PILOTING CONSERVATION AGRICULTURE TO IMPROVE LIVELIHOODS AND FOOD SECURITY FOR SMALL HOLDER FARMERS. PROJECT TCP/KEN/2904

TECHNICAL INPUT ON AGRICULTURAL ENGINEERING AND CONSERVATION TILLAGE EQUIPMENT

VISITS TO KENYA 15-30 September and 10-25 October 2003

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ABBREVIATIONS

AEATRI	Agricultural Engineering and Appropriate Technology Research Institute (Uganda)
CA	Conservation Agriculture
CC	Cover crop(s)
DAP	Draft animal power(ed)
FAO	Food and Agriculture Organization of the United Nations
FAOKE	FAO, Kenya
FEW	Frontline Extension Worker

FFS	Farmer Field School(s)
FTC	Farmer Training Centre, (Machakos; Nakuru, Bungoma, Siaya)
ICRAF	World Agroforestry Center
IMAG	Institute of Agricultural and Environmental Engineering (Netherlands)
KARI	Kenya Agricultural Research Institute
KCTI	Kenya Conservation Tillage Initiative
Kendat	Kenya Network for Draft Animal Technology
MOALD	Ministry of Agriculture and Livestock Development
NARL	National Agricultural Research Laboratory (of KARI)
NARO	National Agricultural Research Organization (Uganda)
RELMA	Regional Land Management Unit (based at ICRAF and funded by SIDA)
RTDC	Rural Technology Development Centre
SARI	Selian Agricultural Research Institute (Arusha, Tanzania)
SIDA	Swedish International Development Cooperation Agency
TC	Technical Cooperation
UoN	University of Nairobi

1 hectare = 2.47 acres
1 acre = 0.40 hectare

Exchange rates (September 2003)

Ksh74 = $US1.00
Ush1975 = $US1.00

ACKNOWLEDGEMENTS

These two visits have meant a heavy work load for many friends, old and new. Working as a team, I was able to fulfil, or even exceed, the expectations of this visit. I extend my great thanks to the colleagues from the Ministry of Agriculture and Livestock Development (Dr Mwamzali Shiribwa and Charles Mwanza) and Kendat (Dr Pascal Kaumbutho, Dr Joseph Mutua, Anthony Karimi and Paul Wamai) who were with me when it mattered most. The farmers, extension workers, artisans and co-trainers were both complementary and complimentary and together we hope to have left a positive trail. Finally many thanks to the Nairobi FAO Representative Bruce Isaacson and Project Coordinator Deborah Duveskog for their support for, and keen interest in, the progress of the Project.

Summary

This technical cooperation visit was made to Kenya as part of the agricultural engineering input to an FAO Conservation Agriculture (CA) project. The visit was split into two components, the first two weeks were spent on a farmer and extension worker training course; the second two weeks on artisan training and equipment evaluation.

The equipment component of the CA training course for 18 farmers and six extension workers from the six Project focus sites in Kenya (Siakago; Machakos; Nakuru; Bungoma; Siaya and Homa Bay), was achieved via a series of discussion sessions with a much greater concentration on practical field work. The trainers, coordinators, equipment, farmers and extension workers travelled from site to site, leaving sets of CA equipment (sprayers and no-till planters) at each one. The weed and cover crop management aspects of the course were dealt with by their respective experts.

The equipment covered in the course comprised: tillage implements, direct (no-till) planters; and sprayers.

Tillage equipment included:

- *Magoye (Zambia) sub-soiler*
- *Magoye ripper*
- *3W (Kenya) donkey-draft direct seeder and ridger*
- *Ridge tyer (Zimbabwe)*

Seeding and fertilizing equipment:

- *Mafrense (Brazil) DAP no-till planter / fertilizer distributor*
- *Fitarelli (Brazil) DAP no-till planter / fertilizer distributor*
- *Fitarelli matraca jab-planter / fertilizer distributor*
- *Magoye seeder / fertilizer distributor*

Chemical application equipment

- *Triton (Brazil) DAP powered sprayer*
- *Jacto (Brazil) manually pulled sprayer*
- *Zimwipe weed wiper (Zimbabawe)*

With the exception of a seminar based on a CA Power Point presentation and interventions in the discussion periods of the weed control and cover crop trainers, the training was done in the field, using the equipment provided. The procedures used were selected (and modified) from the detailed test procedures contained in the FAO Agricultural Services Bulletin 110.

During the second two-week visit, six metal-working artisans (jua kalis or blacksmiths) from the Project focus regions, were trained in CA equipment fabrication and testing at the 3W Engineering workshop, Naro Moru. Equipment made included the 3W DAP lightweight equipment, the Magoye sub-soiler and prototype direct planters based on the single row DAP design from Brazil. Suggestions are made on modifications for local manufacture.

The opportunity to develop CA equipment, interact with farmers and engineers and re-evaluate modified versions, was a rare one for the course participants. But one that is important if CA s to take off in Kenya and the supporting infrastructure is to be in place. It was stressed that artisans, as important stakeholders in the CA process, will be encouraged to participate in scaling up activities such as workshops, field days and demonstrations together with other important stakeholders (farmers, scientists, MOALD officers, NGOs, etc.).

During two-days of work at Lengetia farm (Naro Moru) with farmer Laurie Sessions we assembled the Fitarelli tractor-mounted no-till planter and field-tested it with the local chief and farmers. At the same time, units of the Triton DAP sprayer and the Jacto pedestrian pulled sprayer were also assembled and demonstrated. Three demonstration plots of about one acre in area were established with maize, beans and cover crops. Laurie Sessions has volunteered to monitor these plots and to help establish any further plots that farmers ask for. The equipment has been left with him for this purpose.

Observations and conclusions are made on the following topics:

- *Management of the farmers and extension workers courses*
- *Artisan training course*
- *Equipment development*
- *Dissemination of CA principles and practices*

In summary the conclusions point to a very successful series of interventions with a great deal achieved in a short time. However, the effort must be sustained and the principal actors (farmers, artisans and manufacturers, extension workers and scientific staff) will need further encouragement to ensure the take-off of CA amongst the small-holder farming community in Kenya.

The visit concluded with a seminar on CA for small-holder farmers.

1. PROGRAMME

This Technical Cooperation mission comprised two separate two-week visits which were split by a two-week absence from Kenya. The first visit was from 16 - 30 September 2003 and was devoted to field training in Conservation Agriculture (CA) technologies. My specific brief was to demonstrate locally made and imported machinery within a technical training package which included weed and cover crop (CC) management. The technical programme was coordinated by Kendat (Dr Joseph Matua and Dr Pascal Kaumbutho) and comprised Hottensiah Mwangi (weed management) and Wilfred Mariki (CC management). The trainees included 18 farmers and 6 Frontline Extension Workers (FEWs) from the 6 regions visited. The group remained together throughout the training (from 15-26 September) and travelled from site to site in the following sequence: Siakago; Machakos; Nakuru; Bungoma; Siaya and Homa Bay.

At the request of Josef Kienzle, I met with AEATRI Director Wilfred Ogodola in Uganda during my visit to that country. A brief report of our two meetings is given in Annex 4.

The second visit was made from 10-25 October. Monday 12 to Friday 17 October was devoted to artisan training at 3W Engineering, Naro Moru. This was followed by assembly and trials of the Fitarelli tractor-mounted direct planter. Three 1-acre demonstration plots of maize, beans and leguminous cover crop were established in the Naro Moru region. On return to Nairobi, I presented a seminar at ICRAF on CA experiences in Latin America with reference to the Kenya situation. A detailed Itinerary of the two visits is given in Annex 2 and the names of the people involved in Annex 3.

2 BACKGROUND

The Kenya Conservation Tillage Initiative (KCTI) was established in 1997 with funds from the Swedish Government (SIDA) via their Regional Land Management Unit (RELMA). The aim of promoting conservation tillage (including CA) is shared by a loose confederation of members including the Ministry of Agriculture (MOALD), RELMA, Kendat, the University of Nairobi and the Kenyan Agricultural Research Institute (KARI). The present FAO-supported pilot CA TC Project forms part of the portfolio of the KCTI.

Although the importance of CA globally may be its contribution to sustainable agriculture and environmental protection, in developing countries afflicted with the HIV/AIDS pandemic it can make an especially important contribution. HIV/AIDS has, for some time, been wreaking havoc with the small farm labour supply. In Kenya many households are now headed by a single parent, or even by grandparents, and the scarcity of labour at critical times is undermining their ability to produce even at subsistence levels (Bishop-Sambrook, 2003). CA, by reducing or eliminating the need for soil inversion and hand weeding, can potentially make a major contribution to the alleviation of labour peaks.

The author has had long experience of conservation tillage during three decades of work in Latin America. During this time he has been involved in equipment development and commercial manufacture, as well as farmer and technician training. In July 2003 he participated in a technical workshop on CA supported by FAO in South Africa (Sims, 2003). The present TC mission has a strong knowledge transfer component.

Another relevant element of the background of this visit is the author's very active participation in a series of training courses given to technicians on the evaluation of equipment for small-holder farms. These courses culminated in the production of the FAO Agricultural Services Bulletin 110 (Smith *et al.*, 1994). The experience gained in the six countries where the courses were given has served well to understand the essential ingredients required in training courses aimed at imparting familiarity with agricultural machines, their settings and adjustments.

3. TRAINING COURSE (FARMERS AND EXTENSION WORKERS)

The equipment component of the CA training course for 18 farmers and six extension workers from the six regional sites in Kenya (Siakago; Machakos; Nakuru; Bungoma; Siaya and Homa Bay), extended over a two week period and was completed via a

series of discussion sessions with a much greater concentration on practical field work. The trainers, coordinators, equipment, farmers and extension workers travelled from site to site, leaving sets of CA equipment (sprayers and no-till planters at each one). The weed and cover crop management aspects of the course will be reported by the respective trainers.

3.1. Programme

Date	Course work
16/9/03	Siakago. Field practical with Magoye ripper; Magoye sub-soiler; Mafrense no-till planter / fertilizer distributor
18/9/03	Machakos. Participation of the trainees in the identification of all the equipment. Discussion on findings. Detailed description and use of Triton DAP powered sprayer and Jacto manually pulled sprayer. Detailed discussion of water conservation with tied ridges, using the 3W ridger and tyer.
19/9/03	KARI-NARL (Nairobi). Cover crop demonstration and discussion of management practices. Drip irrigation demonstration.
20/9/03	Nakuru. Intensive training on Triton sprayer. Calibration and calculation of application rates. Hottensiah Mwangi emphasized the importance – through practical demonstration - of using protective clothing when using agro-chemicals
22/9/03	Bungoma. Power Point presentation of CA technology from Latin America. Calibration and use of Mafrense no-till seeder / fertilizer distributor. Calibration and use of Magoye seeder / fertilizer distributor
23/9/03	Bungoma. Discussion on construction and use of Fitarelli DAP no-till seeder / fertilizer. Practical calibration at different gear settings.
24/9/03	Siaya. Tillage. Discussion and use of Magoye sub-soiler (with soil pit dug), Magoye ripper; 3W ridger and tyer. Use and calibration of modified (added mulch-cutting disc) Fitarelli DAP no-till seeder / fertilizer. Practical use of Fitarelli matraca.
25/9/03	Siaya. Further work on the Fitarelli DAP planter with strengthened disc support and wider animal yoke to avoid fouling the animals on the headland turns.
26/9/03	Homa Bay. Group discussion of CA plots. Trainee led description, calibration and use with oxen of Triton DAP sprayer. Course evaluation.

3.2. Equipment

Tillage implements

- **Magoye sub-soiler**

This tillage implement is designed to be used to break plow pans (formed through plowing at the same depth for successive years) prior to embarking on a CA programme. Should root growth be impeded at any time under the direct planting regime, then the sub-soiler can be used again. The Magoye sub-soiler has been designed in Zambia through an IMAG – MoA cooperative agreement.

The implement is basically a narrow tine (in this case a hexagonal-section 25 mm diameter carbon steel rod – probably from discarded rock drilling bits) with a low

angle of attack (~15°). This configuration will give good penetration at low draft. The tine is reversible and moveable to compensate for wear. The tine and adjustment assembly is mounted on a steel plow frame manufactured by Zimplow in Zimbabwe. The frame has been extended by the addition of a triangular mild steel structure which now carries the adjustable hitch point and is said to improve stability in work. The implement is draft animal powered and manually controlled.

- **Magoye ripper**

From the same source as the sub-soiler, the ripper has enjoyed considerable success in Zambia as a tool for ripping and producing a weed-free seedbed only along the line of planting (Stevens *et al.*, 2002). This obviates the need for plowing, but does increase the level of management required to control the inter-row weeds (either mechanically or chemically). Mounted on the same frame as the sub-soiler, the ripper has a 60 mm wide, 260 mm long reversible tine, again with low angle of attack (~15°). There is provision for attaching wings for ridging and the wing mounting plates alone produce a narrow weed-free furrow, suitable for hand planting with a stick or jab planter (such as the matraca).

The Magoye equipment is made in Kenya by the University of Nairobi, using the Zimplow frame imported for Ksh5000 they produce the sub–soiler for an additional Ksh4500 and the ripper for a similar price.

- **3W light-draft direct seeder and ridger**

This light-weight equipment is designed to be used with small draft animals (donkeys, for example) in conjunction with a simple high-lift harness (Inns, 2003). Built by Barney Muckle of 3W Engineering, the equipment is low cost and specially designed with the small-holder farm family in mind. The basic frame carries a winged tine for opening a furrow, and a seed tube for manually metered seeding. The winged tine can be removed and replaced with a ridger.

- **Ridge tyer**

Ridges can be tied, for *in situ* rainwater capture and infiltration, by a separate half-moon shaped tyer. The unit demonstrated is of Zimbabwean origin.

Seeding and fertilizing equipment

- **Mafrense DAP no-till planter / fertilizer distributor**

This robust machine[1] features a chain drive to the fertilizer distributor from the front drive wheel. A second chain takes the drive to the seed delivery system (a horizontal cell-plate system with interchangeable plates). Seed rate is determined by plate type (number and size of holes) and by interchanging the sprockets on the second chain drive. A vertical cutting disc is mounted behind the drive wheel and in front of the chisel tine furrow opener which also carries separate delivery tubes for the seed and fertilizer. An adjustable spring loaded press wheel brings up .the rear. The seeder has a high hitch point to permit an increased downward force on the cutting disc for use in conditions of abundant vegetation.

[1] Made by Mafrense, Mafra, Brazil

Fitarelli DAP no-till planter / fertilizer distributor[2]
This is a simple and robust machine designed as a low-cost alternative to the more traditional no-till seeders (exemplified by the Mafrense machine). A rear spider wheel drives an enclosed chain and sprocket transmission which in turn operates the star-wheel fertilizer distributor via bevel gears, and the seeder metering mechanism via a cone of three bevel gear options. Seed metering is by horizontal perforated disc and seeds are expelled with a spring-loaded ejector. Surface vegetation is cut by a vertical disc and the furrow is opened with a chisel -point tine. It appears that the six machines were delivered without their disc coulters and so a temporary arrangement had to be fitted to permit the practical training sessions. The seeder is pulled by an integral drawpole fitted to the ox yoke, and is pedestrian controlled with height-adjustable handles.

Fitarelli matraca jab-planter / fertilizer distributor
The matraca is a very popular tool for smallholder production in several south American countries. It comprises a seed hopper and fertilizer hopper mounted on wooden members which terminate in handles at the top and two metal 'beaks', or hole openers at the bottom. The beaks are pushed into the ground with the handles held apart. Once the implement has penetrated the soil, the handles are pushed together and this actuates the sliding seed metering mechanism in the bottom of the seed hopper. The seed falls into a delivery tube and into the hole produced by the seeder beak. The seed slide is attached to a crank on the fertilizer distributor which tips the grooved cylinder in the base of the fertilizer hopper and so delivers a measured dose of fertilizer down its delivery tube and into the fertilizer hole laterally displaced from the seed.

Magoye seeder / fertilizer distributor
This is a basic device designed to be bolted to the Magoye ripper so that it trails behind the ripper tine. This allows seeding and fertilizing to take place in one pass of the ripper. There is a single hopper with a dividing wall between seed and fertilizer sections. The metering mechanisms are located at the bottom of each hopper section and a comprise a vertical cell wheel for seed and a grooved cylinder for fertilizer.

Chemical application equipment

- **Triton DAP powered sprayer**

This sprayer has an 80 litre tank feeding a piston pump driven by an eccentric from a pneumatic tyred ground-wheel. Pressure is maintained by an accumulator and there are separate pipes, independently actuated, to the two folding boom sections which have five fan nozzles apiece. The nozzles are fixed to the vertically adjustable boom at 50 cm intervals. Filtering is provided at three points, the tank inlet, the tank outlet and at the nozzles. Whilst there is no pressure regulating valve, wheel skid is avoided by manipulation of the returns valve which provides chemical agitation in the tank. A handle can be fitted to the pump for static calibration. There is provision for shafts to be fitted for use with a single animal, or a yoked pair. Shafts were fabricated during the training session.

- **Jacto manually pulled sprayer**

[2] Manufactured by Fitarelli, Máquinas Agrícolas, Aratiba, R.S. Brazil. zenith@st.com.br

This simple machine is basically a Jacto backpack sprayer mounted on a wheeled frame and driven via an eccentric from a steel-ground-wheel. Power is provided by the operator pulling the machine behind. The single, vertically adjustable, boom has four fan nozzles spaced at 50 cm. Pressure is regulated (to avoid wheel skid) by an adjustable chemical returns valve.

- **Zimwipe weed wiper**

Designed especially for applying systemic herbicides, this is a broom-shaped device with a hollow plastic handle filled with the chemical mix which keeps the applicator sponge moist. The operator wipes target weeds with the sponge thus transferring herbicide which is translocated and will eventually kill the weeds.

3.3 Training methods

With the exception of a seminar based on a CA Power Point presentation (Sims, 2003), and interventions in the discussion periods of the weed control and cover crop trainers, the training was done in the field, using the equipment provided.

The procedures used were selected (and modified) from the detailed test procedures contained in the FAO Agricultural Services Bulletin 110 (Smith *et al*., 1994). A copy of this publication was left with Kendat. Apart from describing and using the equipment in the field, the following activities were undertaken:

Tillage equipment
Depth and width of work, effect on compacted strata in the soil. Efficacy of the equipment for the needs foreseen (weed control, in-situ water conservation, loosening of compacted layers). The importance of angles of attack of soil acting tines. The importance of a clean design which avoids obstructions and provides a clear flow of soil and vegetation.

Planting equipment
Selecting seed metering options according to seed type and uniformity. Seed distribution. The effect of metering mechanism changes on seed rate. Calibration and its importance for crop yields. Adjustments for cutting surface vegetation, seed covering and compaction of the soil around the seed. Importance of yoke length for row planting, fabrication of yokes.

Chemical application equipment
Monitoring variability of output along the boom and total output. Calculation of application rates and adding the correct amount of chemical to the tank. Calibration according to the forward speed of the draft animal or human. The importance of care when using agro-chemicals. The use of protective clothing.

4 TRAINING COURSE (ARTISANS)

Six metal-working artisans (*jua kalis* or blacksmiths) from the Project focus regions (Bungoma, Machakos Siaya, Nakuru, Siakago and Homa Bay) were trained in CA equipment fabrication and testing at the 3W Engineering workshop, Naro Moru, from 13-17 October.

4.1. Programme

The original programme proposed was modified by the addition of a day on fabrication of the Magoye sub-soiler organized by Kendat and UoN. The delayed arrival on-site of the imported CA equipment also required additional field evaluation sessions.

Date	Course work
13/10/03	Introduction to CA. Discussion of 3W equipment to be built in the workshop. Field evaluation and modification of 3W CA equipment. Modification of US prototype no-till planter. Assemble Fitarelli DAP no-till planter.
14/10/03	Field evaluation of 3W CA equipment, US prototype and Fitarelli DAP no-till planters. Design of locally made no-till planter frame.
15/10/03	Magoye sub-soiler fabrication with UoN. Repair and fit disc to US prototype no-till planter.
16/10/03	Discussion on requirements for local manufacture of a DAP no-till planter. Continue fabrication of 3W implement. Fabrication of local DAP no-till planter.
17/10/03	Field testing of new and modified equipment made during the training course. Field evaluation of US prototype planter with disc fitted. Discussion group on costing and marketing. Closure.

4.2. Benefit of the training

The technical content of the training course has been reported by Barney Muckle (Muckle, 2003). The opportunity to develop CA equipment, interact with farmers and engineers and re-evaluate modified versions, was a rare one for the course participants. But one that is important if CA is to take off in Kenya and the supporting infrastructure is to be in place. It was stressed that artisans, as important stakeholders in the CA process, will be encouraged to participate in scaling up activities such as workshops, field days and demonstrations together with other important stakeholders (farmers, scientists, MOALD officers, NGOs, etc.).

Artisans expressed the following views on the value of the experience:

- The educational value of proximity to farming and especially to CA.
- The valued opportunity to try the implements themselves and to see the response of changes under field conditions. This was especially true of the impact of disc and share relative heights and distances.
- The chance to modify prototypes and to see the effects almost immediately in the field.
- The chance to converse with farmers and to hear about the effects of implement modifications. However it was appreciated that, in the specific case of CA, it was a novelty for farmers too, and so the process was one of mutual learning.
- The opportunity to interact with other artisans and to exchange ideas and experiences.
- To be able to take home the finished implements, templates and jigs.

Follow up will be needed. In the case of the Magoye sub-soiler, the plan is for the UoN expert (Wilfred Wamutitu) to visit each artisan and to give training on jig

fabrication. Following that, the Project will place orders with each of them rather than commissioning one batch from UoN. This is a good way of motivating the artisans and should act as a catalyst for them to continue to work in the notoriously fickle market of equipment for small farmers.

5 EQUIPMENT MODIFICATION FOR LOCAL MANUFACTURE

During the artisan training workshop, and the subsequent equipment evaluation at Laurie Session's farm near Naro Moru, modifications of equipment for local manufacture were suggested.

3W Engineering light-weight tool bar
Barney Muckle has previously designed and manufactured (with KARI) a light-weight tool bar which can carry a range of tillage tools, including a winged narrow chisel with a hand-fed planting tube mounted behind. For a CA application a disc has been added to the front of the chisel to cut surface vegetation[3].

During two sessions of field testing the following observations and modifications were made:

- Removal of the wings on the chisel tine. These impeded the free flow of surface vegetation and caused the implement to become blocked.
- The disc was surcharging the soil failure zone ahead of the tine. It was moved further forward.
- The disc attachment was modified to give greater strength and rigidity. This was achieved by separating the fixing bolts and passing the disc stalk through a hollow section.
- The furrow needs to be wider to receive the seeds falling from the planting tube. This was achieved in two ways: i) by adapting a wide (50 mm) chisel tine at the high attack angle (~50° in work) employed successfully on the Fitarelli DAP planter; and ii) creating a triangular section tine by welding angled side plates on to the original narrow tine. This last option appears to be the better of the two in terms of lower draft and better implement control.
- If a vertical disc is used to cut surface vegetation then a suitable downward force needs to be applied to it. This is most easily achieved by adding weights to the implement. A weight tray will eventually be designed, but good penetration in extremely hard soil conditions was achieved by adding weights totalling 28 kg to the 25 kg tool bar.

US Prototype no-till planter
This prototype planter has been imported into Kenya by MOALD for in-field evaluation. It is a heavy (>100 kg) machine fitted with two pneumatic tyres which, in turn, drive two more to operate the fertilizer and seed metering mechanisms. It is my understanding that its creator (Dr Morrison) will be visiting Kenya in the near future to conduct in-depth studies and modifications. At this stage some observations and minor modifications made during initial field trials will be recorded.

[3] The disc used was a scrapped moldboard plow coulter, modified to be attached to the tool bar.

- The prototype appears to have been developed for attachment to the horizontal draw bar of a small tractor. A draw pole was fitted for animal traction but this will have to be modified later to provide a horizontal pull.
- The forward mounted spider wheels for clearing surface vegetation were ineffectual under the conditions of standing wheat stubble and abundant loose wheat straw present at the test site. This is not surprising, and when they were replaced by the disc, this penetrated the very hard soil and cut all the surface vegetation.
- During the initial trial, seed did not flow out of the metal seed tube. This problem could not be detected in work as the rubber connecting tube is not transparent. The seed exit could be modified to avoid the sharp change of angle and to reduce any possibility of soil blocking the flow.

Fitarelli DAP no-till planter

The Fitarelli implement performed better than any other at the site which was characterized by extremely hard soil conditions and abundant surface vegetation. Pulled by a pair of oxen with a combined mass of some 850 kg, the 50 mm wide tine easily penetrated to 12 cm, with no additional weight needed and at the lowest draft (approximately 60 kgf compared with 80 kgf for the 3W implement).

It was decided that the basic configuration of this implement was suitable for modification and fabrication by local artisans and accordingly a tool frame was made using locally available materials. Barney Muckle's drawing of the implement is given in Annex 5. This prototype performed equally well, penetrating to >12 cm.

- Trash build up around the support bracket between the share stalk and the main frame can easily be eliminated by simple re-design of the piece to ensure that it does not interfere with the smooth flow of material as the implement advances.
- The disc appears to be surcharging the soil failure zone in front of the tine. Moving it forward will remove this effect and so reduce implement draft.
- The prototype performed well, the vegetation is cut and the furrow is adequate for pre-rains seeding. It can form the basis of a new CA planter and could be used almost immediately with a simple seed tube for hand-metered seed.

However, in my view, local manufacture of a complete DAP no-till planter is still some way off and for it to be achieved a planter development sub-project will need to be initiated. The following are some of the actions that would be included:

- Materials must be locally available and the parts should be capable of artisan manufacture and repair. Examples are: 1¼" diameter 'black pipe' for the draw pole; 40 cm (instead of 30 cm) diameter discs (if available from Ndume in Gilgil); recycled spring carbon steel for the share support.
- Seed and fertilizer metering mechanisms. There is, apparently, no current manufacture of suitable seeders in Kenya, although the east Africa Foundry Works in Nairobi have manufactured them in the past. Suitable designs may, therefore, exist and should be investigated. The most expensive option would be to import suitable units for incorporation into locally made frames. In this case options such as inclined plate seeders manufactured in Senegal may be a more suitable altrenative as they are capable of dealing with ungraded seed.

The 3W option of hand metering seed down a planting tube would be a low cost alternative that should be researched with farmers.

- Transmission. The Fitarelli chain and sprocket drive from the rear spider wheel could be made locally, albeit at a high cost. A pitman drive would be a more simple and much cheaper solution. The bevel gears used on the Fitarelli implement could be reduced in number once the range of seed sizes and spacings required in Kenya have been established. It could be that one gear ratio with a range of seed plates would be sufficient.

DAP and pedestrian pulled sprayers

The two sprayers imported from Brazil are well designed machines incorporating proven features which would not be difficult to duplicate in Kenya. Artisans would be able, with the appropriate training, to adapt, very easily, the locally available Hardi back-pack sprayer[4] to a frame for the pedestrian controlled machine. (And there are other, cheaper, locally made back-pack sprayers available). The DAP version would be more difficult as the pump requires working with PVC and the sprayer components are altogether slightly more complicated in terms of design.

A major setback, however, is the availability of nozzles at a reasonable price. I visited one outlet (Hardi Kenya Ltd in Nairobi) as was disappointed at the high cost of nozzles[5]. A short term solution would be to buy in a supply from a producing country (say Brazil) to fit to the locally designed and manufactured sprayers.

It must be noted that the sprayers are only now undergoing farmer and artisan participatory evaluation and local manufacture of a finalized design has not yet started.

Fitarelli tractor-mounted planter

Whilst it is very important to ensure not to infringe any patents, this machine could be quite easily copied in all its essential details by the Ndume factory in Gilgil.

6. CONSERVATION AGRICULTURE OUTREACH

During two-days of work at Lengetia farm (Naro Moru) with farmer Laurie Sessions we assembled the Fitarelli tractor-mounted no-till planter and field tested it with the local chief and farmers. At the same time, units of the Triton DAP sprayer and the Jacto pedestrian pulled sprayer were also assembled and demonstrated. Although Lengetia farm is a commercial wheat farm the owners have a strong sense of community service and a desire to promote CA amongst small-holder farmers in the area. The farm itself grows 2500 acres of direct sown wheat using an Australian Rogro[6] 6 m width no-till pneumatic seeder and a locally produced (by Ndume) derivative. Two litres per hectare of glyphosate (Mamba) are applied in 100 litres of water either before or just after seeding. Yields have improved (up to 6 ton/ha) and costs cut when compared with results from traditional tillage. (Seed rates have been reduced from 40 to 25 kg/ha and fuel costs from 30 to 3 l/acre). Rotations will

[4] The 15 litre model is available at Hardi Kenya Ltd, Nairobi at a price of Ksh6950 ($US93)

[5] Nozzle Ksh306; Nozzle holder Ksh 150; nozzle filter Ksh150; 'T' pipe Ksh 459. Giving a price for a single nozzle assembly of Ksh1065 ($US14)

[6] Spring Ridge Engineering Pty Ltd, Australia

include sunflower, safflower, canola (rape) and sorghum. Rainfall is erratic but averages 700 mm/year in two distinct seasons.

With the local Chief (Ndirangu) the Fitarelli was used on the first day to plant and fertilize maize. Its performance was excellent. With the one seed plate supplied the 45 cm rows planted maize at 15 cm intervals. For other crops and spacings a set of suitable seed plates must be supplied, these could be locally produced from blank plates. The DAP and pedestrian-pulled sprayers created the, now customary, great amount of interest. Local manufacture should not present a problem (although locally sourced nozzles are expensive) and the need to include local artisans (*jua kalis*) as stakeholders in the process was (again) emphasised.

The second day was devoted to establishing direct planted maize and cover crop demonstration plots:

- One acre at Lengetia farm. Maize only.
- One acre at Male on land rented by Lengetia farm at a strategic road side site. This site included maize and beans with an inter-row planted cover crop of *Dolichos lablab*.
- One acre at the farm of an interested participant (Peter Kamura) of Male village.

All the plots were to be sprayed in the next day or two with Mamba (glyphosate) by Laurie Sessions using the Brazilian pedestrian pulled four nozzle sprayer as a demonstration. MOALD and Kendat will need to monitor progress and their next visit is planned for three weeks time (i.e. mid November).

Much interest was generated amongst local farmers by these impromptu demonstrations. The principles were painstakingly explained to a sceptical audience. However with careful follow up, more demonstration plots organized in the next few days with the help of Chief Ndirangu, and carefully programmed stakeholder field days, a promising start has been made to disseminate CA principles and practices in the region.

The Project proposes to leave the equipment at Lengetia farm where Laurie Sessions will continue to use it on local small-holder farms as part of the on-going effort to scale up the adoption of CA in the region. This will produce invaluable feedback for further extension and local manufacture.

7. SEMINAR

By way of a roundup to these visits, I was invited to give a seminar at the World Agroforestry Centre (ICRAF) site in Nairobi which was hosted by RELMA (Søren Damgaard-Larsen). It was attended by scientists from MOALD, ICRAF, RELMA, KCTI and Kendat. The presentation was basically the same as that given during the farmer training but related to the situation in Kenya as observed during the previous four weeks of field work. The presentation provoked lively debate on the potential for CA and it is clear that the conservation message needs to be repeated many times before the plow finally loses its mesmerizing power.

At his request, I left a copy of the Power Point presentation with the CA Project coordinator and KCTI Chairman Dr Mwamzali Shiribwa.

8. CONCLUSIONS AND FUTURE NEEDS

Management of the Farmers and Extension Workers Courses

- The CA training course for farmers and extension workers was deemed to be a success by the participants, and in terms of the equipment, the content was complete. However in my opinion the organization was inefficient in its use of the time of both trainers and trainees. Training on CA equipment requires access to draft animals and simple workshop facilities. It was necessary to modify a no-till planter which had been delivered without a disc coulter. This required welding and drilling. Shafts had to be made to fit the DAP sprayer to animals and there was a constant search for nuts and bolts. Travelling from site to site meant that there was never any certainty of encountering the required services. At times this resulted in frustration and long delays. Had the basic training been carried out at one, well equipped, venue, then fewer problems would have arisen.

- Training at a specific site would also have allowed a much more thorough treatment of each piece of equipment and would have permitted far more practice time for each trainee. As it was, too much time was sent in travelling from site to site.

- At the end of the formal training (say for one week) it would have been possible to arrange a study tour of the six sites with all the trainees. At that time it would have been possible to deliver the equipment packages and ensure their correct functioning on-site before moving on. There could also have been concentrated sessions on weed identification and control, and cover crop management.

- For some reason my arrival in Kenya did not coincide with the planning session and initiation of the training course. Although I had offered to arrive a day before the detailed planning session, in fact I arrived the day after and only joined the trainee group during their first practical session.

- The farmers certainly, and the extension workers probably, will need further technical support. The interaction of extension workers with the farmer groups at each site should be carefully monitored to eliminate the ongoing teething problems that are certain to occur as the farmers start to use the equipment in earnest. This is probably a role best undertaken by Kendat.

- It appears that the equipment has not been delivered with quantities of replacement parts. The Fitarelli tractor-mounted no-till planter has (apparently) not been supplied with a set of seed plates for different crops and spacings. The sprayers will require replacement nozzles and pump parts subject to wear. A tyre repair kit and pump will also be needed. Shares will wear and need to be replaced (with new bolts). The local availability of replacement parts should be ascertained and imports made where necessary. The parts should then be held centrally until needed.

- A simple toolkit should accompany each set of equipment. This should comprise the necessary spanners (wrenches), pliers, hammer, screwdrivers, etc. Delivering (relatively) complicated equipment with no means to adjust, replace and repair will inevitably lead to rapid abandonment of the technologies.

- I am not a fervent advocate of bringing in too much more equipment at this stage. I think that the farmers have a lot to digest as it is. The adoption process will entail trial and error with the CA practices already introduced. In fact small areas (of, say, ¼ acre) can be managed as CA plots with little equipment apart from a back pack sprayer and a planting stick. As confidence grows so the demand for equipment will rise and the choice of options should be made by the farmers.

- It appears that no machine was provided with a users' manual. These should be acquired from the suppliers and, if necessary, translated into the most suitable languages. If no such literature is available from the manufacturers, then the Project must produce fact sheets for the basic adjustment, maintenance, calibration and use of the provided equipment.

Artisan training course

- The artisan training was successful in creating confidence in designing, modifying and repairing CA equipment. The artisans trained will be the basis for these activities in the six Project focus regions.

- Further support will be needed and is planned for. As a start, a follow up visit on jigs for the Magoye sub-soiler will be followed by orders for small batches of the same implement.

- The inclusion of artisans as crucial stakeholders in the CA scaling up process will require them to participate in promotional activities (field days and so forth). This will give them the necessary exposure to interact with other stakeholder, and especially with farmers.

Equipment development

- The equipment development process was initiated with the artisan training. Ideas were discussed and designs produced and there is little doubt that the artisans' innovative talent will ensure its continued development.

- The most promising basis for a locally made DAP no-till planter is the Brazilian Fitarelli implement. A prototype frame with share has been made and tested with promising results. Further development of the complete machine is needed and will require the initiation of a sub-project to bring a design to fruition and permit local manufacture.

- Sprayers. Both the DAP and pedestrian pulled sprayers are of relatively easy construction and, once feedback has been received from the ongoing field trials, artisans should be trained to fabricate suitable derivative designs. One major problem foreseen is the very high cost of sprayer nozzles in Nairobi.

Importing a bulk consignment from elsewhere (eg Brazil) would be a better short-term solution.

- Tractor –mounted direct planter. I foresee great demand for custom planting for small-holder planters in the next year or so. Further planters should be imported as a first step. This should now be entrusted to a reputable agricultural dealer in the private sector.

Dissemination of CA principles and practices

- The trials and demonstrations made in conjunction with Laurie Sessions Lengetia farm Naro Moru were a crucial start to raising awareness of CA issues in the region. They complement the efforts already made in the six pilot areas. However in the Naro Moru region the process can be multiplied many times due to the presence of the Fitarelli tractor-mounted direct planter, the two Brazilian sprayers and the crucial and well informed interest of Laurie Sessions who has a passion to spread the CA word amongst small-holder farmers. MOALD and Kendat need to monitor and build on progress in the region (starting in November 2003).

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ANNEX 1. TERMS OF REFERENCE

Draft TOR

Brian G. SIMS

Partnership Expert (TCDC Consultant) in Agricultural Engineering and Conservation Tillage Equipment

Duration of assignment	4 weeks
Duty stations	6 field site districts (Nakuru, Katumani/Machakos, Siaya, Bungoma, Siakago, Homa Bay) and Nairobi
Tentative schedule	15 Sept. – 25 Oct. 2003 (the expert will have a 4 week assignment within a 6 week period)

Duties: Under the overall operational supervision of the FAOR Kenya, the technical supervision of AGST/RAFA and in close collaboration with the National Project Coordinator, and the concerned national project staff (NGO team), the TCDC Consultant in Agricultural Engineering and Conservation Tillage Equipment will perform/carry out the following tasks in support of the project work plan:

The expert will brief the project field teams in the correct use of the CA technology equipment (procured through the TCP from Brazil) and advise on any eventual adaptations of the equipment necessary for local conditions and complement with new concepts the ongoing KCTI/KENDAT work. The expert will also make use of locally available CA equipment and make recommendations for further improvement.

Within the 4 week stay it is planned that the expert will be in each project site for approximately 3 to 4 days for practical field demonstrations and equipment training.

In particular the expert will:

- Introduce the CA equipment to the farming communities in the six field sites and together with KENDAT conduct participatory trainings in the correct use and maintenance of the equipment
- Assess the needs and determine suitable technological options existing for the different operations, such as planting, cover crop management, application of inputs (agrochemicals), harvest etc. as required.
- Share experience and lessons learnt with participating farmers
- On the basis of the discussions with farmers determine necessary adaptations and arrange for local adaptation of the equipment in collaboration between the chosen workshop/manufacturer and the farmers
- prepare a mission report as contribution to the project reporting

ANNEX 2. ITINERARY

September 2003

Mon 15 Travel Bedford – LHR – Nairobi, Kenya

Tue 16 Arrive Nairobi. Field trip to Siakago (Mulilive village), near Embu, Mbeere District. CA training session with Kamukama FFS. Overnight Nairobi.

Wed 17 In Nairobi. Meeting at FAOKE offices with Deborah Duveskog, Mwamzali Shiriba (MoA), Josef Kienzle, to discuss progress on the CA Project. Meeting with Bruce Isaacson (FAOKE Rep); Deborah Duveskog, Wilfred Mariki to brief the Rep on the goals of the CA project, progress to date and future action. Evening discussion with Joseph Kienzle. Overnight Nairobi.

Thu 18 Machakos, FTC, training on cover crops and machinery. Emphasis on animal drawn, and manually pulled boom sprayers. Overnight Nairobi.

Fri 19 KARI, NARL. Observation of drip irrigation plots (including systems for small farmers); and cover crop plots for soil fertility enhancement. To FAO offices and Bank for DSA payments. Revision of CA Power Point for inclusion in the training sessions. Overnight Nairobi.

Sat 20 Nakuru. To RTDC to meet farmers and Engineer in charge. To Kikapu village (Nakuru District). All day training on weed control. Hottensiah Mwangi on chemical weed control followed by intensive training on sprayer calibration. Overnight Nakuru.

Sun 21 Nakuru – Bungoma. Program planning with Joseph Mutua and Wilfred Mariki. Overight Bungoma.

Mon 22 Bungoma FTC. CA Power Point presentation. Seeder overview and calibration (Mafrense planter and Magoye seeder / fertilizer). Overnight Bungoma.

Tue 23 Visit Bungoma CA field plots at Mukuyimi village. Bungoma – Siaya. Overnight Siaya.

Wed 24 Siaya FTC. Joined by Pascal Kaumbutho. Overview of reduced and conservation tillage. Practical with Magoye sub-soiler and ripper. Fitarelli no-till planter and Matraca. Discussion of cover crop plots. Evening meeting to discuss progress and future needs (Pascal K; Charles M; Joseph M;Hottensiah M; Wilfred M.). Overnight Siaya.

Thu 25 Siaya Farmers' Group (Andura focal area). Further trials with re-modified Fiarelli not till planter, donkey-drawn ridger and tyer. Siaya – Kisii. Overnight Kisii.

Fri 26 To Oyugis town and CA field sites at Rachuonyo. Titon sprayer use for final practical 'exam'. Connected to a pair of oxen to simulate Roundup application. CA field sites. Final course evaluation. Oyugis – Nakuru. Overnight Nakuru.

Sat 27 Nakuru – Nairobi. Documentation study and report preparation. Overnight Nairobi.

Sun 28 Nairobi. Documentation study and reporting. Overnight Nairobi.

Mon 29 Nairobi FAO Office. Meeting with FAO Representative (with Deborah Duveskog and Wilfred Mariki) to brief the Rep on the achievements of the CA training activities. Meeting with DD, WM, Mwamzali Shiribwa and Joseph Mutua to discuss progress to date and future action. Overnight Nairobi.

Tue 30 Nairobi – Entebbe

October 2003

Fri 10 AEATRI (Kampala) with Wilfred Odogola. Entebbe – Nairobi. Overnight Nairobi.

Sat 11 Report preparation. Meeting with Kendat staff Pascal Kaumbutho and Joseph Mutua to discuss programme for artisan training. Overnight Nairobi.

Sun 12 Travel Nairobi – Naro Moru. Overnight Naro Moru.

Mon 13 3W Engineering (Barney Muckle), Naro Moru. Initiation of artisan training course. Equipment testing at Muramati (with farmer Stanley Muriuki). Due to the late arrival of the Project equipment from MOALD, it was only possible to try the 3W light-weight equipment. Modifications were suggested. Draw-pole fitted to Morrison planter. Overnight Naro Moru.

Tue 14 Muramati (Stanley Muriuki's farm). Testing modified 3W chisel and disc with added weight. First trial of Morrison planter with spider wheels. Furthe modifications in 3W workshop. Overnight Naro Moru.

Wed 15 Joined by UoN group for training on Magoye sub-soiler manufacture (all day). Overnight Naro Moru.

Thu 16 Discussion (Barney Muckle, Joseph Mutua, BS) on criteria for local manufacture of imported no-till planters and sprayers. Artisans return to modification of tested equipment and fabrication of the 3W equipment. Overnight Naro Moru.

Fri 17 Muramati (Stanley Muriuki's farm) for final testing of equipment made during the course (Tool frame based on Fitarelli configuration, modified 3W tools, Morrison planter with disc attachment. Final classroom session on costing and marketing. Feedback from participants, closure. Overnight Naro Moru.

Sat 18 Report preparation. Overnight Naro Moru.

Sun 19 Technical discussion with Barney Muckle. Overnight Naro Moru.

Mon 20 Kenyatta day (public holiday). Overnight Naro Moru.

Tue 21 Lengetia Farm, Naromoru. Laurie Sessions. Review of no-till planting with Rogro Australian no-till seeder. Assemble Fitarelli planter and field test with seed and fertilizer. Assemble Triton and Jacto sprayers. Demonstration with farmers. Overnight Naro Moru.

Wed 22 To Lengetia farm. Establishment of 3 one-acre (approx.) demonstration plots with the Fitarelli tractor-mounted direct planter. One with maize only at Lengetia; the second at the road side near the village of Male with maize, beans and *Dolichos lablab* as an inter-row planted cover crop; and the third on the land of an interested onlooker (Peter Kamura) at Male. Meeting with Barney Muckle to receive his course report, instruction manual and drawings. Overnight Naro Moru.

Thu 23 Naro Moru- Nairobi. Visit to Hardi sprayer depot. Brief wrap-up meeting with Deborah Duveskog at the FAO office. Overnight Nairobi.

Fri 24 Seminar 'Conservation agriculture for small-holder farmers. Experiences from Latin America' given at ICRAF. Visit to an exposition on 'Rainwater harvesting for improved livelihood' where MOALD Kendat and 3W Engineering all had stands. Report preparation. Overnight Nairobi.

Sat 25 Nairobi – London – Bedford, UK.

ANNEX 3. PEOPLE MET

FAO
Bruce Isaacson, FAO Representative in Kenya
Deborah Duveskog, Project Manager, FAO, Kenya
Josef Kienzle, Agricultural and Food Engineering Technology Service, FAO, Rome

Piloting Conservation Agriculture to Improve Livelihoods and Food Security for Smallholder farmers (TCP/KEN/2904(A)
Ministry of Agriculture
Mwamzali Shiriba
Alex Mungai (MoA Mbeere District)
Charles Mwanda (MoA)
J.M. Nyaxiba (Nakuru RTDC)
Henry Masinde Barasa (Bungoma RTDC)
Mr Mutaro (future coordinator of Bungoma RTDC)
Philip Omolo Obuya (RTDC Siaya)

MoA Frontline Extension Workers
Benjamin Mwaniki (Siakago)
Joseph Mulava (Machakos)
Susa Kiovi (Nakuru)
Elizabeth Sasita (Bungoma)
George Obunga (Siaya)
Nicholas Akiro (Homa Bay)

Farmer representatives
- Bungoma

Esther Ndanyi
Violet Wananda
Benara Nyukuri
- Nakuru

Susan Mwikali
Ben Kamau
Samuel Nugi
- Siakago

Daniel Njeru
Dionisio Njue
Arusia Muthanje
- Siaya

Samuel Miyoyo
Andricus Miyoyo
Arnoda Ochieng
- Machakos

Sammy Mutie
Margaret Kasyoka
Priscilla Muli
- Homa Bay

Kennedy Obongo
Pamella Obondi

Margaret Anyango

Kendat (Kenyan Network for Draft Animal Technology
Pascal Kaumbutho
Joseph Matua
Paul Wamai
Antony Karimi
Gideon Cheweya

Artisans trained at the 3W Engineering workshop
Chrisostin Wafula Murambi. Bungoma
Ephans Kingoo. Machakos
George Owino Ojembo. Siaya
John Waweru Kariabom. Nakuru
Nahashon K Ndiga. Siakago
Philip Ochieng. Homa Bay

KARI
Hottensiah Mwangi (KARI, NARL)

SARI (Selian Agricultural Research Institute), Arusha Tanzania
Wilfred Mariki (FAO Consultant cover crops)

KARI

Dr Wokabi	Director NARL
Gilbert Kibata	Crop Protection Coordinator
F. Gitahi	Green manures

AEATRI (Uganda) aeatri@starcom.co.ug

Wilfred Odogola	Director
Samuel Okurut	Research Engineer

Triple W Engineering, Naro Moru
Barney Muckle
Moffat Mwangi
Peter Mwangi
Robert Citonga

University of Nairobi

Wilfred Wamutitu	Sub-soiler fabrication trainer

Lengetia farm, Naro Moru

Laurie Sessions (and Sarah)	Farmer. sessions@africaonline.co.ke
Robert Coverdale	Farmer. robcover@wananchi.com

Chief Ndirango
Local farmers, both men and women

RELMA

Søren Damgaard-Larsen	Water and Soil Fertility Advisor. S.Damgaard-Larsen@cgiar.org

Pia Barklund	Pia.Barklund@cgiar.org

Others

Ojago Erastus	Kamakakuywas Agricultural Investment. Mechanization services. Interested in representing Fitarelli in Kenya
Stanley Muriuki	Farmer collaborating with 3WEngng. Umande sub-location, Muramati
Aurelia Macheria	Muramati extension officer
Peter Kamura	Farmer of no-till demonstration plot at Male (Box 161, Naro Moru)

ANNEX 4. AGRICULTURAL ENGINEERING AND APPROPRIATE TECHNOLOGY RESEARCH INSTITUTE (AEATRI)

At the request of Josef Kienzle, I discussed the FAO CA Project in Uganda with AEATRI Director Wilfred Odogola. We met on two occasions, in Soroti on 7 October and at the AEATRI site near Kampala on 10 October.

Knife rollers
AEATRI has made a number of DAP knife rollers based on a successful Brazilian design. The cylinders are fabricated from 4 mm mild steel sheet in three diameters: 13, 14 and 15 inches (330, 356 and 381 mm). Eight rows of sharpened knife blades are bolted on to angle strips welded to the cylinders. The knife sections are in staggered rows to reduce shock loading on the animals' yoke. The cylinders can be filled with water or sand to increase their effect on cover crops. It has been found that the 13" implement is too light, the 15" too heavy (at 380 kg) and the 14" just about right. The rollers have been on-farm tested at Palliser and Mbale sites on dolichos and mucuna cover crops. The test programme will continue until the technique has been perfected.

Sprayers
Sixteen farmer field schools (FFSs) have been supplied with back-pack sprayers and trained in their use. These sprayers are manufactured in Kampala but use imported nozzles and other parts.

Three Brazilain sprayers have been imported (the Triton Dap and Jacto pedestrian pulled machine that we used in the Kenya training programme) and a 'wheel-barrow' type with a single bicycle wheel which has proved to be the most popular.

A major constraint to local manufacture of these machines is the supply of nozzles. Imported nozzles are available locally, but at the high cost of some Ush17000 ($US8.60). Josef Kienzle is investigating other sources of supply. I mentioned to Wilfred Odogola that Pascal Kaumbutho (Kendat, Kenya) had expressed the view that there was at least one nozzle supplier in Nairobi. WO will contact PK.

Direct planters
AEATRI has a range of Brazilian-made direct planters for CA, although they do not appear to have been used much to date. Sixty matracas have been manufactured locally, but poor quality wood has resulted in breakages and the seed metering mechanism has not been very well made. Also farmers find it difficult to operate the matraca as it has to be inserted with the handles apart and extracted from the soil with the handles together. I believe that this will prove to be a temporary setback as it has not been a long term problem elsewhere.

Cover crops
The project has not yet established large plots of cover crops. There seems to be a lack of confidence in knowing how and what to plant when and where. I mentioned the successful intervention of Wilfred Mariki in the Kenyan training work. It may be that he could offer some useful technical guidance on next season's cropping programme.

Subsoiling and ripping
As in Kenya, the Magoye subsoiler and ripper have been demonstrated to farmers as part of the CA package. The Magoye seeder unit has also been used.

Project management
The CA project in Uganda is led by the soil science group at the NARO Kawanda site near Kampala. The NGO Africa 2000 Network is charged with the day-to day implementation of the project. They use two field workers and a trainer in soil fertility. Work is done via a network of FFSs. Technical backup is provided by Kawanda, AEATRI and Makerere University which has an FFS project and expertise in soil science. AEATRI has provided equipment training to extension workers and has trained over 300 farmers from 16 FFSs during a 1-week CA machinery course in September 2003.

Conclusion
The very brief contact made with AEATRI has shown that that they have the necessary expertise to use and make the CA equipment. However I gained the impression that there is a lack of familiarity with the application of CA at the farm level. FAO may like to consider some additional TC (especially on cc management and perhaps on machinery use) in preparation for next year's planting season.

ANNEX 5. DAP DIRECT PLANTER PROTOTYPE FRAME (Barney Muckle)