Technology transfer and on-farm evaluation of animal powered equipment: approach and experience of IMAG-DLO

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Abstract

Instead of 'researching' for perfected (yet rejected) *solutions, IMAG-DLO stresses the need for a farmer participatory approach towards: local development of less perfect, yet accepted practical and low-cost technologies; based on simple and durable equipment designs suitable for local manufacture.*

Introduction

Smallholder crop production in many areas of Southern Africa is characterised by low productivity and profitability, particularly so in low rainfall areas and in regions characterised by relatively poor and fragile soils. Here, crop production is often associated with a risk of crop failure, due to drought, poor land management practices, marketing constraints, etc.

These observations apply also to the target group of animal traction farmers in Southern Africa who cultivate between 2 and 20 hectares of land mostly in areas receiving 400 to 1000 mm of rainfall. Such rainfall is often irregularly distributed, both within and between seasons.

Although animal traction farmers are able - with their conventional mouldboard ploughs - to open up and cultivate a considerable acreage of arable land, they face serious time and labour constraints for the subsequent planting and weeding operations. This is compounded by lack of means and unavailability of suitable and affordable equipment.

Considering the prevailing draft power limitations, ploughing is:

* often delayed, resulting in late planting and poor crop establishment.
* limited to a depth of 8 – 12 cm only, increasing the risk of drought related stress due to poor infiltration and conservation of water and aggravating water-runoff and related erosion hazards.

Under these high risk rain-fed farming conditions, animal traction farmers in general adopted low or minimal external output farming systems. The major concern of these farmers is not to maximise yields but to spread the risks of farming and to minimise costs. The suitability of present and proposed improved farming systems should be judged in this context.

Experience in other parts of Africa Asia and South America indicates that given the right conditions and marketing incentives - there is scope for a more efficient and diversified use of animal traction in Southern Africa, enabling progressive smallholder farmers to:

* reduce and alleviate current time and labour constraints,
* increase timeliness and depth of tillage so as to enhance water infiltration and conservation and reduce risks of drought related crop failure;
* thus improve productivity and profitability of farming;
* ultimately become surplus growers with improved access to production inputs and equipment including access to improved post-harvest and processing facilities.

In view of the limited means available and considering the commonly prevailing supply and distribution constraints in the smallholder farming areas, development and promotion of new technologies should be based on locally manufactured or assembled simple and durable low-cost equipment options. As much as possible, these should make use of the already existing equipment such as implement attachments fitted to plough beams.

The approach towards smallholder mechanisation technology development and promotion

In addressing the highly variable, area-specific needs and opportunities for development of animal traction farmers, a participatory on-farm technology development and evaluation programme is called for, based on:

a) effective participation of (leading) farmers in representative areas, at all stages, namely:
   * needs assessment
   * multi-location on farm trials
   * multi disciplinary farmers acceptance and technology impact studies

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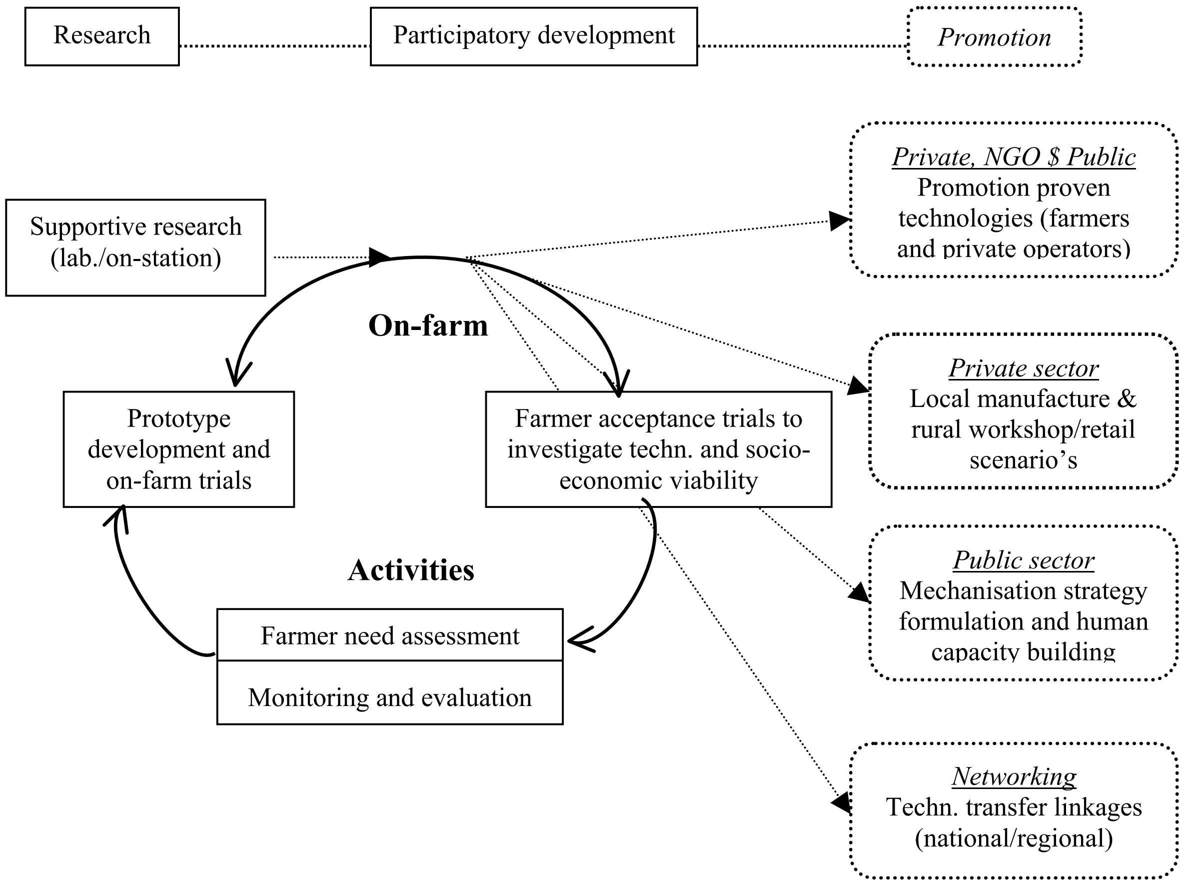
Figure 1: Approach development and promotion of smallholder agricultural mechanisation



active involvement of farmers organisations and members of the local community, NGO and private-sector rural development agencies

b) ensuring a continuous monitoring and evaluation, with feedback to all parties involved.

In such core programmes research plays an important and mostly supportive role, an active liaison and participation of private local manufacturers (and rural workshops) which needs to be pursued right from the start. Figure 1 illustrates the SAMEP "Smallholder Agricultural Mechanisation Development and Promotion" approach advocated and followed by IMAG in Zambia, Mali and South Africa. Its main components are described hereafter.

Observations - needs assessment

Although highly variable and often area and farmer specific, the priorities for development can in general be categorised according to the following approaches:

Diversification of animal traction use.
This aims at improved timeliness of operations and reduced time and labour requirements, while at the same time promoting a more efficient use of already available draught animals for a wider range of activities (besides common ploughing and carting).

Adoption of more sustainable DAP conservation tillage systems: aiming first and foremost at improved infiltration and conservation of water tapping into the positive effect on water run-off, erosion and soil structure, in order to make arable farming less susceptible to drought related stress during the season.

Prototype development and on-farm trials
In addressing the above priority needs for development of smallholder farmers, also agricultural engineering research may play an important role to:
* identify promising options for improvement,
* initiate prototype development and adaptation and testing activities,
* support and participate in-multi disciplinary - on farm trial activities.

Experience has shown however, that the role of on-station or laboratory research, should not be over estimated. Too often research programmes, whether implemented by national or international research agencies, universities, project or even manufacturers, have been ignoring the actual smallholder farmers' context and have thus come-up with solutions which could be classified as

* “re-invented wheels”
* “perfect yet rejected solutions”
* “supply-driven transfer or dumping of technologies from elsewhere” - without local adaptation.

In addressing the needs of resource-poor farmers, emphasis should be placed on practical, flexible, durable and low-cost technology options which are locally developed and adapted to suit local conditions of use. Effective starting points may be as follows:

* indigenous technologies originating from local farmers, rural workshops or blacksmiths which are worthwhile to adapt and to promote on a larger scale;
* proven technologies from elsewhere (within the region or from other DAP areas in Africa, Asia or Latin America) suitable to be adapted to local conditions of use, manufacturing requirements and opportunities,
* only occasionally should technologies based on entirely new equipment designs appear.

In this technology development process, right from the beginning emphasis should be placed on the implementation of multi-location on-farm trials:

- implemented and managed by farmers under actual conditions of use and over a period of time;
- involving local extension and rural development programmes (both public, NGO and private extension and rural development agencies);
- with an effective liaison base and channel for feedback of information to (prospective) local manufacturers.

Approach - farmers’ acceptance and evaluation

A multi-location, on-farm trial programme may take a period of 2 to more than 5 years. Initially emphasis may be more on the technical aspects and this phase will be characterised by continuous equipment adaptation (and or reinforcements). During the course of this on-farm technology development process, gradually an increased awareness will emerge (from researchers and farmers alike) regarding the overall practical and socio-economical prospects (or limitations) of the propagated technologies under the prevailing conditions of use.

Through a combination of impact studies (e.g. in the form of Rapid Rural Appraisals), local farmers’ evaluation meetings and questionnaires, relevant information can be obtained to verify the degree by which propagated technology is being accepted and to assess its prospects and limitations under specific conditions of use.

Particularly at this stage, the co-operating farmers themselves should be considered the actual researchers in the field. They are best placed to judge whether a proposed improved technology or farming system may indeed constitute a practical, meaningful and affordable solution to alleviate their usually very pressing, complex and area-specific needs. For a meaningful evaluation, farmers’ acceptance should be assessed taking into consideration both technical, agro-ecological and socio-economical aspects of a proposed improved technology.

Although not really essential and mostly difficult to realise in practice, field measurements may be useful to quantify certain technical or socio-economical effects. Comparative on-farm implement trials may constitute a practical “one-day” option (with an important promotion effect).

In order to be accepted by smallholder farmers a new technology must:

respond to the priority needs of the farmers in question and thus constitute an obvious, clearly visible practical improvement as far as one or more of the following aspects is concerned:

* reduced time and labour requirement and improved timeliness of operations
* reduced draught force requirement (within reach of the existing draught animals)
* ease of operations, adjustment and adaptable to a variety of conditions (flexible use)
* durability of construction (simple design and minimum maintenance or repair requirements.

be acceptable with respect to the farmers’ consent and for improved conservation tillage systems, the following criteria must be met in addition:

* reduced risk of complete or partial crop failure due to draught stress with emphasis on increased infiltration and conservation of water by means of increased timeliness of operations and deeper ripping or sub-soiling;
* ability to control weed-growth which is crucial in case of minimum or zero-till options)

have easy access and be subject to easy propagation, meaning:

* affordability of equipment (and related inputs) emphasising low-cost implement options which can be made locally (or in the region) at a competitive price

local availability of proposed equipment (including related inputs, spare parts and repair services) and active participation of private rural workshops and retailers in conjunction with local manufacturers.

It should be noted that in the case of conservation tillage technologies, supportive research under controlled conditions may be considered as a way to assess and explain the water infiltration and conservation effects of such technologies, as compared to conventional ploughing. Determination of relevant soil physical characteristics will need to be included.

Approach - promotion of proven technologies
Once farmers' acceptance of a technology has been confirmed, larger-scale on-farm promotion programmes need to be initiated in order to achieve the desired adoption of such technology by smallholder farmers.

As a logical follow-up to the on-farm technology development phase, the promotion phase needs a programme of practical on-farm demonstration including:

* implementation at the level of progressive farmers and farmer organisations: in the form of farmers' days followed by other on-farm demonstrations conducted by leading farmers and extension staff active in the region;
* actively involving local extension and rural development staff of both public, NGO and private agencies and making available sets of related equipment as "extension tools" for on-farm demonstration purposes (supported by extension materials, leaflets, radio broadcasting, etc.);
* effective participation of local manufacturers and involving (prospective) rural workshops and retailers;

Governments in Africa are increasingly recognising that the public-sector on its own is not able to realise the desired development of smallholder farming. Following the directives of National Agricultural Mechanisation Policies, where they exist, an effective NGO and private-sector involvement needs to be facilitated and supported. With respect to the local manufacturing, retailing and maintenance of smallholder farming equipment, this may entail:

* support to initial series productions while making available proven designs and providing technical assistance and advisory services to (prospective) local manufacturers, oriented towards the smallholder farming sector;
* initiation of local assembly scenarios at the level of rural based workshops and small to medium scale enterprises in conjunction with central manufacturers and hardware suppliers;
* support to the establishment of effective networks of rural workshops or blacksmiths and retailers in order to develop a sustainable system of retail and repair services closer to the rural areas.

Besides facilitating the above NGO and private sector involvement, Government agencies have an important role to play in the following fields:

▪ participation of local extension staff in on-farm demonstration programmes, including realisation of an effective monitoring and evaluation of such programmes;
* implementation of supportive on-station research and testing activities;
* development and dissemination of related extension leaflets, manuals, etc. and other marketing and promotion materials;
* implementation of in-service training of extension and rural development workers and farmers' training in the rural areas.

Experiences of IMAG-DLO in smallholder technology development and promotion

Over the last 16 years, IMAG-DLO has been involved in a number of smallholder farmer oriented technology development and promotion programmes in West and Southern Africa.

The practical approach described above towards participatory technology development & promotion was developed and applied in Mali and Zambia. In the earlier days it concentrated on animal traction technologies only, but more recently has incorporated post-harvest & rural processing technologies. For the last two years a similar approach is being followed at Agricultural Research Council – Institute of Agricultural Engineering (ARC-IAE) in South Africa for a programme with respect to smallholder mechanisation development and promotion including post-harvest.

National and regional land management programmes in Southern and East Africa, are presently adopting this practical participatory approach to promote improved conservation tillage systems, based on the ripper and planter attachment developed in Zambia.

Present status - diversification of animal traction issue
Experiences from Mali and West Africa
Over the last 40 years an enormous variety of different implement makes and models of animal traction implements, has been developed and introduced for dry-land farming in West Africa, where the following were introduced:

* different types and models of ploughs, ridges, cultivators, planters, groundnut-lifters, adapted to suit specific soil conditions and farming systems;
* light weight, platform-type donkey carts base on proven design stub-axles;

implements with sizes in accordance with the power of available animals (oxen, donkeys or horses).

Table 1: Present status technology development, promotion and manufacture (IMAG-GLO experience diversification of animal traction equipment in Zambia and South Africa)

Technology	Origin & special features	Present status
Diversification animal traction equipment :		
* Light 6" plough for use by donkeys	Origin : West Africa Locally adapted :light 6" plough body for 1-2 donkeys	Locally manufactured and promoted in new donkey traction regions Zambia. Interest from donkeys farmers I S.A
* Light, adjustable 3-tine cultivator (for oxen or donkeys)	Own design: light weight, simple Parallelogram construction: * light weedier for oxen/donkeys *lighter, easy operation (women) *low-cost option	Locally manufactured and promoted in Zambia for oxen and donkey traction: low cost alternative to conventional, heavy and more expensive cultivators.
*Light ridging body (for ridging & weeding)	Origin: West Africa Light ridger fitted to plough -beams: *Low cost option	Locally manufactured and promoted in groundnut growing regions in Zambia
* Groundnut lifter	Origin : concept West Africa Gr/nut lifting blade fitted to local plough beams & wheels assy's. *New tech. For S.A * interest to adapt for potato lifting S.A	Locally made and promoted in region with gr/nuts cultivated on ridges (e.g. .Eastern Province, Zambia).
*Ripper (used as furrow-opener and planting tool)	Origin: Niger West Africa Locally adapted as attachments to plough beams: *enabling early, timely planting; *replacing 2nd ploughing; *deep ripping: prospects conservation tillage tool: also Tanzania	locally made and promoted on large scale in Zambia (total about 3000 units). Ripper increasingly adopted in other countries in Southern Africa, esp. Tanzania (about 1000 units)
Planter module (used in combination with ripper tine)	Origin: concept Colombia, UK locally adapted as attachment to plough beam behind reaper: *low-cost simple/durable unit as alternative to conventional heavy, expensive planters; *adapted to rough seedbed.	*Final stage prototype development in Zambia. *Growing interest both in Zambia and in other countries in the region :Tanzania, S.A. South Africa : model being developed including fertiliser and dry manure applicator.
*Oxen and donkey carts	Origin: Rumpstad model from West Africa: *based on proven quality stub-axles; *platform-type body;	Since 1994 promotion of supply and retail of imported stub-axles for local assembly of carts by rural workshops in Zambia.

Although initially manufactured and supplied by central manufacturers, the majority of animal drawn implements in West Africa are presently manufactured by rural workshops and blacksmiths. Although of mediocre quality the implements and spare parts being used are cheap, and almost "customer made". Most implements can be characterised as light-weight equipment, especially in comparison with the equipment commonly found in Southern Africa.

Main priorities for development addressed by IMAG-DLO (and other agencies) in Mali can be summarised as follows (see Table 1):

a) improved durability and quality of previously produced implements and donkey carts. Main objectives of the "CAFON rural blacksmith support programme" implemented by IMAG-DLO in Mali since 1992, were:

* practical training of blacksmiths and development of production and assembly to improve

quality and standardisation of locally made implements and spares;
* organisation of autonomous, adequately equipped rural blacksmith associations;
* the supply (partly importation) of certain essential raw materials and key components.

b) development and promotion of (more) sustainable conservation tillage systems: particularly for low rainfall areas with a critically short rain seasons and light fragile soils.

The need stressed was to develop and adopt alternative tillage systems which enable animal traction farmers:
* to improve timeliness and speed of operations
* to reduce risk of drought related stress

Based on the experience in Zambia, rural development programmes in Mali and Burkina Faso are presently adapting and promoting a ripping and direct planting system similar to the one developed at Palabana in Zambia. The main objective there is to improve infiltration of water at start rain season.

c) development of wider range of special wetland rice animal traction equipment in Mali:
* for prevailing heavy clay soils, an improved design mouldboard plough (Rumpstad model) was promoted on a large scale starting in the early eighties. Up until 1992 this successful introduction of ploughs was based on local assembly in a project setting. Other implements proposed in the early phases of this project, such as the heavy and expensive multirow seeders, leveling boards and leveling scoops, proved less successful. For practical and economic reasons these were rejected by the farmers.
* over the years the heavy-duty plough has been accepted by farmers but modified (lightened) by rural blacksmiths in accordance with farmers wishes. Presently this plough model is being produced locally by a network of rural blacksmiths, based on locally available raw materials and using cutting, drilling and welding jigs;
* following the large scale adoption in the mid 90s of the rice transplanting technologies, simple and durable equipment has been developed by the rural blacksmiths enabling the farmers to improve leveling of their rice fields, leveling boards and scoops based entirely on local manufacture.

The practical approach followed towards the local development and promotion of locally manufactured smallholder farm equipment, has played an important role in reviving the importance of the 60,000 ha "Office du Niger" irrigated rice schemes in Mali. A drastic increase in rice yields from around 2-3 tonnes per hectare to a current average of 6 tonnes per hectare has been realised. In particular also the large-scale promotion of improved rice post-harvest and processing equipment proved a successful "tool for development" of this smallholder farming region.

Experiences from IMAG and others work in Eastern and Southern Africa

Particularly in comparison with above described situation is West Africa, the use of animal traction in most of Southern Africa, has for a long time been characterised by:
* its limited variety (sizes and models) of implements developed with emphasis on conventional, relatively heavy equipment originally designed for use by heavy or multiple pairs of oxen;
* lack of diversification, with many regions still confined to ploughing (and carting) only, or manual planting of seed in every 3rd plough furrow.

In Southern Africa the supply of most animal traction equipment, is currently realised by one large-scale manufacturer only (Zimplow in Zimbabwe). Local companies in the other countries in this region, play only a minor role, whereas local rural workshops and blacksmiths are hardly involved. Until recently local manufacturers and suppliers of animal traction equipment had been confined to:
* essentially relatively heavy 8-10 inch ploughs mainly used by multiple spans of oxen. Only recently is a lighter 8 inch plough being promoted by Zimplow for use by weaker oxen or donkeys;
* heavy adjustable cultivators and heavy duty ridgers. Much less attention has been paid to lighter; low-cost conversions suitable for use by smaller oxen or donkeys;
* basically one model of planter: the heavy, relatively sophisticated and expensive SAFIM type requiring high maintenance and repair standards and also a properly prepared seedbed for effective operation,.
* in most regions: relatively heavy box-type ox-carts (mostly based on scrap axles).

Research, extension and rural development agencies as well as the local manufacturing industry increasingly recognise the need to develop and promote lighter implements to complement the above range of conventional, relatively heavy equipment. Particular reference is made to -the increasing number of - smallholder farmers who have to rely on weaker and smaller numbers of oxen and donkeys as their main source of farm power.

Main priorities for development and diversification of animal traction addressed by IMAG-DLO and co-operating agencies in Zambia (since 1985) and South Africa (since 1996), can be summarised as follows (see Table 2.1 " present status of development"):

a) development and promotion of lighter implements, especially low-cost attachments:

* light 6" plough (or: plough body fitted to existing beams) for donkey traction;
* In Zambia, of late there is an increasing demand for lighter donkey equipment as expressed by farmers in areas with declining herds of cattle due to corridor disease problems. A similar interest is being expressed by those donkey farmers in certain regions in S.A. who have access to 1 or 2 pairs of donkeys and not the 5-6 pairs as required to pull the conventional single or double furrow ox-ploughs;
* Lighter, adjustable 3-tine cultivators and light ridger bodies suitable for both smaller oxen and donkeys or low-cost weeding options which could be equally effective and easier to handle by women.

b) development and promotion of low cost crop establishment system based on simple and light implement attachments fitted to existing plough-beams, suitable for oxen and donkey traction:

* ripper attachment which is an effective furrow-opener and "planting tool" to be used either after ploughing or instead of ploughing;
* planter module, used in combination with the above ripper tine, enabling fast and early planting either in ploughed or un-ploughed field.

This Palabana ripper-planter technology, developed and promoted in Zambia is presently being adapted and tried out in several countries.

In South Africa a new model is being developed incorporating a fertiliser and dry manure applicator. This technology may constitute a practical, simple and low-cost alternative for the conventional planters: with limited maintenance and repair requirements and an acceptable performance even under rough seedbed conditions.

c) development and promotion of a groundnut lifter to facilitate harvesting of groundnuts grown on ridges and construction, making use of existing plough-beams and wheels. This technology is being promoted with access in groundnut regions in Eastern Zambia. In South Africa interest has been expressed to develop a potato-lifter version.

d) promotion of proven quality stub-axles as a basis for local assembly of lighter ox and donkey carts: particular interest in regions with diminishing supply of scrap axles (e.g. Zambia) and making possible a significant "dead weight" reduction especially if combined with platform type construction.

Experience in link with work in East Africa

With the direct ripping system there is potential realise dry season planting. In those cases that farmers have to resort to 2nd planting operation, in failure of crop emergence due to dry spells, the ripper-planter technology does enable to replace the otherwise required time consuming, second ploughing operation.

Compared to ploughing this "strip tillage system" increases tillage depth from 8-12 cm to 15-20 cm. At the same time this limits soil disturbance to a minimum, with beneficial effect on soil structure and fertility, especially if combined with appropriate mulching, dry manure or fertiliser application.

The benefits of this "water conservation tillage system" enabling farmers to:

* realise early and timely planting at a correct depth,
* realise a fast operations, and
* facilitate subsequent early manual or mechanical row weeding.

Particular reference can be made to the large-scale promotion of this technology realised by the Land Management Programme operating in several Districts in Tanzania. Here, close to 1000 ripper-planter units have been introduced since 1996 with plans to start manufacture of this equipment in Tanzania.

In all cases where the ripping, direct planting technology is promoted, particular attention has to be given to the promotion of early and effective mechanical weed-control.

Sub-soiling or deep ripping

Experience has shown that under relatively light soil conditions, the present ripper-tine can realise a sufficiently deep "sub-soiling" operation up to a depth of 15 to 25 cm using the commonly available draught animals (mostly 2 pairs of oxen). In some cases two passes may be required to effectively break-up to the compacted plough-pan layer (mostly located at a depth of around 10 to 15 cm).

In an effort to increase the depth of sub-soiling while still remaining within the reach of available draught animals, on-farm trials have been conducted in Zambia with the different design sub-soilers:

* crow-bar model; an heavy sub-soiler originating from animal traction region in Southern Zambia and requiring at least 3 - 4 pairs of oxen to realise an effective sub-soiling effect during the dry season;
* blade-type sub-soiler from Agritex, Zimbabwe
* knife-type sub-soiler from West Africa (Ceemat/ Silsoe)

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* new prototype sub-soiler model

Way forward

Apart from the need to achieve a larger diversity in the range of animal traction equipment options in accordance with area and farmer specific requirements described above, the importance is stressed for the development and promotion of more sustainable conservation tillage systems which can be effectively adopted by smallholder animal traction farmers.

Both at Government level and at the level of agricultural research and rural development agencies, it is increasingly recognised that the common practice of continuos, shallow and mostly delayed ploughing does not constitute a sustainable land management practice from soil & water conservation point of view. This is particularly so, in low rainfall areas with environmentally delicate soils, where the conventional practice results in:

* deterioration of soil structure and rapid depletion of soil fertility and organic matter;
* formation of a compacted plough-pan layer (at depth of about 10 cm), resulting in poor water infiltration, reduced water holding capacity of the soils and impeded root penetration
* depending on soil type, sealing and crust formation as the result of pulverising of the top soil and resulting in increased water run-off and related erosion hazards.

Furthermore ploughing is a time consuming and energy intensive and costly operation. Considering animal drought force limitations, adequate softening of the soil prior to ploughing is required. In many cases therefore, delays in planting will be difficult to avoid, making arable farming even more susceptible to drought related stress during the growing season.

Improved conservation tillage systems address "water conservation" and "water harvesting", two inter-linked conservation aspects. The majority of animal traction farmers in both West and Southern Africa need risk reducing tillage methods for their drought-prone areas.

Here, improved water conservation is the major concern and improved infiltration is bound to be readily accepted.

Soil conservation and the systems approach

With reference to common commercial and tractor based farming practices wehre conservation tillage methods may be well established, animal ttraction farmers also need capacitty to exploit the viable options to prevent further deterioration of soil structure; reduce water run-off erosion and improve

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soil fertility, in combination with other agronomic and soil fertility measures.

Any proposed conservation tillage system is to be looked upon as just one component of an elaborate conservation farming system, involving also the adoption of related agronomic and soil fertility practices and characterised by area and farmer-specific socio-economical constraints.

In fact such constraints will to a large degree determine farmers acceptance and adoption of a propagated conservation tillage system. Under the prevailing high-risk farming conditions, smallholder farmers may therefore be reluctant to adopt minimum or zero-tillage systems as alternatives to ploughing, if such systems rely on high management input, increased labour and or capital costs, or create an additional risk of crop failure due to increased weed infestation and disease.

It must also be recognized that ploughing is the only practical option available to animal traction farmers who need to open fallow-land in shifting cultivation systems and weed control is important.

Technology transfer and networking

In this field of animal traction development, a wealth of knowledge and experience has been acquired at the level of research and rural development agencies in the different countries in Southern Africa.

However much of this is scattered information originating from a particular research environment or applicable to a certain area only: transfer of related technology options to the complex smallholder farming sector with its highly variable needs and opportunities for development, often leads to conflicting messages rather than straightforward applications.

In order to achieve an effective transfer of technology, it is not only that all 'stakeholders" are involved in this process, but also that all stakeholders - particularly the ultimate target-group of smallholder farmer - play their role.

An efficient technology transfer is reinforced by ensuring an active farmers' participation in the process of development and promotion and establishing working links and exchange of information between research, rural development and promotion agencies, manufacturers, suppliers entrepreneurs and farmers, communication between sister institutions, development programmes and individuals, addressing similar smallholder farming development issues in other countries.

Table 2: Present status technology development, promotion and manufacture (IMAG - DLO experience development of animal traction conservation tillage systems in Zambia and South Africa)

Technology	Origin and special features	Present status
Animal traction based conservation tillage equipment:		
*Ripper (used as furrow-opener & planting tool)	Origin : Niger West Africa Locally adapted as attachment to plough beams: *enabling early, timely planting; *replacing 2nd ploughing; *in light soils: deep ripping without ploughing (prospects conservation tillage tool: also Tanzania)	*Locally made and promoted on large scale in Zambia (total about 3000 units). *Ripper increasingly popular in other countries in Southern Africa esp. Tanzania as conservation tillage option.
*Planter module (used in combination with ripper tine)	Origin: concept Colombia, UK Locally adapted as attachment to plough beams behind ripper: low-cost simple/durable unit as alternative to conventional heavy, expensive planters, *adapted to rough seedbed *prospects conservation tillage system –direct ripping/planting in clean, unploughed fields.	*Final stage prototype development in Zambia and RSA. *Growing interest in Zambia, Tanzania and RSA as tool for "rip & plant-on-the-row" conservation system. *S.A: model being developed including fertiliser and dry manure applicator.
*Sub-soilers (for 2 pairs of oxen)	Origin : own design (1999) *attachment fitted to plough-beam * to break-up compacted plough-pan *working depth 15 - 20 cm under dry season conditions *main aim : improved infiltration and conservation of water	Following initial trials of crowbar model sub-soiler, at present development and trials ongoing of simple, lower-draft model (Zambia) NB: Actual scope and farmers' acceptance still to be assessed

Summary

Basic elements of technology and promotion process such as propagated by IMAG-DLO for addressing the needs of smallholder animal traction farmers, can be summarised as follows:

1) most common starting point: adaptation of elsewhere proven technologies to suit local conditions of use, taking advantage of relevant technology concepts from Asia and West Africa;

2) in order to be adaptable under the highly variable, low or minimum external input smallholder farming system, main efforts are directed towards development of "less perfect" but practical, flexible and low-cost technologies. Given the "less perfect" smallholder farming conditions, "perfect solutions" may be easily rejected, both for practical and financial reasons.

3) emphasis is on simple, durable, and light-weight implement options (and implement attachments) with scope for local manufacture (and assembly by rural workshops) in view of current supply, maintenance and repair constraints and the general low purchasing power of farmers. Development and promotion of a technology may prove meaningless without effective support of the private-sector capable and interested to deliver the related hard-ware;

4) right from the start, active participation from the side of private local manufacturers in order to ensure that a propagated technology is "make-able" (choice of raw materials and design features) and "available at affordable prices" .

IMAG-DLO's technical assistance and advisory services provided in Zambia and S.A have been and will continue to be focused at:
* participatory development and promotion,
* initiation of scenario's for local manufacturer and supply and
* strengthening national and regional networking.