Labour Saving Technologies and Practices for Farming and Household Activities in Eastern and Southern Africa

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1. Background

Since spring 2002 IFAD's Gender Programme for Eastern and Southern Africa, in collaboration with FAO's Agricultural Engineering and Food Technologies Service (AGST), has been conducting a series of studies on labour saving agricultural practices and technologies in sub-Saharan Africa with a focus on women farmers and vulnerable groups. These activities started with a distance survey on labour saving technologies in sub-Saharan Africa. The first field survey was conducted in May and June 2002 in Bondo and Busia districts in Kenya. This survey focused on labour saving technologies in the broadest sense including household technologies, agricultural production and post harvest technologies. The sites were selected as there was evidence that both districts have HIV/AIDS prevalence rates which was above Kenyan average and the disease was having a significant impact on labour availability.

2. Tanzania Study on Saving Labour through Conservation Agriculture

The Tanzania study on labour saving technology is focusing specifically on reduced tillage/conservation agriculture (CA) technologies. Conservation agriculture (CA) is the summary term of a farming concept that emphasizes minimum soil disturbance, permanent soil cover with the utilization of cover crops, and adequate crop rotations. CA technologies have been promoted in sub-Saharan Africa by a number of research and development institutions.

One particular interest for fostering the adoption of CA practices in sub-Saharan Africa is their potential to address three crucial areas of importance to small farmers in this region:

- Labour shortages: HIV/AIDS and other diseases, such as malaria, as well as urban migration and education are affecting the labour availability in rural households and increasing the burden of labour-intensive activities on women and children. CA technologies could reduce labour requirements especially in peak seasons for land preparation and weeding.

- Food security: CA can potentially increase food security by making more efficient use of rain water and by increasing soil fertility through the introduction of N-fixing cover crops.

- Household incomes: CA could possibly reduce production costs for hand labour, hired labour, draught animal power (DAP) hire, tractor hire and fertilizer use, and generate additional revenue through the production of fodder crops and cash cover crops.

The study is being conducted in the Northern Zone of Tanzania in Karatu and Babati districts[1]. In Karatu district the Selian Agricultural Research Institute (SARI) with support of German GTZ, Tanzania Farmers Service Centre (TFSC) and FAO/AGST has been conducting on farm trials with conservation farming and the utilization of cover crops. In Babati district a wealth of experience has been collected in the SIDA-funded Land Management Programme (LAMP) in adapting and adopting the 'Magoye Ripper' for Conservation Tillage (CT) practices for the purpose of soil improvement and labour saving.

3. Methodology

The study objectives are threefold:

i. to determine if reduced tillage/conservation agriculture practices are labour saving;

ii. to determine the circumstances under which CA is suitable for adoption and sustained use by vulnerable groups without exposing them to too many risks with regard to their own food security and the stability of their livelihoods; and

iii. to identify potential barriers which hinder the adoption of labour saving practices such as CA and the means to overcome them.

The study has had two phases: a quantitative phase which focused on collecting data to assess the labour requirements for CA in comparison to conventional systems; and a qualitative component which was conducted after farmers had been exposed to conservation agriculture practices for at least one cropping cycle in order to appraise their reaction to CA.

FAO, through the African Conservation Tillage Network (ACT), has sponsored the procurement and shipment of two containers of CA equipment to Tanzania. The equipment list includes various models of hand operated jab planters, DAP operated no-tillage planters, sprayers and knife rollers and tractor operated no-till planters and knife rollers. The recent short rains (commencing in October 2002) was the first season where this equipment was in practical use in Tanzania, including the conservation agriculture plots for this study in Karatu. In Babati the Magoye Ripper was already in use and was evaluated. Data were collected from 27 plots: 17 in Karatu and 10 in Babati. Fourteen were practising the conventional/traditional agriculture and 15 plots were cultivated with different modalities of conservation agriculture and conservation tillage practices. Farmers were selected to participate in the study with a focus on vulnerable poor households including those headed by women. The labour requirement for different activities was recorded by local extension staff throughout the season. The data were aggregated to hours per hectare equivalents for different farming systems, as presented in Tables 1 and 2.

Results from the qualitative study found that the most important objectives of farmers at the study sites is the reduction of labour burden especially for weeding, the increase of production and yields and the achievement of food security, all three points are achievable through the conservation farming system. During farmer evaluations it was obvious that the CA/CT systems are most attractive to small farmers because of their potential to reduce labour peaks due to minimizing tillage and weeding operations (Tables 3 and 4). The study results indicate that labour reduction is achievable although the change of the farming system might require initial additional labour inputs. The availability of additional fodder from the cover crops meets the small farmers' household requirements. The CA technology seems to provide short term farm benefits in terms of soil fertility but also in small farmers' commitment and attitudes towards their soils and land (Box 1). Thus the adoption of CA technology/conservation farming methods would not appear to expose households to any more risks than conventional farming systems.

Box 1: Florence has learned that it is good to keep the soils covered.

Florence is a widow with three daughters and three sons and three grandchildren of which most are living at home. She participated with two plots in our study, one conventional beans plot (hand hoe system) and one CA plot (DAP knife roller, herbicide, soil cover, hand jab planter). She learned during the beans season that, because of the soil cover, the land needed less weeding plus the beans kept growing and producing good yields despite a drought period towards the end of the season. The soil cover helped maintain the soil humidity. Florence got such a good yield that she sold half of the beans in order to pay the school fees for her daughter without asking neighbours and relatives for money. This was the first time for many years that she had enough of her own money to do so. For the long season she decided not to remove the beans leaves left on the field. She placed them in rows and planted the maize in between. She did this on her own initiative because she had learned that the soil cover helps to suppress weeds and to improve the soils, as well as keeping the soils humid and cool.

Moreover, the CA concept matches with shrinking farm power base in both districts where the tractor population is relatively old and the labour force is declining. Demand for draught animal power is high. Farmers complained that not enough casual labourers are available for hand weeding and the prices for hiring labour for land preparation is almost on a par with hiring DAP or tractor power. With DAP equipment for conservation farming (such as the no-till planter, knife roller or Magoye ripper) it is possible to use only two oxen instead of four. In hand power systems, permanent soil cover suppresses weeds which reduces labour requirements for weeding. The elimination of ploughing for land preparation due to planting directly either by hand or by jab planter reduces the hand power demand as well.

The concept of cover crops was well received in Karatu: certain crops such as pumpkins are already used in the cropping cycle and dolicus lablab is valued as a cash crop. Within one cropping cycle farmers noticed a difference in soil fertility and yields due to the cover crops. Farmers preferred the use of cover crops than herbicides to suppress weeds: herbicides were expensive and had no impact other than 'killing weeds'.

There is a danger that, from a socio-cultural perspective, it might be difficult for small farmers to maintain a so-called 'dirty field' which is not properly weeded and has many crop residues on the field (soil cover). Farmers are under pressure from the community to keep their fields clean. The conflict between livestock keepers and crop farmers is long established but the introduction of the CA system may help resolve the conflict if it helps create awareness about the value of crop residues and soil cover.

4. **Conclusions**

This fieldwork has shown that it is possible to tackle the two known labour peaks in smallholder farming (land preparation and weeding) with conservation farming approaches. It has also shown that for small farmers it is not so much the tools and equipment related to CA which have been catching their interest but the cover crops. The impact of introducing these crops in Karatu has enabled farmers to understand the concept of conservation farming including the potential for saving labour and gaining higher yields. After such a sensitization process it is easier to introduce CA equipment in order to let farmers reach the full benefits and the full labour saving

effect of this approach.

5. **Recommendations**

The introduction of cover crops as starting point for conservation farming should be propagated in emergency projects and field activities dealing with labour saving themes. Such projects are currently being discussed in response to the HIV/AIDS crisis in a number of countries in sub-Saharan Africa. The introduction of appropriate CA hand tools and DAP equipment (such as small planting hoes, hand jab planter, DAP ripper and DAP no-till planter) could be the second step. All these require field staff trained in conservation farming methods plus motivated farmer groups including women and the youth.

Demonstration plots, farmer training and local field days are required to expose small farmers and local leaders to the features of conservation farming and their benefits. The potential for labour saving is a very good entry point to sensitize small farmers as this topic has top priority especially in view of the current labour shortages many households are experiencing.

Table 1: Labour Data for Land Preparation, Planting and Weeding- Karatu District

	CA / Conservation farming system [h/ha]			**Conventional / traditional systems** [h/ha]		
	A	**B**	**C**	**D**	**E**	**F**
	DAP knife rolling plus planting by hand jab planter beginners	DAP knife rolling plus planting by hand jab planterhired labour	Planting with DAP no-tillage planter	Hand labour	DAP	Tractor power
Land clearance [1]						
Knife roller	13	13	Not required [2]	-		
Herbicide application	3 [3]	3				
Hand hoe + slash with panga + carry	-			93	93	
Hand - slash + burn	-					6 [4]
Land preparation + planting						
Planting with hand jab planter	463 [5]	256 [6]				
Planting with no-tillage DAP planter			9 [7]			
Hand hoe – digging plus planting by hand				139		
DAP – ploughing (plant by hand behind plough)					74	
Tractor planting behind tractor disc plough						21
Weeding [8]						
Hand weeding with hand hoe plus up rooting of weeds	107	54	25 [9]	172 [10]	110	111 [11]
Total [h/ha]	**586**	**126**	**34**	**404**	**277**	**138**

Yields (beans) [kg/ha equivalents]	**722**	**305**	**835**	**577**	**938**	**1176**

Notes:

1. *In the CA system the land clearance is done by chopping down the weeds and cover crops by knife roller. It was also necessary to apply one herbicide application due to heavy infestation of small weeds emerging after the heavy rains.*
2. *This field was left fallow in the previous season. The field is located along a throughway, hence livestock passed by regularly and had eaten the emerging weeds and grasses and no land clearance was required.*
3. *The labour data recorded are only for the time spent spraying. The time for fetching clean water for spraying is not reflected. For spraying one acre of land with a knapsack sprayer, approximately 80 litres of clean water are needed.*
4. *Slash and burn is banned but is still used sometimes. It has a labour saving benefit.*
5. *In the CA system planting by hand jab planter is recommended. As this season was the first season for most farmers to work with this tool they needed time to practice hence high labour data for beginners.*
6. *A group of young men specialised in using the jab planter and they were hired to do the planting. They gained good work performance and needed much less time compared to the beginners.*
7. *The Brazil type DAP planter was used by one innovator farmer with considerable labour saving effect. The handling requires some training and commitment. Transport to the field was by DAP ox-cart.*
8. *Ideally the effort for weeding should be reduced in the CA sytem. Due to the envisaged soil cover through crop residues, stover and cover crops the weeds are suppressed as they lack sufficient sun-light. Sometimes it is sufficient only to do up-rooting. In other cases scrapping by hand hoe needs to be done to eliminate stubborn weeds. However, the trend shows that less labour for weeding is required as the farmers' awareness for soil cover is raised.*
9. *There was little weed infestation and up-rooting was required only occasionally*
10. *The conventional hand hoe farming system has traditionally very high labour requirement for weeding (also compared to conventional DAP or tractor system). Depending on the weed infestation, two to three rounds of weeding plus one round of up-rooting of weeds can be required. Normally the extended family labour, reciprocal labour arrangements or if affordable hired labour is required*
11. *This field had a heavy infestation of weeds. More than three weedings by hand hoe were required plus uprooting.*
12. *The contribution of children under 16 years of age was weighted by 0.5.*

Table 2: Labour Data for Land Preparation, Planting and Weeding- Babati District

	CA / Conservation farming system [h/ha]				**Conventional / traditional systems** [h/ha]		
	A	**B**	**C**	**D**	**E**	**F**	**G**
	DAP Ripper plus planting by hand in ripper furrow	DAP Ripper plus planting by hand in ripper furrow + herbicide	DAP Ripper with Ripper planter	DAP Ripper with Ripper planter + herbicide	Hand labour	DAP	Tractor for sub-soiling plus vibra flex + DAP mouldboard for planting[1]
Land clearance[2]							
Hand hoe + slash with panga + carry	60	36	Not required	4	30	56	13
Herbicide application	-	4		4	-	-	4
Land preparation [3]							

Hand hoe – digging					113		
DAP – ploughing						52	
DAP – Ripping	15	15	15	15[4]			
Vibra flex							1.5
Subsoiling – tractor							4
Planting [5]							
Planting (maize + cover crop) by hand following the existing ripper furrow		62[6]					
Planting with DAP and hand in new ripper furrow (only maize)	67						
Planting with ripper planter attachment in new ripper furrow (only maize)			8	8			
Planting with hand hoe, - digging holes						120	
Planting behind DAP mouldboard plough						58	58
Cover crops [7]							
Inter row hand planting of cover crop	61		61	61			
Weeding [8]							
Hand weeding with hand hoe plus up rooting of weeds	102	53	102	53	85	65	66
Total [h/ha]	**305**	**172**	**186**	**148**	**373**	**231**	**146.6**
Yields (beans) [kg/ha equivalents]	**1787**				**499**	**407**	

Notes:

1. *The sub-soiler and vibra flex are tractor driven. The vibra flex is a ripping tool with long swinged tines. The soil is loosened but not turned. The LAMP project offers to farmers to do the sub-soiling plus vibra flex at a subsidized hire rate.*
2. *Depending on the previous crop, the stage of weed infestation, and the general condition of the plot land clearance is done by hand using hand hoe, slasher or panga. Some farmers used herbicides.*
3. *In Babati, land preparation is an operation which is done separately from planting.*
4. *The time for ripping with DAP is considerable lower than with the mouldboard plough and only one pair of oxen is required compared to two for mouldboard plough*
5. *In the DAP ripper system planting is either done by hand (in the prepared ripper furrow) as soon as the rains start or using the ripper a second time and planting by hand in the new ripper furrow. A third option is to use the ripper attachment which is very labour efficient, requiring only two instead of three persons.*
6. *The contribution of children under 16 years of age was weighted by 0.5.*
7. *The intercropping of cover crops in between the main crops is done about 2 – 4 weeks after the main crop has emerged. This operation has only been introduced recently in Babati.*
8. *In the conservation tillage plots which used herbicides for land clearance, the labour amount for weeding was considerably lower. The data also suggest that the use of ripper and mouldboard plough for planting reduces the labour demand for weeding.*

The hand hoe system has by far the highest labour requirement.

Table 3: Conservation Farming to Minimise Tillage

Conservation farming	Potential labour saving features over conventional practices	Evidence of labour saving from Tanzanian study (hours/ha)	Suitability for adoption by vulnerable households	Barriers to adoption
DAP knife roller	• Mechanical means to kill cover crops prior to planting • Saves removal of crop residues by hand • Residue acts as cover to suppress weeds	Saves 85% of time over conventional method of removing crop residues by hand (slash and carry out of field)	• Suitable if DAP already available since it can operate with few animals • Can be made locally	• Specifically designed to chop cover crops (dolicous lablab, mucuna) • Not suitable for all weed types, grasses and emerging weeds
DAP Direct planter	• Plant using DAP with no tillage through cover crop/residues • Removes activity of land preparation	Saves 90% of time over conventional DAP system (ploughing with DAP and planting behind plough: 2 people and 4 oxen, and 1 person behind)	• Best suited to early adopters because requires specialist equipment • Requires access to DAP	• Expensive • Not available locally (has to be imported)
DAP Ripper	• Cuts furrow rather than inverts soil (but may stimulate weed growth) • Use fewer animals (2) than conventional DAP tillage (4) • Faster than	Ripper saves 70% of time over conventional DAP system (DAP ploughing) Ripper with planter attachment (requires 2 people): saves 80% over conventional DAP system for land preparation and planting behind plough; saves 70% over ripper for land	• Suitable if DAP and plough already available since it can operate with few animals • Already available on local market • Ripper planter	• Knowledge • Skills in use and maintenance • Unsuitable for use with cover crops • Women do not usually work with DAP

	ploughing • Can prepare land before rains • Can also attach wings to make ridges and a planter for planting	preparation and planting in furrow (3 people, 2 oxen	attachment also available	
Hand Jab planter	• Plant manually with no tillage through cover crop/residues • Useful for intercropping between established maize crops	Jab planter: saves 60% over conventional planting by hand (and saves time on land clearance)	• Suitable but probably not affordable • Takes time to learn to use equipment effectively • Women find it easy to operate	• Competes with conventional small planting hoe • Not suitable for planting large areas

Table 4: Conservation Farming to Minimise Weeding

Conservation farming	Potential labour saving features over conventional practices	Evidence of labour saving from Tanzanian study	Suitability for adoption by vulnerable households	Barriers to adoption
Soil cover: crop residues/ mulch, lablab, mucuna, pumpkins	• Suppress weeds (but may require more time for harvesting cover crop or increased yields of main crop as a result of improved soil fertility)	No data	• Very suitable: low cost, self multiplication of seed • Earn additional income/produce food or fodder	• Availability of seed • Knowledge • Change of perception about 'good' agricultural practices

Herbicides	• Either sprayed for initial land preparation or to suppress weeds during crop growth	Land sprayed with herbicides prior to land preparation: saves 50% of time over weeding land which had not been sprayed (but additional time required for collecting water)	• Not suitable: expensive • Requires significant amount of water • Requires operator training in sprayer calibration and spraying techniques • Safe storage of sprayer and herbicide is problematic in poor households (danger for children	• Herbicide is expensive (lumpy purchase – not available in small quantities) • Availability of water • Concern about effects on other crops • No benefit for soil fertility
DAP ripper with wings attached for inter row weeding	• Use double wings for weeding	No data	• Suitable if DAP and plough already available since it can operate with few animals • Already available on local market	• Knowledge • Skills in use and maintenance • Unsuitable for use with cover crops • Women do not usually work with DAP