Participatory technology development for animal traction: experiences from a semi-arid area of Kenya

by

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Abstract

As part of the general trend towards involving the target group more in development and research activities, participatory approaches are being used more frequently. Participatory Technology Development has been advocated recently as the only research and development process applicable to resource-poor, marginal and complex farming systems such as those found in semi-arid areas of sub-Saharan Africa. Empowerment of the participants, increased confidence of farmers and artisans in their own knowledge, improved capacity of clients to innovate and experiment, and an enhanced ability to cope with change are often claimed to be more achievable using participatory methods than through traditional technology transfer methods. This paper draws on experiences of participatory development in a pilot programme with metal workers and farmers in the semi-arid areas of Lower Embu and Tharaka, Kenya. Institutional issues are explored through the involvement of an NGO (Farm Implements and Tools, FIT), a government applied research and extension project (The Dryland Applied Research and Extension Project, DAREP), government extension staff (Rural Technology Development Unit, RTDU) and local commercial traders. The opportunities and obstacles of participatory technology development are explored in the context of animal traction and options for meeting the challenges are suggested.

Challenges remain in:

- *improving the quality control, standardisation and raw material supply of locally made tools*
- *continuing the feedback from farmer to toolmaker beyond the prototype stage and into the market relationship*
- *coping with the low demand pull exerted by farmers in semi-arid areas*
- *including engineers into the process, even though they may belong to non-local institutions such as universities or large-scale manufacturing concerns*
- *improving communication over the large distances in semi-arid areas*
- *increasing empowerment of farmers and artisans to demand appropriate services.*

Options for meeting these challenges may be found by:

- *working with farmer groups who have higher incomes, are nearer to the manufacturers and can bear higher risks*
- *exploring ways of working with blacksmiths who make cheaper tools and are nearer to farmers in semi-arid areas*
- *involvement of local stockists or traders to provide credit, raw materials, transport and marketing outlets*
- *the use of fact sheets with input from engineers, artisans, and farmers and paid for by advertising from traders to improve quality while consolidating and disseminating the process of product development*
- *improving the participatory facilitation skills of participants.*

Introduction

As part of the general trend towards involving the target group more in development and research activities, participatory approaches are increasingly being used. Participatory Technology Development has been advocated recently for the types of farming systems found in semi-arid areas. Three general types of agricultural system have been identified by recent literature on agricultural development: industrial or commercial, green revolution and a third type characterised by resource-poor, complex and risk-prone farming systems (Scoones and Thompson, 1994). In the first two types agricultural research has

traditionally been top-down, with the assumption that technology can be transferred from research institutions to farmers. However, in the third type of agriculture, which is the most common in sub-Saharan Africa, this has not worked, since researchers have not been able to replicate the complex and marginal physical and socio-economic environment of these farmers. Therefore, an alternative approach has been sought for these areas. It has been variously labeled 'Participatory Technology Development', 'Farmer Back to Farmer', 'Farmer First', and 'Farmer Participatory Development' (Hudson and Cheatle, 1993), but in general the aim is to increase the involvement of the beneficiaries in the research and development process. The semi-arid agriculture found in the Dryland Applied Research and Extension Project (DAREP) mandate area falls within the third type of farming system and attempts have been made by DAREP to develop a participatory methodology for agricultural research, together with farmers, artisans, traders, extension workers, researchers and NGOs.

Furthermore, empowerment of the participants, increased confidence of farmers and artisans in their own knowledge, improved capacity of clients to innovate and experiment, and an enhanced ability to cope with change are often claimed to be more possible under participatory development than through traditional technology transfer methods. This paper draws on our experience of participatory technology development in a pilot programme with *jua kali* (informal sector) metal workers and farmers in semi-arid Lower Embu and Tharaka. Institutional issues are explored through the involvement of non-governmental organisations (Farm Implements and Tools, FIT), a government applied research and extension project (the Dryland Applied Research and Extension Project, DAREP), government extension staff (Rural Technology Development Unit, RTDU) and local commercial traders. We discuss the opportunities and obstacles within participatory technology development specific to animal traction.

Background

Context of technology change

Semi-arid areas such as Lower Embu and Tharaka present special opportunities and challenges to animal traction. Although agriculture is labour limited, rather than land limited, specific hindrances prevent the resource of animal power from being utilised fully. These include low population density (less than 100 persons per square kilometre), poor infrastructure, uncertain returns from farming and harsh technical working conditions for animals and tools (Mellis and Mwaniki, 1995).

Furthermore, farmers in this area are experiencing a period of change which is having a dramatic impact on their traditional farming system of shifting cultivation and pastoralism. Population growth and the consequent land demarcation are causing weed control and soil conservation to become important management issues. There is also a high rate of migration as young men go for off-farm income and older children are away at school. This means that labour is a severe constraint. Farmers are therefore very interested in new tools (including animal power options) which could allow them to adapt to their changing circumstances.

Traditionally, farmers in the area have used tools made by local blacksmiths, such as axes, and the *miro* (a digging stick with a metal blade at the end). Recent changes include the importation of tools and materials to the area, so whereas, for example, blacksmiths used to smelt their own iron to manufacture tools, they now use scrap metal and do repairs only.

The main source of technology change has been inward migration and external travel by the local population. For example in Tharaka, *Victory* plows came into the area from their Akamba neighbours to the south in the 1940s, and more recently from locals working off-farm in towns such as Embu, Chuka and Meru to the north. Illustrating this fact, an ICRA study in 1984 found 23% of farmers owning plows, whereas in 1993 DAREP found the figure had increased to 44% of farmers. Mobile traders at local markets have also brought in new technologies such as *jembes* (dutch hoes) and forked *jembes*. Handtools are sold in many weekly markets, but larger items like plows and wheelbarrows are only available from large towns, necessitating expensive travel and transportation by farmers.

Institutional approaches

It would seem that agencies promoting improved technologies have had little impact in producing technology change in the area. From 1982 to 1988 the Embu, Meru and Isiolo (EMI) project gave free tools to groups of farmers to carry out soil conservation. From 1989 the Dryland Applied Research Project (DARP) offered some shop-bought and locally-made tools such as wheelbarrows and weeders, at cost price to farmers, displaying them at nine sites through the region. These tools were tested extensively with farmers, but there was no adoption. This may have been due to the fact that DARP was not able to respond to farmers comments, nor to deal with associated issues of credit and supply, and, on their part, the farmers had become used to being lent or given free tools.

As project designers became aware of the need to develop technologies *with* farmers rather than *for* them, the Dryland Agriculture Research and Extension Project, was conceived to work using a more participative methodology. The main objective was to 'develop and evaluate sustainable agricultural technologies and participatory research methodologies'. The project operates within a decentralised research infrastructure and is a collaborative project between Kenya Agriculture Research Institute (KARI), Kenya Forestry Research Institute, Ministry of Agriculture, Livestock Development and Marketing and the Natural Resources Institute (NRI). Research scientists work within an interdisciplinary team and technology components include cropping systems, soil and water management, livestock and agroforestry.

DAREP's work on tools has been carried out within the soil and water management programme which looks at the constraints facing farmers in tillage generally and this has led to research on tillage tools, land husbandry and water harvesting (Skinner and Mwaniki, 1994).

Paticipatory technology development

Getting started: participatory rural appraisal

The entry activity for the soil and water management programme was a focused participatory rural appraisal which included stratified samples and group meetings (Skinner and Micheni, 1993).

During the participatory appraisal, farmers expressed that, in terms of tools, their agricultural production was constrained by:

- shortage of plows at the optimum time for land preparation
- lack of transport to carry manure to the field
- lack of labour for weeding
- lack of tools to build soil conservation structures.

This problem of access to tools was caused by:

- their high cost
- the lack of credit
- poor returns from farming
- high transport costs.

Possible remedies were identified during the participatory appraisal including strengthening supply networks, credit support and training of local blacksmiths. In the discussions between the researchers, farmers and extension workers, the participants concluded that research should be carried out on low cost tools which could be made or repaired locally.

Finding what to try: farmer groups

Following the work in the field with farmers, the researcher carried out an initial literature and project review of the potential technologies and methodologies to alleviate the tool supply and tillage constraints.

To keep farmers involved in the process, the results of the participatory appraisal were publicised at the nine DAREP field stations during open days and farmers were invited to participate. At this point the researcher decided to work from only two field stations in order to enable a more in-depth involvement with farmers while keeping within their resources. Farmers were selected on the basis of their interest, wealth rank, and gender. This enabled two enthusiastic groups of about ten farmers to be formed which represented the resources and tillage systems of the local community.

DAREP was initially concerned about the group composition. It was thought that perhaps the differences in wealth within the focus groups would make their interests too divergent to allow them to work together in technology development. However, it was found later that hand cultivators may occasionally hire a plow or aspire to plow

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ownership and plow owners often cultivate some of their land by hand. Furthermore, although representation by women was low at first (considering women do most of the farm work in this area), over subsequent seasons, more women have replaced their husbands and groups are now balanced. However, it was recognised that efforts need to be made to ensure that meetings are scheduled at convenient times for women to attend (eg when older children are back from school and can manage the farm). The tools project tried working with the womens' groups used for some initial tool evaluations, but found them more interested in gaining access to inputs rather than in research and technology development.

The group meetings were extremely useful. Women and men farmers were able to debate and reach consensus on the selection of technologies and evaluation of trials, and the groups also took responsibility for presenting the results of trials to the wider community at project open days. Focus groups chose to test tools for land preparation (*Bukura* plow and *Mutomo* plow), planting (rotary injection planter, jab planter) and weeding (chiefs cultivator, emivator and pye hoe). An ard plow was rejected as looking too weak for their hard soils (it broke during demonstration). It should be noted that tools were only one element in a range of technology options for soil conservation and weed control which are being tested by farmers. They are also investigating zai pits, contour furrows, tied ridges, water harvesting and manure placement. The broad range of technologies available has been important in sustaining the participatory process, as will be seen below.

Trying out: farmer testing

Trials were designed and implemented by farmers in their own fields. Farmers selected criteria for monitoring their trials and both quantitative (labour inputs, accuracy of seed placement, weed counts etc) and qualitative (durability, ease of use etc) data were collected.

Focus group meetings were held to search for and screen the available options, to initiate the research, to monitor the progress and results with farmer-to-farmer visits and to evaluate the groups' experiences at the end of the season. Farmers in the groups particularly liked the farmer-to-farmer monitoring visits and as a result farmers continue to try new technologies which had previously not appealed to them. After experimenting with new technologies in the first season, farmers had suggestions for developments to the technologies. For example one farmer suggested developing the zai pits that were initially presented, into furrows which would be easier to make with a plow (or by hand). Farmers were also concerned about issues of supply and maintenance of the tools that they had been testing.

Improving and innovating: *jua kali* group

To respond to farmer evaluations and concerns with new agricultural tools, it was necessary to work closely with tool designers and manufacturers. During the first season of trials DAREP attempted to involve local blacksmiths, *jua kali* artisans, large-scale tool manufacturers, Ministry of Agriculture extensionists, and researchers from the University of Nairobi. It was found that *jua kali* tool manufacturers form larger towns such as Kivaa and Embu were able to respond rapidly and enthusiastically to farmers' evaluations with a small amount of external input. Although engineers from the local government Regional Technology Development Unit were involved in the process, and had their doubts about the durability and efficacy of some of the implements, it was difficult for them to respond practically to the farmers needs due to the lack of tools and equipment at their workshops and limitations on transport. The University was also involved, but was unable to respond rapidly to farmers requests or *jua kali* needs within their existing academic programme.

Having no experience or expertise of working with small manufacturing businesses, DAREP collaborated with a Nairobi-based NGO called Farm Implements and Tools (FIT) and a local Peace Corps worker to link the farmer focus groups to a number of *jua kali* workers in Embu district. FIT conducted a survey of the metal workers to assess their capabilities and skills and then invited them to join farmer focus groups at one of the field stations. During this meeting, it was found that farmers were able to communicate their agricultural implement needs very effectively, and the *jua kali* workers were invited to respond. One farmer (a local chief) presented his innovation of a drag hoe on which rocks could be placed to adjust the penetration and work load.

At this point the *jua kalis* decided to form an Agricultural Tools Group. To achieve this, the provincial officer for Applied Technical Training was invaluable in liaising with the umbrella Embu Jua kali Association and was able to smooth over the suspicions of the Jua kali Association officials. In response to the farmers' demands, the sectoral group was able to share raw materials, equipment and ideas. One member procured most of the scrap material, enabling buying in bulk, and another member did most of the forging work due to his skill and equipment in that area.

With a small grant for working capital (about US$10–20, provided by FIT), and some ideas for tool design in the form of books (Intermediate Technology's *Tools for agricultur*e; ITDG, 1992) and drawings (from a local artist), *jua kalis* quickly made some new and adapted tools based on farmers' recommendations. These included an improved version of the *Mutomo* wooden-beamed plow, a light one-handled plow, two adapted versions of the chief's drag hoe, two spray pumps and an improved jab planter. The artisans were thus able to incorporate farmers' existing knowledge, external knowledge in the form of a book on tools, and their own expertise in metal-working processes. The tools were then presented back to farmers by the *jua kalis* before the next season at a tool show. A panel of farmers (four women and four men) judged the tools and awarded a prize to the best according to the criteria below (Tanburn and van Bussel, 1995):

type of materials and quality of work
function (flexibility and efficiency)
durability
number of operators required
applicability to different soil types
portability.

FIT suggested the addition of two criteria:

originality/innovation
suitability for use by women in particular.

The prize was given to a wooden plow since the panel said:

'It was light to use, can be used by women and older people.'

'The penetration is very good.'

'It can be used for wet or dry plowing, and for weeding.'

'It looks easy to repair.' (Tanburn and van Bussel, 1995)

Sustainability: marketing and quality control

During the meeting, farmers agreed to invite *jua kalis* to their DAREP open days where they could display and sell their tools. Since the relationship between *jua kalis* and farmers seemed established and the groups had arranged to communicate, no more funds were given to the process in order to see how sustainable it might be.

In Embu, the artisans sold some of the prototypes (including the wooden plow) and obtained orders from farmers in the neighbouring high potential areas. The following season the artisans received invitations to the open days at Mutuobare and Kajiampau, but did not sell any tools or get any orders from farmers in the drylands. These are an example of the comments made by farmers (Mwaniki, 1995):

A woman farmer who often rents a plow and weeds with a panga: *'Some implements were expensive, others seemed poorly made, others were complicated and we did not understand them and therefore could not buy.'*

A male plow owner who weeds with oxen: *'The items are a bit expensive; others we gave our contribution on how they [the prototypes] can be modified, but the changes were not as per our comments; others were viewed as unsatisfactory and thus purchasing was not possible.'*

Thus, although the prototypes had been enthusiastically received, the production models were less good, showing up the difficulty of copying what was now the third generation tool. However, agreements were made that farmers would order tools either directly from the artisans or by writing letters through DAREP. By this method artisans were also invited by the farming community to display their tools at three other DAREP stations. Some drag hoes were bought, but only by extension or project staff. Since then, some of the Mutuobare farmers have visited the *jua kali* workshops in Embu, and a plow, wheeled hoe and drag hoe have been bought by farmers in semi-arid areas. Tools continue to be sold to farmers in the higher potential area around Embu.

The apparent lack of demand from dryland farmer groups has not dampened their interest in

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research, however. They either want to save enough money to buy the tools they like, or to see improvements to *jua kali* tools. The fact that they feel identity as a group has kept them seeking solutions to their problems from their own resources. One group has formed a savings group and meets every month to donate money to one member. Members have used the money for buying *jembes* and *pangas* or paying school fees. Both groups continue to research methods of improving water and soil conservation with both animal traction and hand tillage methods. These include post-plant ridging with a plow, plow weeding, zai pitting, tied ridging and water harvesting, Having contact with the DAREP multidisciplinary team has meant that the same farmers are trying out other technologies such as new crops and crop varieties, water harvesting for trees and crops, and cultural pest control methods. The diversity of technological options has kept the farmers' interest and the momentum of the participatory process going even though one option (access to tools) was being delayed by the other group (the artisans).

A follow-up evaluation of the progress so far was sponsored by FIT and carried out by engineers from the Rural Technology Development Unit (Mwaniki 1995). They found that some tools made by *jua kalis* such as manure forks and water sprinklers were performing well, and appreciated by their buyers, while a wheeled hoe and drag hoe were found not to be functional due to poor manufacture. Furthermore, the Rural Technology Development Unit continues to observe problems of design quality in other tools circulating around Embu. Plows bought by local NGOs and stockists have wrong share positions, weak beams, poor adjustment mechanisms and wrong mouldboard shapes. It appears that even if producers know how to make good tools, the customers are not able to demand the quality they need.

However, both farmers and artisans claim that they have benefited from the process. Typical comments were (quotes from Mwaniki, 1995):

> *'It was good, near to the farmers.'* Jennifer Kiura (Farmer Research Group)
>
> *'Farmers were able to tell producers their problems. I gained in knowledge and would like to participate in future.'* Andrew Gatiti (Chairman, Farmer Research Group)
>
> *'I have new customers, new marketing ideas and have gained knowledge in manufacturing the jab planter. In the future I would like to have jigs and fixtures put in place.'* David Kamau (Artisan)
>
> *'I have learnt new marketing skills and have more confidence.'* Gerald Ngugi, (Blacksmith)

Farmers have been exposed to a number of new tools and new sources of tool supply. Both male and female farmers have learnt to evaluate tools on their own farms and at open days. They have learnt that they can communicate their needs effectively to tool makers and now know where these artisans are to be found. *Jua kalis* have gained confidence in adapting and inventing tools, increasing their skills and product range. They have become more aware of the farmer market and of methods to gain market information and advertise their wares. They also state that they are now more aware of the importance of standardised production and of the use of jigs and fixtures.

Present and future: repeating the process and developing linkages

Organisations involved in supporting the artisans met with them in Embu and made progress in identifying the constraints and opportunities that face the participatory technology development process. The first meeting highlighted the constraints in credit, marketing, group development and quality control. The meetings suggested several ways of overcoming obstacles, trying to identify solutions which would require little external input, and would build on the achievements so far. Examples include:

- working more closely with stockists or middlemen to obtain raw materials on credit and improve the marketing channels
- exchange visits and training would help directly in improving design and production skills while also improving group identity
- design and quality of tools could be improved through more field testing involving farmers, artisans and engineers.

In summary, the artisans felt that the methods used so far should be repeated, with a few extra linkages, in order to develop the products further.

Table 1: Some challenges and options for animal traction development in Embu

Challenges	*Options*
There is a need to improve the quality and standardisation of tools produced by local manufacturers.	Introduce branding of tools as a marketing strategy and to improve accountability for poor standards. Use of fact sheets to educate consumers to demand quality in products. Training courses for artisans.
Plows may be a difficult technology for an entry activity, as the cost is high and quality hard for small-scale manufacturers to achieve.	The project could concentrate initially on simple, cheap tools such as hand tools. As capability and confidence develops the programme could begin to tackle more complex technologies.
Large distances and poor infrastructure between artisans and farmers makes the constant feedback needed for paticipatory development difficult.	Strengthen farmer and artisan organisations.
The low population and buying power of farmers in the area means they exert little demand pull in product development.	Develop tools which are also appropriate to small farmers in the high potential areas. These farmers can more easily bear the initial risk during product development. Development of farmers' organisations in the semi-arid areas may exert more demand pressure on manufacturers. External input may be needed to support the market in area receiving famine relief food.
Manufacturers, engineers, and universities need to develop a more flexible approach which will allow them to be involved in participatory technology development and contribute to its success.	Encourage their closer involvement with small target groups and formalise the linkages. Raise awareness of the benefits of participatory technology development for these organisations.
Farmers and artisans still lack confidence in their ability to demand external input and consequently still play a relatively passive role in the participatory technology development process.	Place more emphasis on group management skills and empowerment. NGOs or extension workers can help with training/support. Field workers need good community development and facilitation skills and training in participatory approaches.
Different agendas of supporting organisations can confuse issues. For example DAREP's interest in 'researchable options' limits it to technologies unproved in the locality and FIT's desire to develop 'innovative methodologies with 100% recovery' limit the approaches they are prepared to facilitate.	Farmer and artisan agendas should remain central to the process. Strong group organisation should allow farmers to make vertical and horizontal linkages to fulfill needs.

Following these suggestions, FIT organised and sponsored a meeting between the *jua kalis* and local stockists using a small business advisor as facilitator. A good relationship was started between these two groups, and interest was shown by the stockists in *jua kali* products.

Discussions continue to be held by the stakeholders as to how tool quality can be improved in a sustainable manner. Recently FIT introduced an idea pioneered by Voluntary Service Overseas in Mombasa. Product information useful to artisans was put on a single A4 sheet and the printing costs were paid for by advertising on the reverse side. In the Embu tool development

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process, plow design information could be printed on such fact sheets. This may enable artisans to be more aware of the critical parameters in making a plow and customers would know what characteristics to look for in good quality tools.

Lessons learnt

Animal traction technology development, especially in semi-arid areas, is a complex activity, involving linkages between farmers, artisans, engineers, business advisers etc. This complexity makes animal traction particularly suited to a participatory technology development approach.

The main external inputs required have been in group selection, identifying ideas to try, small grants of working capital (less than US$200 in total; Tanburn and van Bussel, 1995), and facilitating communication between the users, sellers and producers of technology. The participatory approach has encouraged researchers, engineers and farmers to interact, since the technical staff have actually gone to the field, talked with farmers and responded to them. This has been important to enable the synthesis of local and external knowledge.

The development of organisational structures such as farmer and artisan groups is an important part of the participatory process. These structures increase the self confidence of the participants and allows them to address associated issues of supply, credit and also to share resources.

Tools are best developed as part of an integrated and 'problem-orientated' approach, rather than as aim in itself. This is especially important with different, interdependent groups. Thus if one solution or group fails or stalls, the (other) target group can still continue developing solutions without losing momentum.

Participatory technology development improves the effectiveness of technology selection and screening as farmers and artisans expert local knowledge is involved from the early stages.

When farmers are involved in designing their own research activities, the quality of trial management, monitoring and evaluation is high. Farmer groups were able to make very specific recommendations for evaluated technologies. For example, farm type, soil conditions and detailed instructions for use. Farmer-to-farmer transfer of technologies is correspondingly powerful.

Participatory technology development is an iterative activity, involving constant learning and replanning. Flexibility, creativity, as well as regular monitoring and evaluation (by all stakeholders) is an important part of the process.

In Embu there are many challenges still to be met (see Table 1) and the authors welcome input from others to overcome them.

Conclusions

A pilot programme has identified methods of developing prototype tools using a participatory approach. These and other methods will be needed to take these tools into production and out to the market place. Facilitator and market approaches should be used where possible, but these may need to be supplemented by external inputs to strengthen the market in semi-arid areas.

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