

Investment in agricultural mechanization in Africa

Conclusions and recommendations
of a Round Table Meeting of Experts



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Conclusions and recommendations of a Round Table Meeting of Experts

Co-organized by

Food and Agriculture Organization of the United Nations (FAO)
United Nations Industrial Development Organization (UNIDO)

Hosted by

**Centre for Agricultural Mechanization and Rural Technologies
(CAMARTEC)**

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Preface

Many African countries have economies strongly dominated by the agricultural sector. In some countries, agriculture generates a significant proportion 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. It provides employment for the majority of Africa's people, but despite this domination investment in the sector is still low. Yields of maize and other staple cereals have typically remained at about one tonne per hectare, which is about a third of the average achieved in Asia and Latin America. But this is not the only problem; the population is increasing in most African countries and this is accompanied by a rural to urban migration such that in the course of the next 2 to 3 decades there will be more urban dwellers than rural. Ensuring food security for the entire population is critical. But feeding the increasing urban population cannot be assured by an agricultural system that relies almost entirely on human muscle power.

One of the keys to the success in Asia and Latin America has been mechanization. By contrast, the use of tractors in sub-Saharan Africa (SSA) has actually declined over the past 40 years and, compared with other world regions, their use in SSA today remains very limited. Tractor use over the same period in Asia has increased tenfold. The situation in SSA can be illustrated by the extremely low numbers of tractors per 1 000 ha of arable land; in 1980 there were 2 and by 2003 this had sunk to 1.3. By comparison in the Asia and Pacific region, in 1980 there were 7.8 tractors per 1 000 ha and this had risen to 14.9 by 2003. In 1960, Kenya, Uganda and Tanzania alone had more tractors in use than India. But by 2005, India had 100 times more tractors in use than the total number in use in these three countries.

Even though SSA started at a very low base, the trend over the past three decades has become even worse. SSA is also the only developing region where the number of agricultural workers per hectare is no more than half of the average for all developing regions, a situation even more dramatic because the number of tractors in use is also very low.

The greatest source of power for land preparation remains human muscle power. In Central Africa an estimated 80 percent of cultivated land is worked manually. In eastern and southern Africa the figure is about 50 percent. Because of this not only does sub-Saharan Africa have an acute lack of human resources available for agricultural production, but also it cannot compensate for this shortage by resorting to tractors as there are not sufficient numbers available.

Over the past few decades the failure of the public sector tractor hire schemes led to many development practitioners moving away from conventional motorized mechanization approaches, even though the true reasons for these failures were never carefully analysed. Some suggested, probably quite mistakenly, that such a mechanization approach could never be economic, and attention turned to better exploiting the use of draught animals as a source of farm power. Although some progress was made, this too was found not to be an approach that could offer a significant improvement to the situation.

It is now clear that unless some positive remedial action is taken, the situation can only worsen. In most African countries there will be more urban dwellers than rural ones in the course of the next two to three decades. It is critical to ensure food security for the entire population but feeding the increasing urban population cannot be assured by an agricultural system that is largely dominated by the centuries old hand tool technology. In order to redress the situation, FAO and UNIDO together with many African experts are convinced that, just as has happened in Asian and South American countries, support is urgently needed for renewed investment in mechanization. Furthermore, mechanization is inextricably linked with agro-industrialization, and there is a need to clarify the priorities for supporting this investment in the context of a broader agro-industrial development strategy. This must, however, be done in the right way, taking into account critical factors for success and sustainability.

How can governments and the public sector set about ensuring an increase in investment in mechanization without encountering blockages similar to those experienced previously in the 1960s and 1970s? This issue and others were addressed at a three-day Round Table Meeting of experts that was convened in Arusha, Tanzania, in June 2009 with the intention of providing guidance on the key strategies and good practices for maximizing the benefits and sustainability of investments in agricultural mechanization in Africa. This report summarizes the deliberations of this Round Table Meeting.

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The editors would like to acknowledge the contribution of the numerous persons who ensured that this Round Table Meeting could be held. The event constituted a direct follow-up to the Meeting convened by UNIDO in Vienna in December 2007 on *Agricultural Mechanization in Africa* and at which time a subsequent meeting in Africa was proposed. We are grateful that the Centre for Agricultural Mechanization and Rural Technologies (CAMARTEC) agreed to host the Round Table in Arusha, Tanzania. Special thanks go to the local organizing team that provided an excellent venue for the two days of deliberations. The technical and continued financial support of UNIDO is acknowledged.

The meeting was enriched by the active participation and valuable inputs and ideas from the many experts in mechanization and the financial sector who came from a number of African countries (Cameroon, Ghana, Kenya, Morocco, Niger, Sierra Leone, South Africa, Tanzania and Zimbabwe) together with resource persons from Europe and India. Special thanks are extended to the President of Club of Bologna for his attendance. The outcome of the Round table has already made this topic more visible at policy and donor level and it is hoped that this will lead to more sustainable approaches to agricultural development in the African region.

The first draft version of this document was put together by Lawrence Clark. Special thanks are made to Larissa D'Aquilio (FAO) for leading the publication process, to Madeline Grimoldi for English editing and to Fabio Ricci for the desktop publishing.

Acronyms

ACT	African Conservation Tillage Network (Kenya)
IFC	International Finance Corporation
AfDB	African Development Bank
AGRA	Alliance for a Green Revolution in Africa
AICRP	All India Coordinated Research Projects
AMDTF	Agricultural Machinery Development Trust Fund
AMIS	Agricultural Machinery Industrial Sector
AMS	Agricultural Mechanization Strategy (Kenya)
CA	conservation agriculture
CAMARTEC	Centre for Agricultural Mechanization and Rural Technologies (Tanzania)
cc	cubic centimetres
CENEEMA	Centre National d'Etudes et d'Expérimentation du Machinisme Agricole (Cameroon)
CMDT	Compagnie Malienne des Textiles, parastatal organization, Mali
COMESA	Common Market for Eastern and Southern Africa
DAP	draught animal power
EAC	East African Community
ECCAS	Economic Community of Central African States
ECOWAS	African Community of West African States
FAO	Food and Agriculture Organization of the United Nations
FIs	Financial institutions
FSDT	Financial Sector Deepening Trust (Tanzania)
GDP	gross domestic product
GPRS	Growth and Poverty Reduction Strategy (Ghana)
GTZ	German agency for technical cooperation
ha	hectare
h.p.	horsepower
HIV/AIDS	human immunodeficiency virus/acquired immune deficiency syndrome
HYV	high-yielding variety
ICAR	Indian Council of Agricultural Research
IFC	International Finance Corporation
ILO	International Labour Organization
KENDAT	Kenya Network for Dissemination of Agricultural Technologies
mm	millimetre
MSP	minimum support price

NAMS	national agricultural mechanization strategy
NCAM	National Committees on Agricultural Mechanization
NGO	non-governmental organization
PPP	Public-Private Partnership
Pt-O	power take-off
R&D	research and development
REC	regional economic community
SAU	state agricultural universities
SME	small- and medium-scale enterprise
SSA	sub-Saharan Africa
SWOT	a planning method used to determine strengths, weaknesses, opportunities and threats
UNIDO	United Nations Industrial Development Organization
VAT	value-added tax
WRS	warehouse receipt scheme

Executive summary

OVERVIEW

The specific objectives of the Round Table were to make recommendations on three sets of interrelated issues:

- Definition of the specific areas of action needed to increase the availability of mechanization inputs.
- Identification of the components of a programme to increase investments in mechanization.
- Identification of the potential roles and responsibilities of FAO, UNIDO and other development partners in supporting investment in mechanization in Africa.

MAIN POLICY AND STRATEGY ISSUES CONSIDERED AT THE MEETING

The Round Table Meeting focused on a number of policy and strategy issues for which background papers were presented to promote discussions in the working groups and during plenary sessions. They may be summarized as follows:

1. Public sector mechanization strategy development and investment priorities, including the following topics:
 - Agricultural mechanization strategies – recent experiences
 - Best practices and examples of investment priorities from Asia
 - Purchasing strategies and programmes – tendering for mechanization inputs
 - Cost of doing business and risk management
 - Creation of effective demand
2. Public-private sector models in support of mechanization, including the following topics:
 - Possible codes of practice for the private sector stakeholders – roles and responsibilities of those concerned
 - Responsive business systems for sustained mechanization inputs
 - Criteria for appraising, designing and targeting investment programmes
3. Networking and south-south linkages, including the following topics:
 - South-south technology supply and transfer
 - Global and regional networking among machinery suppliers
4. Financial-sector requirements, including the following topics:
 - Bringing the financial sector on board
 - Innovative funds, facilities and mechanisms such as leasing or contracting

CONCLUSIONS

The Working Groups and discussions during the plenary sessions allowed the following conclusions to be identified:

- Mechanization is not just a question of supplying farmers with tractors and machinery or of making mechanization services available to them through the public sector. The utilization of mechanized inputs must be profitable to all parties concerned.
- The best way to mechanize is for farmers to own their machines or for them to hire services from other farmers. For a better chance of profitability, off-farm use of the tractors (for example) should be considered.
- Tractors need to be serviced, repaired and have available the necessary spare parts. A tractor or machine without these is more of a liability than an asset. Support infrastructure is therefore vital.
- The best way to supply machinery is through the private sector, although this does not necessarily preclude public sector participation. However, this must be done in such a manner as to support the private sector.
- In many Asian countries where mechanization has expanded so significantly, agricultural pricing policy has been used as an instrument to support this.
- In many African countries, most farmers still cannot afford mechanization. This situation depends to a large extent on farmgate prices, which in many countries are volatile and often too low.
- Lack of finance is the overwhelming reason why farmers cannot purchase machinery. Commercial banks are generally not interested in lending to farmers, and their interest rates are far too high for farmers to use loans effectively. Problems related to landownership and registration often lead to farmers lacking sufficient collateral to qualify for loans.
- Local manufacturers often lack skills and sufficient investment funds. Other difficulties often include high tariffs on imported steel and components, and the cost of doing business is frequently quite high.
- There are often inadequate training facilities making it difficult to upgrade the skills of human resources.
- Although off-farm use of tractors may be encouraged to increase profitability of their operation, government and other regulations may stifle such efforts.
- Further efforts are required to convince development agencies and financial institutions that increased investment in agricultural mechanization is required.
- There is often a poorly coordinated approach to mechanization. Mechanization issues are not a concern of agriculture ministries alone, and the ministries of industry, finance, education and others should also be involved.
- There is too little networking activity among interested parties at both national and interregional levels concerning agricultural mechanization.

MAIN POLICY ISSUES

The following key questions were identified as requiring a response regarding policy issues:

- Although government policy will aim to increase agricultural production, is increased mechanization adequately recognized as an essential means to achieve this?
- What should be the role of the public sector in promoting agricultural mechanization?
- Subsidies – should mechanization and/or the manufacture/importation of machinery be subsidized and, if so, how?

- Should the pricing of farm products be used as an instrument to increase investment in agriculture and, if so, what mechanisms are needed?
- Finance – how can this best be made accessible to the private sector so that SMEs can be established so as to offer mechanization services in particular to the small-scale farmers?
- How can the assistance offered by donors who wish to use “aid in kind” (e.g. the supply of tractors) best be accommodated within national development programmes?
- What is the policy regarding protection of farmers against bad commercial and/or financial practices?
- Can land ownership and registration policies be improved so as to improve the possibilities of farmers using their land as collateral?

RECOMMENDATIONS

The following recommendations that emerged from the Meeting are intended to facilitate support of both public- and private sector investment flows into the development of agricultural mechanization in Africa. One of the main objectives is to reduce primary land preparation carried out by hand-tool technology from the current 80 to 40 percent by the year 2030, and to 20 percent by 2050. Increasingly, land should be prepared using a combination of draught animal power (DAP) technologies and tractors.

ESTABLISH NATIONAL COMMITTEES ON AGRICULTURAL MECHANIZATION (NCAM)

The national committees would comprise representatives of all major stakeholders, such as agriculture, finance, industry, trade and other ministries, farmers, together with the financial, private sector, and research and development institutions. The main functions of the committees would be to:

- Assist the national government in reviewing national policy to include a strategy dealing with mechanization.
- Develop and update the national agricultural mechanization strategy (NAMS), including regional strategies, an area where FAO and UNIDO can assist.
- Coordinate efforts between different ministries and institutions.
- Develop more efficient procurement systems, an area where FAO, UNIDO and World Bank can assist.
- Ascertain compatibility of donations with national standards and plans.
- Prepare action plans for capacity building through formal education, research, extension and vocational training.

CREATE AN ENABLING ENVIRONMENT TO INCREASE THE UTILIZATION OF TRACTORS AND OTHER FARM EQUIPMENT

- Increase on-farm use of tractors and machinery by promoting neighbourhood contracting.
- Review existing regulations on the use of agricultural tractors for off-farm applications such as transport of materials, construction of rural infrastructure (roads, irrigation works, etc.) and land clearing.
- Intensify agriculture, including livestock production, by increasing irrigation.
- Facilitate cross-border use of farm equipment.
- Develop an enabling environment for a demand-driven mechanization process by developing agro-processing industries.

INCREASE INVESTMENT IN AGRICULTURAL MECHANIZATION (BOTH PRIVATE AND PUBLIC SECTORS), DRAWING FROM ASPECTS OF THE EXPERIENCE OF INDIA PRESENTED DURING THE MEETING

- Explore the possibility of central banks providing direct support to commercial banks for on-lending to farmers/entrepreneurs and to prescribe a minimum percentage allocation of bank lending to the agriculture sector.
- Explore ways to facilitate long-term financing needed for agricultural mechanization. This could involve facilitation and access to long-term sources of finance such as bond funds, refinancing lines of credit or development trust funds.
- Establish or strengthen rural banking facilities to provide financial services to the agriculture sector.
- Ensure that financial service providers to the agriculture sector are consistently made aware of current best practices in the technical and economic use of agricultural mechanization technologies.

CAPACITY BUILDING

- Assess the current situation and identify the availability of centres offering education, research and extension services focusing on farm mechanization in Africa.
- Estimate the requirements for such centres, including the identification of their geographical locations and, based on the regional strengths of key centres, develop them as centres of excellence.
- Develop in each centre programmes of formal education, research and extension in agricultural mechanization. Explore possibilities for regional training, as not all countries have the capacity to establish training centres.
- Implement short-term training programmes for mechanics in the operation, maintenance and repair of agricultural machinery and processing equipment.
- Extend the training curriculum for motor vehicle mechanics to cover tractors and other agricultural machinery.
- Promote educational outreach programmes to create awareness on how to use mechanized equipment for other off-farm applications in order to increase utilization and effective demand for mechanization.
- Implement short-term training programmes promoting farming as a business, by means of training in farm management, entrepreneurship, business management and agro-processing.
- Establish and strengthen associations of contractors, manufacturers, processors, traders and others at local, regional and national levels.

AGREE ON A CODE OF PRACTICE FOR AGRICULTURAL MACHINERY SUPPLIERS

At international level, under the lead of FAO and UNIDO, develop and agree on a code of practice for agricultural machinery suppliers. This code should strengthen the role of the private agricultural machinery sector in supplying machinery, providing after-sales repair and maintenance services, and building the capacity of machinery owners as part of their role.

CREATE REGIONAL AGRICULTURAL MECHANIZATION NETWORKS IN AFRICA

Membership should be encouraged from research and development institutions, professional organizations, manufacturers and distributors, with assistance from FAO and/or UNIDO if requested. This network will link up with existing thematic networks related to mechanization, including DAP and conservation tillage.

PART I

Summary

Chapter 1

Summary of the round table meeting

1.1 INTRODUCTION

Senior national officials from across the continent were invited to a Round Table Meeting to consider various aspects of agricultural mechanization in Africa. The Meeting was co-organized by FAO and UNIDO and hosted by CAMARTEC in Arusha, Tanzania, from 3 to 5 June 2009.

It was held in preparation for the High Level Conference on Development of Agribusiness and Agro-Industries in Africa (HLCD-3A) that FAO, UNIDO and other partners later organized in March 2010.

This first part of this report presents a summary of the Meeting while Part 11 provides summaries of the papers presented.

1.2 OBJECTIVES OF THE MEETING

The specific objectives of the Round Table were to deliberate and make recommendations on three sets of interrelated issues:

- Definition of the specific areas of action needed to increase the availability of mechanization inputs.
- Identification of the components of a programme to increase investments in mechanization.
- Identification of the potential roles and responsibilities of FAO, UNIDO and other development partners in supporting investment in mechanization in Africa.

1.3 HOST ORGANIZATION, CAMARTEC

The Meeting was hosted by the Centre for Agricultural Mechanization and Rural Technologies (CAMARTEC), which is a parastatal organization established by an Act of Parliament in November 1981. The centre is located in Arusha, Tanzania (Plot 153 A, Njiro Road, Themi).

Its responsibilities are to promote appropriate agricultural and rural technologies for the improvement of agriculture and rural livelihood

so as to speed up the pace of economic growth and eradication of poverty.

Specifically, the objective of CAMARTEC is to undertake applied research and development (R&D), promotion, adaptation, adoption and dissemination of appropriate technologies in the fields of agricultural mechanization, rural transport, water supply and sanitation, low-cost housing, energy and post-harvest technologies. The overall aim is to improve the standard of living and reduce poverty.

CAMARTEC is also the national centre with the mandate for testing and evaluating agricultural machinery and rural development technologies, imported or produced in the country. Such studies concern their quality and suitability to Tanzanian conditions and are undertaken in conformity with set standards.

1.4 PARTICIPANTS

The Round Table Meeting convened experts from a broad spectrum of organizations connected with agricultural mechanization and agro-industrial development in Africa, including:

- Private sector organizations, such as those engaged in financing, equipment manufacture, sales and servicing;
- Government departments;
- Civil society organizations;
- Research and development (R&D) institutions;
- Academic institutions;
- Development partners organizations;
- Relevant support organizations such as industry associations.

A full list of participants is given in Part I, Ch. 3.

1.5 THE MAIN ISSUES¹

The Round Table Meeting focused on six main policy and strategy issues, and background papers were presented to promote discussions in the working groups and during plenary sessions. These are detailed below:

1. *Public sector strategy development and investment priorities to accelerate mechanization related to agro-industries*, including the following topics:

- Agricultural mechanization strategies – recent experiences
- Best practices and examples of investment priorities from Asia

Papers presented on this issue:

- An overview of agricultural mechanization in sub-Saharan Africa (Mrema, FAO)
- Mechanization investments in India and lessons for Africa (Singh, India)
- Agricultural mechanization strategies and their role with agricultural sector policy development strategies (Houmy, Morocco)
- Development Strategies for the Agricultural Machinery Industrial Sector (AMIS) in Africa (Samarakoon, UNIDO)

2. *Direct public sector investment, financial support and examples of public sector programmes*, including the following topics:

- Purchasing strategies and programmes – tendering for mechanization
- Code of practice for doing business with donors and other governments

Papers presented on this issue:

- Commercial competitiveness versus livelihoods enhancement – Why national agricultural mechanization efforts need to be driven via the private sector rather than by central government initiatives (Kaumbutho, Kenya)
- Commercial competitiveness versus livelihoods enhancement (Shetto, Tanzania)

- Selected case studies of public sector investment programmes – D.R. Congo, South Sudan and Sierra Leone (Ashburner and Kienzle, FAO)
- Agricultural mechanization in Mali and Ghana – Strategies, experiences and lessons for sustained impacts (Fonteh, Cameroon)

3. *Facilitating policies and programmes to encourage private sector investment in mechanization*, including the following topics:

- Cost of doing business and risk management
- Creation of effective demand

Paper presented on this issue:

- Creating effective demand for tractors (Hancox, FAO Consultant)

4. *Public-private sector models in support of mechanization*, including the following topics:

- Codes of practice – roles and responsibilities
- Responsive business systems for sustained mechanization inputs
- Criteria for appraising, designing and targeting investment programmes

Paper presented on this issue:

- A review of some public sector driven mechanization schemes and cases of private sector models in Africa (Ashburner and Kienzle, FAO)

5. *Networking and south-south linkages*, including the following topics:

- South-south technology supply and transfer
- Global and regional networking among machinery suppliers

Papers presented on this issue:

- Farm mechanization – India and Africa partnership (Jain, India)
- South-south technology supply and transfer: Experiences from East Africa and Brazil (Sims and Kienzle, FAO)
- Global and regional networking among machinery suppliers: Experiences of the

¹ Summaries of these papers and presentations are to be found in Part II of this report. Full copies of the papers and /or the presentations are to be found in the CD-ROM inside the pocket in the back cover.

African Conservation Tillage Network
(ACT) (Mkomwa, Kenya)

6. Financial sector requirements, including the following topics:

- Getting the financial sector on board
- Innovative funds, facilities and mechanisms, such as leasing and contracting

Papers presented on this issue:

- Financial experiences with crop mechanization in Tanzania (Charles, Tanzania)
- The experience of Financial Sector Deepening Trust (FSDT) in Tanzania (Mushi, Tanzania)

1.6 CONDUCT OF THE MEETING

The Meeting was arranged around the six themes identified above and comprised a combination of plenary papers, plenary discussion, topical debates and working group discussions. The first theme was discussed in plenary in order to set the stage for further discussion and debate on investment priorities. Themes two to four were also introduced through plenary presentations and then discussed in depth during group work sessions, whereas themes five and six were addressed through panel discussions, and the roles and responsibilities of potential partners were discussed in plenary.

The priority components of a programme framework to support investment in mechanization were considered under the following three working groups:

Group I

Finance for agricultural mechanization

Group II

Strategy development, standards, institutional coordination and codes of practice for direct public sector investment

Group III

Capacity building through training, optimization of use, development of private sector capacity, and information exchange and networking

The three groups were required to identify:

- Concrete areas of action to increase

availability and technical knowledge concerning mechanization technologies to be communicated to governments and regional bodies in order to support decision-making and programme design.

- Roles and comparative advantage of FAO, UNIDO and other international private sector machinery related associations in mechanization investment programmes in order to assist the key partners in working together both effectively and efficiently.
- Details of activities, time frame (short, medium or long term) and responsible organization are given in Part I, Ch. 2. These activities formed the basis for developing the draft recommendations that were presented to the delegates in plenary prior to being discussed, refined and accepted.

1.7 RECOMMENDATIONS OF THE ROUND TABLE MEETING

The following recommendations that emerged from the Meeting are intended to facilitate support of both public and private sector investment flows into the development of agricultural mechanization in Africa. One of the main objectives to be achieved is to reduce primary land preparation carried out by hand tool technology from 80 percent as at present to 40 percent by the year 2030 and 20 percent by 2050. The land preparation should be increasingly done by a combination of DAP technologies and tractors.

Establish National Committees on Agricultural Mechanization (NCAM)

a. Comprised of representatives of all major stakeholders such as government ministries of agriculture, finance, industry and trade; and, farmers, financial institutions, and private sector and R&D institutions.

b. Functions of the committee:

- Assist the national government to review national policy to include a strategy dealing with mechanization.
- Develop and update the NAMS including regional strategies, an area where FAO and UNIDO can assist.
- Coordinate efforts between different ministries and institutions.

- Develop procurement systems including smart tendering, an area where FAO, UNIDO and World Bank can assist.
- Ascertain compatibility of donations with national standards and plans
- Prepare action plans for capacity building through formal education, research, extension and vocational training.

Create an enabling environment (policies, institutions, regulations) to increase the utilization of tractors and other farm equipment through:

- Increasing on-farm use of tractors and machinery by promoting neighbourhood contracting.
- Reviewing existing regulations for the use of agricultural tractors for off-farm applications such as transport of materials, construction of rural infrastructure (roads, irrigation works, etc.) and land clearing.
- Intensifying agriculture, including livestock production, through increasing irrigation.
- Cross-border use of farm equipment.

Increase investment in agricultural mechanization (both private and public sector)

- Central bank to provide direct support to commercial banks for on-lending to farmers/entrepreneurs at preferential interest rates for farm machinery and to prescribe to a minimum percentage allocation of bank lending to the agriculture sector.
- Create an Agricultural Machinery Development Trust Fund (AMDTF) where the board of trustees should be comprised of representatives of government and private sector, both partners contributing to the fund. In order to raise funds, levies/tariffs should be imposed on all food imports, a percentage of the national budget should be transferred into the fund, contribution made from commercial banks, commodity boards, equipment suppliers, development banks and donors.
- Where appropriate, to establish rural banking to provide financial services to the agriculture sector.

- Linked to these financial services, it is also necessary to ensure that the technical expertise and inputs provided are related to current best practices in the application of agricultural mechanization technologies.

Capacity building

- Assess the current situation and identify the availability of centres offering education, research and extension services focusing on farm mechanization in Africa.
- Estimate the requirements for such centres, including the identification of their geographical locations, and based on the regional strengths of key centres, develop them as centres of excellence.
- Develop for each centre programmes for formal education, research and extension in agricultural mechanization (explore possibilities for regional training as not all countries have the capacity to establish training centres).
- Implement short-term training programmes for mechanics in agricultural machinery and processing equipment operation, maintenance and repair.
- Extend the curriculum for training of motor vehicle mechanics to cover tractors and other agricultural machinery.
- Promote educational outreach programmes to create awareness on how to use mechanized equipment for other off-farm use in order to increase utilization and increase effective demand for mechanization.
- Implement short-term training programmes promoting farming as a business through training in farm management, entrepreneurship, business management and agroprocessing.
- Establish and strengthen associations, such as farming, contractors, manufacturers, processors and trade, at local, regional and national levels.

Agree on a code of practice for agricultural machinery suppliers

At international level under the lead of FAO and UNIDO elaborate and agree on a code of practice for agricultural machinery suppliers. This

code should strengthen the role of the private agricultural machinery sector to supply machinery, provide after-sales repair and maintenance services, and provide capacity building to machinery owners as part of their role.

Create regional networks of agri-mechanization in Africa

Membership should be encouraged from research and development institutions, professional organizations, manufacturers and distributors with assistance from FAO and/or UNIDO if requested. This network will link up with existing subject matter networks related to mechanization, including DAP and conservation tillage.

1.8 COMPONENTS OF A PROGRAMME FRAMEWORK

Following the deliberations of the three working groups, a programme framework was drawn up giving the outline of the elements required to address the main issues identified by the working groups. The main components of the programme were divided into three main areas; (I) financing, (II) public sector strategy development, and (III) capacity building, information exchange and networking. A complete matrix of the programme as produced by the Meeting is to be found in Part I, Ch. 2.

Financing

Policy measures

It was recommended by the Meeting that as an immediate measure, governments/central banks should allocate a prescribed minimum percentage for on-lending to farmers/entrepreneurs specifically for agricultural mechanization. In addition, advice and guidelines should be made available on agricultural mechanization. It is the responsibility of national governments to set policy but, if necessary and requested, FAO, UNIDO and CAMARTEC might assist in this.

Creation of an Agricultural Machinery Development Trust Fund (AMDTF)

A new AMDTF should be created by governments. FAO and UNIDO should work together with national governments and development partners to stimulate and facilitate the creation of national AMDTFs. In addition, FAO and UNIDO should provide technical expertise and input on best practices in the application of agricultural

mechanization technologies. The progress of mechanization should be monitored. Several proposals as to how funds might be generated were suggested among which were: the imposition of levies/tariffs on all food imports, percentages of national budgets set aside, contributions from private banks and private funds, commodity boards, equipment suppliers, development banks, such as African Development Bank (AfDB) and Alliance for a Green Revolution in Africa (AGRA). The trust funds would be national and channelled through central banks, and each would have a board of trustees with members coming from both the public and private sectors. On a regional level, the Trust Fund could tap into regional economic communities (RECs) such as African Community of West African States (ECOWAS), Common Market for Eastern and Southern Africa (COMESA) and Economic Community of Central African States (ECCAS). Lending from the fund should be through local commercial banks and other financial institutions. It was recommended that preferential interest rates over longer terms would be offered.

Financial Public-Private Partnership (PPP) models

Consideration should be given to guarantee schemes whereby donors, central banks and development partners support commercial and local banks and other financial institutions to lend to farmers and entrepreneurs. Central banks should provide direct support to commercial banks in order for them to lend to farmers/entrepreneurs at a preferential interest rate for agricultural mechanization. Agricultural investment banks comprised of public and private sectors (including International Finance Corporation [IFC]) should be introduced. The progress of achieving these financial objectives should be monitored and evaluated. FAO and UNIDO should encourage national governments to support the creation of these PPPs for the implementation of such schemes. The scheme members should be involved in credit appraisals and project analysis and the risks would be shared. This would constitute a medium- to long-term goal.

Creation of warehouse schemes

Assistance should be offered to governments to facilitate the harmonization of legislation required to institute national warehouse receipt schemes (WRSs). This short- to medium-term goal would provide bridging seasonal finance for farmers and

entrepreneurs as well as guaranteeing fair prices. In addition, the scheme would offer flexibility of loan repayments, give an incentive to farmers and entrepreneurs to invest in their businesses, and allow them to plan for future investment in agricultural mechanization.

Public sector strategy development

Establishment of National Committees on Agricultural Mechanization (NCAM)

An immediate goal of national government should be to establish and empower the creation of NCAM that would include all major stakeholders such as concerned ministries (Agriculture, Finance, Industry, Trade), farmers, financial institutions, private sector, and research and development institutions. These national committees would have oversight functions.

Strategy development

National governments should review agricultural sector policies to ensure that mechanization is specifically included. Policies that affect the introduction or acceleration of mechanization should be reviewed or, where necessary, developed. In particular, there should be provisions in national laws that allow tractor usage across international borders in order to increase their annual use. In overall terms, policies should be aimed at creating an enabling environment for the development of mechanization; national agricultural mechanization strategies should be developed or updated. FAO and UNIDO should assist in monitoring to ensure effective implementation of the strategies. In addition, regional strategies should be developed and regional secretariats put in place, and whenever feasible, countries themselves should develop regional and subregional strategies.

Code of practice for direct public sector investment

A long-term aim of governments should be a disengagement from direct procurement of farm machinery destined for use by either the public sector or private farmers and entrepreneurs. The individual NCAMs should appoint a subcommittee to prepare an action plan for capacity building and for gradual disengagement from procurement activities. Donations of tractors and farm machinery from other countries should be strictly controlled to ensure that the long-term interests of farmers are taken into account. The

NCAMs would ascertain the compatibility of proposed donations with national standards and plans. Capacity building should be included as an integral part of donations when required. FAO and UNIDO should undertake studies to document the impact of donations. The NCAMs should appoint task forces to develop tender specifications and terms to include capacity building that would include training, repair and maintenance to ensure the long-term commitment of suppliers.

Institutional coordination

One of the responsibilities of the NCAM would be to coordinate between the different ministries and institutions involved in mechanization, particularly with regard to the procurement of agricultural machinery. Where necessary the NCAM should appoint a task force to review and improve procurement systems. For the short term, World Bank procedures and guidelines should be considered for formulating national procurement systems.

Standards

A study should be commissioned to assess the feasibility of regional testing centres. FAO and UNIDO would provide a list of internationally approved testing centres and assist in identifying the location for regional centres. Existing standards and procedures should not only be used but also modified to suit national requirements. Several ideas were voiced regarding the testing of farm machinery: tractors already tested by internationally recognized testing centres may be excluded; regional centres would be used mainly for testing complex machines; national centres would test simple tools and equipment; testing and/or certification would be mandatory for receiving state support or subsidies; should be careful not to rely on brand names but insist on tests of specific models; and the development of standards for importation.

Capacity building, information exchange and networking

Capacity building through training

The current situation and availability of education, research and extension services centres available for farm mechanization in Africa would be assessed and an overall requirement for such centres for Africa, including identification of their geographical locations, would be reached. Based on regional

strengths, centres of excellence would be developed as would programmes for formal education, and research and extension centres in agricultural mechanization. The possibility of regional training would be explored as not all countries have the capacity to establish their own training centres. Specifically, training programmes for mechanics in agricultural machinery and processing equipment operations maintenance and repair are urgently required in addition to other short-term training programmes. One way of addressing this would be to extend the curriculum for the training of motor vehicle mechanics to cover tractors and other agricultural machinery. On the commercial side, the implementation of short-term training on farming as a business, farm management, entrepreneurship business management and agroprocessing is urgently required. There is also scope for educational outreach and awareness creation programmes on how to use mechanized equipment for off-farm uses in order to increase effective demand.

Information exchange and networking

There is a need for an exchange of information on markets, regulations, technologies, standards, research tools and results. An efficient way of achieving this is through the formation of networks. Examples of such networks are: contractors associations; suppliers associations; R&D institutions networks; and farmers and non-governmental organization (NGO) associations.

Similarly, with regard to mechanization, there is an urgent need for exchange of information between R&D organizations, manufacturers and distributors as well as to foster links with networks in emerging equipment manufacturers.

Optimization of use of farm machinery

In order to optimize the utilization of farm machinery and remove the constraint of seasonal use, an enabling environment (policies, institutions, regulations) to promote cross-border use of agricultural equipment needs to be created. In many instances the policies and regulations that determine the present scope of use for farm machinery need to be changed. This will expand further on-farm and non-farm contracting opportunities. One example of this would be to increase utilization by increasing the use of machinery for infrastructure programmes related to rural roads, irrigation, storage and marketing. Expanded use of irrigation and off-farm operations,

such as clearing, processing and transportation, will in turn intensify agricultural mechanization.

Development of private sector capacity

This is a priority if the private sector is to take a leading place in the expansion of mechanization. There is an urgent need to develop strategies to support the development of the agricultural machinery industrial sector. In particular, the management and technical capacity of companies in the agricultural machinery supply chain needs to be strengthened. Also, the capacity of business and trade associations and other groupings dealing with mechanization inputs needs strengthening. The possibilities of assisting in the formation of subregional agricultural machinery associations should be investigated.

Chapter 2

Summary of the programme framework

2.1 FINANCING

Policy measures

Activity	Term	Responsibility	Comments
Prescribe minimum percentage allocation by governments/central banks for on-lending to farmers/entrepreneurs for agricultural mechanization based on stakeholder consensus	Short	Government responsibility to set policy framework, if necessary and desirable assisted by FAO, UNIDO and CAMARTEC	
Provide advice and guidelines including preparation of background technical papers on the definition of agricultural mechanization	Short, medium	FAO	

Creation of an Agricultural Machinery Development Trust Fund (AMDTF)

Activity	Term	Responsibility	Comments
Create a new AMDTF	Immediate short to medium	National governments with assistance of FAO and UNIDO (and other donors)	Methods to increase the finance <ul style="list-style-type: none"> • Impose levies/tariffs on all food imports • Set aside percentage of national budget • Contributions from private banks, private funds • Commodity boards • Equipment suppliers • Development banks, e.g. AfDB, AGRA, etc. Management of the Fund <ul style="list-style-type: none"> • National Fund • Funds channelled through central bank • Board of trustees comprised of government, private sector • Partners contributing to Fund • Secretariat manages the Fund on a day-to-day basis • On regional level tap into the REC, e.g. ECOWAS, COMESA, ECCAS Modalities of the Fund <ul style="list-style-type: none"> • The lending from Fund via commercial/local banks and other FIs • Preferential interest rates at longer-term tenors, e.g. longer repayment terms
Work with national governments and development partners to stimulate and facilitate the creation of national AMDTF	Immediate short to medium	FAO/UNIDO	
Provide technical expertise and input on best practices in the application of agricultural mechanization technologies	Immediate short to medium	FAO/UNIDO	
Monitor and evaluate the rate of progress of agricultural mechanization	Immediate short to medium	FAO/UNIDO	

Creation of warehouse schemes

Activity	Term	Responsibility	Comments
Assist governments in facilitating the harmonization of legislation required to institute national WRSSs	Short to medium	FAO/UNIDO	<ul style="list-style-type: none"> • Farmer/entrepreneur credit scheme that provides bridge finance • Guarantees fair price • Ensures flexibility of loan repayments and allows farmer/entrepreneurs to plan for future investment in agricultural mechanization • Creates an incentive for entrepreneurs/service providers/contractors to invest in the business

Financial PPP models

Activity	Term	Responsibility	Comments
Guarantee schemes where donors, central banks and development partners support commercial banks, local banks and FIs to lend to farmers/entrepreneurs	Medium to long	National governments, assisted by FAO, UNIDO and other donors	<ul style="list-style-type: none"> • Scheme members are involved in credit appraisals and project analysis • Risks shared among scheme members
Central bank provides direct support to commercial banks – so they can lend to farmers/entrepreneurs at preferential interest for agricultural mechanization	Medium to long	National governments and donors	
Agricultural Investment Banks comprised of public and private sectors (including IFC)	Medium to long	National governments	
Monitor and evaluate progress being made towards these financial objectives	Medium	FAO/UNIDO	
Encourage governments to support creation of PPP for implementation of such schemes	Short	FAO/UNIDO	

2.2. PUBLIC SECTOR STRATEGY DEVELOPMENT

National Committee on Agricultural Mechanization (NCAM)

Activity	Term	Responsibility	Comments
Establishment of NCAM	Short	National government to establish and empower	To include all major stakeholders, such as concerned ministries (Agriculture, Finance, Industry, Trade, etc.), farmers, financial institutions, private sector and R&D institutions

Strategy development

Activity	Term	Responsibility	Comments
Policy development/review	Short to medium	National government to review agricultural sector policy to ensure that mechanization is specifically included	Provision in law to allow tractor usage across international borders to increase their annual use To create an enabling environment
Develop/update national agricultural mechanization strategies	Short, medium	FAO/UNIDO to assist in monitoring to ensure effective implementation of the strategies	National strategies to be developed or to update the existing ones
Development of regional strategies	Medium	Regional secretariats to assist, for example EAC	Whenever feasible, countries to develop regional/subregional strategies

Code of practice for direct public sector investment

Activity	Term	Responsibility	Comments
Government disengagement from procurement	Long	NCAM to appoint a sub-committee to prepare an action plan for capacity building and for gradual disengagement	
Control of donations from other countries	Permanent policy	NCAM to ascertain compatibility of proposed donations with national standards and plans FAO and UNIDO to undertake studies to document the impact of donations	Capacity building to be included as an integral part of donations when required
Smart tendering	Ongoing	NCAM to appoint task force to develop tender specifications and terms to include capacity building	Capacity building to include training, repair and maintenance to ensure long-term commitment of suppliers

Institutional coordination

Activity	Term	Responsibility	Comments
Institutional coordination	Short	Responsibility of NCAM	Especially to coordinate between the different involved ministries and institutions
Procurement system of agricultural machinery	Short	NCAM to appoint a task force to review and improve where necessary	World Bank procedures and guidelines to be considered for formulating national procurement systems

Standards

Activity	Term	Responsibility	Comments
Study the feasibility of regional testing centres	Short to medium	FAO/UNIDO to provide a list of internationally approved testing centres and to assist in identifying the location for regional centres	Tractors already tested by internationally recognized testing centre may be excluded Regional centres mainly for testing complex machines National centres for testing simple tool and equipment Testing/certification mandatory for receiving state support/subsidy To be careful not to rely on brand names but insist on tests of specific models
Development of standards for importation	Medium	FAO/National Body	Existing standards and procedures can be used but can be modified to suit national needs

2.3 CAPACITY BUILDING, INFORMATION EXCHANGE AND NETWORKING**Capacity building through training**

Activity	Term	Responsibility
Assess the current situation and availability of education, research and extension services centres available for farm mechanization in Africa	Short	FAO/UNIDO
Arrive at overall requirement of such centres for Africa including identification of their geographical locations. Based on regional strengths, develop centres of excellence	Short	Government, FAO, UNIDO
Develop programmes for formal education, research and extension centres in agricultural mechanization (explore regional training as not all countries have the capacity to establish training centres)	Short, medium	Govt., FAO, UNIDO
Implement short-term training programmes for mechanics in agricultural machinery and processing equipment operations maintenance, and repair	Short, medium	Govt.,
Extend the curriculum for training of motor vehicle mechanics to cover tractors and other agricultural machinery	Medium	FAO, UNIDO
Implement short-term training on farming as a business, farm management, entrepreneurship business management and agroprocessing	Short	Govt., FAO, UNIDO
Educational outreach and awareness creation on how to use mechanized equipment for other off-farm uses in order to increase effective demand	Medium	Govt., suppliers and FAO

Information exchange and networking

(Information to be exchanged – market, regulations, technologies, standards, research tools and results)

Activity	Term	Responsibility
Formation of networks: <ul style="list-style-type: none"> • Support contractors associations • Promote and support suppliers associations • Support R&D institutions network • Promote farmers and NGO associations 	Medium	UNIDO
Create network for agricultural mechanization (with membership from R&D organizations, manufacturers and distributors) and foster links to networks in emerging equipment manufacturers	Medium	FAO, UNIDO and all parties

Information exchange and networking

Activity	Term	Responsibility
Create enabling environment (policies, institutions, regulations) to promote cross-border use of agricultural equipment	Short, long	Government, regional grouping
Create enabling environment, policies, regulations for on-farm and non-farm contracting opportunities	Short	Govt. assisted by FAO and suppliers
Review existing regulations for usage of tractor for non-agricultural use	Short	Govt.
Increase machinery use through infrastructure programmes related to rural roads, irrigation, storage and marketing	Medium, long	Govt.
Mechanize irrigation and off-farm operations such as clearing, processing and transportation in order to intensify agriculture	Medium	Private sector

Development of private sector capacity

Activity	Term	Responsibility
Support and develop AMIS strategies	Short	Govt., UNIDO
Strengthen management and technical capacity of agricultural machinery supply chains	Medium	Training institutions supported by suppliers
Strengthen capacity of business and trade associations and other groupings dealing with mechanization inputs	Medium	Training institutions supported by suppliers
Explore possibilities of assisting the formation of subregional agricultural machinery associations	Short	FAO/UNIDO

Chapter 3

List of participants

ROUND TABLE MEETING ON INVESTMENT IN AGRICULTURAL MECHANIZATION IN AFRICA 3 TO 5 JUNE 2009. EAST AFRICAN HOTEL, ARUSHA, TANZANIA

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PART II

Summaries of the papers

Chapter 1

Introduction

Part II of this Round Table Meeting report provides an outline of the topics that were discussed under the six themes and also gives the titles of the papers and the presentations that were used as background material and discussion points for the Meeting. No detail of the contents of the individual papers was given in Part I. For those readers who may wish to gain a further insight into the various topics discussed, this Part II provides a summary of the individual papers and presentations. Some experts provided both a full paper and a presentation

whereas others only provided a computer slide-show presentation that generally contained less detail. Both the presentations and the papers have been summarized but in general the summaries of the full papers are longer and contain more detail than the computer presentations.

For those readers who wish to see a full version of the papers and presentations, these are provided on a CD-ROM inside the back cover of this report.

TABLE 1

Summaries of the plenary paper presentations

1. Public sector strategy development	
1.1 An overview of agricultural mechanization in sub-Saharan Africa	Geoffrey C. Mrema, Director, Rural Infrastructure and Agro-Industries Division, Food and Agriculture Organization of the United Nations (FAO), Rome
1.2 Mechanization investments in India and lessons for Africa	Gajendra Singh, Former Vice Chancellor, Doon University, Dehradun, India
1.3 Agricultural mechanization strategies and their role with agricultural sector policy development strategies	Professor Karim Houmy, IAV Hassan II, Rabat, Morocco
1.4 Development strategies for the Agricultural Machinery Industrial Sector in Africa (AMIS)	Namal Samarakoon, Industrial Development Officer, Agribusiness Development Branch, UNIDO, Vienna
2. Direct public sector investment programmes	
2.1 Commercial competitiveness versus livelihoods enhancement – Why national agricultural mechanization efforts need to be driven via the private sector rather than by central government initiatives	Pascal Kaumbutho, CEO, KENDAT, Nairobi, Kenya
2.2 Commercial competitiveness versus livelihoods enhancement	Richard M Shetto, Director, Agricultural Mechanization; MAFC, Dar es Salaam, Tanzania
2.3 Selected case studies of public sector investment programmes – D.R. Congo, South Sudan and Sierra Leone	John Ashburner, FAO Consultant and Josef Kienzle, Agro-Industries Officer, Coordinator, Infrastructure and Engineering Services, AGS, FAO, Rome
2.4 Direct public sector investment and financial support to agricultural mechanization in Africa: examples from Ghana and Mali	Mathias Fru Fonteh, Head Department of Agricultural Engineering, University of Dschang, Cameroon
3. Enabling programmes for private sector investment	
3.1 Creating effective demand for tractors	William Hancox, FAO Consultant, Rome

4. Review of public-private sector models for mechanization	
4.1 A review of some public sector driven mechanization schemes and cases of private sector models in Africa	John E. Ashburner, FAO Consultant and Josef Kienzle, Rural Infrastructure and Agro-Industries Division, FAO, Rome
5. Networking and south-south linkages	
5.1 Farm mechanization – India and Africa partnership	Ramesh C. Jain, Past President, Indian Tractor Manufacturers Association
5.2 South-south technology supply and transfer: experiences from East Africa and Brazil	Brian Sims, FAO Consultant and Josef Kienzle, Rural Infrastructure and Agro-Industries Division, FAO, Rome
5.3 Global and regional networking among machinery suppliers: Experiences of the African Conservation Tillage Network (ACT)	Saidi Mkomwa, Executive Secretary, African Conservation Tillage Network, Nairobi, Kenya
6. Financial sector requirements	
6.1 Financial experience with crop mechanization in Tanzania	Kathleen Charles, Strategic Planning and International Trade Consultant, Tanzania
6.2 Financing agriculture mechanization – The experience of Financial Sector Deepening Trust (FSDT) in Tanzania	Renatus D. Mushi, Deputy Agriculture Finance Specialist, FSDT, Tanzania

Chapter 2

Public sector strategy development

2.1. AN OVERVIEW OF AGRICULTURAL MECHANIZATION IN SUB-SAHARAN AFRICA

Geoffrey C. Mrema
Director, Rural Infrastructure
and Agro-Industries Division, FAO, Rome

This paper reviews the present situation in Africa and gives reasons as to why a fresh look should be taken on mechanization. It looks at the lessons learned and factors critical to the success of mechanization as well as challenges that have to be tackled. Finally it proposes priority areas for public sector involvement and potential actions for programme development.

Review of the situation

The use of tractors in sub-Saharan Africa (SSA) has barely shown any increase over the past 40 years and, compared with other world regions, tractor use today in SSA remains almost negligible. By comparison, tractor use over the same period in Asia has increased tenfold. The situation in SSA can be illustrated by the extremely low numbers of tractors per 1 000 ha of arable land. In 1980 there were 2 and by 2003 this had sunk to 1.3. By comparison in the Asia and Pacific region, in 1980 there were 7.8 tractors per 1 000 ha and this had risen to 14.9 by 2003. Even though SSA started at a very low base, the trend over the last three decades has become even worse. Also, SSA is the only developing region where the number of agricultural workers per hectare is no more than half the average for all developing regions, and the number of tractors in use is also a small fraction of the number in the other regions.

Despite this, the greatest source of power for land preparation remains human muscle power. In many parts of SSA, up to 80 percent of primary land preparation is carried out with entire reliance on human muscle power. Use of draught animals is confined to those areas where such animals can be kept, and these are mostly the drier areas

where also the farmers have a tradition of keeping livestock that can be harnessed for animal traction. It can thus be seen that not only does SSA have extremely low levels of manpower available for agricultural production but it also has very few tractors available as an alternative source of power.

Why a new look?

Economic growth

Agriculture is one of the most important sectors of many economies in SSA. For economic growth to occur the agricultural sector must become more productive. An essential component to make this happen is sufficient farm power, particularly for the intensification of production and for the need for timeliness in field work during peak periods. Increased power and better equipment – in conjunction with other inputs – contribute to increasing production, productivity and profitability. The incentive to invest is higher when entrepreneurs and/or farmers can avoid dependence on labour for timely and high-quality operations.

Increased food demand because of population increases and rural to urban migration

In many countries in SSA, there is an ongoing rural/urban migration; in 1980, the rural population of SSA was about 246 million and the urban population was only about 82 million but by today in 2010 this is estimated to have increased to 482 million and 317 million respectively. By 2030 on current trends, the urban population in SSA is estimated to be greater than the rural population (582 million people living in rural areas and 612 million in urban areas).

There are inter-regional differences but across the region the trend is the same – rural populations moving to urban areas. As an example, in Tanzania in 2000 the urban population was about 20 percent; by 2050 it is expected to rise to 55 percent. The figures for Kenya are 20 percent, increasing to close to 50 percent in 2050. Most countries in the

southern Africa region will have more than 50 percent of their population living in urban areas by 2020. In Nigeria, where in 2000 the urban population was already 35 percent of the total, by 2050 it is expected to rise to over 75 percent of the population.

Improving rural development and employment generation

This ongoing rural/urban migration is mostly by younger persons and, as a result, there is an ageing rural population that results in a need to combat the deteriorating manual farm power situation that many farming communities face. This exodus of entrepreneurial and innovative young people will continue until the nature and image of farming changes; it is necessary to reduce drudgery in agriculture to make it attractive to the young. One means of doing this is through the use of more and better mechanical technologies.

There is also an urgent need to substitute capital for labour when meeting peak seasonal labour constraints so that household members can carry out other, more profitable, non-farm activities. In addition, increases in scale of operations and/or productivity will lead to an increase in off-peak seasonal labour demand. Investment in tractors and machines can also be used for other income generating, non-farm activities, such as rural road construction and maintenance as well as transportation.

The challenges facing SSA

There are comparatively low population densities in most SSA countries and wages remain low. The displacement of labour, an inequitable distribution of wealth and inherent adverse balance of payments are ongoing problems. Experiences with draught animal and small tractor mechanization were in the past not very successful. As a consequence from 1985, agricultural mechanization dropped off the agendas of most development organizations as well as donor agencies. However, since 2000 there has been an increased interest by SSA governments in mechanization, partly driven by global changes in the tractor industry, in particular the impact emanating from other developing countries such as Brazil, China and India.

The lessons learned

Mechanization in Asia – the driving forces

In Asia it was the biological technologies

(improved yields, varieties, increased fertilizer use, plant protection etc) that provided the impetus for increased mechanization. Market access, satisfactory product prices and opportunities to use labour for off-farm activities also were significant factors. All of these were facilitated by supportive government policies and subsidies most notably through business- and enterprise-friendly policies, laws and regulations. The resulting high effective demand led to the development of local manufacturing businesses and suppliers who in turn have become the new leading global suppliers.

Lessons from past mechanization programmes in SSA

Government-managed and operated tractor-hire schemes, common in the 1960–1980 period, were not successful but at the same time efforts aimed at developing “appropriate” machinery and implements also had little impact on the market; the market simply did not want these products. Attempts to introduce or expand the use of animal traction only proved to be profitable or beneficial in a few situations where particular pre-conditions existed.

The advocates of structural adjustment in many countries in the 1980s predicted that the private sector would get involved in mechanization once the right policies were promulgated and lead to a success in mechanization where the public sector had failed. This did not occur and as public interventions and investments declined, in many cases the private sector has not stepped in. Since 2005 there has been increasing interest in mechanization again by many governments. However, unless interventions are carefully thought out and carried through, there is a danger of repeating the mistakes of the 1960s.

Cross-cutting lessons

Increases in agricultural production and productivity almost always stem from a combination of technologies (biochemical, socio-economic, physical). Programmes that have facilitated or supported access to organized markets and other complementary services have been successful. The development of medium-scale farmers has also played a key role in providing mechanization and other services, as well as providing many different mechanization options and opportunities in addition, and complementary to, mechanization of land preparation only. Many successful combinations of farm power (human,

animal draught and mechanical) have been utilized concurrently with no dogmatic approach to only one.

Policy lessons

From these experiences in SSA as well as the recent experiences in Asia, it is apparent that mechanization should be viewed strategically within a longer-term time frame. Of prime importance is the attention that should be placed on increasing the profitability of investments. It is important to realize that mechanization should not be viewed as a simple technology substitution but as part of a technology package. A major lesson learned is that successful development of farm mechanization has not been dependent on governments' direct involvement in machinery supply, development and financing, or on offering mechanization hire services.

Where mechanization has been successful, the role of government has in most cases been that of creating and supporting an enabling environment for private sector players to provide mechanization services especially to small-holder farmers. Consequently, decision-makers need to focus on the longer-term developmental dimensions of building public and private sector institutions and services.

Critical success factors

Effective demand

Effective demand creates both the need and the opportunity for mechanization that has to be linked to market-oriented enterprises. Detailed attention needs to be paid to the profitability of farming: This is a condition for successful mechanization, not an outcome. At the same time, parallel efficient marketing and distribution systems for both farm inputs as well as outputs of farming are needed.

Economic machine utilization rates

The use of machines can only be profitable and economic if utilization rates are sufficiently high. Extended utilization of machinery can be achieved through such factors as hiring out, asset-sharing, and careful planning, and movement across isohyets. For some operations that are not strictly time bound, such as milling and threshing, the sharing of machines is also a means of increasing utilization rates. Another means is to use tractors for transport and other non-agricultural tasks, such as the construction and maintenance of the rural infrastructure.

Machinery supply chains and services

Consideration needs to be given to the establishment of new and efficient supply chains for agricultural machinery and spare parts, particularly those from Asia. Careful consideration needs to be given to the development of local capacity for servicing and where feasible for manufacturing of machinery and equipment, and in particular to harness the potential entrepreneurial talent available in towns and urban centres. The access to complementary services needs also to be taken into consideration. Credit and/or leasing services play a very important and essential role in the development of these services.

Public sector priorities

The establishment of enabling environments

Technical assistance and business advisory services for companies involved in machinery supply and hiring services need to be provided. At the same time, excessive transaction and information costs for the provision of mechanization services to smaller-scale farmers need to be absorbed or mitigated. It is important that legal and regulatory constraints against leasing should be removed.

Cross-border collaboration for the movement of equipment and provision of mechanization services should be facilitated and promoted. Facilitating policies and other legal frameworks to support hiring or leasing services are required. One important instrument is the removal or reduction of import and sales taxes on agricultural machinery and equipment. Risk management tools, such as insurance, should be made more widely available.

Training and human resources development

Training and extension facilities for the users of mechanical equipment need to be established or upgraded. The entrepreneurial skills of commercial farmers and agribusiness managers need to be strengthened. Technical training for mechanics, technicians and engineers needs to be provided as well as training in term financing for the purchase of machines, implements.

Research and development

The transition to mechanized systems leads to many organizational, logistical and managerial problems. The challenge is to undertake research into these problems and develop appropriate solutions at the national and subregional level. Research is needed into how sustainable rental markets for machinery can be developed and

how the performance and utilization of individual equipment as well as combinations of machinery can be optimized. Institutional options for the provision of mechanization services need to be investigated as well as how efficiency standards for delivery of mechanization services can be developed. The potential impact on the environment needs to be monitored. Regional consultation and cooperation in the testing of agricultural machinery and implements are required.

Conclusions

Experience over the past three to four decades indicates that sustainable agricultural mechanization is unlikely to be successfully established through direct public sector provision of mechanical technologies and services. The low levels of development of agricultural mechanization in SSA indicate that a rethink is necessary. In particular, what is the nature of the mechanization that is required and what government policies and regulatory frameworks can efficiently and sustainably accelerate it?

The public sector does certainly have an important role to play and can effectively promote mechanization processes through:

- The establishment of enabling environments
- Training and human resources development
- The strengthening of local organizations
- Research and development

The promotion of individual technologies, such as animal traction and/or tractors for land preparation, should give way to flexible strategies for promoting diverse types of mechanical technologies that are compatible with local economic, social and developmental conditions.

The foundation of any mechanization strategy or programme is a sound comprehension of the field situation and the prioritization of operations that should be mechanized. This requires close contact with farmers, agro-processors, input suppliers, service providers and other stakeholders. Of great importance is the extending of credit by the local banking industry to farmers/enterprises for the purchase of agricultural machinery. Of even greater importance is whether the farmers/enterprises are able to pay back the loans without recourse to government support. This is the way that sustainable agricultural mechanization systems may be created.

2.2 MECHANIZATION INVESTMENTS IN INDIA AND LESSONS FOR AFRICA

Gajendra Singh

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History of mechanization in India – 1945 to 2008

1945–1960

During the mid 1940s the first importation of tractors and bulldozers took place and a Central Tractor Organization and State Tractor Organizations were set up. The number of tractors in use in 1950 was 8 000; in 1955: 20 000; and in 1960: 37 000 units. These were at government farms and with big farmers. Most farm work and transport was done by draught animals. Up to 1960, demand of tractors was met entirely through imports. In 1942 the first degree programme in Agricultural Engineering was started at Allahabad Agriculture Institute. In 1952 the Indian Institute of Technology in Kharagpur also started degree courses in Agricultural Engineering.

1961–1970

In 1960 five units were licensed to manufacture tractors and production started in 1961. Power tiller production started in 1965. Ninety-six percent of tractors were owned by big farmers (>10 ha). Credit facilities were made available to enable purchase of farm equipment. Traditional water lifting devices could only provide 2–3 irrigations for wheat whereas high-yielding varieties (HYVs) needed 6–8 irrigations. Large and medium farmers purchased diesel engines to power irrigation pumps.

TABLE 2
The agriculture situation 1960–1970

	1960	1970
Agricultural land (million ha)	133	140
Irrigated area (percent)	19	22
Cropping intensity	1.15	1.18
Grain yield (kg/ha)	700	860
Fertilizer use (kg/ha)	2	15
Tractors (thousand)	37	146
Area per tractor (ha)	3 600	960
Power tillers (thousand)	0	9.5
Draught animals (million)	80.4	82.6
Irrigation pumps (million)	0.43	3.30

The renting of pumps also started at this time. Rural electrification to power irrigation pumps was expanded. The first College of Agricultural Engineering based on the United States pattern was established at Pantnagar (with the University of Illinois) followed by six more and two at institutes of the Indian Council of Agricultural Research (ICAR).

1971–1980

Six new tractor units were established but at the same time three existing units were closed. Six units were licensed to manufacture power tillers and two units were closed. Banks opened branches in rural areas and credit was increasingly made available to farmers. As a consequence the tractor market expanded rapidly. Minimum support prices (MSPs) were introduced for food grains and sugar cane. Rural electrification expanded significantly. Farmers installed electric motor and diesel engine-driven irrigation pumps and purchased threshers to handle larger volumes of produce. The custom hiring of tractors for tillage and transport (60 percent of annual use) grew rapidly, and the custom hiring of threshers and pumps also increased. Numbers of draught animals peaked at 83.4 million in 1975. One more new College of Agricultural Engineering was established.

1981–1990

Four new tractor units were established and four existing units closed. One new power tiller unit started but four existing units closed. Power tillers and tractors with an engine displacement of less than 1 800 cc were exempted from excise duty. India was solely an importer of tractors up to the 1970s but by the 1980s India became an exporter of tractors. Rural electrification expanded and farmers installed pumps and purchased threshers. Medium farmers and small entrepreneur farmers bought tractors to meet demand of custom work. Tractor Pt-O driven threshers gained in popularity. MSPs grew annually and grain bulk storage facilities expanded significantly. Seven new Agricultural Engineering Colleges were established as well as a separate Agricultural Engineering Division created at ICAR. Coordinated Projects on Research and Development as well as Extension related to mechanization and post-harvest processing expanded with cooperating centres at ICAR institutes and State Agricultural Universities (SAUs).

TABLE 3
The agriculture situation 1980–1990

	1980	1990
Agricultural land (million ha)	140	143
Irrigated area (percent)	28	33
Cropping intensity	1.23	1.30
Grain yield (kg/ha)	1 000	1 300
Fertilizer use (kg/ha)	39	88
Tractors in use (thousand)	531	1 200
Area per tractor (ha)	260	120
Power tillers (thousand)	16	31
Draught animals (million)	73.4	70.9
Irrigation pumps (million)	6.23	12.87

1991–2000

In 1992 the issuing of licenses for the manufacture of tractors was abolished. Two new tractor units started production. Most farmers custom-hired tractor Pt-O driven threshers provided by entrepreneur-operators (not necessarily farmers). Combine harvesters gained wider acceptability. Eight new Colleges of Agricultural Engineering were established.

2001–2008

Three major international manufacturers established plants in India: John Deere, New Holland and Same. Because of mergers, M&M and TAFE become big groups. In north India, because of savings in cost and time, zero tillage drilling for wheat following rice is becoming popular. The use of laser-controlled land levelling machines on a custom-hire basis is growing and the custom-hire of combine harvesters is also gaining popularity. The number of draught animals is reducing very quickly. MSPs increased significantly in 2008. Three new Colleges of Agricultural Engineering were opened giving a total of 30 colleges.

TABLE 4
The agriculture situation 2000–2008

	2000	2008
Agricultural land (million ha)	143	142
Irrigated area (percent)	34	35
Cropping intensity	1.33	1.36
Grain yield (kg/ha)	1 600	1 850
Fertilizer use (kg/ha)	125	150*
Tractors (thousand)	2 600	3 600
Area per tractor (ha)	55	40
Power tillers (thousand)	100	152
Draught animals (million)	60.3	50**
Irrigation pumps (million)	19.5	25**

*2007; **Estimated

TABLE 5

The sequence of mechanization

Sequence Type of operation	Operation		
	I. High power low skill	II. Medium power medium skill	III. Low power high skill
Stationary	Grinding, milling, crushing, pumping, threshing	Grinding by size, cleaning	Grinding by quality
Mobile	Land preparation Transport	Seeding of grain, harvesting of grain	Transplanting. Harvesting of cotton, fruits & vegetables, sugar cane

The annual admission capacity for bachelor degrees is 1 200; for master degrees 300; and for doctorates 100.

Estimates of investments in farm machines by farmers

1997: Indian Rs 180 billion (US\$5 billion) per year
2005: Indian Rs 300 billion (US\$6.5 billion) per year

Future investments

- Hand-operated tools and implements will grow very slowly with the increase in agricultural workers
- Animal-operated implements will decrease because of decrease in number of draught animals
- Power-operated farm equipment will increase significantly

Policy support provided for food security

A MSP is fixed, combined with the maintenance of buffer stocks of food grains. Major agrarian reforms have resulted in the fixing of ceilings and the consolidation of holdings. Investment has been made in the required infrastructure (rural roads, markets, major irrigation systems and rural electrification). A strong agricultural research and education system coupled with an extensive extension system has been developed. The availability of inputs such as seeds, fertilizers, pesticides and farm machinery has been ensured as well as the availability of credit.

TABLE 6

Projections for mechanization in India

Item	2005	2015	2025
Power (kW/ha)	1.5	2.0	2.5
Agricultural workers (millions)	230	280	340
Draught animals (millions)	53	37	18
Tractors (millions)	3.0	4.5	5.5
Power tillers (thousands)	112	175	250
Diesel engines (millions)	6.4	7.2	7.5
Electric motors (millions)	17	25	35

Research and development

The ICAR and state agricultural universities (SAUs) have been established in different states. Two institutes of ICAR, the Central Institute of Agricultural Engineering (CIAE), and the Central Institute of Post Harvest Engineering and Technology (CIPHET), conduct research and development in the areas of farm machinery and post-harvest engineering and technology. Commodity institutes (for sugar cane, cotton, rice, fodder, horticulture) and national institutes on fish, dairy, dryland agriculture, etc. also conduct research on mechanization.

Several All India Coordinated Research Projects (AICRPs) have been established in: Farm Implements and Machinery; Renewal Energy Sources; Utilization of Animal Energy; Ergonomics and Safety in Agriculture; Post-Harvest Technology; and the Application of Plastics in Agriculture. All of these AICRPs have cooperating centres located in different states so as to cater to mechanization needs of different agro-climatic zones.

Efforts have also been made to improve extension services as well as to provide institutional arrangements in order to make the extension system farmer driven and farmer accountable. Public-Private Partnerships (PPP) have also been encouraged. Mass media support has been augmented by the provision of location-specific broadcasts through FM and AM stations of All India Radio and Doordarshan (DD) National TV Channel. Fee-based advisory and other services in agribusiness development and establishing agriclincs are provided by agriculture graduates. The operation of Kisan Call Centres using toll-free lines has been established.

Federal and state government ministries

Ministries: Agriculture and Cooperation; Food and Agro-Processing; Rural Development; Water Resources; New and Renewable Energy Resources; Commerce and Industries; and Finance.

Planning Commission: Farm Machinery Training & Testing Institutes – Four institutes in central,

north, south and northeast India; about 100 000 personnel have been trained; about 2 280 machines tested; training programmes giving more emphasis on crop/area/technology specific issues; training is arranged through SAUs, agricultural engineering colleges/polytechnics, etc.

State Agro-Industries Corporations: Seventeen state agro-industries corporations as well as joint sector companies have been promoted by the Government of India and by the state governments concerned. The objectives are the manufacture and distribution of agricultural machines, the distribution of agricultural inputs, the promotion and execution of agro-based industries and the provision of technical services and guidance to farmers and others.

Subsidies

Some major items are subsidized (irrigation, fertilizer and electricity). There are subsidies on tractors and power tillers that have been tested at the Central Farm Machinery Training and Testing Institute as well as on irrigation devices and plant protection equipment with certification mark issued by the Bureau of Indian Standards. Power

tillers of 8–15 h.p. and tractors with engines with a displacement of less than 1 800 cc are also subsidized. Individual states or Union Territories may select the items depending upon their area-specific requirements. A very small percentage of farmers obtain a subsidy for tractors and farm equipment.

Credit

Long-term credit is usually for the purchase of tractors and farm machines; short term is used for the purchase of seed, fertilizer, etc. The Reserve Bank of India has mandated banks (both in public and private sector) to provide 18 percent of credit to the agriculture sector. The credit is available from the National Bank for Agriculture and Rural Development (NABARD).

Climate

The climate of India is full of extremities with temperatures ranging from Arctic cold to equatorial hot. Rainfall varies from extreme aridity with less than 100 mm in the Thar Desert (west India) to the world's maximum rainfall of 11 200 mm at Mawsinram, Meghalaya in northeast India.

TABLE 7

Economic and social conditions

India: Economic conditions	India: Social conditions
2nd largest country; Population: 1 150 million	A very poor country: US\$ 800/capita
Annual growth rate: 1.5% (Australia every year)	People below poverty line: 250 million
70% of the population live in rural areas	Literacy: 66%; inadequate schools
Total land area: 297.3 million ha	Shortage of drinking water, poor sanitation
Agricultural workers: 150 million; Total: 280 million	Poor housing; and inadequate hospitals
GDP: Service sector: 54%; Manufacturing: 28%; Agriculture: 18%	Low per capita energy consumption
GDP: Over 1 trillion US dollar and growing: 7–9% annually	

TABLE 8

Land holdings in India and Punjab

Category	India			Punjab		
	1971 (%holdings)	1991 (%holdings)	2001 % holdings	1971 (%holdings)	1991 (%holdings)	2001 Average holding (ha)
Marginal (<1 ha)	50.6	59.4	62.3	37.6	26.5	0.40
Small (1–2 ha)	19.0	18.8	19.0	18.9	18.2	1.42
Semi-medium (2–4 ha)	15.2	13.7	11.8	20.5	25.9	2.72
Medium (4–10 ha)	11.3	7.1	5.5	18.0	23.4	5.80
Large (>10 ha)	3.9	1.6	1.0	5.0	6.0	17.12
Average holding size (ha)	2.28	1.57		2.08	3.35	
Total number of holdings (million)	70.5	106.6	119.2	1.38	1.03	

TABLE 9
Power and irrigation level and yield relationship (2001)

State	Farm power (kW/ha)	Grain yield (kg/ha)	Irrigated area (%)
Punjab	3.5	4 032	84.47
Haryana	2.25	3 088	83.9
Uttar Pradesh	1.75	2 105	72.76
Andhra Pradesh	1.6	1 995	40.73
Uttarakhand	1.6	1 712	-
West Bengal	1.25	2 217	43.45
Tamil Nadu	0.9	2 262	54.5
Karnataka	0.9	1 406	25.4
Kerala	0.8	2 162	17.27
Assam	0.8	1 443	6.22
Bihar	0.8	1 662	48.74
Gujarat	0.8	1 169	31.55
Madhya Pradesh	0.8	907	28.2
Himachal Pradesh	0.7	1 500	22.7
Maharashtra	0.7	757	16.78
Rajasthan	0.65	884	31
Jharkhand	0.6	1 095	-
Jammu & Kashmir	0.6	1 050	41.58
Orissa	0.6	799	33.16
Chattisgarh	0.6	799	20.66

Source: Ministry of Agriculture, Government of India.

Lessons from India for Africa

- Africa like India has tremendous variability in terms of socio-economic conditions, agroclimate, soils and types of agricultural activities.
- Both have large proportions of farmers with very small holdings and are poor.
- Mechanization should be viewed as part of a long term broad-based economic development strategy aimed at economic growth and agro-industrialization.
- For farmers to invest in the development of their farms the ownership of land should be with the farmers.
- Farmers should be assured of a minimum price for their produce, which considers reasonable profitability.
- Africa should move towards mechanical powered systems for mechanizing its agriculture and not invest too much time and resources in developing animal draught power technology.
- Animals should be raised for food (milk, meat), wool, leather and other purposes.
- Through tax and subsidy policies governments should encourage entrepreneur farmers to invest in machinery for use on their farms as well as provide mechanization services to other small-scale farmers who are unable to do so.
- Many operations will continue to be done manually using hand tools as long as labour can be hired at reasonable cost. Hand cultivation will continue to be used in hilly terrains, orchards and for tree crops such as coffee and tea.
- Mechanization should be demand-driven.
- Irrigation potential should be increased by mechanizing water lifting from surface and groundwater sources using engine and motor-driven pumps and tube-wells.
- Assured water/irrigation enables farmers to use higher dose of fertilizers and plant HYV seeds resulting in increased cropping intensity and productivity.
- Larger volumes of crops to be threshed in a short period require farmers to mechanize threshing.
- To plant a second crop, turnaround time is limited, requiring mechanization of land preparation.
- In areas with dry land preparation, 2-axle tractors with suitable tillage equipment are recommended.
- Every tractor should have a trailer.
- Tractors should also have Pt-O driven threshers.
- Whenever necessary, tractors should be used to power stationery equipment such as irrigation pump and post-harvest processing equipment.
- In rice-growing areas with wetland preparation, the use of single axle tractors (power tillers) should be encouraged.

- Diesel engines used on power tillers should also be used for irrigation pumps, threshers and small transport vehicles for transporting goods and people and many post-harvest processing and value- addition activities.
- It is important to realize that ownership of a tractor is not economical if it is used only for farm work on a small holding owned by a farmer because of limited farm work in a year.
- Tractors and power tillers must be used for both on-farm and off-farm activities including renting for custom work. This has proved successful in India and many other developing countries in Asia.
- The African Governments should increase their budgetary allocations for agriculture.
- A protective mechanism should be introduced to support emergency situations in agriculture, including the possibility for farmers to postpone the repayment of bank loans obtained for the purchase of agricultural machinery.

2.3 AGRICULTURAL MECHANIZATION STRATEGIES AND THEIR ROLE IN AGRICULTURAL SECTOR POLICY DEVELOPMENT STRATEGIES

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Introduction

Human development is one of the principle pre-occupations of African countries. Fighting malnutrition, illness, poverty and unemployment, constitute major challenges that will need to be faced for several years to come. The economies of many African countries are strongly linked to the agricultural sector. Much effort has to be made to take into account the important potential for agricultural production with regard to ecological diversification (humid areas, mountain zones, coastal zones, deserts, etc). Nevertheless, agriculture will continue to be the most important sector in the economy of most African countries.

It is now widely acknowledged that engineering technology is one of the most important inputs for agriculture modernization and food production systems in Africa. African governments have encouraged farmers to use agricultural machinery through many development programmes and incentive measures. Unfortunately, in spite of some progress, the role of agricultural machinery is still below what was expected.

In general, it can be observed that governments and donors have adopted a piecemeal approach to encourage mechanization without reviewing the agricultural engineering sector in its entirety and it is now proposed that a strategic approach to agricultural mechanization be taken.

Objectives of the presentation

The objectives of the presentation were to (a) give an overview of agricultural mechanization strategy (AMS) concepts; (b) highlight critical issues to be considered in AMS projects, and (c) present preliminary outputs of AMS project in Niger.

Agricultural mechanization strategy: concepts

The strength of the whole dynamic system of agricultural mechanization depends on the effective functioning of all components and the linkages between them. The end users are farmers, but not only must they be functioning effectively, so too must be the whole subsector supplying these farmers: the retailers and wholesalers,

manufacturers and importers. The concept of a strategy is to provide basic conditions for a largely self-sustaining development of the agricultural mechanization subsector within a policy of minimum direct intervention.

The approach to agricultural mechanization should be both holistic and participatory. A holistic approach requires consideration of both the international and local contexts. These include the local supply of raw materials, local agricultural production, the mechanization subsector, domestic demand and the nature of exports. The impact on these factors of government policies and institutional support needs careful analysis.

A participatory approach is necessary because the many stakeholders involved must be duly considered. These stakeholders can be classified in three levels. At the demand level they include the smallholder farmers, commercial farmers, farming organizations, irrigation groups, crop processors and rural transporters. At the supply level they include the importers, manufacturers, blacksmiths, distributors, machinery support service providers and service contractors. And finally, at the institutional support level are the financiers and financial institutes, government and NGOs, extension workers, researchers, trainers and policy makers.

Across the whole range of government policies, there will be a whole set of strategies for the implementation of the policies. A strategy on agricultural mechanization will be one of a number of other strategies. But at the same time, a strategy on mechanization may impact on the implementation of other government policies. The results of identifying an AMS may be various and widespread, for example institutional and legislation recommendations, programs and projects specifically oriented towards farm power and equipment as well as components that can be incorporated into other agricultural development projects.

Agricultural mechanization strategy: key points to be addressed

There are several **pre-conditions** to consider: (i) an AMS must emanate from a real felt need expressed by political decision-makers; (ii) there needs to be available skilled personnel and sufficient funds to prepare the strategy, producing results within a reasonable time frame; and (iii) developments in other sectors have to be considered.

The *main steps* to respect are: (i) AMS preparation; (ii) analysis of the existing national farm mechanization situation; (iii) the definition of actions to move from the existing situation to the future situation; and (iv) preparation for implementation.

Also, as part of preparation there are several *critical points* to be considered; (i) The project coordinator – he will play a very vital role in the success of the AMS project and in its implementation; (ii) the project team – an AMS needs a multidisciplinary team with analytical skills and experience in macro- and microeconomics, farming systems, agricultural engineering, manufacturing, business and enterprise development, policy and institutional reviews, and the private sector; (iii) a steering committee – to be established with the responsibility for overseeing strategy preparation. Committee members would include senior representatives from relevant ministries such as agriculture and industry, and the private sector. The committee can also provide the vital link between strategy preparation and the ongoing activities of implementation.

Among the appropriate methods and tools to be used are participatory workshops and analytical techniques such as SWOT.

Steps towards implementation

Important decisions need to be taken before final acceptance of the strategy. These include: “How is it to be implemented?”; “What funding is required?”; and “Who are the potential funding agencies for the specific programmes and projects?” One way to facilitate implementation is to identify linkages with other development initiatives, where appropriate.

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

AMS in Niger: some outputs

This is a current going project implemented through

TABLE 10
Comparison of the agricultural sector in Niger and other countries

Countries	Agricultural land ('000 ha)	Irrigated cropland as a percentage of the total (%)	Fertilizer use (kg/ha)	Mechanization (Tractor per '000 ha)
Algeria	8 265	6.8	12.8	11.4
Burkina Faso	4 400	0.6	0.4	0.5
Egypt	3 400	100	392	26.8
Japan	4 762	54.7	282.4	423
Mali	4 700	2.9	8.9	0.6
Niger	4 500	1.5	1.1	0.03
Nigeria	33 000	0.7	7.1	1
D. R. Congo	7 800	0.1	0.2	0.3
World	1 534 466	18.1	90.1	17.5

the Ministère du Développement Agricole.

The original time frame for the planning activities of this project were (i) Diagnostic – March to June 2009; (ii) Participatory Workshop – May 2009; (iii) Strategy Formulation and Action Plan – July to September 2009; (iv) Final Workshop – December 2009. The project has however been delayed and will now be completed in February 2011.

Niger is a country with a land area of 1.2 million km²; a population of 11 million, 83 percent of the population living in rural areas (2005); GDP per capita of US\$391; and a human development index ranking of 174 out of 177 countries. The contribution of the agricultural sector is 43 percent (2006); rainfall ranges from 100 mm in the north to 800 mm in the south; the average temperature is 28 °C; cultivated land is 14 million ha (11.6 percent) in 2007; the estimated potential of irrigated area is 270 000 ha (1.9 percent); and less than 1 percent of water is used for agriculture. The following table demonstrates the agricultural sector in Niger compared with some other countries (Source: FAO, 2001).

The *demand* for agricultural mechanization arises out of the rainfed agriculture, large irrigated agricultural areas (catchment basins include: Lake Chad, Komadougou, Goulbi of Maradi, ADMT², Niger River and tributaries), and from small-scale irrigated agriculture.

Agricultural mechanization in Niger

There are three local manufacturers: CDARMA³,

ACREMA⁴ and UCOMA⁵ (cooperative associations). There is also a government workshop AFMA⁶ and blacksmiths in the informal sector. There are no specialized private companies offering agricultural machinery. The “Centrale d’Approvisionnement” is a government-run importer of tools, machines and equipment. Local manufacturers make ox carts, donkey carts, ploughs, cultivators, motorized rice hullers and motorized threshers. In addition, the “Centrale d’Approvisionnement” imports tractors (296 in 2008), single axle tractors (309), motorized threshers, rice hullers, ploughs, cultivators, ridgers, hoes, seeders, ox carts, donkey carts and pumps.

The key issues concerning *institutional support* are: (i) intervention of the government in the agricultural mechanization subsector is still important; (ii) the recent creation of an agricultural mechanization service; (iii) the importation by the government of tractors from some Asian countries; (iv) low agricultural mechanization skill levels; and (v) lack of financing incentive actions towards agricultural mechanization.

Mechanization strategy hinges around (i) improvement of farmer’s conditions for agricultural production and agroprocessing; (ii) reinforcing human capacities and efficiency; (iii) improvement of accessibility to resources and equipments; (iv) promotion of private sector farm machinery subsector; and (v) reinforcing education, training, extension and research on agricultural mechanization.

2 Ader Douchi Maggia Tarka.

3 Centre de développement de l’artisanat rural et du machinisme agricole.

4 Atelier de construction et de réparation de matériel agricole.

5 Unité de construction de matériel agricole.

6 Atelier de fabrication du matériel agricole.

2.4 DEVELOPMENT STRATEGIES FOR THE AGRICULTURAL MACHINERY INDUSTRIAL SECTOR IN AFRICA (AMIS)

Namal Samarakoon

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Introduction

The presentation is structured as follows: (i) The need for a strategic approach to develop the AMIS; (ii) the objectives of the study and the challenges faced; (iii) the methodology adopted; and (iv) development strategies.

Farm machinery is the basic sector at the interface between agriculture and industry. The efficient local production and the use of the right kind of agricultural machinery are fundamental to Africa's development in order to: (i) raise the productivity of agriculture; (ii) increase the production of food crops; and (iii) provide better storage, transport and local processing of food products. This leads to improved living conditions for rural communities including higher incomes, improved technical skills and the opportunity to work and live on their own land.

However, this *sector (AMIS) is neglected* or rarely recognized. It is to be noted that there are less than 100 industrial or semi-industrial companies for which agricultural machinery and equipment are the main products and most of these were established during the period 1950–1972. These companies employ less than 1 percent of the total industrial labour force. The market represents US\$1.5 billion annually, but less than 10 percent is supplied by local producers. Companies in the sector face small local markets whose demand limits the scale on which they can operate, and exports of finished products or components are virtually unknown. As a result Africa depends mostly on imported materials and machinery with limited value added.

Today the *sector is in crisis*; the use of tractors in SSA has declined; farm machinery is basically considered as an input among many others (fertilizers, seeds, etc.) – little or no attention is paid to the required associated services and there is a virtual lack of all the service facilities (financing, R&D support, qualified manpower, parts, etc.) necessary for its development. Currently AMIS in Africa is in such poor shape financially and technologically that even its own survival is in doubt.

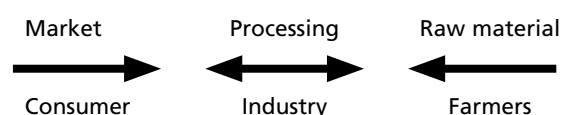
There are also a *number of other economic realities*. In the long run most African countries cannot afford to import equipment in the quantities required to meet the social and economic goals of their rural areas. There is also a tendency for outside suppliers to be more interested in supplying what is convenient and profitable to them rather than what is appropriate for Africa. These outside suppliers rarely identify themselves sufficiently with the real needs of the rural market in Africa. All the while the technology gap is rapidly increasing. The conclusion from this is that fundamentally, mechanization must largely be based on the output of Africa's own AMIS.

The *objectives of a strategy for the development of AMIS in Africa* would be to identify and analyse patterns of development in the AMIS in Africa; formulate development strategies with the aim of contributing to the fostering of the growth of AMIS and the productivity of the agricultural sector, and to identify groups of countries with similar needs, strengths and weaknesses in order to rationalize the provision of development assistance from UNIDO, FAO or other agencies.

A *key conceptual difficulty* is that any attempt to build up an indigenous AMIS is at best a medium-term solution. Africa's problems, in contrast, are immediate – food aid is needed today to feed the population. However, short-term aid undermines the incentives for local production in the long term. Can massive injections of capital into modern farming be the solution? As a strategy for feeding the people in the cities, it may work but it leaves 95 percent of the population untouched because traditional farmers are deprived of much needed resources. This exacerbates their difficulties, emphasizes their income disadvantages and, finally, leads to still more migration.

In looking for the *the way ahead*, it would be unrealistic to expect that current short-term measures be stopped. However, what is needed is a long-term plan to establish a strong indigenous AMIS and a system approach, integrating strategies for agricultural and industrial development ... linking agriculture to industry.

Schematic representation of the AMIS



In the context of the African continent there must be a broader definition of AMIS. Industry must be understood to: (i) comprise all manufacturers (including blacksmiths and craft sector in general); (ii) use whatever materials are available (including scrap steel); (iii) use techniques or patterns of organization that are potentially able to respond to demand, and supply Africa's farmers with the products and services they need; (iv) the scope of the sector covers design, R&D, manufacturing, distribution and support services at the strategic interface between agriculture and industry, and (v) particular attention must be paid to the man-machine relationship as a determinant of physical as well as economic flows. Industry must therefore be planned and developed to provide agriculture with equipment it needs for rural industrialization/mechanization. But also, mechanization and equipment of rural areas must be geared to the real needs of the people in those areas.

Methodology for analysing the present situation of Africa's AMIS

A typological study will identify groups of countries with similar needs, strengths and weaknesses, and it will also rationalize the provision of development assistance. An *industrial system approach* will have the following components: (i) an analysis of AMIS and its main components; (ii) an identification of the dominant variables and indicators by using economic and technical criteria; (iii) run a cluster analysis with dominant variables and indicators; (iv) identify the groups of countries with similar readings in the variables and indicators that characterize components of the AMIS; (v) for each cluster, describe the pattern of AMIS development; (vi) use the results of clustering, correlation analysis and empirical research to identify the strengths and weaknesses of each group; and (vii) finally, establish development strategies that exploit the strengths and address the weaknesses for each group of countries.

The variables used for the typology study are; (i) the input situation and productive capacity of the AMIS in each country (53 countries); (ii) the local industrial environment; (iii) the demand for agricultural tools and equipment arising from the AMIS in each country; (iv) the resources available to the system in which the AMIS operates; (v) gender issue; and (vi) other considerations: population growth, health issues, technological trends, agricultural commodity prices; etc.

Resource-related variables are: cropland, pastureland, forest land, water resources, population density, rural population, life expectancy, investment, crop surplus, agricultural exports and GDP per capita.

Demand-related variables are: arable cropland, irrigated land, crop production index, fertilizer consumption, agricultural value added, holdings, holding pattern, draught animals, tractors, food imports, calorie index, calorie intake, cereal aid, and cereal aid per capita.

Variables related to industrial environment are: manufacturing capacity, manufacturing contribution, industry's contribution to GDP, manufactures exported, debt, export ratio, transport capacity, secondary education, adult illiteracy, female illiteracy, paved roads, agricultural roads, communications and credit.

AMIS inputs are: labour in agriculture, labour in industry, females in education, electricity production, energy self-sufficiency, metal imports, fuel imports, fuel price and foreign investment.

Capacity of industry within the AMIS: mainly a machinery importer, stamping facilities, machining facilities, casting facilities, hand tool production, draught animal implements, powered machines, manufacturing value added, MVA growth, tractor assembly/manufacture.

The results of the clustering process lead to 10 groups of countries. At the two extremes are:

Group 1: Industrialized, high income, large existing markets:

Algeria, Egypt, Libya, Morocco, South Africa, Tunisia.

Group 10: Small populations, small markets:

Cape Verde, Comoros, Djibouti, Equatorial Guinea, Gambia, Guinea-Bissau, São Tomé and Príncipe, Seychelles.

Common development strategies

- A suitable institution should be identified to take on the responsibility for development of the AMIS.
- Ensure that the national programme for AMIS products is aligned with both traditional and newly developing needs for tools and equipment.
- Work closely with the food industry to develop and market equipment to support the diversification of crop use and expand opportunities for industrial development.

- Foster development of the artisan producer and promote the transition from artisan to a SME.
- Evaluate industrial production plans on the basis of real demand and integrate production within an existing metal-manufacture sector.
- Exploit potential for diversification in the interests of rational production economics.
- Evaluate existing distribution and service support set-up and assist where necessary to induce improvement.
- Improve communication and gain access to worldwide sources of information. It is suggested that an African AMIS Intranet be created.
- Continually assess the policy and infrastructure in which AMIS operates, identify constraints and promote corrective measures.
- Assess the potential role of whatever regional bodies exist and explore the ways in which they might influence the development of the AMIS.
- Examine the role of women in order to research the market for equipment specifically suited to them and to plan production of such equipment.

Group-specific strategies (with examples for Groups 1 and 10)

Group 1: Industrialized, high income, large existing markets (Algeria, Egypt, Libya, Morocco, South Africa, Tunisia).

Example of strategy pointers (Group 1)

- Poor agricultural resources, especially water, and arable land in the case of Egypt, point to a need for higher intensity of dryland mechanization technology.
- High food imports suggest a good market for increased local production.
- Poor road networks indicate a need for specialized agricultural transport.
- Would respond to foreign investment in AMIS production.
- Opportunities exist for expansion of AMIS production for local consumption.
- Opportunities exist for specialized production for export to African countries.

- Tractors appropriate to other African countries could be sourced in this group.

Group-specific strategies (Group 1)

- Develop and intensify dryland mechanization technology.
- Develop agricultural transport systems (engine-powered and animal traction).
- Evaluate tractor manufacture for potential redevelopment (existing industry strategy).
- Develop export markets for powered machines (including tractors).
- Explore opportunities for foreign investment in the AMIS.

Group 10: Small populations, small markets (Cape Verde, Comoros, Djibouti, Equatorial Guinea, Gambia, Guinea-Bissau, São Tomé and Príncipe, Seychelles).

Example of strategy pointers (Group 10)

- Limited opportunities for industrial development.
- Potential demand for AMIS in some countries.
- Input situation is favourable in some countries.
- Indicators suggest a role for women in small industries.

Group-specific strategies (Group 10)

- Import most AMIS products and strengthen distribution system.

Conclusions

- There is an urgent need to develop the African AMIS, but this will require at best a medium-term solution.
- Given current global trends, Africa and its major donors must recognize two issues:
 - 1 The importance of agricultural machinery as an essential input.
 - 2 The need to source this input largely at the local level.
- International organizations, donors and suppliers will have to play a lead role in setting AMIS into motion in order to contribute to achieving the Millennium Development Goals.

Chapter 3

Direct public sector investment programmes

3.1 COMMERCIAL COMPETITIVENESS VERSUS LIVELIHOODS ENHANCEMENT – WHY NATIONAL AGRICULTURAL MECHANIZATION EFFORTS NEED TO BE DRIVEN VIA THE PRIVATE SECTOR

Pascal Kaumbutho
KENDAT, Kenya

Summary

Government-driven agricultural mechanization efforts in Africa have mostly been done by expensive and immediate externally, or locally, funded projects and, which have had the objective of ameliorating food crises. There are very few examples of carefully developed, process oriented and inclusive programmes of mechanization where costs, as well as the anticipated impact in economic terms, are defined. In Africa, most agricultural mechanization efforts are “piecemeal” and not planned into holistic value-chain programmes. There is no appropriate regard for value-chain component links that will generate efficient and profitable businesses in the long term. A value-chain approach ensures that mechanization that results in increased production does not lead to over-supplied local markets without value-addition capacity or market information and infrastructure. For example, introduction of conservation agricultural practices (fertilizer use, direct seeders, jab-planters, etc.) in the Kikapu zone of Njoro in Kenya caught farmers by surprise. Maize yields doubled or tripled but the farmers did not have access to sufficient storage capacity. The farmers had no capacity to add value nor was there any built-in marketing infrastructure. Farmers found themselves in a poorly defined and unsupported journey from subsistence to business farming.

Agricultural development efforts by governments do not seem to be genuinely geared towards food security or poverty eradication. In many government and donor-funded farm machinery programmes, mechanization itself

becomes an end. Many technology transfer or technology advancement programmes in Africa fall short of achieving the intended goals of progress or growth. The most popular programmes with governments at the moment seem to be those that are of emergency response nature that call for urgent inputs. In these, corruption easily can be involved. Food aid – to feed the starving; sudden huge imports of fertilizer – to meet the beginning of the rainy season; huge shipments of tractors – for subsidized government tractor-hire schemes; are but a few examples of projects where corruption occurs. Also, too many resources and much time are being wasted in ministerial and conference meeting rooms. Unfortunately, these are usually one-off or impromptu to address short-term problems or analyse problems that never seem to arrive at solutions, time and again. These sittings “float in the air” and they are rarely backed by regional or local strategic plans into which agreed actions would fall and that would make a visible or measurable difference.

Would it not be better to spend these funds on programmes that would see more resources and support reach the farmers? As an example, there were thousands of proven pea and millet varieties developed by ICRISAT in India that are highly suitable for semi-arid Africa. Why is more effort not put into getting these much needed new varieties to needy farmers – rather than put yet more resources into research – to generate more varieties, including ventures into genetically modified organisms (GMOs)? A 1 000 m² greenhouse unit complete with drip-irrigation and technical support that would launch Kenya farmers into business farming costs less than a day in a luxury hotel for a delegate at a conference! The question has to be asked: Is this the best use of resources for poor Africa?

A “scarcity mentality” also seems to be prevailing: In Africa much time is lost among professionals and business persons “fighting” for limited opportunities and resources for projects. With better planned and inclusive programmes,

there would be adequate resources and work for all professionals, industrialists and farmers alike. An “abundance mentality” would set in, creating more sharing, improved and collaborative approaches or prosperity for growth, as well as peace among peers and competing industrialists.

Farmers need a voice and a say – often they have answers to their prevailing difficulties but not the means to alleviate them. Government structures are rarely conducive to the genuine inclusion of farmers. Governments need the help of NGOs and civil society to adequately seek opinions and include farmers in programmes that are geared towards helping them.

Two examples from the Kenyan experience

A NAMS study for Kenya was carried out in 1992–1994. A Cabinet paper resulted, where a Centre of Excellence for Mechanization, among other national guidelines, for structured national mechanization processes were recommended and defined. Despite this, Kenya still does not have an agricultural mechanization policy that would guide the much-needed integrated government and private sector strategies. Nevertheless, private sector driven efforts have continued to make a significant difference at industrial and farm levels.

In horticultural farming, the government through the Horticultural Crops Development Authority (HCDA) constructed some state of the art coolers in about nine locations in the country. The designs and locations for these were determined almost a decade before they were actually constructed. Today these coolers lie mostly empty, particularly because the determination of their location and utilization structures did not involve industrial stakeholders, be they farmers or exporters of fresh produce. By the time the coolers were operational a value-chain system driven by private sector exporters and their brokers had evolved that had not included the coolers in the planning. The powerful private sector driven system was self-sufficient and by the time it was operational it did not need the government coolers among other well-intended, but useless, support measures.

In conclusion it can be said that in most African countries the pace of adoption of agricultural and industrial mechanization efforts may be initiated by governments but unless private sector business-driven initiatives take over, sustainability in a profitable business sense is most unlikely.

It is a fact that in most agricultural mechanization processes the private sector, with profit sensitive

entrepreneurs, remains ahead of government initiatives. Indeed in many cases the government can and must learn from what is possible in the industrial sector before introducing new mechanization ventures. In many cases, governments take on donor-driven and other externally influenced mechanization efforts without adequate regard for the existing capacity of the private sector capacity and process support. Many public sector interventions rarely reach full bloom unless industrialists and farmers see practical and sustainable profitable business results. Unfortunately many resources and much time have been lost because such interventions are rarely centred on credible longer-term business assessment and solid implementation plans.

But there are still a few integrated government support and private sector, business-driven ventures in the African continent that have made a strong impact and demonstrated the needed difference that can be achieved by agricultural mechanization interventions – if they are carried out correctly. In Ghana, for example, the government introduced tractors by providing farmers with finance and service through the private sector. This allowed farmers to buy tractors and to build up viable contract hire businesses. Integrated efforts are necessary but private sector drivers and users of technologies in profitable business must be adequately engaged and supported at every stage.

3.2 COMMERCIAL COMPETITIVENESS VERSUS LIVELIHOODS ENHANCEMENT

Richard M. Shetto

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Summary

Livelihoods enhancement

In agricultural communities, the most fundamental livelihood outcome is food security. This is unattainable for most households relying on hand power. In Africa, hoe cultivation is dominant, resulting in smaller areas under cultivation, reduced total output, reduced cash cropping, increased food insecurity, reduced farm incomes and a higher incidence of poverty.

Most households have access to land that they are unable to cultivate because of shortages of farm power. As a result communities are placed in extremely vulnerable positions and struggle to survive external shocks such as droughts.

The *opportunity to earn cash* or food through hiring out their labour and land is an essential survival strategy for many hoe cultivators. However, the need to earn cash for survival draws them away from working on their own land at critical times during the farming season. Also, labour is becoming scarce in many communities as a result of education, migration, employment opportunities in other sectors and through ill health (malaria, HIV/AIDS). As a result of these labour shortages, food production will be constrained in the near future.

Food security improves as households switch power sources, with tractor and DAP owners and tractor hirers generally being food secure. Households with access to DAP and tractors generally cultivate larger areas than hoe cultivators, realize greater yields, improve household food security and produce a marketable surplus, hence contribute significantly to poverty reduction. Households reliant on hand power typically cultivate 1–2 ha; DAP hirers cultivate 2 ha; DAP owners 3–4 ha; tractors hirers about 8 ha and tractors owners more than 20 ha. The use of DAP and tractors leads to commercialization and improved farm incomes enabling households to afford to purchase inputs such as seed, fertilizers and implements/machinery.

Loss of access to a source of farm power, such as tractor-hire services or draught animals, invariably

results in a reduction to the area cultivated, which leads to reduced farm incomes hence perpetuating poverty.

In *the absence of concerted efforts* by governments in Africa to intervene to address some of the vulnerabilities of the hand hoe farming system, it is likely that these communities will face a continuing state of collapse. Supporting infrastructure, such as the existence of extension and financial services, plays a key role in enabling farmers to make effective and sustained use of farm-power resources. Some essential elements of supporting infrastructure include: (i) providing farmers with access to knowledge and information on improved farm power technologies in a drive to support the process of commercialization of the sector; (ii) facilitating access to financial services that many farmers require in order to purchase implements and tractors; (iii) ensuring the availability of appropriate implements; (iv) ensuring the availability of skilled and well-equipped maintenance and repair service sector.

The public sector (local authorities to national government) has an obligation to: (i) enable small farmers in rural areas to have access to labour saving and mechanization technologies; (ii) direct public sector support (subsidies, grants) are acceptable to make mechanization technology available to rural small farmers; (iii) subsidized mechanization inputs will enable small farmers to participate in change process from subsistence to commercialization; (iv) in rural areas, private sector mechanization services providers rarely exist; hence local authorities and central governments may need to fill the gap.

Subsidized inputs or grants may be necessary to encourage and facilitate: (i) the introduction of new technologies and approaches; (ii) conservation tillage systems for smallholders; (iii) transport facilities for market access; (iv) single axle tractors (power tillers).

Mechanization can: (i) increase labour productivity; (ii) clear more land; (iii) plant greater area of crops; (iv) increase crop diversification; (v) weed and harvest those crops; (vi) increase the area of crops that will provide greater income; (vii) ensure more timely operations that will increase yields; (viii) increase benefits if costs are reduced.

Mechanization can also: (i) reduce drudgery and free farmers from the yoke of the jembe; (ii) reduce transport costs/tonne (especially important if crop production is also increased).

A shortage of farm power (because of malaria, migration) results in scaling back of farm and family activities leading to a downward spiral into poorer livelihoods (late planting, poor weeding).

But, mechanization can produce *bottlenecks* in the system (weeding, harvest). Is there *potential* to increase cropping area?

3.3 SELECTED CASE STUDIES OF PUBLIC SECTOR INVESTMENT PROGRAMMES – D.R. CONGO, SOUTH SUDAN AND SIERRA LEONE

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and

Josef Kienzle, Rural Infrastructure and Agro-Industries Division, FAO

Background

All three countries/regions are in a post-conflict situation. During the conflicts, external interventions were generally restricted to the supply of emergency inputs. Now that the conflicts are over, the question is how to move from emergency relief to development? This presentation takes three case studies from which some conclusions to this question can be drawn.

Democratic Republic of the Congo – is the second largest African country (2.3 million ha). There exist four agro-ecological zones: Forest, Savannah, Highlands and Swamps. In the mid-1990s agriculture was mainly practised using hand tools although there were about 600 draught animals in the highlands and between 800 and 1 200 tractors (mainly in Katanga Province). There have been some very recent initiatives with 700 tractors imported by the national government and 220 tractors imported by the Provincial Government of Katanga.

Sierra Leone – is a small country (72 000 km² and a population of 5 million). There are four agro-ecological zones: Coastal plains (swamps – 15 percent of land); Interior plains (50 – 200 m altitude – 43 percent of land); Guinea highlands (> 500 m altitude – 20 percent of land); and Plateaux, south of the highlands. Farmers rely mainly on hand tool technology. There was a growth of interest in animal traction in the 1970s but only on a small area. In the 1970s, 300 tractors were imported. In 1978 the World Bank financed the “Mechanical cultivation project” with the objective of privatizing mechanization services. In the 1980s, 300 more tractors and 200 power tillers were imported. The World Bank project terminated in 1983 and all tractors were sold off by 1985. There was an attempt to set up a joint venture agricultural mechanization company. In 1991 internal strife broke out, and it was not until 2002 that the entire country was declared to be under the control of the central government. There have been several recent initiatives in Sierra Leone: In 2003 an Agricultural Sector Report

was prepared and by 2005, mechanized imports included: 70 agricultural tractors, 28 trucks, 30 rice mills and 45 rice hullers. There was also a “Draft Agricultural Mechanization Scheme” proposed by FAO (but not implemented) as well as a “National Agriculture Response Programme” established by the Ministry of Agriculture building on the initiative “Operation Feed the Nation”.

Sudan—is the largest African country (2.5 million km²) and with 1.93 million ha under irrigation. In the past there existed a number of ambitious mechanization schemes for both irrigated areas and rainfed agriculture. Attempts to involve the private sector were not always successful except that most of the extensive dryland sorghum production in the 1970s and 1980s was in the private sector and fully mechanized. In South Sudan there has been civil strife for over two decades and prior to that there were few attempts to introduce mechanization. After the “Comprehensive Peace Agreement (CPA)” was signed in 2005, there were many returnees and attention focused on rebuilding their livelihoods. The Government of South Sudan (GOSS) is convinced that farm power is a key factor in the rehabilitation of agricultural production. One hundred tractors

with implements including graders were imported in August 2008 and additional equipment is to be procured. The plan is to deploy this machinery through the private sector but the methodology of how this will be achieved is still under discussion. Training centres will be established in each of the ten States of South Sudan.

Conclusions

A planning exercise is clearly needed (an AMS)

- This is now taking place in D.R. Congo
- This has been formally requested in Sierra Leone
- The Sudanese AMS developed in the mid-1990s now needs updating with reference to South Sudan

An AMS formulation can assist the planning process

- But all stakeholders including: policy makers, private sector suppliers, must support and participate in the initiative from the outset
- The stakeholders of an AMS will determine the ultimate success (or failure) of agricultural mechanization proposals in a country

TABLE 11

Observations

Issue	Conclusion
Should motorized services be made available uniformly throughout each country?	<ul style="list-style-type: none"> • Experience shows the support infrastructure will be weak if this is attempted
Who are the target beneficiaries?	<ul style="list-style-type: none"> • Normally the resource poor farmers
Who should be the direct beneficiaries?	<ul style="list-style-type: none"> • Would it not be better to target experienced farmers, entrepreneurs and operators?
Machinery and equipment procurement by governments/donors	<ul style="list-style-type: none"> • This seems attractive and easy! • Await an overall mechanization plan • Advise donors to await this plan • Carefully plan equipment deployment • Ensure adequate infrastructure (management, service and training) • Ensure technically coherent tender specifications (contract specialists if not available)
Mechanization support – repairs and servicing	<ul style="list-style-type: none"> • The public sector is cumbersome for this task • But the private sector will need to be engaged prior to equipment acquisition
Equipment deployment	<ul style="list-style-type: none"> • It seems generally agreed “No Donations”
What are the alternatives to “No Donations”?	<ul style="list-style-type: none"> • Hire purchase agreements • Can the private financial sector/banking system be engaged? • Would the financial sector be happy with the proposed direct beneficiaries? • Will any subsidies be applicable (initial costs, spare part costs, import taxes)?

3.4 DIRECT PUBLIC SECTOR INVESTMENT AND FINANCIAL SUPPORT TO AGRICULTURAL MECHANIZATION IN AFRICA: EXAMPLES FROM GHANA AND MALI

Mathias Fru Fonteh

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Introduction

Most African countries have economies strongly dominated by the agricultural sector. In some countries, agriculture generates up to 50 percent of the 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. 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.

One of the major reasons put forward for the lack of effectiveness to mechanize in Africa has been the fragmented approach to mechanization issues. Formulation of national AMSs and plans for their implementation are now seen as the solution. A number of African countries have now concluded that mechanization is the way to go to stimulate economic growth and have therefore embarked on mechanization programs following different approaches. In Mali, an AMS was elaborated in 2002 and based on 2008 estimates; the implementation was to cost 367.7 billion CFA Francs⁷. Analysis of the cost of implementing the strategy indicates that about 99 percent of the cost would be for the purchase of equipment. In Ghana, no AMS has been developed but a government-led program has been importing tractors since the year 2004 to accelerate the adoption of mechanization technologies by

Ghanaian farmers. The approach in Ghana is being carried out within the framework 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.

Implementation of agricultural mechanization programs requires significant investment from both the public and private sectors. Because of the problems of limited access of farmers to agricultural mechanization technologies, the Malian and Ghanaian governments have found it necessary to make direct investments and provide financial support to farmers to enhance agricultural mechanization.

The aim of this paper is to analyse the approach used for direct public sector investment and financial support in Ghana and Mali so as to learn from their experiences. The objectives are to:

- identify key elements of the direct public sector investment approaches and financial support used in both countries in agricultural mechanization;
- identify lessons from their experiences;
- provide recommendations for sustainable direct public sector investment and financial support.

Direct public investment and financial support

Because of the low purchasing power of most small-scale farmers, the high cost of agricultural machinery and the poor access of farmers to agricultural credits, the Malian and Ghanaian governments have deemed it necessary to make direct public investments and also provide financial support to farmers to encourage the development of agricultural mechanization. Measures taken have included provision of agricultural equipment to farmers on a loans basis at subsidized prices and at more favourable terms of repayment than would be obtained from commercial banks. Other measures have included providing guarantees to farmers' loans and free training of tractor operators.

Key elements in Mali

The Malian government provided direct public investment and financial support to farmers in the acquisition of 400 tractors and associated equipment purchased from India. Also, the prices

⁷ 1 US\$ = 497 CFA Francs, 26 August 2010.

of the tractors were subsidized. For example 39 h.p. tractors purchased by the government from India were supplied to farmers at about 2.8 million CFA Francs to stimulate demand for tractors. These same tractors were later assembled locally and sold at about twice this price. In addition, the interest on the loan was significantly lower than that obtained from commercial banks. Furthermore, the government made additional direct investments by purchasing 49 percent of the shares of a local tractor assembly plant.

Table 12 summarizes the financial support provided by the Malian government to enhance agricultural mechanization. Farmers in Mali who produce cotton and rice have access to loans for the purchase of mechanization technologies and hence are much better equipped especially with animal traction equipment and power tillers than other farmers. This is because these subsectors are organized (have farmers organizations, supervised by parastatal companies that facilitate provision of inputs and the commercialization of their produce). Hence, equipment can be given to farmers on a loan basis and the loan repaid after harvest.

Farmers cultivating other crops such as millet

and sorghum, which are the staple crops of the country, and which account for about 75 percent of all cereals produced, have many problems to access credits for equipment. The government has elaborated a project to assist such farmers who are usually very poor. The state provides interest-free loans of up to 500 000 CFA Francs for the purchase of a pair of draught animals, a plough and an animal-drawn cart. The farmers pay 5 percent of the loan initially and are supervised to plant trees, which constitute the guarantee for the loan. The wood is harvested and sold after 5 years and the money used to repay the balance of the loan if the farmer had not completed the repayment. The rate of repayment is very good and has been estimated at about 90 percent.

The Malian government provides even more assistance to young farmers. One hundred tractors have been supplied to youths at subsidized prices, interest free and payable in 10 years with a 1-year period of grace. The farmers are also trained in developing business plans for the acquisition of loans from commercial banks, with the state providing up to 80 percent of the guarantee for the loan.

TABLE 12

The different types of financial support to Malian farmers by the state

Target group	Nature of financial support	Repayment terms/guarantees
Relatively well-off cotton & rice farmers	Purchase and supply of animal traction equipment and power tillers	Repayment after harvest
Poor millet & sorghum farmers	Loan of 500 000 CFA Francs for animal traction equipment	Interest free loan, repayable after 5 years Planted trees used as loan guarantee
Well-to-do farmers	Subsidized prices for tractors and implements	Lower interest rate than from commercial banks
Young farmers	Subsidized prices for tractors and implements	Interest free Loan repayable in 10 years with a one-year period of grace
Young farmers	Free capacity building to elaborate business plans 80% guarantee on loans to finance plans	Bank rates and conditions

TABLE 13

The different types of financial support to Ghanaian farmers by the state

Target group	Nature of financial support	Repayment terms/guarantees
All	Tax-free importation of equipment	
Well-to-do farmers	33% reduction on tractors and equipment	30% down payment Interest free loan, repayable after 3 years
Contractors operating agricultural mechanization centres	33% reduction on imported tractors	10% down payment Interest-free loan, repayable after 5 years
Tractor operators	Free training	

Key elements in Ghana – acquisition of mechanization technologies

The first financial support provided by the state in Ghana is that agricultural machinery is imported tax-free. For private owners, a tractor with a set of implements (trailer and plough) is supplied at 66 percent of the total cost of the tractor. The owner makes a down payment of 30 percent of the discount price of the equipment and contracts to complete payment within 3 years interest-free. Equipment hiring service providers pay 10 percent of the value of the equipment and contract to pay the balance over a 5-year period, interest-free. Table 13 summarizes the financial support provided by the Ghanaian government to its farmers and equipment service providers.

Lack of skilled tractor operators is a major constraint to mechanization in Ghana. Poorly operated tractors result in frequent breakdowns and in shorter lifespans. This makes tractors expensive to operate. To remedy the situation, the state has invested in free training of tractor operators.

Lessons, experiences and critical issues

Financial support and profitability of agricultural mechanization

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. In Ghana, the state has concluded that agricultural mechanization is not profitable without financial support to farmers. Hence tractors are provided to farmers at subsidized prices and also concessionary terms of loan repayment. 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.

In Ghana, however, some studies have concluded that agricultural mechanization is currently profitable for some crops without subsidies. This view is also shared by the private sector equipment suppliers who are doing good business selling tractors despite the existence of the state subsidized tractor scheme. In Mali, the Confederation of Chambers of Agriculture (APCAM) has concluded

that with crops such as rice and cotton, with a good market value and with a ready market, mechanization is profitable.

From the above, it would appear that a critical issue that needs to be addressed is that of low and very variable farmgate prices. Experiences in Europe and India indicate that to resolve the problem, the state should provide a guaranteed minimum price for at least the strategic crops. This will enable farmers to determine if investment in mechanization would be profitable before they embark on production.

Financial support and sustainability

In Ghana and Mali, the governments are 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 is justified by the fact that farmers have difficulties to obtain loans to acquire mechanization technologies. The intention of the state is therefore to stimulate demand and later reduce its involvement. A critical issue however is the sustainability of subsidized mechanization.

In both countries, advocates 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. For example in Mali, it is estimated that only about 2 percent of loans granted to youths for the acquisition of 100 tractors from the state 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 interest-free.

In Ghana, previous subsidized mechanization projects failed because farmers did not value the equipment and hence misused them. In addition, farmers could not/did not repay for the loans and hence program of subsidies failed. There are indications that the current approach of supplying tractors to farmers at concessionary terms is also likely going to face the same problems of the past as regards repayment of loan by farmers. No data are available for loan repayment rates in Ghana but there seems to be general agreement by stakeholders that the rate of repayment is poor. Partial data from Mali suggest it could be as low as 2 percent.

Experience from Mali and Ghana suggests that the state should not be directly involved in providing farm equipment to farmers because the

rate of repayment is likely going to be very low and this approach is subject to abuses. The state should instead provide loan guarantees to banks and farmers encouraged to develop business plans and given loans through the banks at concessionary terms. In this way the rate of loan repayment would be considerably increased. When farmers develop established businesses, the state can then quietly withdraw from supporting farmers and allow the banks to operate normally.

Recommendations

Because of a relatively weak agricultural machinery private sector, the poor purchasing power of farmers and difficulties of farmers to obtain loans, direct public investment and financial support to farmers is necessary. In Mali, the state is a shareholder in one of the companies assembling tractors. Both Mali and Ghana are importing farm machinery and distributing to farmers with subsidies and at favourable terms of repayment. For this approach to be sustainable, political will and commitment is needed to provide this support only to deserving farmers, to punish defaulters and encourage farmers respecting their engagements with the state so that they can grow to be role models for others to emulate. To complement this, farmers should be trained to regard agriculture as any other business and to obtain loans from commercial banks with some collateral, with state guarantees and at favourable repayment terms.

Chapter 4

Enabling programmes for private sector investment

4.1 CREATING EFFECTIVE DEMAND FOR TRACTORS

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Introduction

This paper deals with four major topics: (i) increasing tractor utilization; (ii) development of tractor-based contractors; (iii) public and private sector enabling environment; and (iv) cost of doing business for tractor owners.

First though, the *historical situation* in Africa is compared with Asia: In 1961 Africa had more tractors in use than Asia, but by 1980 there were three times more tractors in use in Asia than Africa. The reasons why this happened in Asia and not in Africa includes such factors as the introduction of HYVs, the increased use of irrigation, rising rural wage rates and costs of using draught animals. As a consequence, in a 4- year period from 1967 to 1971, the tractor population in India doubled. Most new tractors were on farms of over 10 ha. Much the same happened in Pakistan. Increased use of tractors led to increased cropping intensities, increased diversification in cropping patterns and more timely land preparation. The point is made that although tractors were purchased by the larger farmers, their use was only made possible by the owners carrying out contract work for (smaller) neighbouring farms as well as off-farm transport. In Africa the average tractor utilization is 400 hrs, whereas for Asia it is 700 hrs.

However, the whole demand for tractors was only made possible by satisfactory product prices as well as government set minimum crop support prices (in India). In both India and Pakistan, as well as other Asian countries, local industry responded to the demand for tractors and machinery by expanding the importation, manufacture and repair, and support services that are essential if mechanization is to succeed. The *lessons* to be learned from this are that: (i) farmers must have the potential to generate income and profits; (ii) farmers

must have security of land tenure or ownership; (iii) only larger farmers can afford tractors but that smaller farmers benefit from the contracting services offered; (iv) governments need to actively promote mechanization but that supply should come from the private sector; (v) governments have to create an enabling legislative environment; and (vi) farmers need to have appropriate and effective access to credit.

The theme throughout this paper is to increase effective demand for mechanization through the development of tractor-based contractors following a minimalist cross-sector approach based on public and private sector demand-led growth. The paper calls for donor initiatives to support the trialling of a tractor-based business linkage programme as a new approach to encourage mechanization through tractor-based contractor development as an alternative to government tractor-hire schemes.

Creating effective demand for mechanization in Africa

Increasing tractor utilization and farm profitability are pre-conditions for the creation of effective demand. This is linked to an effective local demand and pricing for agricultural products, which at the moment does not exist in many African countries. It will, however, still be mostly medium- and large-scale commercial farms that will be able to afford to purchase and operate their own machinery. Smaller farmers will need access to a flexible source of farm power but without the associated risks of machine ownership. This can be done by making more efficient use of tractor capacity, i.e. a more effective tractor-hire market as is practised in many Asian countries.

In order to increase *effective utilization* of tractors and because of the restricting effect on tractor utilization by seasonal agriculture, owners will have to look for other sources of income generation from their tractors. Other areas include transport work, road maintenance and other public sector infrastructure operations. Limiting constraints to this are currently the

failure of both owners and potential customers to recognize the business opportunities that exist. Technical assistance programmes may be needed to assist in identifying and promoting such business opportunities. A tractor-based contractor development programme is required.

The Asian experience has shown that the availability of an effective *agricultural machinery supply chain and services* is essential to stimulate demand for machinery. This sector must therefore also be included in any programme for the development of mechanization. In particular, rural access to these services is essential. It is suggested that concentration should be on the development of new supply chains with India and China, both of which offer reasonably priced, technically appropriate machinery. Another option in many countries would be the development of local manufacturing capacity, initially perhaps under licensing agreements.

The Asian experience has also demonstrated how important an *effective public sector enabling environment* is. In Africa, as public interventions and investment have declined, the private sector has not stepped in to provide farmers and entrepreneurs with the market, business and financial services required. Consequently, with poorly developed markets and low levels of economic activity in many regions, public sector initiatives and actions are now required to encourage and promote mechanization, improve rural infrastructure and strengthen agricultural support services. Some essential actions that have to be undertaken are: (i) promote and encourage development of tractor-hire services; (ii) support companies engaged in machinery supply and servicing; (iii) promote cheaper credit through term loans, leasing and hire purchase; and (iv) remove or reduce import duty and sales tax on farm machinery and spare parts. In addition, there is the necessity to increase human resources in order to develop the new skills required (technicians, engineers, business, commerce). Finally, support is required for the development of farmers and commercial associations.

In the *agricultural sector*, therefore, this paper is proposing an alternative solution to the large government sponsored tractor-hire schemes of the past by encouraging the development of the existing tractor owner into a tractor-based contractor, in order to fill the vacuum left by government withdrawal from this subsector. Governments have an obligation, in view of their past interventionist failures, to use their agricultural mechanization

policies as a vehicle to promote the use of tractor-based contractors, and encourage tractor owners to undertake more contract work in all sectors. To support such policies, agriculture ministries will need to improve their extension and research services.

Rural credit schemes have underperformed in the past in many African countries. Now, credit is mostly only available through the commercial banking sector. But the commercial banking system in Africa is highly urban orientated and cannot cater to the borrowing needs of the rural population. The resulting credit famine is exerting a high level of control over the pace of mechanization and the replacement of ageing rural tractor populations. The use of credit can be a powerful tool in the promotion of mechanization. It is therefore important that the availability of agricultural credit is formulated as part of an overall rural development strategy, equally focused on encouraging both on-farm and off-farm rural development.

The *roads sector* offers considerable potential opportunities for tractor owners to broaden their business activities. There has been a general withdrawal in many countries from direct public sector involvement in road construction and maintenance. The use of more appropriate, low cost labour-based technology and the development of local small-scale private sector labour-based contractors is being promoted. However, the barriers of entry for an individual tractor owner to break into labour-based roads contracting are substantial.

Many *donors and recipient governments* have not yet recognized the role that tractor-based contractors can play in the overall dynamics of a rural development programme. To date, aid has often been channelled into providing specific mechanical inputs as part of a large agricultural development assistance package. Unfortunately, a greater part of this assistance has been undertaken without any reference to an agricultural mechanization policy, or indeed to an overall rural development strategy. Donors (and governments) should therefore satisfy themselves that a comprehensive mechanization policy is in place.

The *cost of doing business* plus the inherent *risks* involved in tractor ownership are *key constraints* currently affecting demand for mechanization inputs in African countries. The major costs of doing business for the tractor owner is funding the initial capital costs of purchasing the tractor and

working capital for running costs. The major risks are not being able to meet the loan repayments and lack of tractor-hire opportunities.

The *availability of credit* is a major factor in the development of mechanization. Investment in farm machinery requires large amounts of capital that is amortized over several years. Lending large amounts over long-time horizons is risky for lenders. Consequently lenders are often reluctant to provide such finance when the risks are perceived as unacceptable or even marginal. In the past, governments and donors have provided credit through agricultural development banks and credit projects, but most of these have now been phased out. This has resulted in a funding gap. Similarly, the closure of marketing boards has also eliminated an important source of working capital for farmers.

Commercial banks remain the main *source of credit* for purchasing a tractor, but most of them are situated in main urban centres and this, combined with high risk and high interest rates, makes it difficult for farmers to access this source of credit. Leasing and hire purchase are also becoming increasingly available but still relatively unknown or inaccessible to most farmers. Tractor manufacturers and dealerships can sometimes offer credit schemes for selected customers but these are very restricted. The costs of obtaining and paying for credit is prohibitive as interest rates charged to the borrowers can vary between 20 and 25 percent of the loaned amount, and transaction costs can be up to 8 percent. Risk cost in case of default can be up to 3 percent of loan amount, and insurance costs range from 3 to 8 percent of asset value.

The *business costs of direct taxation* can be offset against either capital allowances or depreciation allowance. Indirect taxation, which is VAT (value-added tax), increases the cost of doing business considerably if the tractor owner fails to keep appropriate records and is unable to claim input tax refunds. Taxation on inputs such as spare parts, will add up to 31 percent on the imported cost, and similarly diesel fuel and oil imports will attract duty as high as 200 percent. These are significant costs that have to be borne by the tractor owners over which they have no control. Many governments have recognized the impact of these costs on tractor operations and have reduced taxes and duty levied on new tractors to zero, but there is still room for reducing VAT, import duty and license costs in order to reduce the working capital requirements of tractor operation.

Conclusions

It can be said that the overriding factor must be the *profitability of farming* to drive the demand for mechanization. Consequently, farm production has to be linked to market-oriented enterprises in order to generate the cash flow necessary to cover the cost of tractor ownership. Only the medium and large farmers will be in a favourable position to purchase a tractor and to be able to supply tractor-hire services to neighbouring small-scale farmers who need a flexible source of tractor power that offers minimum risk to them. Increasing tractor capacity is achieved by increasing annual tractor utilization rates through encouraging tractor-based contracting, increasing existing tractor utilization and making tractor hire more profitable.

The tractor-hire sector needs support and promotion, both in agriculture and in other public/private business sectors in the rural areas. To achieve profitable year-round contract work, tractor owners will need to consider a “cross sector” approach to sourcing tractor-hire opportunities that are outside the limited window of opportunity that exists for agricultural work. The constraints that at present inhibit this will need to be addressed through the establishment of a “technical assistance programme” to identify and exploit contracting opportunities for tractor owners.

The Asian experience has shown that the required *machinery supply and support services* should be provided by the private sector in response to demand. There are already well-established dealerships in most African countries supplying well-known brands of machinery and these are being joined by Indian and Chinese manufacturers offering, in many cases, cheaper and more appropriate models of equipment for the African market.

The importance of a *government sponsored enabling environment* to promote and support mechanization in rural areas has been demonstrated in Asia. The first priority is to address appropriate sector policies affecting profitability of farming, land tenure and ownership, legal and regulatory frameworks, and an effective judiciary to create incentives for domestic and foreign private investment. A specific enabling environment to promote mechanization should also concentrate on: providing rural infrastructure and extension services; promoting tractor-based contracting through technical assistance programmes; improving access to rural credit through reducing interest rates, transaction and risk costs for term

lending; leasing and hire purchase and removing or reducing import duty/licenses and VAT on machinery, spare parts and fuel for farmers.

Donor initiatives are required to assist governments in finding a balanced overall rural development strategy that includes sound agricultural and mechanization policies that will provide an enabling environment for the development of all on- and off-farm subsectors in the rural economy. A donor initiative may also be required to *support a tractor-based contractor development programme*.

The *cost of doing business* and the *inherent risks* involved with tractor ownership are affecting the demand for tractors. In the past, governments and donors have enhanced the supply of term finance through development banks and credit projects but these have now been phased out, although this gap in funding still exists and the availability of term finance is now severely limited. Similarly, the closure of marketing boards has also eliminated an importance source of working capital for farmers.

The *business costs* of direct taxation could be *offset* against either capital allowances or depreciation allowance. Indirect taxation, (VAT) can increase the cost of doing business considerably. Tax on spare parts can add over 30 percent to the cost even before the importer adds his markup. Similarly, diesel fuel and oil imports sometimes attract duty as high as 200 percent. These are all areas where governments are able to give support to the development of mechanization.

Chapter 5

Review of public-private sector models for mechanization

5.1 A REVIEW OF SOME PUBLIC SECTOR DRIVEN MECHANIZATION SCHEMES AND CASES OF PRIVATE SECTOR MODELS IN AFRICA

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Ghana

Ever since the late 1940s there have been several tractor and mechanization schemes and by 1968 tractor numbers rose to over 4 000. Most of these initiatives were frustrated by management and organizational problems and none of the formal schemes proved to be sustainable and they eventually collapsed. "Aid-in-kind" also figured in these mechanization projects, which included tractors and implements, seed drills, harvesting and processing equipment, sprayers, irrigation pumps and workshop equipment. In the 1980s the country embarked upon an Economic Recovery Programme, which benefited agricultural (and other) exports but made imported mechanized inputs more expensive.

Emphasis then changed to the use of animal traction, particularly in the more northerly regions. Most tractors in the public sector were sold off and private individuals or companies used them to provide contract ploughing services. Group ownership of tractors had also been promoted but with mixed success and the most active sector were private farmers. In the late 1980s demand for mechanized services exceeded supply, in part because of breakdowns. Although tractor rehabilitation was tried, there was little impact. In 2005 there were only 1 800 operational tractors. Given the extensive agricultural sector in Ghana, it is not difficult to imagine that without mechanical assistance, there is little chance of achieving significantly improved food security and livelihoods. Appreciable numbers of tractors are currently being imported and sold directly to the private sector.

Mali

Tractor use in Mali is mainly restricted to some irrigated areas and the cotton-growing areas. Cotton production was of course closely controlled, monitored and managed by the parastatal Compagnie Malienne des Textiles (CMDT). Different approaches were tried. For example, second-hand tractors were imported by CMDT and the significant numbers of the 28 h.p. Bouyer tractor were introduced. This was a so-called intermediate technology design, developed in France as a low-cost mechanization option. Until recently over half of the tractors in Mali were of this type but they were not entirely successful. When the CMDT withdrew from the provision of mechanized services an attempt was made to provide cooperative services. There is extensive use of motorized equipment for threshing and milling in the region and these are self-sustaining and economically viable. Tractors were and still are used in the irrigated rice production areas and are considered a major factor in the raising of crop yields. Mali too has recently imported additional tractors that are being locally assembled.

Senegal

Senegal has a long history of using animal traction, and it is only in the intensive rice-growing areas of the Senegal River delta that tractors and motorized harvesting equipment are used to any great extent. This region was managed by a public sector company until its dissolution in 1987. When the public sector withdrew, the motorized equipment was acquired by farmer groups and by a few entrepreneurs. But devaluation of the currency in 1994 increased running and repair costs, and at the same time local prices for agricultural products remained at the same level.

Kenya

Before independence, mechanization was mainly restricted to large commercial farms. Finance had been available from banks and there were supporting services available through dealership

networks close to the farming areas (a similar situation existed in pre-independent Zimbabwe, Zambia, Malawi and Uganda as also in Nigeria and Ghana). Significant numbers of tractors were imported and a fully equipped testing station was established. After independence in 1964, a tractor-hire service was put in place to make tractor services available to smallholder farmers. However, even at the peak of operations between 1975 and 1986, only a 43 percent utilization rate was achieved and only 40 percent of the target area was cultivated. Both of these then declined, resources were withdrawn and the service virtually ground to a halt thereafter. However, it is recognized that the provision of these services contributed to the opening of new land for wheat and other crops.

Tanzania

At various times over the past 50 to 60 years a number of schemes have been established to provide tractor-hire services, and mechanization centres with workshops were set up in various parts of the country. The largest of these was the ill-fated Tanganyika Groundnut Scheme that aimed at bringing large tracts of land into groundnut production but ended in failure. As structural adjustment programmes came into operation in the early 1980s, government involvement in agricultural production was withdrawn and the tractor-hire schemes were either liquidated completely or handed over to local authorities. In private ownership, problems arose in making the tractors economically viable among farmers used to subsidized tractor-hire rates. The situation was further exacerbated by the sudden rise in oil prices and there was a dramatic decrease in the sales of farm machinery. The average age of the existing fleet steadily increased and in 2007 it was estimated that 85 percent of the fleet had reached the end of their economic life.

Uganda

Agricultural tractors were introduced in Uganda in 1949 to improve levels of food and cash crop production (mainly cotton, sugar cane and tea). A tractor-hire service was set up under the Department of Agriculture, which ran through to the 1970s. One of the objectives was to reach small farmers through subsidized hire services. However, it proved difficult to make the scheme financially viable and alternatives such as innovative intermediate technology type low-cost tractors were sought. By the mid-1980s, the public sector

schemes were abandoned, the machinery sold off and attention turned towards stimulating the use of draught animals.

Sudan

Sudan is the largest country in Africa and also has the most extensive area under irrigation (1.93 million ha). Over 60 percent of this area falls under three gravity fed schemes producing cotton, sugar cane, groundnuts and wheat. Public owned and run agricultural corporations were established to operate these schemes through the provision of centralized mechanization services. There are now also some private companies offering specialized machinery services, mainly for land preparation and harvesting.

The remaining 40 percent of the irrigated area is under pump irrigation producing cotton as the main crop. Established as private schemes many were later nationalized but have not been able to function without subsidies. There are also large areas of extensively farmed, mechanized rainfed agriculture where the main crop is monocropped sorghum. Yields are low and have been falling; fallow periods are generally not observed; there is little use of fertilizer. Expansion of the cropped area has been through increasing the area of marginal land cultivated. It might be observed that in the case of the vast mechanization schemes that were attempted in the Sudan, the publicly owned and management systems have not proved to be viable. It should also be observed that private sector farm management has not been without fault, particularly in the rainfed mechanized areas, where the sustainability of the cropping systems is questionable.

Another feature concerning tractor usage in Sudan has similarities to many other countries, not only in Africa. This relates to tractor ownership as reported in the mid-1990s. The majority of these were then in private hands and were old but kept running and repaired by their owners and mechanics in the informal sector. These factors contributed towards keeping the costs low, and together with better timeliness of their services enabled the small hire operators to successfully compete against the public sector mechanization centres and their subsidized rates.

Sierra Leone

The first agricultural tractor is reported as having been brought to Sierra Leone in 1949 for rice cultivation and by the 1960s a few more large

tractors had been imported. In the 1970s the public sector imported about 375 wheeled and track-laying tractors. The World Bank financed a mechanized land cultivation project from 1978 to 1983 and workshop and repair services were established for use by the tractor owners. In the 1980s a further 300 wheeled tractors, 8 tracklayers and 200 power tillers were imported to the country for a new joint venture agricultural mechanization company.

By 1985, most of the public sector tractors had been sold off to the private sector. Up to 1991 a further 95 second-hand tractors were imported by the government. These were either sold off or distributed to various agricultural regions also for sale to farmers and farmers' associations. In later years there were several attempts by cooperatives and farmers' associations to run mechanized services. Generally these schemes were not financially successful; financing, fuel and even the equipment to be used for the operations arrived late or were insufficient and led to poor timing of services. Transport services were not always paid for and there was a shortage of trained operators. In addition the maintenance and repair services were often far from the sites where the equipment was operating.

Lessons learned from these tractor-hire schemes

Although there are several common themes, there are differences between the schemes from the different countries cited. There also seem to be similarities between experiences in French-speaking countries, and experiences in English-speaking countries.

In *French-speaking countries* the cotton and groundnut industries had a large influence on the development of mechanization schemes. The cotton companies in collaboration with the parastatals provided advance credit secured on the cotton harvest. An extension service was also provided. Credit for seasonal inputs was repayable after harvest, and loans for machinery were repayable over several seasons. The parastatals also collaborated with research institutions and influenced farmers' choice of mechanization systems as well as providing training and support for rural artisans to support the repair and maintenance of the equipment. Groundnut production was similar but with the emphasis on animal traction technologies.

Some large irrigation schemes were also

developed mainly for rice production. Some were implemented and managed by individual specialist parastatals. Others were organized by a department (Genie Rural) in the Ministries of Agriculture and which ran heavy earth-moving equipment for the physical infrastructure but also ran tractors to provide mechanization services to the farmers.

Animal traction was also encouraged and supported. At first, credit was available from special agricultural credit banks but most of these banks were soon wound up or restructured mainly because of poor repayment of loans. Farmers then found it difficult to afford equipment manufactured by specialist workshops, thus they tended to purchase more from rural artisans. At the time, the quality of this artisan equipment was criticized but it did respond to demand. Support increased for the production of this equipment and training and support for these artisans was provided by many aid agencies.

The parastatals were at first unaffected by the structural adjustment programmes but gradually their involvement in credit schemes, extension services and the supply of mechanization inputs was reduced; machinery hire services were gradually abandoned and the equipment sold off to farmers and farmer associations. This caused considerable difficulties because the new owners often lacked management skills. Also charge-out rates were low so that it was difficult to provide for depreciation. This is not to say that the private sector failed completely to provide mechanization services. The low price of cotton (also rice and groundnuts) in the 1990s also had a considerable influence.

Similar generalizations cannot be made for the *English-speaking countries* as agricultural production differed considerably because of the diversity of the climate in these countries. Several factors influenced the situation: first, particularly in East Africa, was the colonial settlement by commercial farmers; second, the activities of large international companies, for example Tate & Lyle and Bookers (sugar), Mitchell Cotts (tea and pyrethrum), British Cotton Growers Association, Cadbury's (cocoa), Nestlé, Coca Cola, and General Tyre as well as many more; and third, there were the interventions of aid agencies, particularly following independence.

Under various programmes significant amounts of equipment were imported some of which proved to be unsuitable for the particular conditions in those countries. Networks of different manufacturers' dealers became well established in the 1950s and

1960s. But problems started to appear in the 1970s and 1980s as donations mostly bypassed the traditional dealer networks; even spare parts were sometimes included in the donor packages. As a result, many dealers disappeared or retreated to outlets in major urban areas.

Import substitution also became an objective in several countries and, particularly in Kenya and Zimbabwe, this proved successful. A shrinking market and other problems have meant that only a few of these companies survive today. The situation in West Africa was different in that there were almost no commercial settler farmers. A market did exist from plantations and from small- and medium-scale farmers growing cash crops, particularly cotton. A number of dealers established themselves in northern Nigeria in the 1960s and 1970s. A number of local enterprises developed in Ghana after the 1980s, when the influence of the public sector decreased.

The reasons *why public sector tractor-hire schemes failed* is a question that is often glossed over and the reasons are often presented in a simplistic manner. The authors put forward some common generalizations and comment on them:

- **The public sector is a poor manager of commercial ventures** – there are diverse opinions on this. The authors believe that it is doubtful that this can be classed as a fundamental reason for the failure. However, there is no doubt the public sector does encounter problems in ensuring the provision of timely service inputs that influences the success or failure of any farming enterprise relying on these services.
- **The private sector is better able to manage commercial farming enterprises** – this statement can also be doubted. For example, entrepreneurial farming in the Sudan raises a question mark over this statement. But also many cases exist that demonstrate that privately managed farm enterprises are profitable. But whether the benefits have reached the rural poor is questionable in many cases.
- **The private sector is better able to manage tractor-hire schemes** – this is also contentious; some would quickly agree, sceptics are wary for many reasons. Consideration needs to be given to the question of what is needed to make a tractor-hire scheme work. Some aspects are discussed below.
- **The demand for mechanized inputs** tends to be for tillage and which is mostly a very short period. Fields tend to be small, irregular and scattered and in addition difficult to cultivate. This leads to inefficient use of the tractors.
- **Successful farming relies upon timely interventions** and requires flexibility in the provision of mechanization services. The public sector is often restricted to fixed working hours with weekends free. Machinery often has to be returned to the depot after working.
- **Repair of equipment** needs to be carried out quickly requiring rapid access to spare parts. Fuel is required often and in the right place. Bureaucracy in the public sector slows this down and purchasing flexibility often is lacking.
- **Available equipment may not conform to the requirements of the farmer** – particularly with equipment procured by public tender or through “aid-in-kind”.

Other mechanization activities

The subsector of mechanization also covers other activities, not just the use of tractors. There are large *cotton producing areas in West and Central Africa* and here the use of DAP is dominant, using implements developed in the region from various research centres. In Ethiopia, the use of DAP has a long history and still dominates in farming. Also *local manufacture* of animal drawn implements has its place in West Africa although the viability of many of these workshops has been problematic. Many of them were developed by the cotton parastatals that had a considerable influence on the development of cotton cultivation and the associated mechanization of the crop. Local artisans also started to produce in particular spare parts for these implements often using recycled material. Training projects in the 1970s and 1980s achieved remarkable results and led to an expanded fabrication of a wide range of equipment.

In Africa generally blacksmiths are the predominant service provider for equipment repair and tool fabrication in rural communities, and there have been many projects of technical assistance aimed at improving skills of these artisans. FAO has produced a number of training publications on the subject. Concerted efforts were also made to

better train rural artisans not only in blacksmith skills but also in sheet metalwork, fitting and welding. Training programmes for mechanics were also funded and run by both bilateral and multilateral agencies.

These organizations not only provided training but also developed a range of designs for equipment that could be made in rural workshops. This also included items for a wide range of markets, not all of which were within the agricultural sector. Of particular relevance to the agricultural sector is the range of *post-harvest and primary-processing equipment* that is locally fabricated. Post-harvest equipment is normally crop specific but the range includes cassava production machinery, oil-palm processing equipment, and equipment for rice harvesting, threshing and milling.

Although there are now many rural workshops established and capable of fabricating a diversified range of equipment, they still endure a number of disadvantages that include: lack of resources to maintain stocks of ready-made items and problems with raw material acquisition. There is no doubt that they are now making a serious contribution to the necessary infrastructure for agricultural mechanization – it is however less certain that this is sufficient for the needs of mechanization based on the use of tractors.

There is also considerable local artisan activity in the manufacture of *tools and equipment for irrigated farming*. The simplest equipment for water lifting is often made from old vehicle inner tubes or tyre carcasses. Watering cans are also often fabricated by small workshops from galvanized iron sheets. The Special Programme for Food Security of FAO includes a water component where low lift pumps have been promoted, the treadle pump being the selected model as it is easy to fabricate locally. Other low lift pumps have also been developed for local fabrication. There are also various designs of hand-operated pumps for greater depths, some claiming to operate to 70 m but this depth of work severely restricts delivery rates. The paper cannot provide an exhaustive review of the range of manual- or animal-powered pumps used in Africa but the objective is to indicate that there is a potential local market for such locally fabricated equipment. The issue of motorized pumping sets is not covered in the paper.

Over the years there have been many *incentives and initiatives to support the development of mechanization*. Among these is multifarm use of agricultural machinery. This arose from the

concern that in the large mechanization schemes the annual tractor usage was low compared with what was accustomed in the developed world. Encouragement was given for privately operated mechanization services, particularly for machinery based on commercial farms so that this could also provide services to the farmers in neighbouring communities. This was the subject of an FAO Panel of Experts meeting in 1980 out of which a Bulletin was prepared.

Many *spare parts and rehabilitation programmes* were initiated in an attempt to reduce frequent machinery breakdowns that had been attributed to such problems as damage and wear experienced during transport, lack of operator skills, and rocks and stumps in fields. The possibility of manufacturing some spare parts locally was also explored and technical information on this subject was prepared by FAO in the 1980s. At least one major international tractor manufacturer initiated a locally based tractor rehabilitation scheme in which an “as new” rehabilitated tractor was produced at a price about a third lower than a brand new one.

Support service workshops were also supported and FAO, GTZ and ILO, among others, produced a number of guides and manuals most of which are now out of print. Perhaps the utility of this type of material has now been surpassed? The long-standing, main workshops of the principal agricultural machinery dealers provide the main source of service expertise and are unlikely to benefit today from these publications.

Agricultural tractor and machinery testing programmes were set up at a number of research centres in Europe and North America; the one at the University of Nebraska in the United States being perhaps the most renowned. In the 1950s to the 1970s, there were also initiatives to develop test centres in Africa. Centres were opened in Kenya, Uganda (mainly training and the centre of the hire programme) and Zimbabwe. *Agricultural mechanization research centres* were established in Cameroon, Côte d’Ivoire, Malawi and in Ethiopia. Equipment for tillage, animal traction, post-harvest and rural construction featured prominently among their work. It is thought that the centres are still open although suffering from severe budgetary constraints in most cases.

This does not constitute an exhaustive list of such institutions but they are indicative of the efforts made to provide research and development support to mechanization programmes. The testing programmes were gradually abandoned

and attention turned in most of the centres towards prototype development work of machinery suitable for local manufacturing and operating conditions (so called “appropriate technology”). The publication *Tools for Agriculture*, of which several editions were prepared by the Intermediate Technology Development Group (ITDG, now known as Practical Action), played a major role in circulating information regarding potential designs.

There is now *renewed interest in testing and evaluation* of agricultural equipment. In particular the quality of handtools has received renewed attention in view of the large volumes being acquired by aid agencies for emergency programmes and the poor performance of some of the items received. A number of FAO publications contain recommended specifications and test procedures. Hand carried spray application equipment was also a cause for concern; operators rarely wearing protective equipment and some of the equipment being subject to leakages and poor quality fabrication. A series of recommended standards have been developed by FAO over the past decade. Details of all these publications are given in the paper.

Human resource development

A wide range of opportunities for *professional training* at various levels has been built up in Africa over the years. Many agricultural engineering university courses were introduced after independence, in addition to the traditional universities that had already existed in many countries. Many national and regional Associations of Engineers came into existence at this time. East and Southern Africa also have strong agricultural engineering training programmes in a number of prestigious universities. Solid networks of professionals, technicians and practitioners have also been initiated often with a specific interest in animal traction. The French-speaking countries of course also have a number of professional agricultural engineers although their background training is somewhat different from that in East and Southern Africa. The overall picture is that there are certainly many professionally qualified personnel available in many African countries.

A number of well-equipped *technician training centres* have been established, many through the assistance of bilateral or multilateral cooperation where skills-training is imparted for a range of specializations including carpentry, blacksmithing, metalwork, machining, motor mechanics, fitting, building construction. Some of these centres

achieved high standards in their technician outputs but, as *donor support was gradually withdrawn* from the 1980s onwards, it has proven increasingly difficult to maintain these standards with public sector funding alone. Some specialist centres were created as a result of technical assistance projects – aimed at training of specific skilled technicians or artisans and in order to promote the fabrication of a particular range of agricultural equipment – but because of various problems the future has become bleak for most of the centres and few flourish today. Other centres were established in the 1970s especially for the *training of operators and mechanics* sometimes associated with mechanization schemes and programmes.

Strategy formulation

In 1987 the FAO Panel of Experts on Agricultural Mechanization focused their attention on *agricultural mechanization strategies* that came about because of advice being sought by some member states following the collapse of tractor-hire schemes and efforts on ways to mechanize agriculture. A publication from 1981 provided guidelines as to the way forward and served as the main reference for several years but it left the *modus operandi* for the exercise very much to the implementers.

Since then a number of avenues have been explored, none of which have been entirely successful. A very detailed FAO supported mechanization study was undertaken in Malawi in 1992 and in the same year, Kenya undertook a strategy formulation exercise although without FAO support. Other FAO supported strategy formulations were carried out in Sudan (1995), Guinea (1996), D.R. Congo (1997) and Burkina Faso (1998). In all of these countries the agricultural mechanization scenario has since changed considerably but it is less clear if this has been influenced to any significant extent by the mechanization strategies that were then formulated.

The *cumulative experiences* of this work were brought together in two brief but concisely written papers published by FAO. The first of these lays emphasis on the important but separate roles that need to be identified for the government on the one hand and the private sector on the other. This emphasizes that in order for the agricultural machinery subsector to be sustainable, the action plan or strategy must ensure that all actors are subsequently able to

make a livelihood from their businesses, be they farmers, retailers, fabricators or importers. The second paper outlines the steps that might be followed during the formulation process.

Recent mechanization trends

Recent influences on agricultural mechanization have been affected by the global economic, social and environmental situation, with 2008 ending in financial disarray and uncertainty. Food riots erupted as basic food prices escalated dramatically in many developing countries. The oil price increased greatly but by the year end had dropped back to very low levels and the global banking system came under heavy pressure. Africa continued to suffer from a number of internal conflicts. Interest in environmental conditions and sustainability continued to be hotly debated, with global warming continuing to receive major attention and with the issue of carbon sequestration and its beneficial effects being particularly highlighted. Also, labour constraints because of the HIV/AIDS pandemic, the continued urban migration throughout Africa, and the focus on poverty alleviation and on improving livelihoods were major issues for discussion and concern. An increasing contribution that techniques such as those proposed under “good agricultural practices” (GAP) and conservation agriculture (CA) can have on the livelihoods of the rural populations in both Africa and Asia could also be noted.

With regard to *influences on Africa*, as the tumultuous year 2008 commenced, there was increasing awareness that China and India were seeking to capture some of the growing outsourcing of business from the West and to seek a greater share of the more non-traditional markets for its industrial output. Africa received increased attention for the marketing of goods from these two countries. “Aid-in-kind” reappeared and agricultural tractors, equipment and machinery together with transport vehicles are among the wide range of goods that have been offered and accepted as donations. Not all of the goods arrive as finished products and assembly plants for tractors and transport vehicles have been established in a number of countries.

FAO, taking into account many of the above considerations in Africa, decided that it was time “for a new look” at mechanization. The current situation was analysed in depth in an attempt to identify why progress, if any, over the past four

decades has been so slow. Comparisons were made, in particular with Asia, where growth in the number of tractors has increased tenfold in the period 1970–2000. The paper suggests that four main lessons can be learned from the Asian experience regarding successful policies:

- Encourage commercial agriculture and focus investments and support so as to increase the profitability of both farm and non-farm enterprises.
- View mechanization within a longer-term time frame as part of a broad-based economic development strategy.
- Recognize that mechanization involves important changes to the structure of the agricultural sector.

- Encourage economic demand for essential supply systems and support services.

Suggestions as to how this might be put into practice within SSA were:

- Focus on arduous operations.
- Encourage medium-scale farmers to provide mechanization services to their smallholder neighbours.
- Encourage the combination of biochemical technologies with mechanization.

The enabling environment necessary to achieve these ends was considered to include the following:

- Create an effective demand for the agricultural products leading to profitable farming that will contribute towards the demand for other inputs including mechanization.
- Establish policies and support services to encourage efficient use of mechanization inputs.
- Establish efficient agricultural machinery supply chains and service enterprises.

With reference to this paper the following are highlighted:

- The continued need for training.
- The continued need for research and development programmes.
- The need to reflect upon which training and training materials might be of use if the “new look” is to achieve reality in SSA.

Conclusions

This paper has reviewed some of the salient points emerging from the experiences in eight African countries as attempts have been made to introduce machinery and equipment to relieve the arduous tasks of manual labour during the process of food production.

Many of the earlier efforts were ambitious, concerning huge tracts of land and backed up both with donor support and strong public sector interventions. Appreciable advances were made in the establishment of training and research institutions and efficient dealer networks put into operation in many of the countries. Unfortunately, attempts to create mechanized services have generally been disappointing.

However, this refers mainly to those programmes focused on the use of agricultural tractors – the use of animal traction has flourished in many countries. Machinery for post-harvest operations and primary processing has also seen strong private sector involvement.

Renewed attention is being turned to tractors and also on improving the availability of more specialized equipment. One such urgent need is for equipment for planting directly through crop residues and for weed management under systems of CA.

There seems to be general agreement that the way forward must involve the private sector and that mechanized activities must be profitable. Some countries have acquired equipment but viable programmes still remain to be put in place. It hoped that the review presented in this paper may assist the reflection required during this formulation process.

Chapter 6

Networking and south-south linkages

6.1 FARM MECHANIZATION – INDIA AND AFRICA PARTNERSHIP

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Introduction

This paper looks at the (1) Indian tractor industry; (2) World tractor market; and (3) Farm mechanization in Africa and India. The paper ends with proposals for the way forward.

The Indian tractor industry

In 1971–1972, as a percentage of power used in agriculture, tractors had a 7.5 percent share. At present tractors account for a 42 percent share. India presently has more than 3 million tractors in use, far higher than in China (about 1 million tractors). Density of tractor use in India is 12 tractors per 1 000 ha whereas the world average is 17 tractors per 1 000 ha (the United States is 27). Farm mechanization using tractors started in India in the early 1960s. By 1990 annual sales of tractors in India were about 120 000 units and grew steadily to about 270 000 units in 2000. Between 2000 and 2004 annual sales slipped back to about 172 000 units and then grew steadily again to reach a peak of about 356 000 units in 2007. Since then sales have slipped once again to an estimated 330 000 units in

2009. The *Compound Annual Growth Rate* for the last 19 years is 6 percent while for last 6 years it has been 13 percent. Over 70 percent of tractor sales were in the 31 to 50 h.p. range. Virtually all tractors sold in India are domestically manufactured. There are nine major tractor manufacturers but the market is dominated by three: M&M⁸ Group (39 percent); Tafe Group (22 percent); and Escorts (12.5 percent). John Deere and Sonalika each have about 9 percent of the market. The export market is also growing with numbers of tractors exported rising from about 8 000 units in 2000–2001 to over 43 000 units in 2007–2008. Exports were mainly to the United States (60 percent) and countries of the *South Asian Association for Regional Cooperation* (SAARC) (20 percent). Only 5 percent of the total exports went to ASEAN⁹ countries and Africa. John Deere (31 percent); M&M (22 percent); TAFE (19 percent); and New Holland (14 percent) had the greatest share of the export market.

World tractor market for Indian manufactured tractors

The United States and SAARC¹⁰ are target markets for Indian tractors and 80 percent of exports go to these markets. The western Europe market is dominated by 90 h.p. -4WD and larger tractors having advanced features such as an air-conditioned cab. There is also a market for specialized tractors such as vineyard tractors. A greater potential for

TABLE 14

The tractor market in India in the early 1970s

Tractor usage limited to own agricultural work	Low-cost tractors having basic features were preferred
Tractors were used primarily for land preparation	Simple in design
Fields were scattered and irrigation dependency on rain was high	Standard features such as sliding mesh gearbox
Mostly progressive and big landholder used to buy tractors	Manually controlled hydraulic systems
Largely single cropping patterns	Manual start
Manual labour was available in abundance	Basic drivers seat
Low h.p. tractors were demanded	

8 Mahindra and Mahindra.

9 Association of Southeast Asian Nations.

10 South Asian Association for Regional Cooperation.

TABLE 15

The present tractor market in India

Increased use of tractors in non-agricultural applications	Constant mesh synchromesh gearboxes
Moving towards secondary mechanization leading to the use of new attachments such as reapers, combine harvesters, seed drills, diggers and planters	Wet disc brakes
Land consolidation is completed in most of the states. States moving further towards electronic record-keeping	Side shift levers
Farmers with small landholdings 2–4 acres are investing in tractors	Mix mode hydraulics compatible with tipping trailers
Multicropping and cash crops pattern	Deluxe adjustable driver seats
Reduced availability of cheap farm labour	Multistage air filtration
Higher h.p. tractors are more in demand.	Electric engine starters
Tractors with add-on features are now in demand	Dual clutch
Power steering	Provision for stereo

Indian exports is offered by markets in South America and Turkey. Africa is also a large potential market for Indian tractors. Japan and Korea have strong local manufacturing facilities and also import negligible numbers of tractors. In China there are many local manufacturers, selling at low prices. This offers the potential to set up or acquire tractor manufacturing plants.

The world tractor market

World sales of agricultural tractors and machinery in 2005 was about US\$70 billion. This is estimated to rise to US\$89 billion by the end of 2010 and to US\$112 billion by 2015. In 2005, the Asia and the Pacific region accounted for 34 percent of total sales followed by North America with 30 percent and western Europe with 24 percent. On a global basis, sales to Africa were negligible. This situation is not expected to change in the near future. Of the global sales of agricultural machinery, tractor sales are about 30 percent of the total. The global tractor market was estimated to be about 1.2 million in 2005 of which approximately half were tractors of less than 50 h.p. In India over 80 percent of tractors sold are less than 50 h.p. In Africa most tractors sold are over 50 h.p.

Short-term trends affecting the growth of agricultural equipment

- The minimal impact of global slow down
- The agricultural equipment market has largely been unaffected by general tight credit conditions – the top three companies have strong financing operations or connections
- Prices generally stabilized in 2009
- In 2008 agricultural commodity prices were high

The three largest tractor and agricultural machinery manufacturers in the world are AGCO, Case New Holland and Deere & Company.

Farm mechanization in Africa and India*Agriculture in Africa and India*

- Africa has 632 million ha of cultivatable land. Of this 143 million ha or 23 percent is cultivated and is mostly rainfed.
- India has 162 million ha of cultivatable land. Of this 142 million ha or 88 percent is cultivated. Of this, 55 million ha is irrigated.

Major Crops

Africa: maize, coffee, wheat, rice, oil seeds, sorghum, cotton, pulses, cassava

India: maize, coffee, wheat, rice, oil seeds, potato, cotton, pulses, sugar cane

There is a large commonality in crops and crop cycles; however, India has developed strengths to support crop cycles that have assisted farmers in improving productivity.

TABLE 16

The agriculture situation in Africa

Strengths	Gaps
Availability of large areas of unused arable land	High imports of food
Ample labour available	Low level of farm mechanization
	Low farm productivity
Potential to improve	Emphasize
Increased productivity	Large gap between supply and demand
Shift government focus to agriculture	Increase per capita consumption of food grains
Development support from South and East Asia (India and China – preferred partners)	

TABLE 17
Yield of principal crops in Africa and India: impact of mechanization

Crop	Africa (tonne/ha)	India (tonne/ha)
Maize	1.3	1.8
Rice	1.4	2.9

Enormous potential to increase productivity by mechanization

- Manual labour: Man can feed himself and up to three other humans
- Animal draught power: Man can feed himself and up to six others
- Mechanical power: Man can feed himself and up to 50 others

TABLE 18
Comparison of agriculture productivity between Africa and other countries

Region	Cereal yield (kg/ha)	Fertilizer use (kg/ha)	Irrigation (% of arable land)	Tractors (per 1 000 ha)
Africa*	1 040	13	5	3
Average of 8 countries**	3 348	208	38	24
India	2 367	103	34	22

* Less Egypt and Mauritius

**Average of Bangladesh, Brazil, China, India, Pakistan, Korea, Thailand, Viet Nam.

Mechanization benefits attained by India

Between 1951 and 2001, the availability of farm power increased from 0.522 to 1.723 kW per ha. During the same period, the average yield of food grains increased from 0.25 tonnes/ha to 1.35 tonnes/ha. India has increased productivity by 12–14 percent; the saving in seed through using seed drills is 20 percent; savings in fertilizer use is 15–20 percent; enhanced cropping intensity is 5–22 percent and the increase in income and returns is 24–49 percent. From the early 1960s to 2001 the number of tractors has increased from about 60 000 to 2.7 million; power tillers have increased in number from 1 500 to 70 000; combine harvesters have increased from 100 to 4 400; the cultivated area has increased by 7 percent; the irrigated area has increased by nearly 100 percent and farm animal numbers have decreased by 23 percent.

In terms of food production, the increases between the early 1950s and 2000 have been dramatic. For example, foodgrain production has increased by over 300 percent; potato production by nearly 1 400 percent; oil seeds by nearly 400

percent; and sugar cane by over 400 percent. Farm mechanization has significantly affected the attainment of this higher productivity.

Agriculture and mechanization in Africa:

Overview

Overall, productivity is very poor, largely because of low levels of investment in all types of production inputs. This is illustrated in Table 18.

Tractor shipments to Africa

Between 2000 and 2008, tractor shipments to Africa increased from 7 773 to over 24 000. By far the greatest numbers of tractors shipped were in the 71–90 h.p. size range (53 percent in 2000 and 46 percent in 2008); 26 percent of tractors shipped

were in the 41–70 h.p. range; and 16 percent were in the 91–125 h.p. range.

Massey Ferguson has the greatest share of the market with over 31 percent of tractors sold, followed by New Holland (15.5 percent), Landini (14.3 percent) and Deere (12.3 percent). Other brands in the market include Escorts, Same, Mahindra, Case IH, Tafe. Tractors sourced from India included Escorts, Deere, Mahindra, Tafe, New Holland, and Same. In 2007, Indian tractors held about 21 percent of the market.

TABLE 19
Farm power sources for land preparation in sub-Saharan Africa and other regions

	Hand (%)	Animal (%)	Engine power (%)
Sub-Saharan Africa	65	25	10
Other developing regions*	25	25	50
India	6	7	87

*Asia, Near East and North Africa, Latin America & Caribbean.

Africa – Opportunities and observations

Opportunities

- Largest importer of agriculture products in the world
- Government focus is shifting towards mechanization of agriculture
- Offers highest potential for agricultural machinery sales in a stagnant world scenario
- Looking eastwards for development support (India and China preferred partners)
- Indian focus on Africa in order to further attainment of global power status – offers financial support in the form of Indian line of credit
- Land – Availability of large unused arable land (1.34 times of India)
- Manpower – Ample manpower
- Mechanization – Low level of mechanization
- Need – Largest gap between supply and demand for agricultural output
- Huge potential for tractor sales and earning revenue and contributions
- Huge potential for implements and Genset business also

Observations

- Fifty percent all total industry sales covered by 71–90 h.p. sector
- Market has majority of business defined as “FLOW through Distributor”
- Significant tender business also exists, often government administered
- Indian Government financing has become an important factor
- Increasing general Chinese investment in Africa is starting to impact tractor business also

Framework for farm mechanization in Africa

Farm machinery opportunities from India to Africa

Mechanization – It is important to understand that it is not just farmers who are involved. There are important linkages between the main interest

groups: manufacturers; importers; distributors and dealers; and farmers and for mechanization to succeed it is essential that all are making a livelihood (i.e. profit) from their businesses.

The different roles of the private sector and the public sector

Farmers need: choice, markets, favourable price environment (both input and output), stability, credit, information

Retailers and dealers need: free competition, assistance with business development, credit and finance, clear and fair legislative framework, good infrastructure, good communication, stable market, access to information

Manufacturers need: free competition, access to raw materials, credit and finance, investment capital, marketing assistance, access to foreign exchange at undistorted rates, technical assistance

Importers need: suitable commercial environment, free competition, foreign exchange, easy access to import licenses (abolish?), credit and finance

The farm machinery industry in India

The farm machinery manufacturing sector has increased greatly over the past 30 years. There are now 14 agricultural tractor manufacturers in the market, 7 power tiller manufacturers, and nearly 7 000 companies making tools and implements. There are other companies making combine harvesters (15); reapers (45); tractor parts and accessories of agricultural machinery (546); earth moving machinery and parts (188); diesel oil engines (200); rice processing machinery (300); dairy and food industry machinery (500). There are also over 1 million village craftsmen.

Farm mechanization: India proposal

The way forward:

- Survey and feasibility report
- Detailed action plan
- Seeding of farm machinery (tractor and equipment)
- Development of channel system
- Business association

It is time for a new look at agricultural mechanization in Africa. By this, India can help by empowering African farmers through farm mechanization and farm implements and in turn help Africa to attain food security in the near future.

6.2 SOUTH-SOUTH TECHNOLOGY SUPPLY AND TRANSFER: EXPERIENCES FROM EAST AFRICA AND BRAZIL

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and

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and Agro-Industries Division, FAO

Introduction

Historically farmers have been motivated to mechanize their agricultural operations primarily through: increasing labour productivity; increasing farm income; and reducing drudgery. In Brazil, though, in the 1970s an additional issue led to farmers mechanizing. This was the great loss of topsoil and agricultural productivity as a result of erosion caused by inappropriate tillage practices. Consequently the concept of conservation agriculture (CA) was developed. Today, especially in southern Brazil, CA practices, including no-till are the preferred way of farming.

Soil conservation is of equally vital importance in Africa but at the same time in many regions there is a pressing need to raise labour productivity. Farm labour is being depleted through increasing rural-urban migration and the debilitating and lethal effects of pandemics. This affects particularly the fit and young. Reducing soil tillage and conserving soil organic matter slows down or eliminates soil erosion and raises soil fertility and crop yields. Reducing soil tillage not only reduces energy inputs but it also reduces production costs and improves the timeliness of agricultural operations.

This paper describes the development of mechanized CA in southern Brazil and then discusses the lessons that have been drawn for a promising programme of south-south technology transfer from Brazil to Africa.

Experiences in Brazil

Farmers in southern Brazil, mostly immigrants, started farming using conventional mechanized practices with tractors or draught animals as the source of power. Bare soil led to high erosion and also weed control presented particular problems. In looking for solutions, farmers tried moving to no-tillage and with this came the idea of permanent soil cover. This led to the development of what today is known as conservation agriculture. A fundamental component of CA was the change from power intensive soil tillage to energy saving no-tillage. The most important machine for CA is a

no-till seeder or planter and also often (particularly initially) the need for spraying equipment. Brazil has a well-developed input supply chain, both for machinery and services. Manufacturing expertise exists for all types of machinery including hand-operated jab planters, animal-drawn machines to tractor-powered planters. Details of the range of equipment available can be found on the FAO CA website.

The *evolution of the CA equipment industry in Brazil* came about as a result of deforestation and the consequent soil erosion and land degradation. The development of CA was an evolutionary process involving technological, social and economic factors, research and development, manufacturing, communal use of equipment, and government finance and support. At the beginning of the 1970s pioneer farmers started to experiment with no-tillage. This was followed by systematic research into no-till planting leading to the manufacture of the first machines. Pioneer farmers and regional workshops developed functional no-till planters and a diverse range of crops and cover crops amenable to no-till systems. During this process, manufacturers were developing their products and were creating new designs of no-till planters.

Following the start in the early 1970s, there then followed several important milestones in the development of the CA machinery industry in southern Brazil. In the mid-1970s problems in the manufacturing processes were addressed by the Ministry of Industry and Commerce. In the 1980s the World Bank assisted in the formation of soil commissions and the first Brazilian manufactured no-till seeder was produced. The 1980s and 1990s saw further development and understanding of the design concepts for planters and seeders. From 1978 to 1984 the World Bank funded the Paraná rural programme to develop and promote no-till in southern Brazil. In the mid-1980s the first animal traction planter was developed and glyphosate production started in Brazil. In 1993, in the State of Rio Grande do Sul no-till expanded from 50 to 850 000 ha in 4 years and advantageous credit was made available. In the late 1990s, comparative on-farm evaluation of CA machinery was introduced leading to manufacturers' design improvements.

Mechanized no-till has been continually strengthened in these past 4 decades. Now there are some 25 *no-till planter manufacturers* producing some 300 models. The *area under no-till* increased from 1 million ha in 1992 to well over 26 million in 2010. Today, smallholder farmers in southern

Brazil are in transition; they are changing from animal power to tractor power using small no-till machines, renting services for animal-powered planting and spraying equipment or simply renting crop management services and devoting themselves to other profitable activities. Throughout, this process has been assisted by finance from the federal, municipal and state governments. The fruits of these synergistic efforts by many stakeholders have made Brazil a world leader in CA technology, which is being disseminated worldwide through publications, study tours to Brazil and trade missions.

The *main setbacks* to no-till expansion in the 1980s were the lack of knowledge of efficient herbicides and imperfect planter technology. However, through research work and farmer experience, the concepts of crop rotation and the use of cover crops, as well as the need for proper land preparation prior to CA, were developed, consolidated and adopted.

Experiences in East Africa

FAO is promoting the adoption of CA among smallholder farmers through several projects. This is being carried out through study tours and trade missions from East Africa to southern Brazil to stimulate an exchange of technical information and promote the manufacture of locally adapted CA equipment in Africa. FAO had previously relied on the direct importation of Brazilian equipment, which is neither sustainable nor desirable. Details are to be found on the African Conservation Tillage Network (ACT) website. A recent study tour for one of the projects consisted of visiting and meeting Brazilian manufacturers, a joint workshop for the exchange of ideas between manufacturers, and also one-to-one discussions between interested manufacturers on both sides. The discussions were rounded off with a session to identify a future collaborative action programme with manufacture, training and importation as the main elements.

The East African *manufacturers* felt that they were ready for an agreement on joint production whereas their Brazilian counterparts felt that such a proposal would only be viable as a second option and suggested that the first step would be to adapt the equipment to the region through creation of customer awareness and demand. There was a general willingness to produce together in joint venture arrangements, but only after a full evaluation of the parties' interests had been factored in. It was suggested that some samples

of implements and equipments could be made available through ACT for demonstration purposes in order to create more awareness in East Africa.

Training for the manufacturing of complex parts is necessary for the East African manufacturers. Training on the equipment operation was pointed out as very critical. User manuals need to be available in English and other local languages. The issue of bringing a delegation of technicians to Brazil for technical training would be explored. The Ministries of Agriculture from East African countries should be involved in the training initiatives.

The question of direct *importation* also needs to be discussed, including the availability of English version marketing manuals and catalogues, and operational manuals in order to promote the equipment in the region. Initially it has been found expedient to import CA machinery directly from Brazil to East Africa and has been mainly concentrated on technology for the smaller farm sector (manual and animal-powered equipment). Direct importation is convenient for short-term projects but it does not build the manufacturing skills in the recipient country that are needed for the development of a sustainable agricultural engineering industry.

Brazil is currently actively pursuing initiatives to promote development linkages with Africa through a number of agencies whose mandate is to promote Brazilian products and industries in the world. To encourage their participation in the technology transfer process they will be provided with a concise summary of this successful trade mission workshop. Other initiatives in West Africa are being established.

There have already been some *positive results* emanating from this project-led intercontinental interaction. This has mainly centred on East African manufacturers' efforts to produce equipment of similar design to that available in Brazil, and that has been imported into East Africa through the efforts of the project and one private company in particular, Brazafic.

The *local manufacturing sector in East Africa* has recently awoken to the potential of CA equipment. The cross fertilization of ideas with Brazilian companies during the study tour and workshop described above has been instrumental in focusing the attention of policy makers and manufacturers alike. There are several examples of initiatives that have already been taken:

- Intermech of Morogoro, Tanzania, has been encouraged to produce batches of manual and draught animal powered CA equipment by the Tanzanian Ministry of Agriculture, Food and Cooperatives. These batches are bought by the Ministry and sold on to farmer end-users via the extension service trained in CA technology.
- Femo Works, Nairobi, Kenya, started from a position of little knowledge of agricultural engineering technologies but now this company is making the plastic mouldings for a jab planter.
- Nandra Engineering, Moshi, Tanzania, produces animal-drawn rippers for reduced tillage and also has a commercial production of jab planters (in common with several regional manufacturers). As a result of the study tour to Brazil, the company developed an animal-drawn no-till planter. The outlook for the commercial production of this well-made machine is very promising.

What are the *next steps*? Although important advances have been made, there is more to be done. One recommendation would be to take advantage of Brazilian manufacturers' offers for hands-on training of East African equipment development engineers. Once the East African manufacturers are familiar with CA equipment design, then the possibility of joint ventures can be explored further. At the present stage of development of CA in East Africa, Brazilian manufacturers are concerned that effective, farmer-driven, demand for CA equipment is sufficiently great to support joint venture manufacture.

Conclusions

The Brazilian example of mechanization of no-till and CA led to an extensive expansion of CA-focussed agriculture with a mix of smaller, animal-powered farms and larger fully mechanized farms. It has become clear that the successful adoption of CA in southern Brazil has been because of the synergistic and catalytic interaction of investments from all the stakeholders. Investment in R&D, training and support to both industry and user has been fundamental to the success of the venture. The same would almost certainly have to be as true in East Africa as it has been in more developed economies.

The experience in Brazil demonstrated that:

- The process evolved from the perceived need for urgent action to combat soil degradation and erosion.
- Although initiated by the private sector, the evolutionary process was facilitated by widespread and profound public sector and international donor support.
- Very active farmer demand for no-till equipment led to the development of a manufacturing and machinery supply-chain industry that supplied and serviced a complete range of agricultural machinery.
- The evolution of the CA equipment supply has been a principle factor in the development of an agricultural engineering industry, especially in southern Brazil, which has gained worldwide respect.

There are some lessons that can be drawn for the African situation:

- There is presently a clear desire to move away from hoe-based farming.
- The problems of land degradation and soil erosion are equally pressing in the African situation.
- A piecemeal approach will not produce the desired results. Interlinked and consolidated action from a range of stakeholders is a necessary prerequisite for positive change in farm mechanization. These will include: governments, international donors, financial institutions, private sector manufacturers and service providers, and farmers.
- Farmers' vision for more viable and sustainable farming operations can be invigorated by positive examples – for instance the process of CA innovation and adaptation.
- The process of mechanization of farming will necessitate actions tailored to the specific situation in Africa.

The most probable future scenario will be a mixture of local manufacture of equipment for small- and medium-sized farms in combination with the importation of more complex equipment. Manufacture will be part of an equipment supply chain that will create and support the necessary conditions to allow African farmers to escape from the tedium and low productivity of hoe

farming. Development of CA technology will not only liberate hand-hoe farm families but will also protect agricultural soils and ensure sustainable production into the future.

6.3 GLOBAL AND REGIONAL NETWORKING AMONG MACHINERY SUPPLIERS: EXPERIENCES OF THE AFRICAN CONSERVATION TILLAGE NETWORK (ACT)

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Introduction

Africa is losing the battle to feed its population. Eighty percent of the most desperately poor people in Africa are subsistence farmers, whose cereal crop yields have been stagnant at about 1 tonne per hectare during the past 35 years. Land degradation, erosion, drought and climate change have caused agricultural yields in parts of Africa to fall by up to 50 percent.

The level of engineering technology inputs in African agriculture is strikingly low and has been cited as one of the main constraints hindering the modernization of agriculture and food production systems in the continent. Fertilizer use per hectare is only 6 percent of that of Asia; irrigation only 13 percent of the irrigated area of Asia; and the number of tractors per 1 000 ha is only 12 percent of that of Asian countries. Africa's population is growing at an annual rate of approximately 3 percent while growth in food production is only 1–2 percent per annum and food production must double by 2030 if hunger and starvation are to be avoided. This is unlikely to be achieved under current land management practices, which are responsible for excessive natural resource degradation that threaten the short, medium and long production potential of the natural resource base.

The objective of this paper is to look beyond just the mechanization hardware; to look for complimentary interventions that can accelerate or hinder the wide-scale adoption of mechanization. More thought will be shared on the benefits of partnerships, networking and farmer-based institutions in enhancing mechanization.

Possible interventions – conservation agriculture (CA)

One such intervention is CA, which uses a variety of principles and techniques with the aim of producing high crop yields and at the same time reducing production costs, maintaining soil fertility and conserving soil moisture. It is a way to achieve sustainable agriculture and improve

livelihoods and it is a technology being practiced and benefiting many smallholder and large-scale farmers particularly in North and South America. Adoption of the technology is also expanding in Africa.

CA has three basic principles:

- Disturb the soil as little as possible. The ideal is to plant directly into the soil, without hoeing or ploughing. Tillage is reduced to ripping planting lines or making holes for planting with a hoe.
- Keep the soil covered as much as possible. Mulch, special cover crops and/or crop residues left on the field protect the soil from erosion by water and wind, enhances water infiltration and its retention as soil moisture for crop use, and limits weed growth throughout the year.
- Mix and rotate crops. This prevents or reduces the survival and multiplication cycles of pests, diseases and weeds.

To gain the full benefit and sustainability of CA, all three principles have to be applied at the same time. This ideal is not possible everywhere, but farmers should try to go into that direction as far as possible.

The *benefits* of CA are: increased water infiltration; reduced runoff and soil loss; reduced evaporation losses; and improved soil-moisture storage. In this way, CA also helps to mitigate climate variability and change. CA also helps to improve groundwater recharge. CA reduces labour requirements particularly the power required for land preparation and hence enables farmers to increase the area farmed and to plant on time. CA also helps to increase or stabilize soil organic matter levels and biodiversity. CA may thus contribute to carbon sequestration and by planting without ploughing the land, the decomposition of soil carbon and hence carbon dioxide emissions are reduced.

The major *challenges* of practising CA relate to the need to change attitudes. *Ploughing* has been the recommended traditional tillage practice for hundreds of years and for many people it is difficult to imagine growing a crop without ploughing. Retention of *crop residues* on the field is another serious challenge for many farmers keeping livestock and practising communal grazing systems. *Weed control* is a problem for most farmers particularly during the first year and

especially those opting for mechanical weed control as opposed to users of herbicides. Elimination of ploughing, which is also practised by farmers to control weeds, initially increases weed infestation. However, the use of winter weeding techniques and preventing weeds from seeding helps to reduce the seed bank reservoir in the soil and thus gradually reduces the recurrence of weeds.

The principles of CA as stated above can be implemented in various ways depending on the agro-ecological environment and the resources available to farmers. CA is not a technology for the rich or the poor only, but rather is a technology that applies across farmers with a diverse resource base applying the three key principles in different ways.

Techniques for manual systems

(a) Conservation farming basins can be used where farmers have to rely on the hand hoe using their own manual labour. Carefully and uniformly spaced planting stations, about 15 cm deep and 15 cm wide are placed along a straight line running across the main slope with the aid of a string and pegs at each end of the string. These stations are also known in Zambia and Zimbabwe as conservation farming basins or CF. Preparation of the basins can be done anytime during the dry season so that they are ready for planting at the beginning of the rainy season. Weed control is carried out throughout the season.

Experience shows that this system enables higher crop yields particularly during drier years because of improved water harvesting in the basins, precision placement of manure or fertilizer and timely planting. Subsequent crops in the rotation are planted in exactly the same basins, thereby ensuring more efficient utilization of residual fertility from the previous crops. There are currently about 200 000 ha under basins farming in Zambia and Malawi. Laborious as it is, it is precision farming using rudimentary tools that comparatively delivers better yields even in years of inadequate rain.

(b) Jab planting into residues can be carried out where the farmer has good soil cover from residues or other biomass. Planting is carried out using a hand held jab planter that enables opening of a planting hole, placement of seed and fertilizer as well as covering, all in one operation. This technique enables easy direct seeding into unploughed soils covered with residues and helps to save the labour needed to make the planting basins and leads to more efficient crop establishment.

In both systems, shallow weed control (by the machete or cutlass) throughout the year is recommended and experience shows that the weed pressure drops considerably in subsequent years.

Techniques for animal-drawn systems

(a) Rippers and subsoilers can be used in animal-traction systems and various options are available. Planting rows may be opened using a ripper or subsoiler drawn by animals. Deep subsoiling (25–30 cm deep) may be needed during the first season of implementation to break an existing plough pan (hard layer). In subsequent seasons a shallow furrow opening ripper is used to prepare planting furrows.

Planting is carried out manually into the furrows leaving the residues on the surface. Weed control can be achieved manually or chemically through use of appropriate herbicides, and the key to good control is catching the weeds when they are still small. It is vital to prevent the weeds from seeding in order to reduce the seed bank in the soil. Although rippers are relatively cheap and adaptable to the ox-drawn plough beam they cannot be used effectively in systems with heavy loads of mulch because the residues get caught up on the implement. Such problems have been overcome with direct seeders that have a mulch cutting coulter.

(b) Seeding into residues with animal-drawn planters is a technique whereby a narrow (2–4 cm wide) furrow is opened and seeds and fertilizer are placed precisely into the furrow. Direct seeders are available from many manufacturers in Brazil and dealers in South Africa, Kenya and Zimbabwe. The use of such equipment improves work rates and saves labour. Multi-row seeders for crops such as maize, soybean and cotton are also available on the market but at a higher cost.

Techniques for tractor-based systems

Using the same principles, CA can also be applied in tractor-based systems. In Zimbabwe the use of CA in commercial farming systems was driven by the good availability of suitable direct seeding equipment and sprayers that could be mounted on the tractor. In such systems harvesting of crops such as soybeans, wheat and maize is carried out by combine harvesters that chop up the stover. This allows direct seeding equipment to function well. A variety of such equipment is available in many parts of the world such as Brazil, Australia, South Africa, Zimbabwe and Kenya. A major advantage of this equipment is its capacity to save fuel and machinery wear and tear.

CA can thus be implemented in various ways using whatever equipment a farmer has at his/her disposal. What is important is to ensure that the three key principles are adhered to. There are over 100 million ha under CA worldwide, but only 4 percent of this is in Africa.

Networking in the mechanization of CA

(a) *Partnerships in research and development*

Brazil took 20 years to achieve 1 million ha of no-till but then adoption of the practice over the next 16 years grew exponentially to 20 million ha. Analysis reveals that it was the intensive planter research and development that revolutionized no-till. Key partnerships for success were the private sector, public agricultural research (IAPAR), farmers and the state. Manufacturers backed by other partners continued to multiply the machine models to cater for regional requirements and international demands. Now, 300 different models are available in Brazil. The animal traction no-till planter was developed with the assistance of different incentives but again through partnerships.

For Africa, underinvestment in R&D is a serious problem. The putting in place of comprehensive R&D facilities in each country would be expensive and could well lead to serious underutilization of the investment. At the moment a few African countries have sophisticated R&D facilities that are lying idle because of various reasons such as a lack of skilled experts or inadequate work volumes. Strengthening institutions and partnerships with the private sector, farmers, and civil society organizations is now essential to increase market responsiveness and competitiveness, and ensure that the poor benefit.

(b) *Networking CA equipment supply in Africa*

ACT, with partners such as FAO, FAPEAGRO,¹¹ the private sector and R&D institutions, have embarked on initiatives to enable farmers to access quality CA equipment. Some measures taken include a study visit to Brazil, a workshop in Brazil between East African and Brazilian manufacturers, and ACT workshops and links to R&D institutions for production of specialized machinery. ACT encourages the production of prototype CA equipment by East African workshops, and which are then distributed to farmers for testing and feedback. Up to now the achievements can be

11 Fundação de Apoio à Pesquisa e ao Desenvolvimento do Agronegócio, Brazil.

summarized as: (i) five of the six manufacturers have shown interest and are producing specialized CA equipment; (ii) two of the workshops have invested in tooling in anticipation of mass production demands and quality assurance; and (iii) several importers are stocking jab planters, animal drawn and no-till tractor seeders for the market.

However several challenges remain. Quality assurance is still a concern and is because of lack of expertise, old existing machinery and tooling. Without greater investment in machinery, materials and working capital, the goal of producing millions of items (instead of hundreds) is unlikely to be realized in the near future.

There are several *entry points for mechanization* of CA. Farmers are more attracted to invest in mechanization if their investment costs are recouped in the shortest time possible. Producing for the market brings more profits for farmers and hence better capacity to afford mechanization. Smallholder CA in Africa has focused on staples (maize, sorghum) in pursuit of food security goals. But, because the marketing of these staples suffers as a result of government interference and as well the ability of farmers only to produce a single crop in a year (under rainfed conditions), the aim of eradicating poverty is not achieved. Farmers with smallholdings are unable to get out of poverty.

Financial benefits to be achieved from CA are therefore more likely when applied to cash crops and which include rice, cotton and wheat. In particular, power tillers have been successful in rice mechanization mainly because of the supportive market prices. Rice is also very labour intensive and it is financially beneficial to substitute labour with machines. Introduction of CA to conventional mechanized farmers will enhance available options for them to conserve energy, conserves enough moisture to support a second crop and saves water for other down stream users, hydropower generation and the ecology.

Another entry point is to introduce CA into existing or forthcoming conventional tillage mechanization projects. Introducing CA no-till seeders to be used with existing prime movers stands a chance of reducing environmental degradation and eventual adoption of beneficial options of CA by these farmers.

There are a number of critical issues to be addressed. Strategic planning is required so that forward planning on future mechanization needs and infrastructural investments are identified and accommodated for. These include opportunities that are expected to emerge in the near future such as mechanization of the livestock industry, horticulture, fruits and processing, and cold storage facilities. National governments need to enter into a dialogue at subregional level (regional economic commissions), and they need to prioritize and so enable sub-regional investments in manufacturing of mechanization machinery production. Designated national R&D institutions should be capacitated and assigned a quality assurance mandate for a subregion in order to make optimal use of investments and expert staff. Networking among mechanization institutions should be stepped up in the endeavour to exploit synergies, reduce duplication of work and costs.

Chapter 7

Financial sector requirements

7.1 FINANCIAL EXPERIENCE WITH CROP MECHANIZATION IN TANZANIA

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Introduction

This paper addresses key issues, constraints and challenges facing government policy-planners and stakeholders in charting the way forward in crop mechanization. Emphasis is given to addressing the problem of lack of access to credit and/or finance.

Background

To place this financial conundrum in historical context there was a period in this country when agriculture was a priority sector, and government a primary financier. Under President Nyerere farming and agricultural production were activities supported by government; farmers had access to machinery, educational/medical facilities, transport and to food. Crop Boards were set up to guarantee markets for farmer produce; essentially the crop value chain was managed by the state. Farmers were organized into “groups” under a policy known as “Ujamaa” where farmers were compelled to form cooperatives. In the mid-1980s Tanzania became a free market economy and was accompanied by the government’s withdrawal from many social and/or economic development services, especially within the agricultural sector. These services were to be met by a private sector that had little formation or training during this critical period of transition. People and farmers living under a socialist regime were simply not prepared to become entrepreneurs or business owners overnight. Early 2000 saw increased donor and government support for private sector training and capacity building. By that time though, many farms were in a state of neglect; stagnation had set in and the number of smallholder subsistence farmers increased, municipal services deteriorated, extension services shrank, schools were oversubscribed and the transport infrastructure

was in a state of decay. Nevertheless, during this time of serious challenge, farmers took initiatives to establish informal credit unions in order to provide credit facilities. Many of these credit unions have survived in the rural areas. Credit terms are expensive and a majority of the unions need capacity building and training. As a result of nearly 30 years of centrally planned economic activity, the private sector, including farmers, has had difficulty adapting to pressures of a competitive business environment. Moreover the prevailing mindset did not view farming as a business. That mindset is changing now so that farmers and their communities are not viewed as mere “peasants” unworthy of attention or new investment.

Related issues

Other issues and constraints that impact crop mechanization, farm modernization and investment attraction include:

- Poor road, rail transport and information technology infrastructure to move goods to market;
- Low quality inputs (availability, quality of seeds, fertilizers, pesticides, etc.);
- Lack of access to new technologies and training on farm implements, power tillers, tractors, etc.;
- Low level of national budgets allocated to agriculture;
- Land use discrepancies and ownership transfer still a controversial issue;
- Lack of centralized databases, including dissemination of information on commodity prices, equipment procurement and market trends;
- Lack of knowledge-sharing on crop mechanization benefits – which machines, implements and/or tools are best suited for particular crop varieties, soils and ecological conditions;

- Lack of affordable credit for farmers for inputs, including machinery;
- Lack of entrepreneurial incentives and inability to retain the youth on the farms;
- Enormous post-harvest losses.

A great *potential for crop mechanization and irrigation* exists. The percentage of arable land cultivated for farming is very low in Tanzania. Agriculture is the source of employment and income generation for the majority of Africa's population but the level of crop mechanization is much lower than in Asia, Latin America and the developed world. However, high levels of economic growth (average 6.5 percent) over the last decade have renewed interest in crop mechanization. New suppliers from China, India and Brazil have entered the market. The most popular tractor brands include: Massey Ferguson, New Holland, CATIC, Ford and John Deere. There are new makes of power tillers on the market made in Japan, Korea and India but with varying degrees of success. The total number of tractors in Tanzania is estimated to be 9 000 but of these it is estimated that 5 000 are out of service. SSA has a long way to go to catch up with the rest of the world. Investment in new technologies is not only dependent on access to capital. Farmers need knowledge of which types of equipment are suitable for their conditions and crops being grown. Access to information is an extremely important and integral part of making crop mechanization a reality on the continent.

In recent years within Tanzania a few suppliers (Massey Ferguson, Africatic and John Deere), working in tandem with financial institutions, farmer groups and local distributors/agents, have been able sell tractors and machinery. This accelerating pace of crop mechanization will enable Tanzania and other countries in the region to meet rising demand for food. Demand for food in Africa will continue to rise with rapid urbanization. The utilization of grains, cereals and other feedstock for production of bio-fuels will increase demand further. In Tanzania, bio-fuel production (if planned accordingly) can complement food production.

There is a vast potential for irrigation and there are opportunities for private sector investment in large-scale and small-scale irrigation projects.

A programme framework to attract investment in crop mechanization. Political will is absolutely critical for transformation of agriculture into a commercially viable activity. Finance is still a big issue and a great deal of technical cooperation

between suppliers, donors, government and stakeholders is required. Investors realize Tanzania has a stable political climate, friendly national workforce, attractive investment incentives as well as a strategic geographic location. A coherent programme framework for attraction of investment in crop mechanization must be developed with action items to:

- Promote R&D to identify agricultural and agro-industrial applications of crop mechanization.
- Create PPPs among financial institutions, farmers, NGOs, donors and equipment suppliers that provide credit to farmers on affordable terms.
- Encourage private sector investment by reducing the cost of business and providing incentives as well as enabling the creation of joint-ventures for agro-industrial development projects.
- Create a financial facility or a special fund to provide low-cost credit to farmers.
- Encourage entrepreneurship on farms.
- Embolden the Tanzanian Business Council to create a working committee for the agricultural sector.
- Work with EAC countries to create a regional plan that strengthens agriculture value chain management.
- Promote investment in irrigation starting with small farm holder groups.
- Promote organic farming, bio-fuel production and local fertilizer plant facilities.
- Promote development of small-scale agro-processing industries in rural communities.
- Convene district councils, district business councils and village leaders to discuss and implement a leasing finance program to serve small-scale farmers.
- Create Farmer Field Resource Centres (FFRC) to engage farmers and their communities in the entire chain of production and agricultural transformation.
- Stimulate demand for mechanization technology through presentation of new types of equipment.
- Introduce a national WRS leading to fairer

prices for the farmers.

- Source inputs on equitable terms.
Subsidization of any input needs to be done in an open, transparent fashion that does not favour any one or more suppliers.
- Work with international organizations to develop a more holistic approach to implementation of crop mechanization strategies and use of agricultural machinery systems.
- Develop a strategy to reduce high-post harvest losses.
- Introduce educational seminars and create databases that raise farmer knowledge on engineering technology and food production systems.

In 2007, under a *special initiative called “FAMOGATA”*, the Morogoro region was officially designated the “Grain Basket of the Nation”. This region is endowed with fertile soils, numerous river beds, large tracts of uncultivated land and huge production potential, and is close to Dar es Salaam. Only 20–25 percent of the total arable land is utilized for agricultural production. Most farmers are still using rudimentary farm implements to plant and harvest their crops. Farmers need access to credit to help accelerate crop production through acquisition of simple yet modern farm equipment that is durable and easy to maintain. Agricultural implements for planting, weeding, sorting, harvesting and drying are among many types of farm implements required by farmers.

In 2008 the “*Tractor Finance Pilot Scheme 2008*” was put in place. For farmers to increase their use of mechanization, they require access to finance on reasonable terms and conditions and that, ideally, comes from a blend of public and private capital, including donor lending (or donor support). In January 2008 FBME Bank Ltd, was approached by a local management company, DEMACO, to assess a feasibility study on crop mechanization finance. Numerous credit unions were interviewed to determine the level of demand for tractors, power tillers and farm implements. The new partners (equipment supplier, DEMACO and bankers) discovered that many farmers were willing and able to make sizeable down payments for obtaining loans. The partners agreed to assign roles and responsibilities to ensure the scheme would be a success. On 18 March 2008 a Memorandum of

Understanding (MOU) was signed. DEMACO agreed to oversee delivery of tractors and establish after-sales service centres to make sure spare parts and accessories are available at all times. This is a crucial element for sustainability of such a scheme. This initiative is a small step but great leap forward in creation of an innovative scheme to finance crop mechanization. The strategic partnership is a viable approach to helping farmers and should be replicated on a much larger scale. The Danish-funded Private Sector Agricultural Support (PASS) agreed to work with the bank on credit appraisals; and to provide 50 percent cash guarantees for borrowers accessing credit from the bank. To date, loan repayments are being remitted in a timely fashion.

Public sector financing initiatives preferably require the creation of a new financing facility specifically dedicated to this purpose and that can be focused at the grassroots level. The Department of Crop Mechanization manages one government programme that allows farmers in rural communities to design their own proposals for obtaining finance. The Tanzania Agriculture Partnership is working with government to set up Commodity Investment Plans that are meant to bolster business-based agricultural development. The partnership aims to create agricultural commodity investment plans; forge PPPs; analyse value-chain links to identify investment priorities and identify projects.

Recommendations for the creation of a new financing facility for crop mechanization

- Create a New African Agro-Industrial Development Fund in which government funds are blended with other resources, either private or public. These funds to be channelled into a separate fund called “The Agro-Industrial Development Trust Fund”. The fund directors will represent a mix of public/private sectors. Potential investment sources both internal and external will be identified. The fund will have a set of by-laws that govern fund management, investments and disbursements, and the pool of resources will enable this facility to provide grants, soft loans and financing.
- Given the vast landmass in Tanzania it is advisable to start with 2–3 regions. Existing financial institutions will be ranked in terms of suitability for administering funds from the facility to farmers purchasing and/or

hiring equipment, including acquisition of inputs for crop cultivation, harvesting and irrigation. This process has already been initiated.

- Set up agricultural training facilities to assist farmers on seed varieties, crop production techniques, environmental protection, soil retention and livestock/poultry keeping, etc.
- The government should allocate a percentage of tax revenue into surveying landownership of farms; and expediting the issuance of Certificates of Occupancy and/or Title Deed to be assigned to legitimate land owners.
- Create centres for farmers to learn about: how and where to access finance; the benefits of crop mechanization; equipment leasing; training courses; commodity markets, price trends and how to find local, regional and international buyers; and business management.
- Create national and regional databases of Agricultural Project Investment Profiles
- Compare national agricultural investment priorities with existing UNIDO and FAO programs in each country and region. Assess EAC country Agricultural Mechanization Strategies (AMS) as well as their respective Sector Investment Strategies (SIS) for the agricultural machinery industry.
- Provide training for extension officers, farmers and other entrepreneurs so as to improve their understanding of the different power and mechanization options; exposing them to new technologies and opportunities will be a tremendous boost.

In Tanzania the government has recognized that private sector investment in agriculture is a major constraint to development. Although services provided to rural communities have expanded, agriculture development requires access to unique and innovative lending schemes and products. Rapid private sector growth in agriculture, as all other sectors, is dependent on financing being available to support critical links in the value chain, including processing, packaging, transport and distribution of products to local and international markets.

7.2 FINANCING AGRICULTURE MECHANIZATION – THE EXPERIENCE OF FINANCIAL SECTOR DEEPENING TRUST (FSDT) IN TANZANIA

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Introduction

Operating in Tanzania, the FSDT is a multi-donor trust funded by DFID, CIDA, SIDA, DANIDA, Royal Netherlands Embassy and the Government of Tanzania (based on a World Bank credit). Its main aim is to help accelerate access to and deepening of financial services in Tanzania. It was registered in 2004 and commenced operations in 2005. The FSDT provides its support to the private sector, the financial institutions and NGOs, as well as the government at strategy and policy levels through the Bank of Tanzania (BoT), the Ministry of Finance and Economic Affairs, and other key ministries.

The market environment

In Tanzania, economic activity in rural areas is dominated by agriculture. However, the farming sector mainly comprises non-commercial farmers operating on a small scale and in rural areas where the provision of financial services is either entirely lacking or greatly limited. For example according to the FinScope study in 2006, only 5.5 percent of the rural population has access to the formal financial sector, 1.8 percent to the semi-formal sector and 35.9 percent to the informal sector. The remainder, 56.8 percent are excluded from any form of financial services.

The main reasons for farmers' limited access to financial services are: (i) segregation of small-scale peasants – who need to be aggregated into groups of economical size; (ii) poor infrastructure; (iii) lack of collateral or other security; (iv) the non-commercial nature of the agricultural sector; (v) lack of entrepreneurial skills (e.g. no capability to make business plans); (vi) limited financial abilities (e.g. no record-keeping); (vii) a general lack of a harmonized strategy; (viii) a general limited commercial awareness; and (ix) limited supply of financial services to the agricultural sector, even from the MFIs.¹¹

11 Microfinance Institutions

The roles of the government and the public sector

The main role of the government and the public sector is to create a conducive and enabling environment through the formulation of a sound policy framework and supporting strategies to put policy into practice. Examples include: rural financial services strategy; financial literacy strategy; and the formal registration of assets. The government also has to work on improvement of infrastructure; creating supportive legal framework; and implementing guarantee schemes that balance the needs of borrower, lender and guarantor. Such enabling environment will create awareness and subsequently increase demand.

Thought will need also to be given to regulation: whether and to what extent to regulate the sector, and whether anything other than the formal financial institutions ought to be regulated. In rare cases of severe market failure, the government may also consider directly providing the financial service; but this should be only on a temporary basis by way of demonstration to encourage the private sector.

The roles of the private sector and financial institutions

The main role of the private financial sector in agriculture mechanization is to fund the sector by using different financial instruments. In Tanzania, the private sector has so far made limited inroads in funding this area. Asset financing is the most likely route in financing the agriculture mechanization, with leasing and higher purchase likely to show the greatest potential in this field. There are a number of reasons for this limited access as mentioned under “market environment” above, but lack of security for loans is one often cited by financial institutions.

One of the ways to achieve security in financing agriculture mechanization is by collateralizing the asset that is being financed during which access and use of the asset is allowed. Access and/or full ownership of the financed asset also can be held by the lender until full payment is effected. Other means of alternative loan security methods include: guarantee schemes; cash collateral and non-traditional means such as group guarantees, chattels and residential certificates.

There is also the question as to whether the recently introduced financial leasing act is likely to be effective in contributing a solution to stimulate financial access.

Important guidelines for best practice

- Financial institutions must be able to work freely with no, or very limited, government interference.
- Financing should be market led and demand-driven.
- Not all farmers will qualify for finance for agriculture mechanization.
- There must be a realization that it may not be worthwhile to finance small-scale, non-commercialized farmers.
- The amount of finance should be based on the level of demand and need (e.g. no need to finance a tractor if application qualifies for no more than a power tiller).
- Consideration should be given to financing entrepreneurs who may not necessarily be farmers but yet are engaged in agricultural activities.
- Consideration should be given to indirect financing, e.g. through SACCOs,¹² agriculture marketing boards and cooperative societies.
- It is important that financing should be secured through insurance.
- Direct financing by the government should be avoided; it has proven to be not sustainable, and it distorts the market and raises false expectations.

Intervention by FSDT

FSDT does not provide funding directly to the final consumer. Rather it funds financial institutions that reach out to the ultimate users of the financial services. Financial interventions for agriculture (including mechanization) are high on the FSDT agenda and several instruments are available. These include: subsidized loans; subordinated debt; guarantees (e.g. by way of matching funds); and by grant. Grants may be considered if the purpose is demonstrated to be a public good or for the purpose of demonstration. However, up until now there have been few interventions in the agricultural sector. The few that have been made have been direct portfolio financing (e.g. wholesale funding to Dunduliza – Mbarali rice farmers) and guarantee and cash collateral (e.g. NMB¹³ agriculture input financing,

¹² Savings and Credit Cooperatives

¹³ National Microfinance Bank Ltd

and FBME Bank financing of agribased clients).

FSDT has so far done nothing specifically targeting agriculture mechanization. This is mainly because the demand from financial institutions has not been forthcoming. Financing process must be initiated by the concerned financial institutions.

Conclusions

Financing is an important component for the expansion of agriculture mechanization; however, to achieve this it is important to improve the financing environment. The challenges need to be addressed by all stakeholders, each having their own responsibility.

FAO AGRICULTURAL AND FOOD ENGINEERING TECHNICAL REPORTS

- 1 Production and processing of small seeds for birds, 2005 (E)
- 2 Contribution of farm power to smallholder livelihoods in sub-Saharan Africa, 2005 (E)
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Investment in agricultural mechanization in Africa

Conclusions and recommendations of a Round Table Meeting of Experts

Many African countries have economies strongly dominated by the agricultural sector and in some this generates a significant proportion of the gross domestic product. It provides employment for the majority of Africa's people, but investment in the sector remains low. One of the keys to successful development in Asia and Latin America has been mechanization. By contrast, the use of tractors in sub-Saharan Africa (SSA) has actually declined over the past forty years and, compared with other world regions, their use in SSA today remains very limited. It is now clear that, unless some positive remedial action is taken, the situation can only worsen. In most African countries there will be more urban dwellers than rural ones in the course of the next two to three decades. It is critical to ensure food security for the entire population but feeding the increasing urban population cannot be assured by an agricultural system that is largely dominated by hand tool technology.

In order to redress the situation, FAO, UNIDO and many African experts are convinced that support is urgently needed for renewed investment in mechanization. Furthermore, mechanization is inextricably linked with agro-industrialization, and there is a need to clarify the priorities in the context of a broader agro-industrial development strategy. This must, however, be done in the right way, taking into account critical factors for success and sustainability.

This issue and others were addressed at a three-day Round Table Meeting of experts that was convened in Arusha, Tanzania, in June 2009, with the intention of providing guidance on the key strategies and good practices for maximizing the benefits and sustainability of investments in agricultural mechanization in Africa. This report summarizes the deliberations of this Round Table Meeting.

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