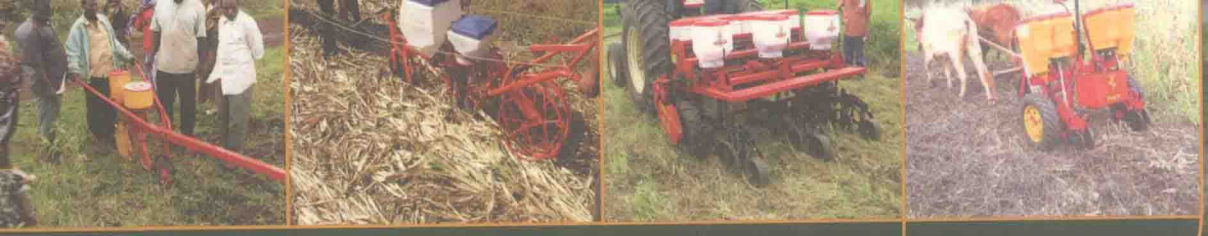

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Mechanization for Rural Development:

A review of patterns and progress from around the world

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Mechanization for Rural Development: *A review of patterns and progress from around the world*

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FOREWORD

Agricultural mechanization is a crucial input to agricultural crop production. It is frequently very capital intensive, compared to other (usually annual) inputs and it has repercussions on the efficiency of all other inputs used in crop production, including seeds, fertilizer, water, and time/labour. It is also much more complex in its application, requiring not only correct use, but also a service infrastructure for maintenance and repair. For this reason it is essential for FAO's Plant Production and Protection Division (AGP) to embrace the agricultural mechanization sector in the context of Sustainable Crop Production Intensification.

Whilst agricultural mechanization is indispensible for production, it can also have very detrimental effects on the environmental sustainability of farming (soil compaction and erosion, tillage, chemical pollution). However if the correct technologies are applied, for example: climate smart agriculture such as conservation agriculture; safe and efficient application of pesticides; precision application of fertilizers; soil compaction management; efficient harvesting; and natural resource conservation, then sustainable intensification can ensue.

The services provided to member countries will include the policies and infrastructures required by them to establish or expand their capacities to facilitate environmentally friendly mechanization in a socio-economically sustainable way. This includes roles for cooperatives, for the public sector, as well as for the commercial private sector, from financing and operational arrangements for the use of agricultural mechanization, to training in the use of machines, their maintenance and the related commercial supply infrastructure for sales, and after sales services.

This publication presents a kaleidoscopic view of agricultural mechanization experiences from around the globe and, as such, provides a solid launching pad for the promotion of sustainable mechanization technologies that are so vital if we are to feed, with due regard to the planet's natural capital, the burgeoning world population both now and into the future.

Clayton Campanhola
Director
Plant Production and Protection Division

ACKNOWLEDGEMENTS

This compilation of agricultural mechanization experiences from around the world is the culmination of an activity initiated by Geoffrey C. Mrema when he was Director of the Rural Infrastructure and Agro-Industries Division (AGS) of FAO. The papers that became the 16 Chapters were commissioned by FAO and have been subjected to initial edition and revision by a team of editors including: John E. Ashburner, Reynaldo Lantin, Josef Kienzle, Brian G. Sims, Geoffrey C. Mrema, Divine Njie and Lawrence J. Clarke. Dmitry Prikhodko of FAO's Investment Centre Division contributed useful comments, especially on Chapter 9. Final editing of the complete set was undertaken by Brian G. Sims in August and September 2012. Magda Morales formatted the document for printing and we express our appreciation of her efforts. Proof reading was undertaken by John E. Ashburner and Brian Jackson.

ABBREVIATIONS AND ACRONYMS

ADBN	Agricultural Development Bank, Nepal
ADLI	Agricultural Development Led Industrialization
ADMA	Agricultural Dealers and Manufacturers Association
AFMIC	Agricultural and Fishery Mechanization and Infrastructure Committee
AGCO	Allis-Gleaner Corporation
AGRISHOW	International agriculture in action trade fair (Brazil)
AGS	Rural Infrastructure-and Agro-Industries Division (of FAO)
AGSE	Agricultural Engineering Branch (of FAO)
AICRP	All India Coordinated Research Project
AIT	Asian Institute of Technology
AMS	Agricultural Mechanization Strategy. Agricultural Mechanization Stations China)
ANFAVEA	National association of motor vehicle manufacturers (Brazil)
ARCEDEM	African Regional Centre for Engineering, Design and Manufacture
ARDA	Agricultural and Rural Development Authority (Zimbabwe)
AREX	Department of Agricultural Research and Extension (Zimbabwe)
ASEAN	Association of South-East Asian Nations
BIS	Bureau of Indian Standards
BRRI	Bangladesh Rice Research Institute
CA	conservation agriculture
CAMARTEC	Centre for Agricultural Mechanization and Rural Technology (Tanzania)
CAR	Central African Republic
CARD	Coalition for African Rice Development
CAT	Conservation Agriculture Technology Database
CDA	controlled droplet application
CGIAR	Consortium (formerly Consultative Group) of International Agricultural Research Centers
CIAE	Central Institute of Agricultural Engineering (India)
CIFEMA-SAM	Bolivian small-scale agricultural machinery manufacturing company
CIGR	International Commission of Agricultural and Biosystems Engineering

CIMMYT	International Maize and Wheat Improvement Centre
CIPHET	Central Institute of Post Harvest Engineering and Technology (India)
CIS	Commonwealth of Independent States
CKD	completely knocked down
COMECON	Council for Mutual Economic Assistance
CNH	Case New Holland
DA	Department of Agriculture
DAP	draught animal power
DDF	District Development Fund (Zimbabwe)
DEES	Directorate of Extension and Engineering Services (Namibia)
DFID	Department for International Development
DGPS	differential global positioning systems
DRC	Democratic Republic of Congo
EAC	East African Community
ECA	Europe and Central Asia
EIMA	International agricultural and gardening exhibition (Italy)
ENTAM	European Network for Testing of Agricultural Machines
ESCAP	Economic and Social Commission for Asia and the Pacific
EXPOINTER	Rio Grande do Sul agricultural fair (Brazil)
EU	European Union
FANR	Faculty of Agriculture and Natural Resources (Namibia)
FAO	Food and Agriculture Organization of the United Nations
FEBRAPDP	Brazilian federation for no-tillage farming
FFS	Farmer Field School
FMP	Farm Mechanization Programme (Zimbabwe)
FSU	Former Soviet Union
FTLRP	Fast Track Land Reform Programme (Zimbabwe)
FY	Financial Year
GB	Governing Body
GDP	Gross Domestic Product
GFCF	Gross fixed capital formation
GIS	Geographic information systems
GPS	Global Positioning System
GW	Gigawatt
HIV/AIDS	human immunodeficiency virus infection / acquired immunodeficiency syndrome
HYV	high yielding variety
IAE	Institute of Agricultural Engineering (Zimbabwe)
IAPAR	Parana State Agricultural Research Institute (Brazil)
IBGE	Brazilian institute of geography and statistics
ICAR	Indian Council for Agricultural Research

ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDE	International Development Enterprises
IFAD	International Fund for Agricultural Development
IIT	Indian Institute of Technology
IITA	International Institute of Tropical Agriculture
ILO	International Labour Organization
InPhO	Information Network on Post-Harvest Operations
INTDIR	International Directory of Agricultural Engineering Institutions
IPAM	Environmental research institute of Amazonia (Brazil)
IRRI	International Rice Research Institute
ISO	International Organization for Standardization
ITINTEC	Institute for research into industrial technology and technical standards (Peru)
ITMCO	Iran Tractor Manufacturing Company
JECF	Japan-ESCAP Co-operation Fund
JICA	Japan International Cooperation Agency
KR	Kennedy Round
kW	Kilowatt
LIDAR	light detection and ranging
MADI	Mashare Agricultural and Rural Development Institute (Namibia)
MAPA	Ministry of agriculture, livestock and supply (Brazil)
MDA	Ministry of agrarian development (Brazil)
MDG	Millennium Development Goal
MECI	Morogoro Engineering Cluster Initiative
MOAC	Ministry of Agriculture and Cooperatives (Swaziland)
MODERFROTA	Programme of modernization of the agricultural tractor fleet, implements and harvesters (Brazil)
M&M	Mahindra & Mahindra
MTS	Machine Tractor Stations (China)
NABARD	National Bank for Agriculture and Rural Development
NAEF	National Agricultural Engineering Forum (Nepal)
NAIP	National Agricultural Innovative Project (India)
NAMTA	National Agricultural Machinery Traders Association (South Africa)
NARC	Nepal Agricultural Research Council
NAREGA	Mahatma Gandhi National Rural Employment Guarantee Scheme (India)
NARS	National Agricultural Research System
NATMIRC	National Marine Information and Research Centre (Namibia)
NATP	National Agricultural Technology Programme (India)

NAWIC	Namibia Agricultural Water and Information Centre
NCD	North Central Division (Namibia)
NED	North Eastern Division (Namibia)
NEPAD	The New Partnership for Africa's Development
NFMC	National Farm Mechanization Committee
NHB	National Horticulture Board (India)
NHM	National Horticulture Mission (India)
NGO	Non-Governmental Organization
NI	National Institute
NN	National Network
NNFU	Namibia National Farmers Union
NT	No till
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
PPP	Public Private Partnerships
PRONAF	National programme to strengthen family agriculture (Brazil)
PUMP	Productivity Upliftment Micro-projects Project (Namibia)
REFPI	Research and Extension in Farm Power Issues (Bangladesh)
RNAM	Regional Network for Agricultural Machinery
RO	Regional Office
RS	remote sensing
SAAMA	South African Agricultural Machinery Association
SAU	State agricultural universities (India)
SCMP	Smallholder Credit and Marketing Project (of IFAD)
SCPI	Sustainable Crop Production Intensification
SDSB	Swaziland Development and Savings Bank
SIL	Systematics International Limited
SKD	semi-knocked down
SME	small and medium-scale enterprises
SNL	Swazi National Land
SP	sub-programme
SSA	sub-Saharan Africa
STP	Sâo Tomé and Príncipe
STW	shallow tube well
TAC	Technical Advisory Committee
TAFE	Tractors and Farm Equipment Ltd.
TCDC	Technical Cooperation between Developing Countries)
THS	Tractor Hire Services
UK	United Kingdom
UN	United Nations
UNAPCAEM	UN Asian and Pacific Centre for Agricultural Engineering and Machinery
UNDP	United Nations Development Programme

UNIDO	United Nations Industrial Development Organization
USD	United States dollars
USSR	Union of Soviet Socialist Republics
VDMA	German association of mechanical and plant engineering
WAMED	Worldwide Agricultural Machinery Directory
WARDA	West African Rice Development Association
WT	Wheeled Tractor (as in 2WT and 4WT)

SUMMARY

Farm mechanization seems to have become, to a certain extent, the neglected waif of agricultural and rural development. As an essential input, mechanization can transform farm family economies by facilitating increased output and reducing the drudgery of hand-powered production. Mechanization, when carefully selected and appropriate to the task, is also capable of protecting natural capital and the environment whilst boosting food production.

However we have seen in recent years that consideration of mechanization as a vital input, in need of research and development, has been frequently neglected. Indeed, and as an example, the UK Government's 2011 Foresight Report (Foresight: The Future of Food and Farming: Challenges and choices for global sustainability[1]) barely mentioned the role of agricultural engineering. Following a meeting with the Government Chief Scientist, the UK's Institution of Agricultural Engineering was invited to respond to this deficiency and, as a result, produced, in 2012, the document 'Agricultural Engineering: a key discipline enabling agriculture to deliver global food security'[2].

Agricultural engineering departments in the CGIAR'[3]s international research centres have been wound down and closed and the availability of world-class undergraduate training is also in serious decline. Why this should be the case is not clear when careful studies have made it abundantly clear just how crucial an input mechanization is in the pursuit of global sustainable crop production intensification and improved rural livelihoods (for example see the deliberations of the 2009 FAO, Rome forum on how to feed the world in 2050[4]). In FAO itself the resources invested in the selection of appropriate mechanization options have been declining, although the vital role of rural mechanization is recognized as a vehicle for raising rural incomes through high quality service provision on the farm, for road transport and in the development of entrepreneurial enterprise in the agricultural product value addition chain[5].

However, following the recent food scarcity and price hike and the subsequent financial crisis with spiking prices for food stocks such as maize, wheat and soya, the focus of the world returned to a realization of the important role of agricultural production and productivity. When looking at the resources required for increased and sustained agricultural production (land, water and

[1] http://www.bis.gov.uk/assets/foresight/docs/food-and-farming/11-546-future-of-food-and-farming-report.pdf.

[2] http://www.iagre.org/sites/iagre.org/files/repository/IAgrEGlobal_Food_Security_WEB.pdf

[3] Consortium on International Agricultural Research

[4] http://www.fao.org/wsfs/forum2050/wsfs-background-documents/hlef-issues-briefs/en/

[5] See FAO's recent Diversification Booklet 19: Hire services by farmers for farmers. http://www.fao.org/docrep/015/i2475e/i2475e00.pdf

farm power for mechanization) it is clear that Africa has comparatively the most abundant land resources; however, the continent has the lowest farm power base with less than 10 percent of mechanization services provided by engine-powered sources. At the same time approximately 25 percent of farm power is provided by draught animals and over 70 percent comes from people's muscles (mostly from women, the elderly and children). This human power source often only has rudimentary tools and equipment at its disposal for soil preparation, crop care, transport of goods and bucket irrigation.

The 2009 high level FAO expert forum already referred to has made it very clear what the challenge ahead is: how to feed approximately 9 billion people in the year 2050. We have learnt lessons and now we must take care that the past mistakes of trying to achieve intensification only through mechanization is adapted to ensure its sustainability. FAO has coined the term "Sustainable Crop Production Intensification (SCPI)". In other words we need to produce more food with fewer inputs. One could also say that the goal is to produce food more efficiently in terms of energy inputs compared to the food outputs. FAO has summarized this vision in a guide for policy makers called Save and Grow[6]. In parallel with this guide, we must also ensure that mechanization initiatives are sustainable. Mechanization should not only be seen as the employment of heavy duty, high horse power equipment to clear the remaining virgin lands and forests, which would be extremely undesirable. Sustainable mechanization means the use of intelligent, lean and efficient engineering technology solutions to minimize the impact of heavy machinery on the natural resource base – the soil and the landscape.

Modern engineering technology does not necessarily require the genetic modification of crop plants (although this can be one more tool in the toolbox needed to achieve SCPI). It can be applied through simple solutions at the available farm power level (hand/human, draught animal and mechanical/motorized). One good example of this approach comprises the simple forms of precision farming that make efficient use of available seeds and fertilizer and inputs for crop protection. Other positive examples would include: the multi-use of expensive machinery for transport and for irrigation pumps besides farm mechanization only; conservation agriculture (with specialized mechanization) to arrive at energy efficient and lean soil management in line and accompanied by the protection of natural processes; and drudgery reduction. In the same way that FAO and the world have an obligation to eliminate hunger from the globe, FAO and partner agencies in development also have an obligation to appreciate that the poorest and most vulnerable people (women, elderly, children) are often undertaking the bulk of the farm work with simple or rudimentary tools; and this should no longer be tolerated. Inputs of mechanization and related services at the appropriate technology level can have a tremendous impact on

[6] http://www.fao.org/ag/save-and-grow/

reducing drudgery which is in itself already a major, socially driven, motivation and reason for increasing support to agricultural mechanization[7].

This present set of 16 discussion papers provides a world-wide kaleidoscope of farm mechanization issues for developing countries and brings out many site-specific (or rather region-specific) issues which should be of vital interest to policy makers globally.

The full list of papers, as they appear in the Chapters of this book, is as follows:

Africa

1. Investing in Agricultural Mechanization for Development in **East Africa**. Nuhu Hatibu
2. Agricultural Mechanization in **Southern African Countries**. Timothy E Simalenga
3. Agricultural Mechanization in **West and Central Africa**. Mathias Fonteh

Asia

4. Rural and Agricultural Mechanization in **Bangladesh and Nepal**: Status, processes and outcomes. Scott Justice and Stephen Biggs
5. Agricultural Mechanization in **India**. Gajendra Singh
6. **China**: Development of Farm Mechanization and the Agricultural Machinery Industry. Maohua Wang

Near East

7. The **Near East** Region. Bassam A Snobar and El Hassane Bourarach

South America

8. The Development of Farm Mechanization in **Brazil**. Francisco de Assis de Carvalho Pinto, Daniel Marçal de Queiroz and Ricardo Capúcio de Resende

Transition Countries of Eastern Europe and Asia

9. Agricultural Mechanization in **Countries in Transition in Eastern Europe and Central Asia**. Lawrence Clarke

Cross-cutting themes

10. Agricultural Mechanization and the **Environment**. Theodor Friedrich
11. **Agricultural Mechanization Strategies**. John Ashburner and Reynaldo Lantin
12. Agricultural mechanization in development: **A donor's view**. Tokida Kunihiro

[7] FAO. 2006. Farm power and mechanization in sub-Saharan Africa. Rome. FAO. Agriculture and Food Engineering Technical Report 3. pp67.

13. **Off-farm use** of agricultural machinery. Bill Hancox
14. Agricultural Machinery **Manufacturing and Supply**. Brian G Sims

Information Exchange

15. Investing in **Information Dissemination and Exchange**. Trevor Cree
16. **Information Exchange and Networking**: the RNAM Experience. Reynaldo Lantin

Some conclusions and pointers for the future

Lawrence Clarke has drawn out some general pointers for successful mechanization strategies. These include:

Interventions to assist the farmers (the demand side)

- Remove policies and regulations which restrict the choice of farm machinery by the purchaser;
- Any state supported leasing or credit programmes should allow the farmers to purchase or lease imported machinery as well as domestically produced machines;
- Consumer protection legislation should be introduced particularly for contracts and credit and to protect consumers against being sold faulty or inappropriate machines;
- Government programmes should concentrate on providing information for farmers and farm businesses to enable better choices to be made that consider both technical and business issues.

Approaches to improve the supply side

- Removal of policies which protect local industries. Such policies include subsidized finance, removal of favourable tax exemptions for domestically manufactured machinery, removal of protective tariffs on imported machinery and the removal of barriers to foreign investment.
- Free up the market for the importation of foreign machinery, including removal of unreasonable testing and certification requirements.
- Privatize state owned and operated machinery stations.
- Reduce bureaucracy and barriers to business development; create an environment which eases the development of businesses including such measures as easing import restrictions, creating a level playing field for foreign businesses, reducing taxation and easing restrictions on leasing of property and capital equipment.
- Any subsidized programme operated by the state should have a predefined period of operation after which it would be privatized.
- Introduce training and education programmes for commercial development as well as technician training (scope for donor support).

- Lending for the purchase of farm machinery as well as for emerging service providers can be a risky business for private banks and it is for this reason that credit from private banks is often unobtainable or expensive. Donors should consider supporting the farming and agricultural machinery sector by underwriting credit for these purposes. Such programmes could include business and technical training elements.

Interventions to support efficient, lean and environmentally sound mechanization

- Introduce so-called smart subsidies for mechanization inputs that are in line with sustainable mechanization and concepts such as 'Save and Grow' as described above.
- Develop precision agriculture applications as an integrated tool within the sustainable agricultural intensification concept or within the 'Save and Grow' concept.
- At global policy level: work on global agreements for good practices in the procurement and supply of agricultural equipment and mechanization inputs. Good practices means avoiding short-sighted politically-motivated arrangements with no after-sales support and with equipment levels that are not appropriate to the level of training of the recipient countries.
- Accept FAO together with other bodies such as UNIDO and OECD as international bodies that can provide a neutral platform for private and public sectors to work in harmony to develop and **implement** sustainable mechanization strategies for the benefit of farmers and rural enterprises in developing regions.

CONTENTS