

IMAG-DLO and conservation tillage: Activities and experiences

by

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Abstract

The Institute of Agricultural and Environmental Engineering (IMAG-DLO) belongs to the Agricultural Research Department of The Netherlands Government. The Department of Development Cooperation within IMAG-DLO works in Africa and Asia and concentrates on animal traction and crop processing technologies. Applied tillage research conducted by IMAG-DLO in partnership with the Ministry of Agriculture in Zambia clearly showed the need for alternative tillage systems in order to improve conservation of rainwater and soil, to improve timeliness of planting, and to cope with reduced availability of draft power. The research resulted in the development of the animal drawn conservation tillage equipment: a ripper, ripper-planter and sub-soiler. All implements are low-cost, durable attachments which can be simply interchanged with the plough body of any commonly available plough beam. It was realized that, when introducing these conservation tillage tools on smallholder farms, weeding would become an even more critical aspect than it already was in the conventional ploughing system. Herbicides are beyond the reach of most farmers and the availability of an effective mulch cover is not guaranteed. Mechanical weeding with draft animals is a practical option to keep the weed problem under control. For weeding a new animal drawn cultivator was specifically designed to suit harsher soil conditions while ripper-ridger, could also be used. All equipment was designed to enable local manufacture in the region. The animal traction based conservation tillage techniques as developed and promoted by IMAG-DLO and its partners, can be seen as an intermediate step towards a fully fledged system of Conservation Tillage. This paper highlights the experiences regarding user support, as well as the "dos and don'ts" of equipment development, promotion maintenance and marketing. Design, manufacture and distribution of implements, applied technical and socio-economic research and training issues are also discussed.

1. Introduction

1.1 IMAG-DLO

The Institute of Agricultural and Environmental Engineering works under the Agricultural Research Department (DLO) of the Ministry of Agriculture, Nature Management and Fisheries of The Netherlands. The mandate of IMAG-DLO is to research and develop agricultural and environmental mechanisation technologies which are socially, economically and environmentally accepted. The institute has approximately 200 staff. IMAG-DLO's Department of Development Co-operation works in Africa and Asia. The mission of the department is to contribute to increased agricultural income and food security in a sustainable manner.

Within this context the prime task is to work on mechanisation technologies which increase labour productivity. Most activities relate to animal traction and post-harvest technologies. The major target groups are smallholder farmers and rural entrepreneurs (IMAG-DLO, 1998).

Typical characteristics of activities carried out by the department are:

- multi-disciplinary
- building partnerships with local organisations
- advancing links between the public and private sector, in particular between research, training, extension, manufacture and marketing.

Most activities are funded on a project basis, The Netherlands Government being the larger financier. Other funding comes from international organisations and private firms.

1.2 IMAG-DLO in Southern Africa

IMAG-DLO long-term assignments in Southern Africa started in Zambia (1987-1999) and were in 1997 extended to South Africa (Box 1). In addition, short-term advisory services are provided to governments, NGO's and rural development programmes in an increasing number of other countries.

In Zambia IMAG-DLO has been involved in five programmes. The two partners are the Ministry of Agriculture, Food and Fisheries and Africare. Till 1995 the focus was on animal traction. This followed the policy decision by the Government of Zambia, in the mid-eighties, to move away from tractor based mechanisation for the small scale sector and to boost animal traction instead (Mwenya et al, 1992). IMAG-DLO's work on animal traction centers around two principles:

- Increased use of animal traction, especially in areas where the technology is new and
- Diversified use of animal traction, to operations other than ploughing and transport and particularly for ripping, planting, weeding and harvesting.

In 1995 post-harvest technologies were added to the activities in Zambia. Emphasis was on manual or engine operated machinery for threshing, shelling, dehulling, milling and oil expelling.

In South Africa IMAG-DLO has a formal link with the Institute for Agricultural Engineering of the Agricultural Research Council with regard to the initiation of a wide-spread, smallholder oriented, conservation tillage on-farm trial and demonstration programme. This programme includes adaptation and local manufacture of equipment developed in Zambia.

1.3 Conservation tillage: Research & development

Since 1988 IMAG-DLO is involved in on-farm research and implement development focussing on soil & water conservation tillage and related planting and weeding techniques.

It was found that many farmers who use animal traction for land preparation do not manage to plant their crops in a well prepared seedbed during the optimum planting period, yield reduction being the result. The delays and other inadequacies in planting are caused by the following interrelated factors, which are further compounded by a worsening environmental and economic situation:

- The optimum planting period, especially in the southern part of the country, is very short: 1 to 2

weeks. Compared to this critically short period ploughing with draft animals is a slow method.

- The percentage of households owning draught animals is 50% at most (Dibbitts & Mwenya, 1993). In most areas the percentage is much lower. Many farmers depend on draught animals which are hired or borrowed well after the rains have started.
- Crops are planted at uneven depths in furrows made by the plough causing uneven germination.
- In fields where ploughing with animals is done year after year, often a hard layer is formed hindering rain water infiltration and deep rooting.
- During the dry season the condition of draught animals deteriorates affecting their capacity to plough when rains start.

Supply and maintenance of animal traction equipment is inadequate. Several farmers apply a reduced tillage system. These farmers do not plough but work the field in lines, holding the plough on its point whereafter seeds are sown in the furrows. This reduced tillage system solves some of the immediate problems farmers have when ploughing: lack of time, labour and draught power.

Opportunities for practical improvements of the reduced tillage system applied by farmers formed the basis for directing the on-farm trials towards conservation tillage.

There are many definitions for 'Conservation Tillage'. Generally, soil disturbance is prescribed to be kept to a minimum. Ideally, the soil is only worked to such an extent that it allows the placement of seeds at the required depth. Usually, it is also understood that the soil surface is protected by a cover of mulch or stover whereby a 30% soil cover is often being stated as the criterion. Many conservationists further assume that (spot) weed control has to be based on the use of herbicides.

Box 1

Long term IMAG-DLO Technical Assistance in Southern Africa

Name programme & Period

Z A M B I A

National Animal Draft Power Coordination Project (1987-1996)

Ministry of Agriculture, Food and Fisheries (MAFF; HQ Lusaka)
Policy support; National animal traction survey;
Lobbying & networking

Magoye Animal Draft Power Research & Development Project (1987-1993)

Magoye Regional Research Station of Ministry of Agriculture
Applied research on technical and agricultural suitability of various animal traction technologies; Developing protocols for on-station and on-farm comparative tests

Palabana Animal Draft Power Training Project (1989-1993)

Palabana institute of Ministry of Agriculture
Curriculum development for ADP in-service training;
Physical establishment of ADP training center

Palabana Animal Draft Power Development Programme (1993-1996)

Palabana institute of Ministry of Agriculture
In-service staff and farmer training; On-farm demonstrations;
Production of extension materials; Prototype development and on-farm research, including post harvest technologies

Smallholder Agricultural Mechanisation Promotions (1996-1999)

Africare & Ministry of Agriculture
Support to local manufacturers, rural workshops, and private equipment wholesale and retail; On-site testing of post-harvest and animal traction equipment; Support to improved draft animal supply and management; Liaison between public, NGO and private sector

S O U T H A F R I C A

Smallholder On-farm Trial & Demonstration Programme (1997-1999)

ARC-IAE Institute for Agricultural Engineering, Pretoria
On-farm trial & demonstration of animal traction and post-harvest technologies; Support to private local manufacturers;
Smallholder farming policy support

Planting in lines using an animal drawn ripper tine without prior ploughing is a step in the right direction: much less soil is disturbed than by ploughing. The soil is only worked in narrow bands, while the surface between these lines is left undisturbed. However, weed infestation problems are likely to arise.

A good mulch cover would suppress weed growth very well, and enable farmers to control the weeds by hand (either with a hand hoe or a herbicide), if timely and consequently done almost throughout the year. But the availability of enough mulch is a major bottleneck. Many farmers clean their fields by burning old weeds and the residues of the previous crop usually after first having taken away the bulk of stover for use as building material and animal feed or by allowing their animals to graze on it. Even without burning, the quantities of stover remaining on the fields are normally too small to form a protective mulch cover. Weeds will quickly overgrow the field and get out of control, particularly on fields that are too large to allow complete eradication of weeds by hand hoe.

Chemical weed control increases labour productivity tremendously, and would therefore be an attractive option. However, herbicides and spraying equipment are not a reality for most farmers; they are either not available or too expensive.

Considering the above, the following elements were included in IMAG-DLO's approach towards conservation tillage research and development.

1.3.1 Equipment development

A plough is not the best implement for breaking up soil in lines. This practice requires equipment which can work in narrow bands but deep enough, especially in dry soils and without turning over the soil, as is done by the mouldboard of a plough. Modified animal drawn planting and weeding equipment is also needed.

1.3.2 Early land preparation and early dry planting

To spread labour and to fully utilise the first rains, land preparation starts as early as possible in the dry season. In this way, and when appropriate, dry planting can be practised. It also enables planting of crops at a much earlier stage than in the conventional system.

1.3.3 Weeding

Because a thick enough mulch cover or herbicides are not guaranteed inputs on most smallholder farms as yet, another option that must be availed. For draught animal users who see the benefits of conservation tillage and who work large areas, a sturdy cultivator or ridger, in addition to ripping equipment, is indispensable. Weeding with draught animals is a technology which is already known and accepted by many farmers. It will enable farmers to make a safe and practical start with conservation tillage by reducing the risk of weeds getting out of hand.

1.3.4 Supplementary feeding of draught animals

Supplementary feeding is necessary to ensure good condition of draught animals which in conservation tillage are put to work in the field before the rains start.

2. Equipment development

IMAG-DLO contributed to the development of the following animal traction equipment suitable for conservation tillage (Stevens, 1998):

2.1 Magoye ripper attachment

This is used for making planting furrows, followed by planting by hand in unploughed or ploughed fields. The attachment works well in dry soils. With additional extensions the

attachment can also be used for other field operations.

2.2 Ripper-planter attachment

This is a ripper attachment to which an additional planter module is fitted. The planter can be used much earlier in the season than a conventional planter. Different crops can be planted by using different seed rolls.

2.3 Sub-soiler attachment

This is for deep furrowing in compacted soils. The attachment needs a beam extension.

2.4 The adjustable cultivator

For weeding, this implement resembles the popular adjustable cultivator produced by Zimplow of Zimbabwe. The features are the same but its design is meant to be more durable in harsh soil conditions. A donkey version of this new adjustable cultivator, with 3 instead of 5 tines, is currently being developed.

2.5 Ripper-ridger attachment

This is a Magoye ripper attachment to which a pair of adjustable wing extension blades and an optional rudder are added. Just as any ridger, it can be used for weeding and making and re-building ridges (Jonsson, 1996).

Other than the cultivator which is a complete implement, all other equipment are attachments which fit on the plough and ridger beams. Plough beams are commonly available in areas of Southern Africa where animal traction is used. They can be modified to make them fit on other types of beams such as beams of donkey ploughs.

The fact that most implements are attachments, renders the investment for farmers who change to conservation tillage relatively low (see Chart 1).

For the above listed attachments to work well, the farmer needs to carefully set them using a hitch point. Removing the hitch-point and setting the implement with the wheel, which is common farmer-practice when a plough is used, cannot work. A sturdy hitch assembly was developed. For good setting, a longer chain than used for ploughing (up to 3.5 *hitch assembly* metres) is also needed.

Chart 1

<u>Indicative off-factory prices (excl. VAT) in US \$</u>	
Magoye ripper attachment	\$ 22
Ripper-planter attachment	\$ 98
Planter attachment (without ripper tine)	\$ 76
Subsoiler attachment	\$ 29
Adjustable cultivator	\$ 122
Ripper-ridger attachment	\$ 50
Set of ripper wing extension blades	\$ 15
Rudder assembly for ripper-ridger	\$ 12
Hitch assembly	\$ 8

The development of the mentioned equipment took several seasons and involved a cycle of prototype development, on-farm testing and cooperation with manufacturers to prepare commercial production.

At this stage all equipment was being manufactured in Zambia. In 1997 local manufacture of the attachments was initiated in South Africa. Manufacturing guidelines are available.

3. Observations and experiences

3.1 Farmers responses

Farmers using the new implements prefer to use them for direct ripping systems. They make furrows in unploughed or winter-ploughed fields followed by dry planting or planting during the very first rains. Mechanical weeding is done as early as possible after planting with one or two repeats. The direct ripping system can be considered a practical step towards the development and introduction of a fully fledged, animal traction based, conservation tillage system among smallholder farmers. The equipment development activities of IMAG-DLO have attracted interest from programmes and organisations promoting conservation tillage (ZNFU/CFU, 1987). Besides Zambia, where approximately 1500 ripper attachments are in use, the equipment has been introduced in Tanzania, South Africa, Zimbabwe, Namibia and Lesotho. Organisations in Mozambique and Kenya have expressed interest in acquiring the implements.

3.2 Importance of equipment development

Although the development and introduction of new equipment is not an end in itself, it marks the removal of a potential bottleneck in the process of popularising conservation tillage among small scale farmers. As Benites and Friedrich (1998) state: "... there are constraints to the adoption of conservation tillage or no-tillage concepts on animal draught or motorized mechanization levels. There is an urgent need for further local development and commercial supply of suitable equipment to the farmers in order to assist in the adoption of conservation farming practices..."

3.3 Equipment manufacture

In its equipment development work, IMAG-DLO emphasizes cooperation with and support to local manufacturers at the earliest possible stage. When feasible this includes small and medium sized rural enterprises. The early link with manufacturers is necessary to ensure sustainable commercial production once the technology has been fully developed.

Work on conservation tillage equipment in Zambia was done with 5 medium size companies of which one continued to show sufficient interest in commercial manufacture. Cooperating with several manufacturers in stead, of with one or two minimises the risk of having no reliable manufacturer once the equipment is ready for the market. While developing the conservation tillage equipment several companies lost interest or capacity to produce an acceptable standard. Similar experiences were recorded for other types of equipment (OSPP, 1997).

Important elements in raising and maintaining interest of manufacturers are:

- supply of information on test results and potential demand from farmers
- finances for jigs, technical drawings and first series production.

3.4 Marketing and repair services

Capable and interested manufacturers are few and mostly located in towns. Obviously, hardly any farmers buy directly from the manufacturer. For proven equipment to be adopted on a significant scale, mass marketing through private channels is necessary. Manufacturers are seldom good distributors. In most of Southern Africa countries a widespread network of private agricultural outlets is not yet available. It is therefore important that this gap between farmers and manufacturers is closed.

In Zambia IMAG-DLO, in cooperation with Africare under the SAMeP programme, obtained positive experience in setting up a network of private, rural based, and small scale, equipment outlets. The marketed equipment includes commonly known and new implements, as well as spare parts. All outlets are existing businesses, such as general dealers. Some of them are already involved in agricultural input supply and crop marketing. An important next step in this programme is to facilitate private commercial wholesale and distribution to these outlets, which is until now being done by SAMeP as a pilot scheme (SAMeP, 1998).

Equipment repair and maintenance is another essential service needed by farmers. Rural workshops are therefore included in the network of outlets. Especially the supply of spare parts, in addition to steel and tools, is vital for these workshops. Training and financing are usually required as well.

3.5 Gender

Compared to the conventional system a major benefit of conservation tillage for female farmers is labour spreading during land preparation and planting. Female farmers who use animal traction, usually depend on draught power borrowed from the husband or other relatives or hired from elsewhere. In situations where draught animals are scarce, traction is available only after the owner has finished ploughing. This causes serious delays in planting by the borrower or hirer, especially in areas with a short rain season. With

ripping equipment, land preparation can be done much earlier and faster (2 to 2.5 ha per day per pair of animals). Because ripping can start much earlier than ploughing, land preparation can be spread over a longer period. In this way the owner of draught power can make the animals available for non-owners more timely. If female farmers, whose major responsibility is to grow food crops, can plant earlier, and possibly larger acreages, food production will increase and household food security will improve.

When conservation tillage is applied the weeding job may be a threat for female farmers. On many farms where animal traction is used, a large part if not all of the weeding, is still done by hand, mainly by women and children. The reasons for emphasizing weeding with draught animals when conservation tillage is introduced, include gender considerations. Female farmers benefit in two ways from weeding with animal traction:

- considerable savings in labour requirement and
- the share of male labour in doing the job increases when draught animals are used.

The introduction of conservation tillage means a far reaching change in farming practices. Female farmers need to be deliberately involved in work to develop and promote conservation farming to ensure that they have enough information to practice the system and to ensure that they can play their role as decision makers and disseminators of technology. In its equipment testing and demonstration activities, IMAG-DLO experienced that it is not very hard to involve a fair representation of female farmers, provided an extra effort is made, especially by fieldstaff and community leaders, to approach them.

In Zambia many female farmers belong to women clubs. Although many clubs are dormant do not undertake communal productive activities, usually the major reason for starting them up) the club structure can be effective for extension purposes.

3.6 Draught animals

Compared to handhoe systems, the use of draught animals for conservation tillage increases labour productivity and therefore agricultural production and income. This potential is undermined by the prevailing, and growing, shortage of draught animals. In many areas cattle and donkeys are traditionally not reared. In other areas the number

of cattle is diminishing at an alarming rate. This is caused by drought (Mashavira, 1997), poor animal feeding, inadequate control of diseases, and overworking of draught animals. The revival or introduction of effective veterinary and animal husbandry services is necessary for widespread adoption of animal traction based conservation tillage.

In this regard the use of crop residues for mulch, as promoted in conservation tillage, is an issue since the same crop residues can also be fed to livestock (or left for grazing by livestock which is the common practice in communal areas). This need not be a contradiction. The feeding value of crop residues strongly varies and depends on the type of crop and the stage at which it is harvested. In Zambia good experiences exist with feeding of groundnut and cowpea stover to draught animals (Palabana ADPDP, 1995). The stover is harvested and dried at the same time as harvesting the pods and stored away in special structures for feeding during the dry season. Poorer quality stover can be used as mulch provided no livestock is allowed in the field.

3.7 Dissemination

In the experience of IMAG-DLO and its partners in Zambia radio broadcasts, on a very regular basis and in different languages, are a powerful means in raising awareness on the existence of new, in this case conservation tillage, equipment. Increased awareness strongly supports the interest of farmers in attending, and requesting for field demonstrations to see what the equipment looks like and how it is used. Awareness raising can be further enhanced with posters and leaflets.

An intensive programme of field demonstrations and farmer training, in combination with reliable and widespread supply of affordable equipment, is needed to ensure that farmers start practising conservation tillage. A field demonstration programme is a must, but is expensive in terms of time, human resources and transport. In many rural areas there are clear opportunities for sharing and reducing these costs by establishing co-operation among public, NGO and private organisations. If these opportunities are fully exploited, the rate of adoption should improve.

An important lesson which has been learnt from programmes promoting profitable, new equipment for treadle pump irrigation and manual oil expelling is that the costly exercise of wide-spread

and continuous field demonstrations will finally payoff once a critical mass of adopters is reached. The intensity of field demonstrations and other forms of promotion can then be relaxed as the equipment seems to start selling itself (Egan, 1997; OSPP, 1997)

4. Conclusion

IMAG-DLO will continue its work towards the advancement of conservation tillage. The institute is committed to provide advise and support to public, NGO and private sector agencies with regard to:

- design, manufacture and distribution of implements.
- applied technical and socio-economic research.
- promotion and training.

References

- Benites, J. and T. Friedrich. Overcoming constraints in the adoption of conservation tillage practices. FAO, 1998. Paper presented at International Workshop on Conservation Tillage for Sustainable Agriculture, Harare, Zimbabwe, June 1998.
- Dibbits, H. and E. Mwenya. Animal Traction Survey in Zambia. IMAG-DLO The Netherlands and Ministry of Agriculture, Food and Fisheries Zambia. 1993.
- Egan, L.A. The experiences of IDE in mass marketing of small scale affordable irrigation devices. Paper presented at joint FAO/IPTRID East and Southern Africa workshop on small scale irrigation, Harare, Zimbabwe, April 1997.
- IMAG-DLO, Smallholder Agricultural Mechanization Promotions (SAMeP) Programme Information. Brochure. 1998.
- Jonsson, L.O. Rain water management to avoid drought. Local Management of Natural Resources Programme, Tanzania. 1996.
- Mashavira, T.T., H.H. Dhliwayo, P.S. Mazike and S.J. Twomlow. Agronomic consequences of reduced tillage. season. Paper presented at the University of Zimbabwe Draught Animal Power Workshop. February 1997.
- Mwenya,, E, W.N.M. Mwenya and H.J. Dibbits. Animal draft power in Zambia: constraints to development and possibilities for improvements. In: Starkey, P., E. Mwenya and J. Stares (Eds). Improving Animal Traction Technology. Proceedings of the first workshop of the Animal Traction Network for Eastern and Southern Africa. CTA. 1994.

- Oilseed Processing Project (OSPP), Various project documents. Africare Zambia. 1997.
- Palabana ADPDP. Crop residues for draft cattle in the dry season. Extension leaflet. Palabana ADPDP Zambia. 1995.
- SAMeP. Progress Reports No. 1, 2, 3 & 4. Smallholder Agricultural Mechanisation Promotions Zambia. 1996-1998.
- Stevens, P.A. Ripping with draft animals. IMAG-DLO extension brochure. March 1988.
- Zambia National Farmers Union/Conservation Farming Unit (ZNFU/CFU), Conservation Farming, Handbook for Small Holders in Regions I & II, 1997.