming seasons for which data are available. There are significant regional variations in the yield. Consistently, regions such as Ségou, Sikasso, Mopti and Koulikoro, with the highest levels of mechanization, generally have the highest yields as well. Tombouctou, is one of the regions in Mali with the lowest level of mechanization as shown by the data on Tables 2 and 4, where the majority of the farmers use hand tools. The rice yields in this region however are consistently one of the highest. Clearly other factors other than the level of mechanization are at work here and need to be investigated.

Table 7 shows the evolution of cereal yields and the total area planted in Mali from 1996 to 2007. During the 2007 farming season, the weighted average yields for cereals in Mali was 1 172 kg/ha, which is about 17 percent higher than the average of 1 000 kg/ha for SSA. However, the yields of cereals have not increased consistently but have tended to fluctuate. Maize, wheat and rice yields have been about 100 percent greater than the average of about 1 000 kg/ha for cereals. Indigenous crops such as millet, sorghum and fonio have significantly lower yields. With millet and sorghum accounting for about 75 percent of the cereals produced in Mali (DNA *et al*., 2007), their low yields have a profound effect on the average yield of cereals in Mali. From the year 2003, the area cultivated with cereals increased significantly probably because of the increased level of mechanization.

The productivity of rice farmers in the zone supervised by the ON is presented on Table 8. This is a zone with a relatively high number of power tillers used for cultivation and where the farmers receive extension services. The introduction of power tillers in the ON zone has greatly contributed to increased yields from 3 to 4 tonnes/ha to about 6 tonnes/ha. This is because the land is prepared in a timely manner. This is a zone where the impact of mechanization has been very well demonstrated.

Interestingly, the area per farming unit has been decreasing but yields have increased significantly such that the total production per farmer has been increasing steadily. This was because the area allocated for each farming enterprise was reduced by the ON, and farmers were encouraged to respect cultural practices and use improved inputs.

TABLE 6
Yields in kg/ha for some cereals in various regions of Mali

Period	Crop	Region							
		Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Bamako
Average for 1995–2000 (kg/ha)	Millet	850	810	977	796	1 098	386	349	
	Sorghum	851	975	1 032	984	677	711	277	
	Maize	1 036	1 331	1 764	1 327	585	538		
	Rice	974	1 469	1 496	3 627	1 129	1 896	843	
2005/2006 Season	Millet	783	780	1 047	822	643	780	545	858
	Sorghum	972	815	1 024	812	586	1 137	592	781
	Maize	1 236	1 007	1 460	1 054	712		700	1 641
	Rice	1 241	1 119	1 524	4 889	958	2 348	743	3 583
	Wheat						2 200		
	Fonio	613	615	548	867	482			663
2007/2008 Season	Millet	822	820	981	816	619	513	519	
	Sorghum	960	938	953	918	749	806	584	
	Maize	1 621	1 532	1 676	1 325	624	1 299		
	Rice	1 276	2 455	1 887	4 962	1 641	2 351	973	
	Wheat		1 650	1 650	2 500		2 487	1 000	
	Fonio	924	600	665	658	656			
Weighted average 07–08		**1 062**	**977**	**1 208**	**1 509**	**899**	**1 256**	**814**	

Source: Average yield data for 1995–2000 was adapted from Dembele, Z.V. (2001); 2005/2006 data from CPS-MA, 2006; and 2007/2008 data from Tongola *et al.* (2008)

TABLE 7
Evolution of cereal yields and the total area planted in Mali from 1996 to 2007

Year	Yields kg/ha for various cereals							Total area cultivated, * 1 000 ha
	Maize	Millet	Rice (paddy)	Sorghum	Fonio	Wheat	Weighted average	
1996	1 288	550	1 505	835			**809**	**2 649**
1997	1 598	790	1 873	999			**1 099**	**1 985**
1998	1 687	729	1 755	996			**1 074**	**1 971**
1999	1 642	897	2 199	967			**1 205**	**2 097**
2000	1 454	878	2 237	993			**1 201**	**2 377**
2001	1 332	704	2 106	837	908	2 352	**1 007**	**2 294**
2002	1 158	694	2 010	737	507	2 524	**991**	**2 631**
2003	1 148	510	1 944	695	470	2 569	**791**	**3 201**
2004	1 436	667	2 313	885	592	2 449	**980**	**3 471**
2005								
2006	1 493	780	2 284	845	535	2 200	**1 090**	**3 119**
2007	1 928	717	1 955	638	669	888	**1 172**	**3 459**

Source: Compiled from CPS-MA, (2006); CPS-MA (2007) for 2006–2007 data; and Tongola *et al.*, (2008) for 2007 data.

TABLE 8
Productivity of rice in the Office du Niger (ON) zone from 1990 to 2006

Year	Area, ha	Production, tonnes	Yield, kg/ha	Number of farming units	Area, ha per farm
89/90	44 251	106 593	2 409	9 621	4.6
90/91	43 872	143 938	3 281	9 973	4.4
91/92	44 435	180 909	4 071	10 465	4.2
92/93	44 843	208 541	4 650	10 864	4.1
93/94	45 442	222 634	4 899	11 159	4.1
94/95	44 950	209 978	4 671	11 842	3.8
95/96	46 407	232 206	5 004	13 235	3.5
96/97	47 984	246 112	5 129	13 767	3.5
97/98	49 314	267 186	5 418	15 441	3.2
98/99	48 680	298 123	6 124	16 459	3.0
99/00	51 040	306 036	5 996	20 018	2.5
00/01	52 995	325 300	6 138	21 818	2.4
05/06	73 326	437 621	5 968		

Source: Dembele Z.R. (2001) and CPS-MA (2006) for 05/06 data.

6.4 CONTRIBUTION OF AGRICULTURE TO THE ECONOMY

The ultimate goal of an AMS is to provide agriculture-led industrialization and increase the standard of living of farmers. This would only be possible if agriculture is a profitable activity and generates significant revenues. The Malian economy is dependent on agriculture as shown on Table 9. In 2004, the agricultural sector employed about 5 million persons, which was about 79 percent of the total labour force. The percentage of the workforce engaged in agriculture has dropped over the last decade in Mali from about 83 percent in 1996 to about 79 percent in 2004, which is an annual drop of about 0.55 percent. On the other hand the number of persons employed by the agricultural sector has been increasing steadily.

In 2006, agriculture accounted for about 37 percent of the GDP of Mali, down from about 51 percent in 1996. Considering that about 79 percent of the workforce is engaged in agriculture in Mali, the contribution of agriculture to the economy is relatively low and indicates the low productivity of the workers and low per capita added value from the sector. In real terms, the amount of money contributed by the sector has increased by about 27 percent over the last decade.

TABLE 9
Importance of agriculture in the Malian economy during the period 1996 to 2006

Year	Agricultural labour force, in thousands	Percentage of workforce engaged in agriculture	GDP, millions of constant 2000 US$	Percentage from agriculture	Amount from agriculture, millions of constant US$
1996	4 268	83.1	1 943	51.8	1 006.5
1997	4 339	82.6	2 074	44.5	922.9
1998	4 411	82.1	2 199	46.5	1 022.5
1999	4 485	81.5	2 347	46.5	1 091.4
2000	4 562	81.0	2 422	41.6	1 007.6
2001	4 647	80.4	2 716	37.8	1 026.6
2002	4 735	79.9	2 828	35.0	989.8
2003	4 826	79.3	3 039	38.8	1 179.1
2004	4 920	78.7	3 105	36.4	1 130.2
2005			3 294	36.6	1 205.6
2006			3 469	36.9	1 280.1

Source: adapted from: The World Bank Group (2008), FAO (2006).

Chapter 7
Impacts of agricultural mechanization approach in Ghana

7.1 ENABLING ENVIRONMENT

As discussed in Section 2, agricultural mechanization is not an end in itself but it is just one of the inputs that needs to be mobilized to meet national development objectives. The formulation and implementation of an AMS should therefore be an integral part of a national development planning process. Successful implementation of the AMS therefore depends on social and economic stability, adequate infrastructure, reliable utilities, adequate fiscal policies, and a well-trained and disciplined-workforce.

As mentioned in Section 5.2, agricultural mechanization in Ghana is being developed as part of FASDEP, which is part of GPRS. GPRS and FASDEP have plans of action, with projects geared towards providing the enabling environment to complement the implementation of mechanization policies. NDPC (2005) states that GPRS II is anchored on the following priorities:

- Macroeconomic stability.
- Accelerated private sector-led growth.
- Vigorous human resource development.
- Good governance and social responsibility.

These are all essential pre-conditions for the successful implementation of an AMS.

As concerns macroeconomic stability, the goal in GPRS II is to implement policies that will enhance and sustain economic stability. These include: prudent fiscal policies, a flexible monetary policy that ensures stable prices, stable exchange rates and affordable credits to the private sector.

A number of policy interventions have been envisaged to accelerate private sector-led growth. NDPC (2005) notes that the capacity of the private sector will be strengthened to effectively perform as the engine of growth and poverty reduction by: improving Ghana's access to global and regional markets; enhancing the efficiency and accessibility of national markets; strengthening of firms' competency and capacity to operate effectively and efficiently; enhancing government capacity for private-sector policy formulation, implementation, monitoring and evaluation; facilitating private-sector access to capital; improving institutional and legal bottlenecks; supporting adoption of technological innovation and entrepreneurship; enhancing the quality of public services and accelerating the development of other sectors that are strategic to the attainment of private sector-led growth. Strategic support services that are being developed to improve the productivity of agriculture and agro-industry are transportation, energy, science and technology.

In the domain of human resource development, the goal is to ensure the development of a knowledgeable, well-trained and disciplined-labour force with the capacity to drive and sustain private sector-led growth. For human resources development, education and training are required, as well as access to adequate health care, water and sanitation, etc. These all are to be improved under the policy.

Finally, on good governance and social responsibility, the goal is to empower stakeholders to participate in the development process and to collaborate effectively in promoting peace and stability in Ghana. Measures towards attaining this objective include the promotion of an effective, responsible and accountable state administrative system with improved capacity to engage the private sector and civil society in formulating strategies for accelerated growth and poverty reduction.

The GPRS therefore provides a national coordinated development framework in which agricultural mechanization is an important component and with complementary policies to support the implementation of mechanization policies. The GPRS clearly identifies the role of the public and private sectors. The state is primarily a facilitator and the private sector the equipment and service provider. The GPRS has policies geared towards improving the facilitating role of the state in a participatory manner to create a favourable socio-economic environment for private sector-led growth. All these are also very conducive to the successful elaboration and implementation of an AMS.

7.2 REDUCED DRUDGERY (LEVEL OF MECHANIZATION)

Since the implementation of GPRS I during the period 2003–2005, progress has been achieved in farmers' access to mechanized tillage and access to processing equipment (NDPC, 2005). Farmer access to mechanized tillage equipment increased from 5 percent in 2002 to 12 percent in 2004 as against the target of 15 percent, while access to processing equipment increased from 24 percent in 2003 to 42 percent in 2004 thereby exceeding the target of 30 percent. The creation of AMCs has contributed to improving the access of farmers to agricultural mechanization technologies. The increase in the number of AMCs to the point where each district in Ghana should have at least one, will greatly improve the situation.

Detailed information on the number of agricultural equipment and its evolution in Ghana is very patchy and shows a great deal of discrepancy between information presented by FAO (2006) and information obtained from the field. Hence the data on tractor use intensity are unreliable and was not determined. For example, in 2003, based on official data from Ghana, FAO estimated the number of tractors in Ghana to be 3 600. Other authors report that the estimated number of tractors in Ghana in early 2000 was about 4 000 (Mahama, 2007; Mahama *et al*., 2007). However, a census in 2004 by the AESD (2008b) revealed the distribution of tractors in Ghana as shown on Table 10 with a total of 1 736 serviceable tractors. This was surprising because the state also had the impression there were about 4 000 tractors in Ghana. The three northern Regions (Northern, Upper East, and Upper West) accounted for 55 percent of the tractor population.

During the period 2004–2006, 1 000 Farmtrac tractors were ordered from India by the AESD and supplied to farmers. For 2007–2009 the target is to order 3 000 tractors. So far, a total of 1 430 tractors have been ordered and supplied to farmers by the AESD. These consist of the following: 230 Farmtrac tractors, 500 Mahindra tractors and 500 John Deere tractors all from India, and 200 compact tractors from the Czech Republic. In addition, 500 power tillers have also been distributed to farmers. At the end of 2008, the estimated tractor population in Ghana was about 3 166. This was based on the tractor census in 2004 and the tractors acquired by the state. However, the private sector is also involved in importing and selling new and used tractors, which are not easily accounted for, and hence the total number of tractors in service is difficult to determine.

TABLE 10
Summary of the serviceable tractor population on a regional basis in Ghana in 2004

Region	Number
Upper East	157
Upper West	181
Northern	609
Brong Ahafo	319
Ashanti	188
Eastern	39
Western	14
Central	63
Volta	132
Greater Accra	34
Total	**1 736**

Source: AESD (2008b).

One thousand additional John Deere tractors are to be delivered at a rate of 100 tractors per month until late-2009. The target is therefore that by the end of 2009, 4 000 tractors would have been supplied to farmers under the FASDEP initiative. As part of the FASDEP initiative, about US$2 million worth of agro-processing equipment and storage facilities have been acquired and distributed to farmers using funds from the Highly Indebted Poor Country Initiative.

Ghana has ten regions and each of these is to be supplied with two sets of water drilling rigs for boreholes for irrigation purposes. Each set comprises two Farmtrac tractors, one adapted to carry the drilling rig and the second tractor pulling the compressor. These will be operated by the private sector under the supervision of the state using a similar approach used in the creation and management of AMCs.

TABLE 11
Estimated available power for agriculture in Ghana in 2002

Major source	Number of units	Power per unit, kW	Total power, kW	Percentage of total
Human	7 200 000	0.01	720 000	51.73
Bullock	970 000	0.5	485 000	34.85
Tractor	4 000	46.7	186 800	13.42
Total			**1 391 800**	**100**

Source: Josiah *et al.* (2008).

It is estimated that about 60 percent of farmers in Ghana use hand tool technologies, 25 percent use DAP while about 15 percent use mechanical power in agriculture (Mahama, 2007). There are reported to be about 970 000 work bullocks and 16 000 donkeys. The use of animal traction is more widespread in the Northern and Upper Regions where the environment is more conducive. Other sources, such as Josiah *et al*. (2008) give different proportions for the various power sources in Ghana as shown on Table 11. On the other hand, Twum (2002) indicated that about 92 percent of the cultivated area in Ghana was carried out with hand power, 3 percent by draught animals and 5 percent by mechanical power. The same author estimates the number of bullocks at only 40 000 compared to close to a million on Table 11. The above suggests that there is very little reliable data on mechanization in Ghana. Any successful AMS should therefore have a component on monitoring and evaluating the process.

Using the number of farm workers in Ghana estimated by FAO (2006) as 5 741 000 in 2002 and the number of 4-wheeled tractors to be about 2 000 and the same assumptions made by Josiah *et al*. (2008) would give a more realistic estimate of the distribution of the various power sources in 2002. The analysis results in the following distribution:

- Human power: 50 percent
- Animal Power: 42 percent
- Mechanical power: 8 percent

This seems more in line with the assessment of the NDPC (2005) that access of farmers to mechanical power increased from 5 to 12 percent between 2002 and 2004 as against a target of 15 percent. In 2002, according to Josiah *et al*. (2008), 13.4 percent of Ghanaian farmers already access to mechanical power, which is greater than the level noted in 2005.

There is agreement from various data sources that farmers' access to mechanical power has increased in Ghana over the last couple of years. This can be attributed to the increasingly favourable enabling environment regarding agricultural mechanization. The increasing demand for mechanical power by farmers has stimulated interest within suppliers to assemble tractors locally. The AESD estimates that only about 40 percent of farmers requesting for tractors from the government are satisfied. Two Indian tractor models, Mahindra and Farmtrac, are to be assembled in Ghana. According to African Agriculture (2008), a tractor assembly plant was inaugurated in October 2008 in Kumasi by the then Ghanaian President, John Kufor. The project is a private venture of three partners: Zoomlion Ghana, Mahindra & Mahindra of India and the Garages Association of Ghana Limited. It is projected that 70 percent of the tractors will be assembled locally. Mirpuri (2008) reports that the foundation stone for the construction of an assembly plant for Farmtrac tractors was laid in late 2008 in Tema by the Ghanaian president. This is a private venture by Foundries & Agricultural Machinery (Ghana) Ltd, which is the sole distributor of Farmtrac tractors in Ghana.

The private sector would not engage in the supply of agricultural mechanization technologies and services if it is not a profitable venture. The local assembly of tractors in Ghana by the private sector is therefore an indication that the enabling environment is favourable for suppliers of the technology. Local assembly is expected to significantly improve the provision of after sales services of tractors and also bring down costs of purchasing and operating tractors in Ghana.

7.3 AGRICULTURAL PRODUCTION AND PRODUCTIVITY

Figure 6 shows the agricultural labour intensity in Ghana from 1991 to 2003. Productivity increased slightly from 1994 and peaked at about 1.1 ha/farmer in 2000. Since then, it has been fairly constant at about 1 ha/farmer. It is hoped that with the increasing access of farmers to mechanization technologies during the FASDEP initiative, from 2004 onwards, the agricultural labour productivity curve would show an increasing trend.

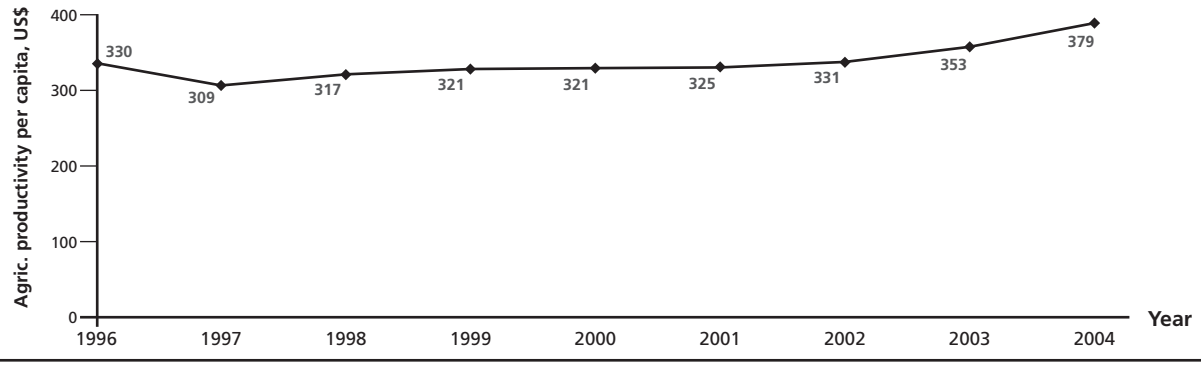
Agricultural productivity can also be defined as the added value per agricultural worker, i.e. the per capita contribution of agricultural workers to the GDP. Figure 7 shows the evolution of this indicator in Ghana from 1996 to 2004 in constant 2000 US$. The productivity has been increasing steadily from a low of US$308 per capita in 1997 to a high of US$379 in 2004. The information suggests that the rate of increase was faster from 2002 to 2004 probably as a result of the impacts of FASDEP I. It is anticipated that the trend would continue as a result of the impacts of FASDEP II. Unlike in Mali, the data for two years suggest the productivity is increasing. This can be attributed to the coordinated actions carried out in the subsector under the FASDEP initiative.

Figure 8 shows the food production in Ghana from 1997 to 2007 for cereals (maize, millet, sorghum and rice), for starchy staples (cassava, cocoyams, yams and plantains) and the total for these eight food crops. The index presented is simply a relative increase to the base period where the average production in 1997–1998 = 100. The data indicate that the total food production has been increasing steadily since 1997 and that in the course of a decade, production increased by 45 percent. This has been largely because of the increased production in starchy foods, which have increased steadily by about 50 percent over the same time period. Production of cereals has fluctuated and has been decreasing since the year 2002. The steady increase in food production can be attributed to the comprehensive agricultural policies in place in which agricultural mechanization is an important aspect and suggests that the impacts can be sustained. However, the reasons for the less impressive performance of the cereals sub-sector needs to be analysed and steps taken to improve the situation.

FIGURE 6
Evolution of agricultural labour productivity in Ghana from 1991 to 2003

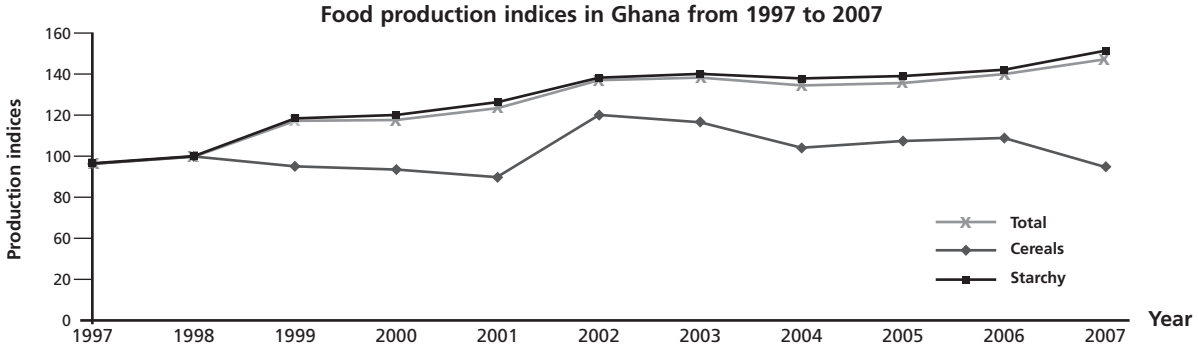
Source: FAO (2006).

FIGURE 7
Evolution of the agricultural productivity of Ghanaian farmers from 1996 to 2004



Source: Adapted from The World Bank Group (2008) and FAO (2006).

FIGURE 8
Food production indices in Ghana from 1997 to 2007



Source: Compiled from SRID-MoFA (2007) and SRID-MOFA (2008).

TABLE 12
Growth rates in Ghana in agricultural subsectors (%) from 1997 to 2006

Year	Subsector			Weighted national average
	Crops & livestock	Cocoa	Fisheries	
1997	4.5	4.0	1.0	**4.3**
1998	4.4	11.0	1.8	**5.1**
1999	4.7	-0.5	1.0	**3.9**
2000	1.1	6.2	1.6	**2.1**
2001	4.6	-1.0	2.0	**4.0**
2002	5.2	-0.5	2.8	**4.4**
2003	5.3	16.4	3.0	**6.1**
2004	5.4	29.9	3.5	**7.5**
2005	3.3	13.2	-1.2	**4.1**
2006	6.0	8.7	3.6	**5.7**
Average 97–2002	4.08	3.20	1.70	**3.97**
Average 03–2006	5.00	17.05	2.23	**5.85**
Average 97–2006	**4.45**	**8.74**	**1.91**	**4.72**

Source: SRID-MoFA (2007).

TABLE 13
Area and yields of food crops in Ghana from 1997 to 2007

Year	Area, x 1000 ha			Yields, kg/ha	
	Cereals	Starchy	Total	Cereals	Starchy
1997	1 264	1 207	2 471	1 321	10 568
1998	1 340	1 305	2 645	1 353	10 241
1999	1 300	1 508	2 808	1 298	9 845
2000	1 307	1 412	2 719	1 283	10 642
2001	1 370	1 540	2 910	1 172	10 568
2002	1 598	1 653	3 251	1 349	10 750
2003	1 463	1 691	3 154	1 396	10 755
2004	1 332	1 646	2 978	1 375	10 770
2005	1 350	1 595	2 945	1 406	11 265
2006	1 438	1 674	3 112	1 334	11 043
2007	1 270	1 687	2 957	1 317	11 570

Source: Compiled from SRID-MoFA (2007) and SRID-MoFA (2008).

Table 12 shows the evolution of the growth rates of three agricultural subsectors and the national average of the sector. The data indicate that the agriculture sector has been experiencing growth over the last decade with an average growth rate of about 4.7 percent per year. The rate of growth during the period 2003 to 2006 was higher (5.85 percent) compared to 3.97 percent during the previous period. Hence, during the implementation of the FASDEP initiative, growth in the agricultural sector increased with the cocoa subsector registering the highest growth.

Table 13, shows some reasons why production has increased significantly. This has been achieved through increase in the cultivated area and increases in yields of food crops, especially the starchy staples. The total area of food crops has been increasing steadily but it is the area of starchy foods that has been more consistent with an increase of about 480 000 ha over a decade. The area for cereals has fluctuated a great deal, and the 2007 area is basically the same as in 1997. Analysis of the yields between two periods, 1997–2002 (before FASDEP) and 2003–2007 (after start of FASDEP), indicates there have been improvements in the yields of both cereals and starchy foods. During the period 1997–2002 the average cereal yield was 1 296 kg/ha while for starchy foods it was 10 436 kg/ha. After the start of the FASDEP initiative, the average yields in 2003–2007 increased to 1 366 kg/ha for cereals and 11 081 kg/ha for starchy foods. This is the best indicator of the increased productivity of Ghanaian farmers as a result of the implementation of the FASDEP initiative in which agricultural mechanization is a very important component.

The productivity of farmers in Ghana as relates to cereal yield is therefore about 36 percent higher than the average of SSA and suggests that Ghana is doing something right. However, it is still far short of the average yield in Asia and Latin America of about 3 000 kg/ha. Since the implementation of GPRS I between the period 2003 and 2005, post-harvest losses in cereals achieved the intended target of 15–20 percent and perishables managed a moderate achievement of 33–35, falling short of the target of 15–20 percent (NDPC, 2005). The reduction in post-harvest losses has contributed to the increased availability of food in Ghana.

7.4 CONTRIBUTION OF AGRICULTURE TO THE ECONOMY

Agriculture continues to contribute the largest share to the GDP, even though the share of the sector in national output is declining (MoFA, 2007**).** Table 14 shows the importance of agriculture in the Ghanaian economy from 1996 to 2006. The percentage of the workforce engaged in agriculture has dropped over the last decade in Ghana from about 57.8 percent in 1996 to about 55.9 percent in 2004, which is an annual drop of about 0.2 percent. On the other hand the number of persons employed by the agricultural sector has been increasing steadily.

In 2006, agriculture accounted for about 37.4 percent of the GDP of Ghana down from about 39 percent in 1996. Considering that about 56 percent of the workforce is engaged in agriculture in Ghana, the contribution of agriculture to the economy is relatively low and indicates the low productivity of the workers and little added value from the sector per worker. In real terms, the amount of money contributed by the sector has increased by about 54 percent over the last decade.. The productivity of Ghanaian farmers is however higher than in Mali where about 80 percent of the workforce is engaged in agriculture and contributes to only about 37 percent of the GDP.

TABLE 14
Importance of agriculture in the Malian economy during the period 1996 to 2006

Year	Agricultural labour force, in thousands	Percentage of workforce engaged in agriculture	GDP, millions of constant 2000 US$	Percentage contribution from agriculture	Amount from agriculture, millions of constant 2000 US$
1996	4 982	57.8	4 214	39.0	1 643.5
1997	5 104	57.6	4 391	35.8	1 572.0
1998	5 224	57.3	4 598	36.0	1 655.3
1999	5 346	57.1	4 800	35.8	1 718.4
2000	5 471	56.9	4 977	35.3	1 756.9
2001	5 604	56.6	5 177	35.2	1 822.3
2002	5 741	56.4	5 410	35.1	1 898.9
2003	5 881	56.1	5 691	36.5	2 077.2
2004	6 021	55.9	6 010	38.0	2 283.8
2005			6 364	37.5	2 386.5
2006			6 759	37.4	2 527.9

Source: Adapted from: The World Bank Group (2007), and FAO (2006).

Chapter 8
Analysis and recommendations

Under this Section, the constraints to agricultural mechanization in both countries will be presented. Second, factors leading to success or failure in the enhancement of agricultural mechanization in both countries will be analysed. Finally, recommendations based on the experiences of Mali and Ghana, which could be used to update the FAO guidelines on the elaboration and implementation of an AMS, would be made.

8.1 CONSTRAINTS TO AGRICULTURAL MECHANIZATION

Discussions with stakeholders in both countries sought to find out what were the main constraints or challenges of small entrepreneurs to successfully implement agricultural mechanization. The constraints were essentially the same in both countries and are summarized in Box 1.

8.2 FACTORS CONTRIBUTING TO SUCCESS OR FAILURE OF AGRICULTURAL MECHANIZATION

8.2.1 Situation in Mali

There have been delays in the adoption of the AMS, which was completed six years ago. This was because of changes in political will and commitment, changes in policies resulting from the election of a new government, and the fact that the AMS was not an integral part of a national development planning process. With the implementation of the PDES initiative to develop Mali through a Green Revolution, the AMS is now an integral part of a national development strategy. In addition, the PDES encompasses projects in many sectors that are complementary to the AMS. These include: infrastructure, developing the private sector, good governance, education and health, economic growth and regional integration. This is a very comprehensive program that places the implementation of the AMS within a very favourable framework to succeed. It is now time to adopt the AMS as the conditions are now very favourable for successful implementation.

BOX 1

Constraints to agricultural mechanization in Mali and Ghana

- In Mali, there is consensus among all stakeholders that enough agricultural equipment is available in the market, but not accessible to many farmers. In Ghana, however, stakeholders have concluded that agricultural equipment is not easily available. *A major constraint in both countries is therefore the poor access of farmers to mechanization technologies. This is as a result of: the high cost of mechanization inputs, the low purchasing power of the majority of farmers to acquire them and the poor access to loans by farmers.*
- Lack of skilled tractor operators. In Ghana, this is considered to be one of the reasons why government supported mechanization schemes failed in the past.
- Commercialization of agricultural produce (no guaranteed markets, low market prices, etc.).
- Poor availability of spares because suppliers are concentrated in the major towns of Bamako and Accra.
- Farmers usually do not consider agriculture as a business but as a way of life.
- Existing land tenure system.

Though the AMS has not been adopted, it is still considered the reference document used for planning in agricultural mechanization and has contributed to raising awareness on the importance of improving the productivity of farmers. Some of the projects envisaged in the Malian strategy have been realized although not exactly in the form proposed. These have contributed to creating a better socio-economic environment for the level of mechanization to improve. In addition, the following factors have contributed to increasing agricultural production in Mali despite the non-adoption of the AMS:

a) A stronger political will and commitment to agriculture was manifested from the year 2003 and hence agriculture took a higher profile. Previously, tractor based mechanization was not encouraged but from 2003 onwards this changed when the president of the country decided to promote tractorization. Also, government felt that it was more prudent to invest in agriculture than rely on imported food.

b) Before 2003, only export crops such as cotton were considered to be profitable. The world economic context changed with increases in food prices, which made the production of some food crops profitable. Food crops could therefore justify more expensive mechanization technologies.

c) Markets have been opened in the Economic Community of West African States (ECOWAS) creating opportunities for commercialization of agricultural products.

All the above have contributed to increasing agricultural production. Productivity however has been constant. This can be attributed to the non-implementation of the AMS and the absence of an implemented and coordinated multisectoral national development strategy in which agricultural mechanization is an important aspect.

Mechanization has been generally more successful in Mali for crops with a good or fair price on the market and with a ready market. This suggests therefore that mechanization strategies should be focused on a few strategic crops within each country in a subregion and subregional trade encouraged.

In Mali, the government is involved in the provision of some mechanization services (tractors and implements, power tillers, etc.) to farmers whereas this should be the role of the private sector. This may end up in a failure as was the case in previous attempts if things are not done differently.

8.2.2 Situation in Ghana

The following strengths have been recognized in the Ghanaian approach to promoting agricultural mechanization:

- Mechanization approach focuses on selected commodities based on comparative and competitive advantage, for food security and for income diversification. This implies that the emphasis is on farming as a business and hence only profitable crops would be able to afford mechanization services and products.

- Agricultural mechanization in Ghana, though without an adopted AMS, is being carried out as an integral part of a national development process. Therefore policies affecting mechanization stem from national policies and have been engrained into the various work plans of national institutions and hence do not easily change. In addition, because the national policy is to stimulate agriculture-led growth, many complementing policies that enhance agricultural production and productivity were put in place simultaneously. As a result, growth in productivity has been steady and sustained.

- Ghana already has a relatively good infrastructure, numerous training institutions in agricultural engineering (four public universities, one private university and four polytechniques), a good extension service, and a high profile AESD headed by a senior engineer and with four services headed by engineers. The AESD also carries out testing and makes recommendations on the types and models of equipment the state should buy. Simultaneously, GIDA works on irrigation development. FASDEP therefore just served to coordinate their activities more and provide additional resources within the agricultural sector, which in turn was coordinated within the GPRS framework.

- Agricultural modernization is very high on the political agenda in Ghana. Annual farmers' days presided over by the Ghanaian president are organized with handsome prizes given to winners. In 2008, the best farmer was built a five-bedroom apartment.

The following were identified as weaknesses to the Ghanaian approach:

- The lack of an AMS has meant that not all stakeholders, especially farmers and private sector equipment and service providers, have been involved in the planning and implementation of mechanization policies. Hence a detailed diagnosis of the problems confronting farmers and private sector equipment and service providers still needs to be carried out. The Ghanaian approach to agricultural mechanization for now is essentially top-down.

- In Ghana, the government is involved in the provision of some mechanization services (tractors and implements, power tillers, etc.) to farmers whereas this should be the role of the private sector. This may end up in a failure as was the case in previous attempts if no lessons from these failures have been learned to ensure sustainability.

8.2.3 Discussion

One of the main constraints encountered in both countries was the lack of data to determine the long-term impacts of mechanization. Where data existed, they were not very reliable as various sources had information that was frequently uncorrelated. Data collection should therefore be an important aspect of an AMS to permit the determination of long-term impacts. This calls for monitoring and evaluation of the implementation of the AMS.

Preliminary indications are that progress in increased production and productivity has been steadier in Ghana. This can be attributed to the comprehensive agricultural policies in place in which agricultural mechanization is an important aspect and suggests that the impacts may be sustained. In Mali, production has been increasing but productivity has been constant.

Ghanaian farmers are more productive than their Malian counterparts. In the year 2004, the per capita contribution of a Ghanaian farmer to the country's GDP was US$379 compared to US$230 in Mali. In the year 2007, the average yields of cereals, the staple food of Mali, was 1 172 kg/ha whereas it was 1 317 kg/ha in Ghana. Another indicator of the productivity of Ghanaian farmers is that about 56 percent of the workforce engaged in agriculture, contributes 38 percent of the GDP of the country while in Mali, about 80 percent of the total workforce engaged in agriculture contributes about 37 percent of the GDP. Although production has increased in both countries, the major issue is whether agricultural mechanization is profitable with or without subsidies (see Box 2).

In Ghana and Mali, the governments are involved in the provision of some mechanization technologies (tractors and implements, power tillers, etc.) to farmers whereas this should be the role of the private sector. This is justified by the fact that farmers have difficulties to obtain loans to acquire mechanization technologies. The intension of the state is therefore to stimulate demand and later reduce its involvement. There are, however, concerns about the sustainability of subsidized mechanization as indicated in Box 3.

BOX 2

Profitability of agricultural mechanization: are subsidies needed?

In both Mali and Ghana, opinions of stakeholders differ as to whether agricultural mechanization is profitable with or without subsidies. There is agreement that agricultural mechanization is profitable only for crops with a "good" or "fair" local market price and with a ready market. Mr Gyarteng, a former director of the AESD in Ghana, states categorically that farmers should not produce crops if there is no ready market.

In Ghana, the AESD representing the state has concluded that agricultural mechanization is not profitable without subsidies. This view underpins the AESD strategy of supplying tractors to farmers at subsidized prices and also of providing concessionary terms of loan repayment. Mr Gyarteng is also of the opinion that agricultural mechanization without subsidies will not work in developing countries such as Ghana because equipment is very expensive. He argues that the state needs to assist farmers with subsidies to a point when the farmers become competitive. This approach he says was used successfully in Malaysia to develop the oil-palm industry. The state later withdrew from the sector after farmers had finished repaying their loans, and today the sector is completely managed by the private sector and Malaysia is a major palm oil producer worldwide.

In Mali, the state is also of the view that mechanization equipment is expensive and that mechanization based on equipment purchased with loans from commercial banks with interest rates of about 14 percent is not profitable. As such the state needs to subsidize farm equipment and provide loans at concessionary interest rates of about 6–7 percent per year. This was the view expressed at a meeting with stakeholders who constituted the steering committee for the elaboration of the Malian AMS. In Mali and Ghana, state officials indicated that in Europe and North America, where there is a better enabling environment, the state still provides subsidies to agriculture and hence poor African farmers cannot be expected to do better.

Researchers in the University of Ghana in Legon such as Dr Aliu Mahama take a very different view. Studies have concluded that agricultural mechanization is currently profitable in Ghana without subsidies. This view is also shared by the private sector in Ghana. For example, Mr Shewak Ram Mirpuri, the Chief Executive Officer of Foundries & Agricultural Machinery (Ghana) Ltd, which is the sole distributor of Farmtrac tractors in Ghana, says despite the state subsidized tractor scheme in Ghana he is doing a good business selling tractors and concludes this is testimony of the profitability of agricultural mechanization. To buttress this view, his company has just laid the foundation stone for the assembly of Farmtrac tractors in Ghana. In Mali, APCAM, which is a confederation of Chambers of Agriculture, has concluded that with crops such as rice and cotton with a good market value and with a ready market, mechanization is profitable. According to the secretary general of APCAM, *farmers are prepared to pay for agricultural mechanization equipment. The most serious handicap is access to loans and the high interest rates from commercial banks.* This view is also shared by farmers and private sector equipment suppliers in Ghana. In Ghana only about 4 percent of bank loans are directed towards agriculture and a much lower percentage for the purchase of equipment.

BOX 3

Subsidies, loan repayments and sustainability

In both countries, those who advocate for subsidies, concede that the problem with this approach is that of sustainability of the funding mechanism and also of farm enterprises. Because of political interference in the award of loans, the rate of recovery of state loans is considered to be very poor even when the farmers are engaged in the profitable use of the equipment. For example in Mali, the APEJ, which provided 100 tractors from the state to youths as loans, estimates that only about 2 percent of the youths are repaying the loan despite the fact that the tractors were subsidized and there was a one-year period of grace before loan repayments could start. To ensure sustainability of the loan mechanism, it is suggested that loans should be given only to farmers who are business minded and whose operations are profitable.

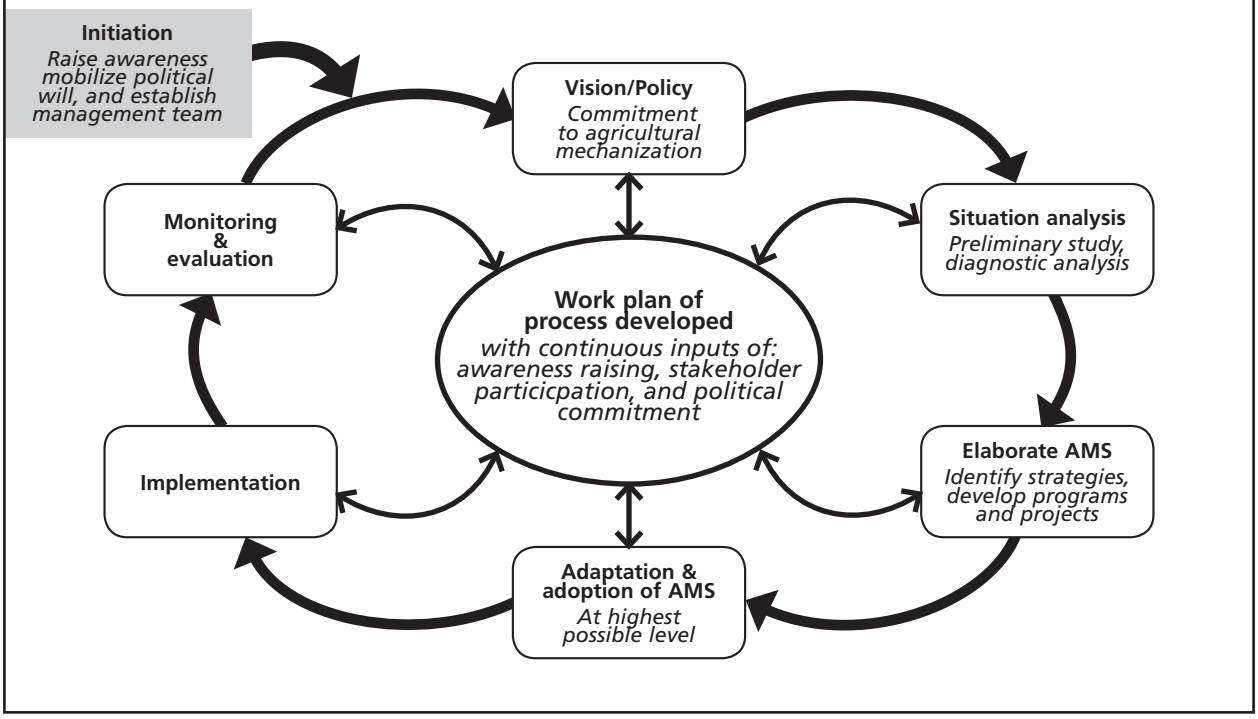
In Ghana, Mr Gyarteng, an advocate of subsidies, agrees that the problem with subsidies is that of sustainability. In the past, subsidized schemes all failed for a number of reasons: farmers did not value the equipment and hence misused them (e.g. tractors were used as cars to travel from one village to another), farmers could/did not repay for the loans and hence the subsidy program failed. He is of the view that the current approach of the MoFA supplying tractors to farmers at concessionary rates is likely going to face the same problems of the past as regards repayment of loan by farmers. This is because there is a feeling that tractors supplied by the state can be owned without payment because the farmers would simply be taking their own share of the "national cake". Also, government has been very reluctant to go after those who defaulted with payments and is still not ready to use high-handed or forceful measures to recover debts owed to the state. No data is available for loan repayment rates but there seems to be general agreement in Ghana by stakeholders that the rate of repayment is poor. Partial data from Mali suggests it could be as low as 2 percent. However, some stakeholders in Mali are of the opinion it is not as bad. It is thought that many more farmers repay their loans but these may not be fully accounted, as some funds are possibly being diverted elsewhere by the services responsible for their collection.

Stakeholders in Mali and Ghana feel that the approach adopted by the MiDA (in Ghana) has a better chance of succeeding and should be tried. The approach is very business like and it is likely that farmers will be more serious to repay loans to a bank. The state in effect hides behind a bank to supply the loan and later quietly withdraws once the farmers are well settled business operators. In Ghana, MiDA is still training farmers and hence results of this approach are still awaited.

To resolve this problem, the Millennium Development Authority (MiDA) in Ghana is striving to change the mind set of farmers by training them to consider agriculture as a business rather than as a way of life – the attitude of many of them. Farmers are trained to develop business plans, which are then submitted to banks for funding. The state however is behind the funding mechanism and provides loan guarantees and ensures that the terms of the loan are concessionary compared to commercial rates. In so doing, it is the commercial bank and not the state that is seen to be giving the loan and hence the repayment rate should improve. A similar system is also being operated in Mali but under a quite different project, APEJ, which is promoting youth employment.

Another way out of the poor repayment issue by farmers is that the state should get tough on defaulters and support farmers who respect their engagements. In so doing, progressive and successful farmers would grow to be role models that others can emulate.

FIGURE 9
Process for the elaboration and implementation of an AMS



Based on the experiences of Mali and Ghana, the planning process shown on Figure 9 for mechanizing agriculture can be proposed. This should not only be focused on the elaboration of the AMS but also on the adoption and implementation. This draws inspiration for the planning process for integrated water resources management (IWRM) presented by Cap-Net *et al*. (2005) and is partly based on the steps in the elaboration of an AMS presented by Houmy (2008).

8.3 RECOMMENDATIONS

1. It is desirable to prepare an AMS as soon as possible at the start of the mandate of a new political administration in a country to reduce political and institutional instability, and increase chances for adoption and implementation.
2. The AMS should be prepared only when there are policies in place outlining the broad national development strategy and how agriculture fits into the bigger picture. Ideally, the AMS should be elaborated and implemented within the context of an agricultural development strategy that fits within a national development strategy. This is because of the various aspects that have to be brought on board from many sectors, for the AMS to have the desired impact.
3. Implementation of the strategy should focus on the entire food chain and not just on land preparation because bottlenecks would be created in other parts of the chain. For example, in Mali, power tillers have considerably increased the area cultivated for rice but there are now labour problems regarding planting, harvesting and threshing.
4. Political will and commitment at the highest possible level are very important for the elaboration, adoption and implementation of an AMS. FAO should assist at the highest possible level to mobilize and sustain this will and commitment throughout the process; otherwise, the strategy may remain unimplemented.
5. Political will and commitment are also very important to place mechanization high on the agenda, raise awareness and drive the mechanization process. In the case of Mali, without the adoption and implementation of the strategy/plan, some progress has been made since 2003 because of the high profile agriculture enjoys resulting from the interest the president of the country has in agriculture in general and mechanization in particular.

6. Implementation of the action plan requires a considerable amount of resources. For Mali, the revised 5-year action plan for 2008–2013 requires about 370 billion FCFA. Of this amount, the state intends to contribute 10 percent, the beneficiaries 20 percent and development partners 70 percent. It would be desirable to associate development partners during the elaboration of the strategy to facilitate implementation. In addition, this may contribute to raise awareness of the strategy/action plan and assist in the mobilization of political will and commitment. Hence, FAO would not be the only one involved in keeping the issue alive.
7. In Mali, politicians have taken the lead in looking for immediate solutions to address food crisis with the importation and assembly of tractors. However, this needs to be done within the context of a long-term concerted effort to transform subsistence smallholder agriculture to medium- to large-scale commercial agriculture and bring about food security and generation of revenue from exports. The adoption and implementation of the AMS therefore still has its raison d'être.
8. Farmers are willing to pay for agricultural equipment but need loans at more favorable interest rates than those offered by commercial banks. Stakeholders have concluded that the development of a flexible sustainable financing mechanism with preferential interest rates for loans for the acquisition of equipment is the key to the successful implementation of an AMS.
9. Within each country in a subregion, the implementation of the AMS should initially focus on a few profitable and strategic crops with a good rate of return on investment and with a ready market and subregional trade encouraged. The demand for mechanization is likely to be good if farmers can afford to mechanize in order to increase their income. Without a ready market to absorb increased production, mechanization would not be sustainable.
10. Because of a relatively weak private sector, the poor purchasing power of farmers, and difficulties of farmers to obtain loans, the state should somewhat be involved in the provision of services to farmers. In Mali, the state is a shareholder in one of the companies assembling tractors. In Ghana, the state is importing tractors and equipment, and distributing to farmers with subsidies and at favourable terms of repayment. For this approach to be sustainable, political will and commitment are needed to punish defaulters and encourage farmers respecting their engagements with the state so that they can grow to be role models for others to copy. To complement this, farmers should be trained to regard agriculture as any other business venture and be able to obtain loans from commercial banks, with state guarantees and at favourable repayment terms.
11. Ghana is a country where the elaboration of an AMS has very good chances of being a success story, which could be emulated by other countries. This is because the AMS would fit into a national development scheme, which is currently being implemented. FAO should therefore consider providing financial and technical support for this to be achieved.

References

AESD. 2008a. Proposed national policy and strategy for agricultural engineering in Ghana. Draft report of subcommittee reviewing agricultural engineering policy and strategy in Ghana. Personal communication.

AESD. 2008b. Summary of tractor population on a regional basis. Personal communication.

African Agriculture. 2008. Available from: http://africanagriculture.blogspot.com/2008/10/ Consulted 1 November 2008.

Arnon, I. 1981. *Modernization of agriculture in developing countries: resources, potentials and problems.* New York, John Wiley & Sons. 565 pp.

Ashburner, J.E. & Kienzle, J. 2009. *Mechanization in Africa – public and private sector schemes*. Agricultural and Food Engineering Working Document No. 8. FAO, Rome. 31 pp.

Barger, E.L.M., Lijedahi, J.B., Carleron, W.M. & Mekibbe, E.G. 1963. *Tractors and their power units*, 2nd Edition. New York, John Wiley & Sons.

Boamah, J.K. 2006. *Agricultural engineering policy in Ghana and its effects on agricultural development.* Proceedings of the 3rd national conference on agricultural engineering organized by the Ghana Society of Agricultural Engineering, at the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana from 1 to 4 August, p. vi–xii.

Boshoff, W.H. & Minto, S.I. 1975. Energy requirements and labour bottlenecks and their influence on the choice of improved equipment: pp 1995–1999. *In* Westley, S. B., Johnston, B. F. (Eds). *Farming equipment innovations for agricultural development and rural industrialization.* Nairobi Kenya, Institute for Development Studies, University of Nairobi, 238 pp.

Cap-Net, GWP & UNDP. 2005. *Integrated water resources management plans: training manual and operational guide.* Available on the Internet from: http://www.cap-net.org/TMUploadedFiles/FilesFor67/IWRM Plan.doc. Or from www.gwpforum.org.

Clarke, L.J. 1997. *Agricultural mechanization strategy formulation: concepts and methodology and the roles of the private sector and the government*. Rome, FAO. Available on the Internet from: http://www.fao.org/ag/AGS/AGSE/STRATEGY.htm. Consulted 2 December 2008.

CPS-MA. 2006. *Bilan de la Campagne agro-pastorale 2004/2005 et perspective de la campagne agropastoral 2005/2006.* Bamako-Mali: CSP-MA, 41 pp.

CPS-MA. 2007. *Bilan de la Campagne agro-pastorale 2006/2007* Bamako-Mali: CSP-MA.

Dembele, R. 2001. *Rapport phase diagnostique : mécanisation, version finale.* Projet d'Appui à la définition d'une politique nationale de mécanisation agricole au Mali (TCP/MLI/0165). Bamako-Mali, FAO / D.N.A.E.R, 69 pp.

Dembele, Z.V. 2001. *Rapport Agronomique: Version finale*. Projet d'Appui à la définition d'une politique nationale de mécanisation agricole au Mali (TCP/MLI/0165). Bamako-Mali, FAO / D.N.A.E.R, 74 pp.

Diarra, H. 2008. *La mécanisation agricole au Mali.* Report de la division de mécanisation agricole, direction nationale du génie rurale, Ministère de l'Agriculture, Bamako Mali, Octobre 2008, 22 pp.

DNA, CPS, DNPIA, DNSI, Coopération Française & FAO. 2007. *Recensement general de l'agriculture: campagne Agricole 2004/2005.* Résultats définitifs. Volume 1: Rapport de synthèse. Bamako-Mali: Authors. 143 pp.

DNSI. 2006. *Annuaire Statistique de Mali 2006.* Bamako-Mali: DNSI. 104 pp.

FAO. 1994. *Agricultural mechanization strategy for Ghana: main report*. Rome, FAO, 39 pp.

FAO. 2003. *Compte rendu final.* Projet d'appui a la définition d'une politique nationale de mécanisation agricole au Mali (AG : TCP/MLI/0165) préparé pour le Gouvernement du Mali. Rome, FAO-AGST. 15 pp.

FAO. 2006. FAOSTAT Online Statistical Service. Rome: FAO. Available online at: http://faostat.fao.org.

FAO & UNIDO. 2008. *Agricultural mechanization in Africa … Time for action: planning investment for enhanced agricultural productivity*. Report of an expert group meeting jointly held by FAO and UNIDO in Vienna on 29–30 November 2007. Rome, FAO. 26 pp.

Ghanadistricts. 2006. Available online at: http://www.ghanadistricts.com/home Consulted 29 September 2009.

Gifford, R.C. 1988. *Agricultural mechanization in development: guidelines for strategy formulation.* FAO Agricultural Services Bulletin No. 45, Rome, FAO, 77 pp.

Houmy, K. 2002. *Mécanisation agricole au Mali: rapport de l'atelier de Février 2002.* Projet d'Appui à la définition d'une politique nationale de mécanisation agricole au Mali (TCP/MLI/0165). Bamako-Mali: FAO / D.N.A.E.R. 28 pp.

Houmy, K. 2008. *Guide de formulation d'une stratégie de mécanisation : étude de cas : stratégie nationale de la mécanisation agricole au Mali*. Document de travail sur le génie rural et alimentaire, Rome, FAO. 50 pp.

Josiah, M.N., Bani, R.J. & Mahama, A.A. 2008. Availability of energy and agricultural mechanization in Ghana. *Journal of Food, Agriculture & Environment,* Vol. (6)2: 132–143.

Mahama, A.A. 2007. *Modernising Ghana's agriculture: the challenges ahead*. The 3rd workshop on modernising Ghana's agriculture: the challenges ahead, 27–28 September, Ho Polytechnic. Ghanaian Society of Agricultural Engineers.

Mahama, A.A., Seidu, M. & Kotei, R. 2007. Tractor use and impact on agricultural production in the northern regions of Ghana: *In* Bart-Plange, A., Addo, A (Eds). *Engineering Ghana's agriculture and health for economic progress.* Proceedings of the 3rd national conference on agricultural engineering, 1–4 August at KNUST Ghanaian Society of Agricultural Engineers.

MA-SG. 2008. *Stratégie nationale de mécanisation agricole et plan d'action 2008–2012.* Bamako-Mali: MA-SG. 28 pp.

MoFA. 2007. *Food and Agriculture Sector Development Policy (FASDEP II)*. Accra-Ghana: MoFA. 70 pp.

Mirpuri, S.R. 2008. Personal communication. CEO, Foundries & Agricultural Machinery (Ghana) Ltd., Tema. Email: famcpint@4u.com.gh or mcpint@4u.com.gh.

NDPC. 2005. *Growth and Poverty Reduction Strategy (GPRS II) (2006–2009).* Accra-Ghana: NDPC. 177 pp.

République du Mali. 2006. *Loi d'orientation agricole (LOA).* Loi # 06-045 du Sept 2006. Bamako-Mali : Ministère de l'Agriculture. 41 pp.

Rijk, A.G. 1999. Agricultural mechanization strategy. *In* Stout, B. A. and Cheze, B. (Eds). *Plant production engineering: CIGR handbook of agricultural engineering,* Vol. III, CIGR/ASAE, p. 536–553.

Shetto, R.M. 2007. Challenges for agricultural mechanization in sub-Saharan Africa. *In Addressing the challenges facing agricultural mechanization input supply and farm product processing.* FAO Technical Report # 5. Rome: FAO. 71 pp.

Sims, B.G. & Kienzle, J. 2009. *Farm equipment supply chains: Guidelines for policy makers and service providers: experiences from Kenya, Pakistan and Brazil*. Agricultural and Food Engineering Technical Report No. 7. FAO, Rome. 48 pp

SRID-MoFA.2007. Agriculture in Ghana: facts and figures (2006). Accra-Ghana: SRID-MoFA. 55 pp.

SRID-MoFA. 2008. Production estimates 2007, January 2008. Accra-Ghana: SRID-MoFA, 3 pp.

The World Bank Group. 2007. World development indicators. Available from: http://ddp-ext.worldbank.org/ext/DDPQQ/report.do?method=showReport. Consulted 27 December 2008.

The World Bank Group. 2008. *2008 World development indicators online.* Washington, DC: The World Bank. Available at: http://go.worldbank.org/U0FSM7AQ40. Consulted 27 December 2008.

Tongola, M., Dieng, I. & Ba, B.C. 2008. *Mission conjoint CILSS/FEWS-NET/Gouvernement d'évaluation préliminaire de la campagne agricole 2008/2009 au Mali.* Bamako-Mali: CILSS/FEW-NET. 17 pp.

Toure, A.T. 2007. Programme de Développement Economique et Social (PDES). *Un meilleur avenir pour les Maliens a horizon 2012-vision et actions*, 82 pp. Available at http: www.koulouba.pr.ml/spip.php?article1185. Consulted October 2008.

Twum, A. 2002. *Global farm power assessment studies – Ghana country report.* Rome, AGSE-FAO, 51 pp.

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Rural Infrastructure and Agro-Industries Division (AGS)
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
00153 Rome, Italy.

E-mail: ags-registry@fao.org
Fax: (+39) 06 57056850
Web site: http://www.fao.org/ag/ags