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An Assessment of the Sustainable Uptake of Conservation Farming in Zimbabwe

International Crops Research Institute for the Semi-Arid Tropics

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Executive summary

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the River of Life Church (RoL) have, for the past three years, been providing training and monitoring support to 15 non-governmental organizations (NGOs) promoting conservation farming (CF) across 48 districts in Zimbabwe. The central component of the CF package that is being promoted is the planting basin. These are small holes/pits, dug in an unplowed field, where seed is planted. The planting basin is maintained by timely weeding in summer and winter, the application of manure and mineral basal and top dress fertilizer, crop rotation and covering the soil with organic residues. Farmers practicing CF have realized yield advantages exceeding those of conventional practices by between 10 and 100%, depending on input levels, the experience of the farm household and seasonal rainfall. These yield increases have led to a rapidly growing number of households applying at least part of the promoted management components of CF.

This study was undertaken in order to better understand both the household and institutional factors that have influenced CF uptake patterns among smallholder farmers and the impacts of CF uptake on household food production and physical and chemical soil properties.

Data was collected from 232 households practicing CF with extension and input support from ten different NGOs for at least one season. These households were located in 12 districts encompassing Natural Regions II–V. Socioeconomic data was collected through formal household interviews and focus group discussions. Biophysical data on weeds, crop yields and soil was collected from a CF plot and a conventionally managed farmer practice (FP) plot.

The infiltration rate was 48% higher in basins than in the FP plot and 87% higher than in the area between basins. The bulk density was 6% lower in the top 15 cm in basins as compared to the area between basins and the FP plot. In addition, total soil nitrogen and phosphorus was 12 and 15% higher in the top 20 cm of the soil. These improvements in the soil's physical and chemical properties, combined with their better weed management, doubled the maize yields produced by the FP plot during the 2006/07 season. Previous increases in productivity have encouraged participating farmers to increase areas under CF. In 2004/05 the average plot size was 1450 m^2; for 2006/07 it was 2021 m^2, with farmers in some districts establishing more than 0.5 ha of basins. Yield data from this season suggests that, on average, CF plots contributed to 40% of participating households' cereal requirements. A minimum area of 0.6 ha per household should be the future target, as this area should produce the household annual cereal grain requirements (at least 900 kg) for most seasons.

Besides the practice of preparing basins, the following components of CF were adopted by at least 70% of the participating households: basal manure application, topdress with nitrogen (N) fertilizer and timely post-planting weeding. The least implemented components were crop residue application (60%), basal inorganic fertilizer application (60%) and crop rotation (28%). The low number of farmers practicing crop rotation was due to the limited access to legume seed, the preference for cereals and the traditional practice of growing legumes in furrows rather than basins. Although 60% of the farmers applied crop residue, in many instances the soil cover was less than the 30% required for effective mulching. Whether or not fencing is desirable for conserving crop residues needs to be followed up and can only be evaluated in terms of the value that crop residues have as animal fodder.

There was a strong relationship farmers' experience of CF and their adoption of its various components. Household labor availability and the impact of HIV/AIDS did not limit the uptake of the CF package, and it could be argued that current NGO initiatives to promote CF as a means of combating food insecurity are justified. Even though household labor availability did not limit the adoption of CF, many farmers indicated it did require more labor than conventional practices; extra labor was required for digging basins, weeding and crop residue management. This higher labor demand was also due to the farmers' inexperience of the required steps, but it is anticipated that digging basins and weed control will require less and less labor over time. However, the accuracy of this hypothesis will need checking. The active involvement of both NGOs and the government Agricultural Research and Extension Office (AREX) increased the likelihood of adopting CF by providing inputs and backstop advice.

Profitability analysis showed that CF leads to higher gross margins in US$/ha, higher labor productivity in US$/day and a lower maize production cost per kg. The profits are higher across all Natural Regions and will increase with number of years that CF is practiced. CF profits are also higher than those of FP with N topdress in high rainfall regions.

Farmers who practice CF recommended technical and institutional changes to support the expansion of CF in the smallholder farming sector. These included (i) agricultural inputs (hoes, seed, fertilizer, herbicides) and market development through local retailers, (ii) an evaluation of herbicides for weed management, (iii) empowering farmers with respect to decision-making, and (iv) establishing and strengthening farmer CF groups in order to facilitate reflective learning.

The conclusion is that CF does contribute to increased yields across all agroecological zones and can thus make a major contribution to household food security. These increased yields, combined with better financial returns from CF when compared with conventional management practices, have convinced farmers to increase the size of areas under CF. There is also evidence of spontaneous adoption among farmers who were not initially targeted by the NGOs involved. However, the extent to which this spontaneous adoption has taken place across the different agroecological zones does require further study. The challenges of crop residue application and crop rotation require further research and extension efforts. Impacts on soil physical and chemical properties – and subsequently crop yields – as well as changes in labor requirements over time also need further investigation. We also suggest that technical, market and institutional changes at local level are required to support the sustainable adoption of CF by the smallholder farming sector, in order for them to attain a minimum area of 0.6 ha under cereals.

An Assessment of Sustainable Uptake of Conservation Farming in Zimbabwe

1 Introduction

Conservation Agriculture (CA) is gaining increased recognition in southern Africa as a group of technology interventions that have the potential to sustainably increase yields for a wide range of crops (maize, sorghum, pearl millet, cowpeas, soya beans, sunflowers and cotton) through the conservation of soil, water, nutrients and farm power. Since 2004, there has been a series of growing initiatives in Zimbabwe to promote CA through various donor-funded relief and recovery programs[1], with the aim of improving crop production among vulnerable smallholder farmers.

The terms 'conservation agriculture' and 'conservation farming' have often been used interchangeably. For the purposes of this report the two are used more specifically, adopting the definitions of the FAO Task Force for Zimbabwe:

1. Conservation Agriculture (CA) is a broader term, which encompasses activities such as minimum tillage and zero tillage, tractor powered, animal powered and manual methods, Integrated Pest Management, Integrated Soil and Water Management, including Conservation Farming. It is generally defined as any tillage sequence that minimizes or reduces the loss of soil and water and achieves at least 30% soil cover by crop residues
2. Conservation Farming (CF) is conservation agriculture that can be practiced by smallholder farmers using small implements such as the hand hoe to create planting basins. CF also aims at achieving soil cover and is actually a modification of the traditional pit systems once common in southern Africa, and is a variation on the *Zai pit* system from West Africa, which may also be considered a CF technology.

For the past three years, ICRISAT has provided technical assistance to more than ten non-governmental organizations (NGOs) under the Protracted Relief Programme (PRP) to promote CF across 13 districts in the semi-arid areas of Zimbabwe. As a result, farmers are showing a growing interest in CF and, depending on input levels, the level of experience of the farm household and seasonal rainfall, yield gains are reported as ranging from 10 to more than 90% when compared with those of to the traditional practice of overall spring plowing and planting. These yield increases have led to a rapidly growing number of households trying at least part of the promoted management options of CF.

1.1 Conservation Farming – Planting basins

Below is a summary of the key components of CF practices promoted under the PRP. For this report, they were the basis for measuring CF adoption. For further details see Figure 1 and Annex 1.

[1] The United Kingdom's Department for International Development's (DFID) 'Protracted Relief Programme (PRP)', European Commission Humanitarian Relief Aid Office (ECHO) and the European Association of Non-Governmental Organizations (EuronAid).

1.1.1 Winter weeding

The first step in preparing a CF field is to remove all weeds. This should be done soon after harvesting, i.e., from May to June. Weeding is done using implements such as hand hoes and machetes in order to disturb the soil as little as possible. The importance of weeding before land preparation is to ensure that the plot is weed-free at the time of basin preparation and to prevent any dispersal of weed seeds.

1.1.2 Digging planting basins

Planting basins are holes, dug in a weed-free field, into which a crop is planted. They are prepared in the dry season (July to October). Recommended dimensions are 15×15×15 cm (an adult's hand length is approximately 15 cm). The advantage of using basins is that they enhance the capture of water from the first rains of the rainy season and also enable precision application of organic and inorganic fertilizers.

1.1.3 Application of crop residue

Crop residues are applied on the soil surface in the dry season, soon after harvesting. Sufficient residues are used to achieve at least 30% soil cover. This mulch buffers the soil against extreme temperatures (thereby reducing soil evaporation), cushions it against traffic, suppresses weeds through shading and improves soil fertility.

1.1.4 Application of manure

Fertility amendments are applied soon after land preparation in the dry season. In CF, the application of both organic and inorganic fertilizers is recommended as they complement each other. Organic fertilizers such manure and/or compost are applied at a rate of at least a handful per planting basin. More can be used in wetter areas.

1.1.5 Application of basal fertilizer

Inorganic basal fertilizer is also applied soon after land preparation and before the onset of the rains. One level beer bottle cap is applied per planting basin and covered lightly with clod-free soil. Application rates can be increased in wetter areas.

1.1.6 Planting

The basins enable the farmer to plant the crop after the first effective rains, i.e., when the basins have captured rainwater and drained naturally. An effective rainfall event is 30 mm for sandy soils and 50 mm for heavier soils (Twomlow and Bruneau, 1999). Seed is placed in each basin at the appropriate rate and covered with clod-free soil.

1.1.7 Application of topdressing

Nitrogen fertilizer is applied at a rate of one level beer bottle cap per basin three to six weeks after crop emergence after the first weeding. Soils must be moist at the time of application. Such precision ensures that nutrients are available where they are needed.

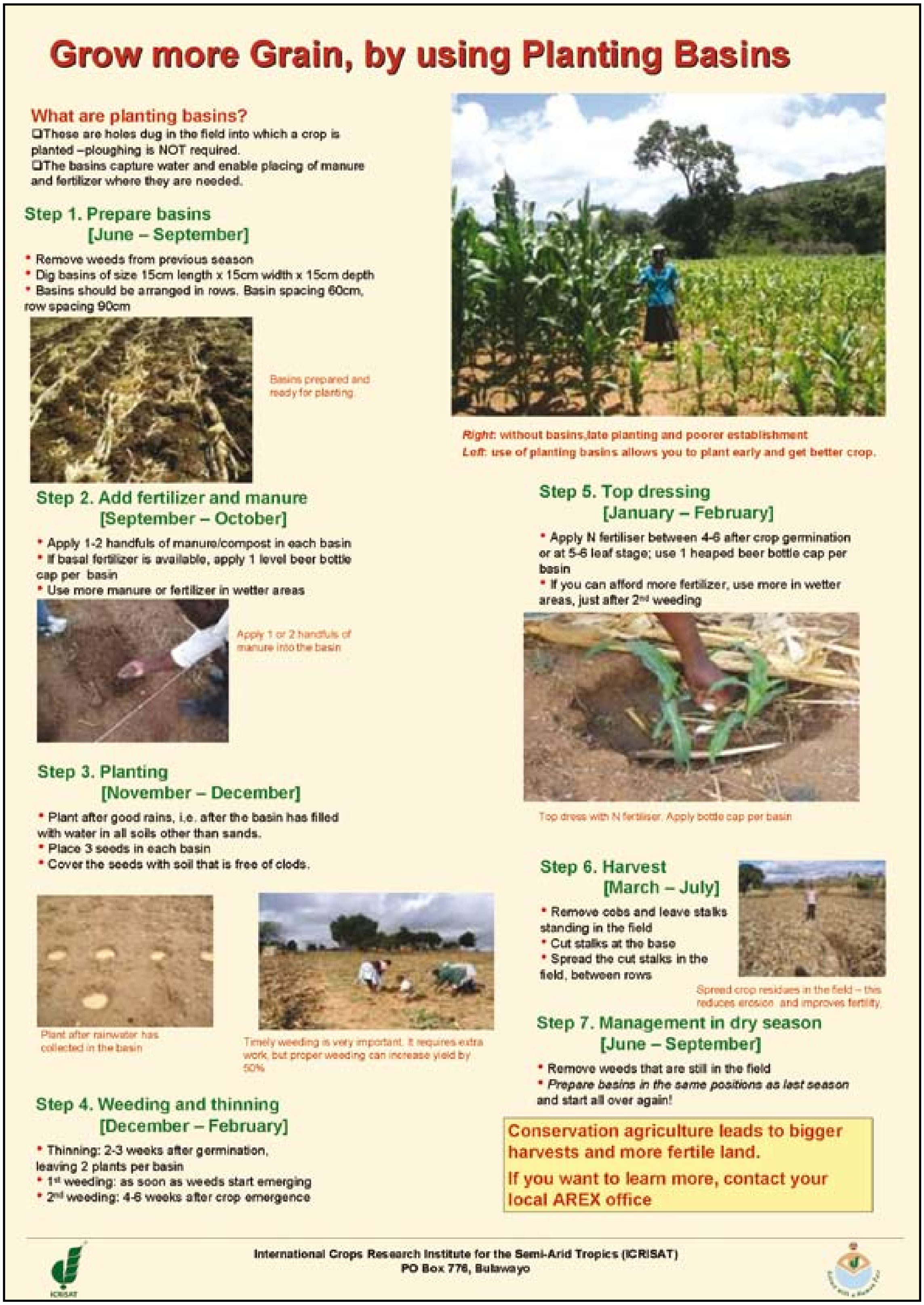

Figure 1. The planting basin calendar.

1.1.8 Timely weeding

In conventional tillage systems, farmers plow or cultivate repeatedly in order to suppress weeds. With reduced tillage, weeds can be an initial problem and require more effort to eradicate. One strategy is to weed timely, i.e., when weeds are still small, which prevents them from setting seed. Timely weeding in combination with mulching should lead to effective weed control.

1.1.9 Crop rotation

Rotating crops is one of the key principles of CF. Cereal/legume rotations are desirable because there is optimum plant nutrient use by synergy between different crop types. The advantages of crop rotation include the improvement of soil fertility and weed, pest and disease control. It produces different types of outputs, which reduces the risk of total crop failure in cases of drought and disease outbreak.

1.1.10 The rationale for CF uptake studies

CF has been promoted by various NGOs in Zimbabwe, initially under the DFID-funded PRP, and more recently through various EU-funded initiatives, with the aim of sustaining yield gains and improving the food security of vulnerable households. These NGOs have encouraged and facilitated the uptake of CF following the principles described above. A simplistic definition of adoption/uptake is the use of a new technology, though this can be further elaborated as the 'incident' and 'intensity of adoption/uptake'. The 'incidence of uptake' indicates whether or not a farmer has used a technology whereas 'intensity' explains the degree of its use. For example, 'incidence' herein refers to whether or not a farmer was practicing CF in 2007 and 'intensity' shows the proportion of CF components that are being used or practiced.

CF has been shown to improve crop yields, even under drought conditions. Recent evaluation reports suggest that there has been an incremental uptake of the various components of the CF package. However, there is a need to better understand why some farmers adopt the complete package and others only parts. The benefits of CF in terms of crop yield, contributions to household food security, economic returns to the farmer and impact on weed density and soil properties also need to be quantified.

1.1.11 Study objectives

This study was undertaken to assess the uptake and impact of CF on smallholder farms in Zimbabwe. It also compared CF with conventional farmer practice in the following areas:

a) Labor requirements

b) Economic returns

c) Weed density

d) Soil physical and chemical properties.

Within the broad analysis of CF uptake, this report evaluates the relative success of different NGO strategies in promoting CF in order to define best practices.

2 Methodology

The study was conducted between March and June 2007 and covered 12 districts where NGOs had been promoting CF for the preceding three years (Figure 2). Seven of the locations were from districts that had NGOs receiving technical support from ICRISAT under PRP, while River of Life (RoL) provided training to NGOs operating in the other five districts (Table 1). These 12 districts included areas with high and low annual rainfall.

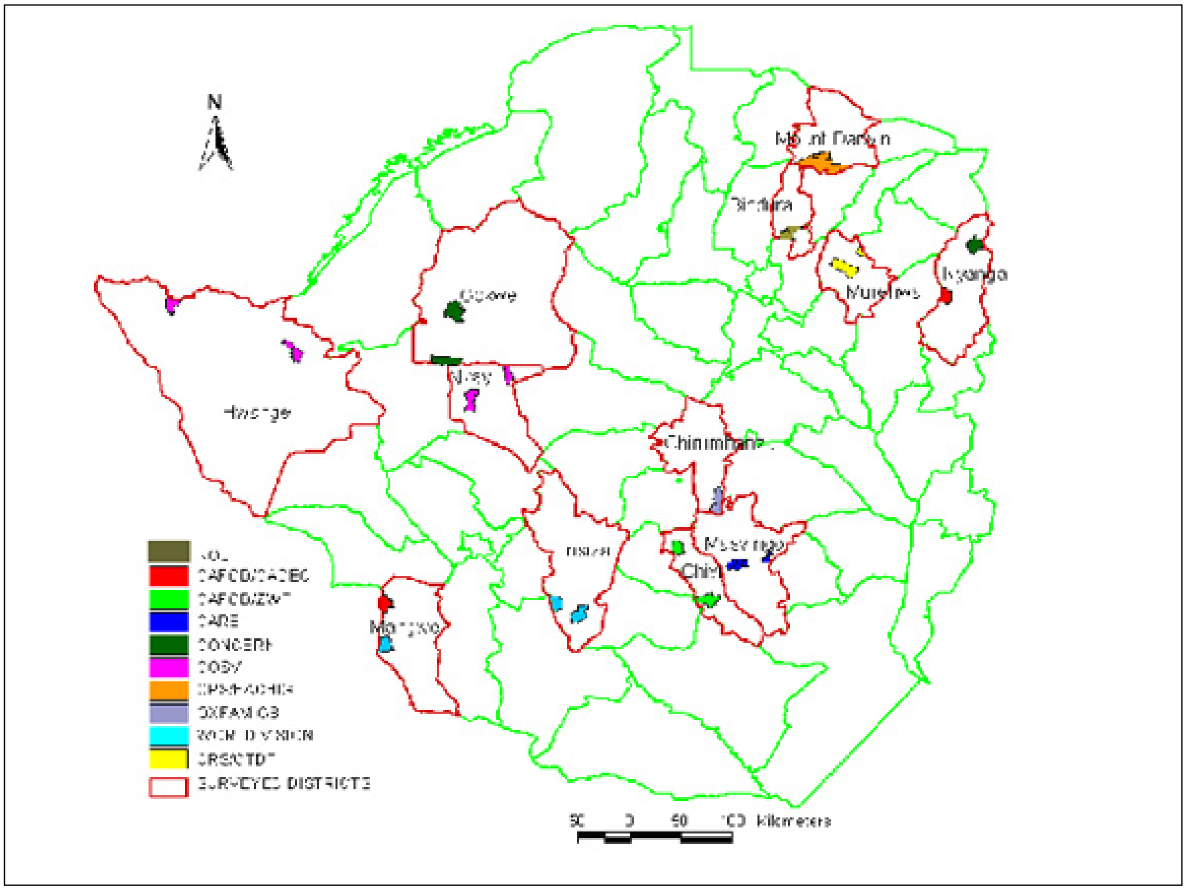

Figure 2. The location of wards and districts sampled for the CF uptake survey, 2006/07.

This study employed five complimentary approaches to gather socioeconomic and biophysical information: (i) farmer interviews through formal household questionnaires (see Annex 2), (ii) focus group discussions (see Annex 3 for Checklist), (iii) yield measurements, (iv) weed density measurements and (v) soil study.

Interviews, focus group discussions and weed measurements were carried out by three teams, each covering four districts. Upon their arrival in each district, the teams contacted the local NGO, AREX and any other agencies that were involved in CF promotion. Local leadership facilitated farmer participation at focus group discussions.

In each district around 20 households were interviewed and geo-referenced in order to develop a database for continued monitoring in subsequent seasons.

Table 1. Sample of CF uptake study.

District	Promoting agencies	Natural region	Household interview	Focus group discussions
Bindura	RoL	II	20	2
Chirumhanzu	ICRISAT/Oxfam GB	III	16	1
Chivi	ICRISAT/CAFOD-ZWP	V	20	2
Gokwe South	Concern	III	18	2
Hwange	ICRISAT/COSV, RoL	IV/V	20	2
Insiza	ICRISAT/World Vision	IV	20	2
Mangwe	ICRISAT/CAFOD-CADEC/World Vision	IV/V	20	1
Masvingo	ICRISAT/CARE	III	22	2
Mt Darwin	CRS-FACHIG	II	16	1
Murehwa	CRS-CTDT	II	20	2
Nkayi	ICRISAT/COSV, RoL, Christian Care	IV	20	2
Nyanga	CAFOD-CADEC	V	20	2
Total			232	21

2.1 Farmer interviews and Focus Group Discussions (FDGs)

A farmer questionnaire was developed, field-tested and modified during enumerator training. The final questionnaire is attached in Annex 2. After the individual household interviews were completed, an FGD was held in each community. Prior to the FGD a checklist was developed (see Annex 3).

The household interviews took place with the key decision-maker on field crops, as well as any other members of the household who might be regarded as key informants, at the selected household's homestead. Farmers were asked about their current CF practices such as winter weeding, the management of crop residues, timely weeding and crop rotation. If farmers were not practicing one of these management options they were asked why. Other questions related to weeding practices, labor allocation, planting times, crop rotation and residue management. During each interview, the team member visited the plots where the farmer was practicing CF as well as plots where field crops were grown the conventional way, i.e., through FP. These interviews were carried out before the FGD to avoid any bias that might arise from influence by other farmers that might be present.

FGDs (at least one per ward) were held in order to collect supplementary qualitative information on the adoption and impacts of CF in the community. To ensure conformity, each FGD was guided by a checklist developed by the three teams.

2.2 Biophysical measurements

Biophysical data was collected from the household's CF plot and from an adjacent field where crops were planted according to the more normal practice of FP. Part of this data collection was done during the farmer interviews; yield data was collected by NGO and AREX staff and detailed soil measurements were taken by a separate group that followed the three survey teams.

2.2.1 Yield determination and the contributions of CF to household food security

The total areas of the CF plot were measured during the field visits. On both CF and FP plots, an area of at least 50 m × 20 m was demarcated in order for yield estimates to be made at harvest. Larger plots were demarcated when the whole CF plot area was greater than 2000 m^2. Harvest bags were left with each household and it was agreed that at harvest each one would record how many sacks of maize cobs/sorghum heads were harvested from each plot to the nearest half bag. Yield data was collected in June 2007. From spot checks made in previous seasons, a 50 kg bag of maize cobs contained 24.0 kg of grain and sorghum 11.3 kg of grain.

For the purposed of this study it was assumed that a typical household required 900 kg of cereal grains to achieve basic food security for the year. Contributions of CF plots to household food security were determined by calculating the total yield from each household's area of land under CF and the proportion of 900 kg attained.

2.2.2 Weed assessment

Quantitative weed density assessments were made on the CF and FP plots of each interviewed household. A 50 m string transect was placed diagonally across each plot and marked at 50 cm intervals. A score of 1 was given when weed(s) were observed within a 5 cm radius of a point on the transect and 0 when weeds were absent. The following formula was used to compute a plot's weed density index (WDI):

$$\text{WDI score} = \frac{\text{Sum of scores} \times 100}{\text{No. of points on transect}}$$

2.2.3 Soil physical and chemical properties

From each interviewed farmer, a composite soil sample of five samplings was collected using a hand hoe from both the FP and CF plots. The depth of sampling was about 15 cm and samples were analyzed for pH (in H_2O) and soil organic carbon (Walkley-Black method). This generic soil sampling was followed by a more detailed soil sampling at 37 farmers' fields, of whom 33 were interviewed. The 37 farmers were located in eight districts encompassing Natural Regions II, III, IV and V (see Table 2 for more details). In each district a farmer who had been practicing CF for one, two or three years was selected and in some districts (e.g., Masvingo, Nyanga and Nkayi) two different wards were chosen with farmers practicing CF for one to three years. In Bindura, farmers had been practicing CF for up to eight years and, to capture possible changes, farmers with two, three, four, six, seven and eight years of continuous practice were sampled. Where possible, farmers with plots in close proximity to each other were sampled in order to avoid differences in soil type within a ward. However, the entire sample frame of eight districts allowed comparisons to be made on the impacts of CF for a wide variety of soil types (see Table 2). Soil sampling was done in basins, between basins and on FP plots.

An extra soil sampling was done at ICRISAT's experimental plots at the Matopos Research Station on a 'tillage × mulch rate' trial.

On all 37 farmers' sites, as well as the ICRISAT fields, two types of soil samples were collected:

1. Volumetric soil samples, for the determination of bulk density.
2. Composite samples, for the determination of pH (H_2O), soil organic carbon (Walkley-Black method), total nitrogen (N) using the Kjeldahl method and total soil P using the Murphy-Liley method.

Table 2. Sampling details of detailed soil sampling on 37 farmers' fields.

District	Ward	Natural Region	Soil type[a]	Years of CF	Total number of farmers sampled
Bindura[b]	10-12	II	5G/E,5AE,6G	2,3,4,6,7,8	6
Murehwa	14	II	5G/E,5AE,6G	1–3	3
Chirumanzu	8	III	5G/M, 6G, 4E	1	1
Masvingo	12	III	7G	1–3	3
Masvingo	14	III	7G	1–3	5
Chirumanzu	7	IV	5G, (4M/S/E)	2–3	3
Mangwe	2	IV	5G (4M/S/E)	1–3	3
Matobo	15	IV	3E.4	1–3	[c]
Nyanga	3	IV	5G,(4M/S/E)	1–3	3
Nyanga	17	IV	5G,(4M/S/E)	1–2	2
Nkayi	3	IV	1,(2)	1–3	3
Nkayi	14	IV	1,(2)	1–2	2
Chivi	5	V	5G, 4P, 2, 4M	1–2	2
Chivi	19	V	5G, 4P, 2, 4M	3	1

[a] Zimbabwe soil classification as published by Nyamapfene (1991).
[b] Wards 10 and 12 in Bindura were adjacent to each other and considered as one.
[c] Samples were collected from ICRISAT's experimental fields at the Matopos Research Station.

The bulk density samples were collected at 0–5, 5–10, 10–15, 15–20, 20–30 and 30–40 cm depths using steel cores with a known internal volume of 100 cm^3 for 5 cm depth intervals and around 170 cm^3 for 10 cm depth intervals. In the CF plots, soil samples were taken within and between basins. Samples were stored in plastic bags and taken to the laboratory for determining fresh and oven-dry (24 hours at 105°C) weights.

The composite samples for chemical analyses were taken at 0–20 and 20–40 cm depths using a soil auger. Each composite sample consisted of three samples collected from a basin, an area between a basin or an FP plot at 0–20 or 20–40 cm depths. The composite sample was mixed thoroughly on a tray, sub-sampled and taken to the laboratory for analysis. On several soils it was impossible to move the auger beyond a 20 cm depth. In these cases bulk density samples were used for the chemical properties.

On all 37 farmers' fields, infiltration was determined by ponding a steel core with 100 ml of water (Plate 1). The time to complete infiltration was recorded and subsequently converted to an infiltration rate in mm per minute. For each farm, infiltration was measured in basins, between basins and in the nearest FP plot.

From a subset of eight farmers located in Bindura (4), Masvingo (3), and Chivi (1), undisturbed soil samples were collected at 0–5, 5–10, 10–15 and 15–20 cm depths in order to determine water retention characteristics. These samples were also taken in the basin, between basins and on conventionally tilled plots. Water retention was determined using the hanging column method (Plate 2). Each sample was saturated and then exposed to −10, −25, −50 and −100

Plate 1. Infiltration measurements using steel cores (ponded method).

cm water tensions. The water released between the levels of water tension was measured in a burette (Plate 2).

2.1 Estimation of CF uptake factors

As the promotion of CF in Zimbabwe can still be considered to be at an initial stage (with the exception of some areas where RoL has been working for more than four years), it is rather difficult to measure adoption levels via the spontaneous uptake of the technology over time. This study thus sought to estimate the level of uptake of the different components of the CF package being promoted by different NGOs in Zimbabwe. The eight main components that farmers should follow are: (i) winter weeding, (ii) digging planting basins, (iii) applying crop residues, (iv) applying manure, (v) applying basal fertilizer, (vi) topdressing, (vii) timely weeding and (viii) crop rotation.

CF is promoted as a package of all the above components, with the poorest households initially provided with seed and fertilizers as an incentive to adopt them all. The study

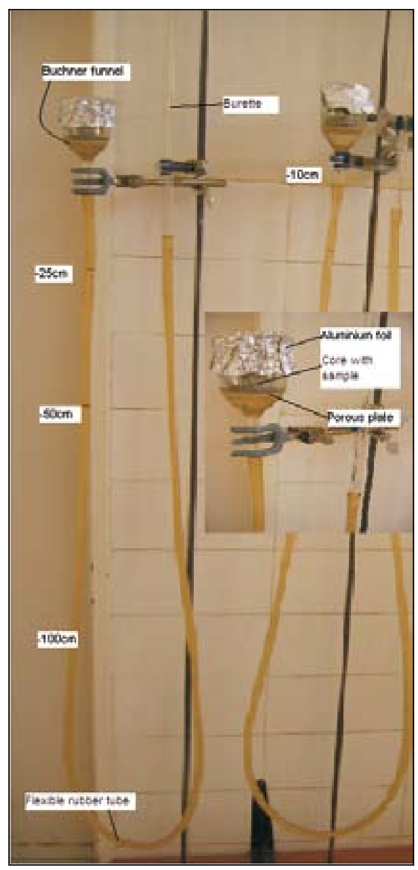

Plate 2. Hanging column method used to determine water retention.

analyzed the intensity of every farmer's uptake of these eight components and determined factors contributing to variations in intensity levels and their ability to adopt all the CF components. A farmer who had fully adopted all eight CF components was given a score of one. Farmers who had stopped practicing or dis-adopted CF were given a score of zero. Those farmers who had adopted various components of the CF package were given scores between zero and one. A Tobit regression model was used to analyze the influence of different household socioeconomic and farm characteristics on CF adoption intensity (Tobin, 1956; McDonald and Moffit, 1980).

2.2 Profitability analysis

Based on production costs and the estimated revenue earned from maize production, an enterprise budget was carried out to compare the viability of CF against conventional animal draft tillage practices/farmer practice (FP). Data used for the profitability analysis was collected from yield measurements, farmer interviews and FGD; secondary data included the input prices of seed and fertilizers, plowing services, labor costs and product prices for maize grain and stover. A sensitivity analysis was carried out to assess the changes in viability of CF practices under different agroecological regions.

3 Results and discussions

3.1 Description of the households

Ninety percent of the households interviewed were actively practicing CF on part of their farms during the 2006/07 cropping season. Most of the farmers interviewed received input and technical support from NGOs, with those in Mangwe (95%) having the highest and those in Bindura (72%) the lowest. The farmers who did not receive technical support were spontaneous adopters who copied the CF methodology from their neighbors. In 9 of the 12 sampled districts the sampling frame specifically targeted households that were practicing CF in 2006/07 season; each household in these nine districts had established planting basins in their fields. In the remaining four districts (Nkayi, Hwange, Mangwe and Insiza) 17 of the 60 households interviewed had not practiced CF in 2006/2007, either because the NGO responsible for introducing CF was no longer operational in the area or because they had simply dis-adopted the practice, opting instead for conventional animal draft tillage.

Table 3 provides an overall summary of the 232 households interviewed and by Natural Region. Across all the agroecological regions, at least two-thirds of these households were female-headed. The average age of the head of household ranged from 45 to 50 years, and farmers in higher rainfall regions had more years of farming experience. Most experienced CF farmers were located in RoL areas.

Table 3. Household characteristics by Natural Region.

Variables	Description	Natural Region II	Natural Region III	Natural Region IV/V
Sample size	Number of respondents	40	54	138
Gender	Male (%)	37.5	35.2	32.1
	Female (%)	72.5	64.8	67.9
Age	Years	45.2	44.7	49.5
Illness	Presence of chronically household member (%)	47.5	48.1	38.7
Death	Experienced death in the household in past 12 months (%)	5.0	9.3	6.6
Farming experience	Years	30.4	21.6	22.7
CF experience	1st time (%)	22.5	24.1	42.3
	2nd + time (%)	77.5	75.9	57.7
Labor	Mean adult family labor	1.0	1.0	1.1
Draft access	With draft power (%)	40.0	40.7	48.9
NGO seed	Have access (%)	87.5	59.3	60.6
NGO basal fertilizer	Have access (%)	77.5	46.3	43.8
NGO topdressing	Have access (%)	85.0	72.2	59.1
Extension access	Number of meetings/training sessions per season	8.0	7.0	4.5
NGO promoting CF	Access to NGO support (%)	95.0	85.2	73.0
CF plot size	Area (m^2)	2261	2168	2123

The impact of HIV/AIDS on CF adoption was investigated, with illness and death experience used as proxy for the pandemic. Close to half of the households interviewed had a chronically ill household member, but less than ten of these respondents had had a death in the home within the 12 months prior to the interview period. HIV/AIDS is assumed to be one major constraint to agricultural production as household members have to spend valuable work time looking after the ailing. Post-funeral trauma also has implications on family resources.

NGOs also provided inputs for 2006/07 season, and at least 40% of the respondents had received seed, basal fertilizer and topdressing fertilizer. However, there were some major differences between the Natural Regions. NGOs operating in Natural Region II tended to supply more fertilizer, both basal and topdress, than NGOs operating in Natural Regions III, IV and V. In fact, less than 46% of respondents in the drier areas received basal fertilizer from NGOs. This was in contrast to Natural Region II, where more than 75% of those farmers interviewed were provided with basal fertilizers by NGOs. This is despite the fact that evidence from the previous two years of monitoring throughout Zimbabwe clearly showed that soil fertility amendments are essential components of the CF package (Twomlow and Hove, 2006).

3.2 Weed assessment

Weed assessment results showed evidence of better weed management on CF basin plots compared to FP plots (Figure 3). There was a higher proportion of CF basin plots than FP plots with a weed density score of less than 25. A higher percentage of households practicing CF had an index score below 50, whereas FP plots had high weed infestations. These figures can be

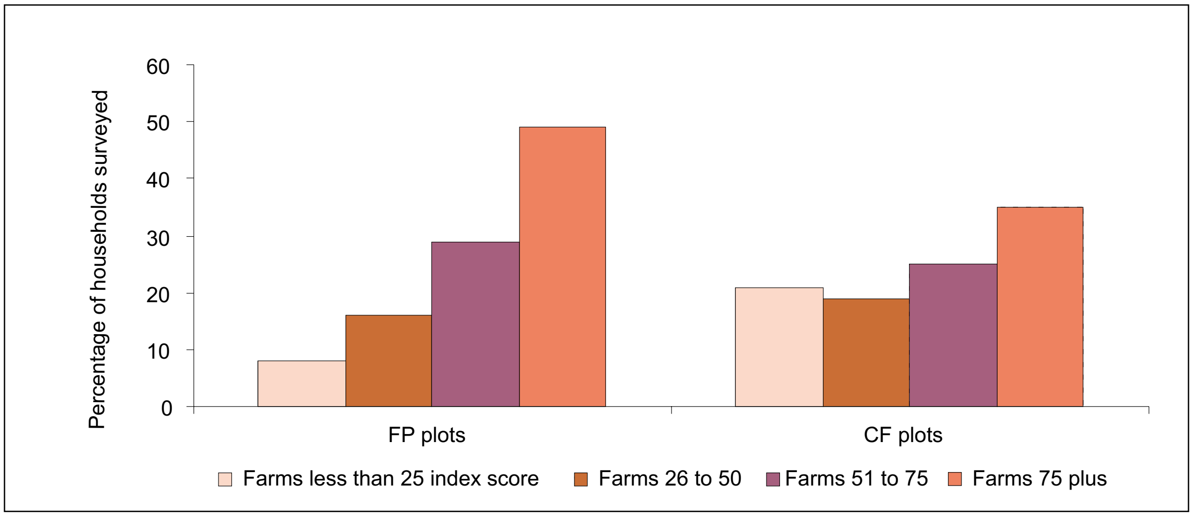

Figure 3. Levels of weed control in CF and FP plots, averaged across 232 households from 12 districts in Zimbabwe, 2006/07.

attributed to the higher weeding frequency of CF basin plots. However, in higher rainfall areas some CF basin plots had higher weed infestations, which required more weeding sessions during the cropping season.

3.3 Changes in soil physical and chemical properties

3.3.1 *Soil physical properties*

The detailed study of 37 farmers' and ICRISAT fields clearly showed that definite changes in soil physical properties took place on CF plots. There was also a dramatic reduction 60% in soil bulk density in the top 15 cm of the soil profile within the basins compared to the soils from the FP plots (Figure 4). This resulted in a trend of improved water retention within the CF basins, as one farm from Chivi District showed (Figure 5). However, there was no trend in water retention as a function of the number of years that CF had been practiced.

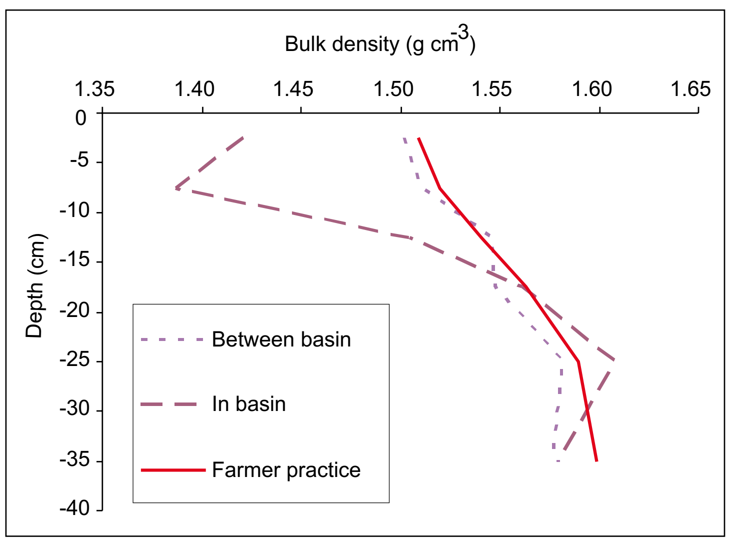

Figure 4. Bulk density as function of depth in the soil profile for conventional plowing, area between basins and within basins (37 farmers + ICRISAT's fields).

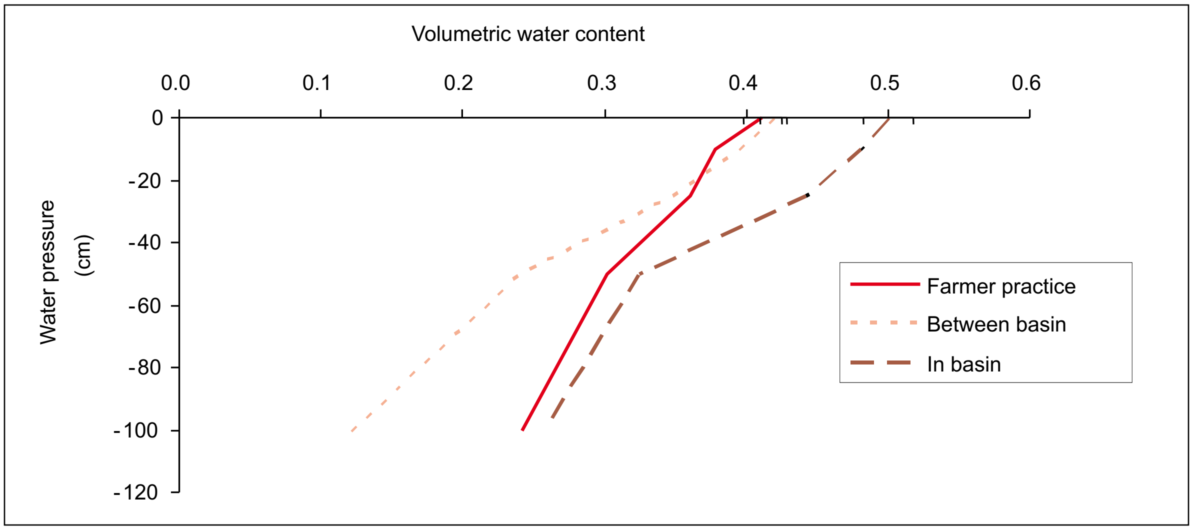

Figure 5. Soil water retention characteristics of FP Plots – the area between basins and in the basins for farms from Chivi District (bars represent standard errors).

The observed changes in bulk density (Figure 4) and water retention characteristics (Figure 5) within the basins coincided with higher infiltration rates in the basins (Figure 6). Not only was an increase in infiltration within the basins observed with each successive year of practice, but a reduction in infiltration for the untilled areas between the basins was also noted. This is an important finding, as lower infiltration rates in untilled areas lead to a preferential inflow of rainwater into the planting basin with its higher infiltration rates – a water harvesting effect.

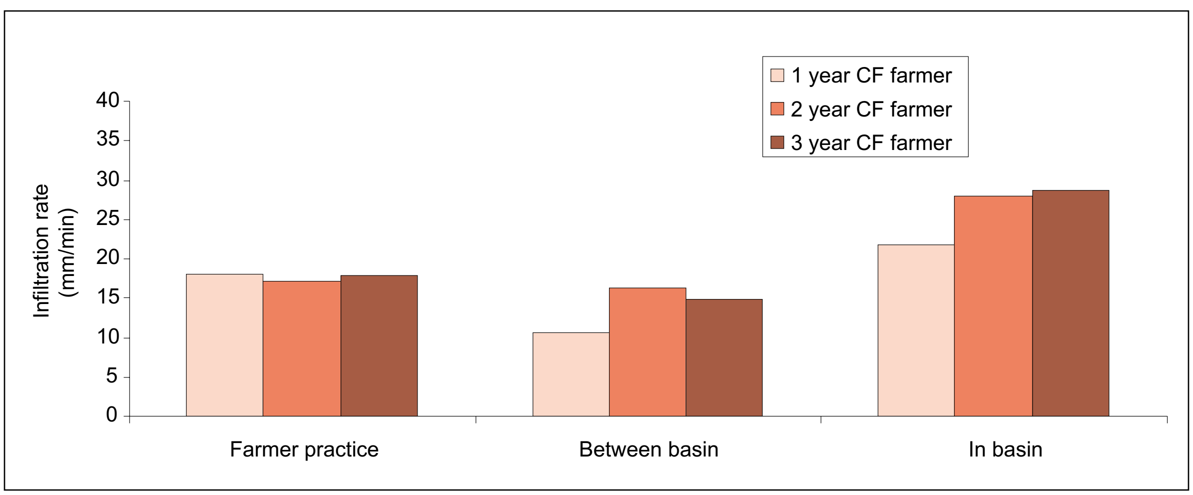

Figure 6. Infiltration rates averaged across 37 farmers' fields from eight districts for FP, areas between Basins and in basins a function of the years that CF had been practiced (bars represent standard errors).

3.3.2 Soil chemical properties

As with soil physical properties, marked changes were observed in the pH especially the top 20 cm (Figure 7) and soil organic carbon (Figure 8) in basins. However, no trends as a function of the number of years under CF could be discerned.

The higher pH values and percentage of soil organic carbon in the basins can possibly be attributed to the precision application of a variety of low-quality organic fertilizers such as kraal manure, compost or leaf litter. However, no major increases in total soil N or P were found when comparisons were made between FP plots and CF basin plots. Data from ICRISAT fields showed a similar picture, although levels of N and P as well as pH were higher due to a different soil type as most communal farmers' fields.

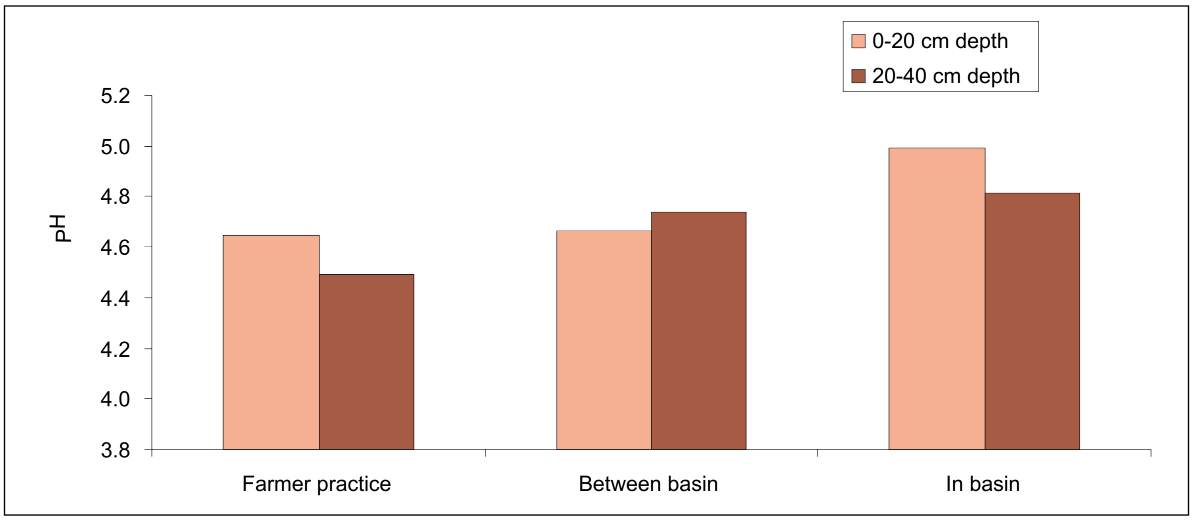

Figure 7. Soil pH values averaged across 37 farmers from eight districts across Zimbabwe for FP plots, areas between basins and in basins (bars represent standard errors).

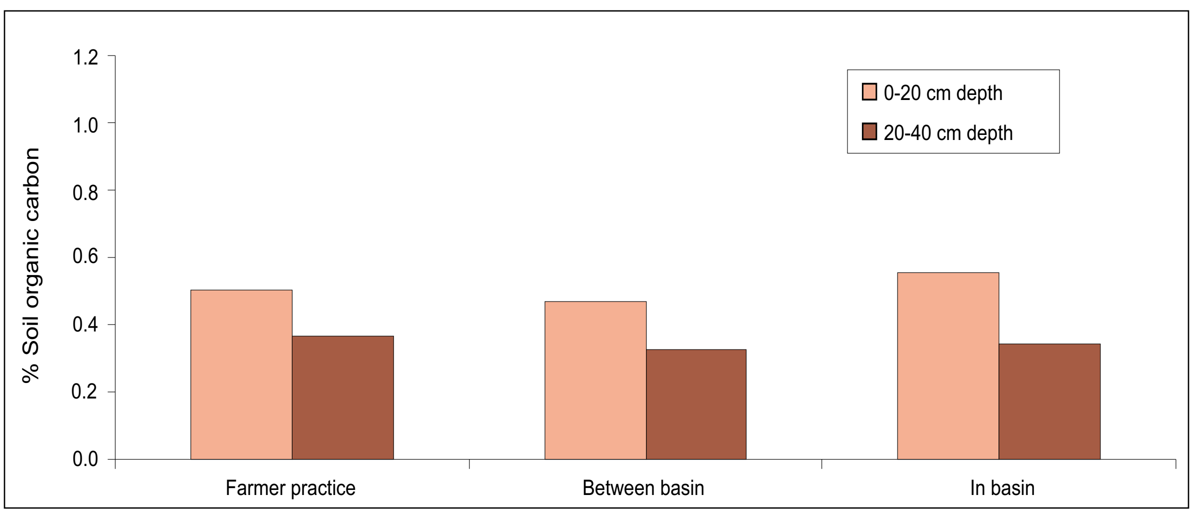

Figure 8. Percentage soil organic carbon in soil averaged across 37 farmers from eight districts across Zimbabwe for FP plots, area between basin and in the basins (bars represent standard errors).

In the generic sampling, differences in soil pH were only consistent between districts. However, detailed soil sampling further revealed significantly higher soil pH in the top 20 cm in basins than in areas between basins or on conventionally-managed plots (Figures 9 and 10). Soil pH was significantly lower in Murehwa and Bindura compared with those of other districts (Table 4). Both are located in Natural Region II with soils that are leached to higher degrees than the soils in Natural Regions III-V (Nyamapfene, 1991). The pH obtained by generic sampling did not correlate with the one obtained from more detailed sampling. Soil pH was also not well related to other soil chemical properties. The predictability of generic sampling was found to be low.

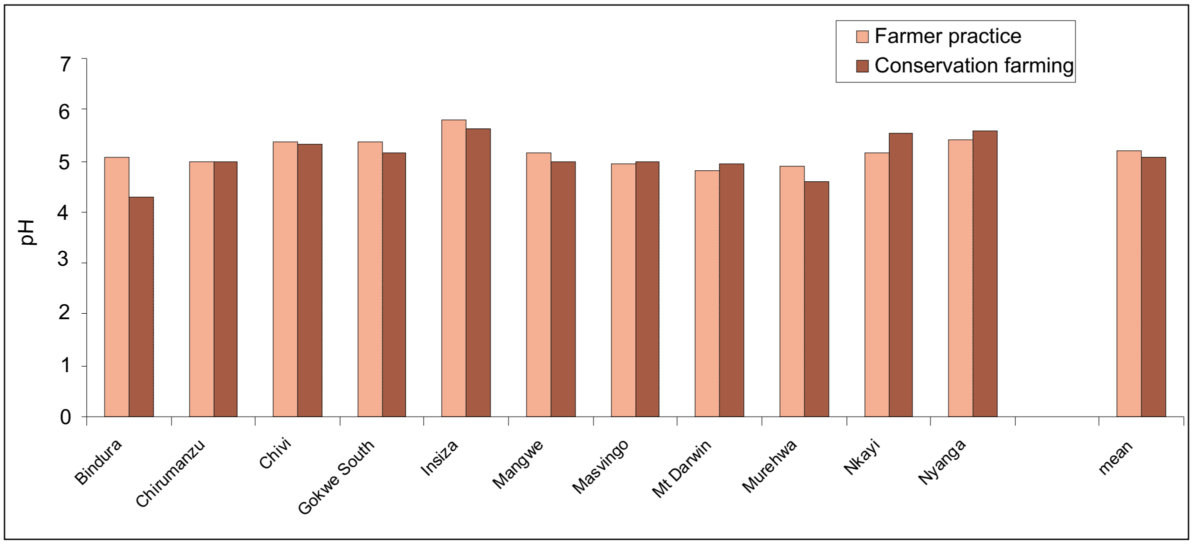

Figure 9. Topsoil pH in FP (N=130) and CF plots (N=174) from 176 different farmers across 12 districts in Zimbabwe (bars represent standard errors).

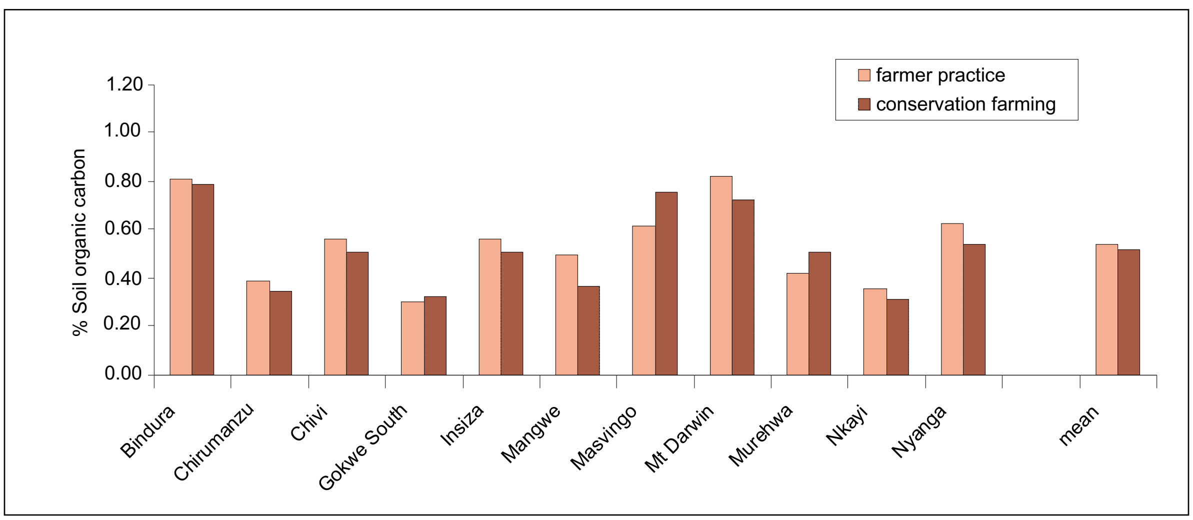

Figure 10. Soil organic carbon in topsoil in FP (N=130) and CF plots (N=174) from 176 different farmers across 12 districts in Zimbabwe (bars represent standard errors).

Table 4. Average, minimum and maximum soil pH (0–20 and 20–40 cm were pooled) from 37 farmers' plots across the eight sampling districts.

District	Average	Maximum	Minimum
Murehwa	3.6	4.5	2.3
Bindura	3.8	5.7	2.4
Nkayi	4.8	6.8	3.8
Nyanga	5.1	7.2	4.1
Chivi	5.1	7.0	3.5
Masvingo	5.1	6.8	3.6
Mangwe	5.1	5.9	4.3
Chirumhanzu	5.2	6.9	4.0

3.4 Changes in planting stations

Farmers have been encouraged to maintain the same plot each year and keep the planting stations in the same position. Doing so encourages an improvement in soil physical and chemical properties (see Section 3.3) and facilitates the re-establishment of the basins in subsequent seasons. Survey results show that 80% of the respondents did maintain the same plot and planting stations (Figure 11).

However, 15% of the respondents did change planting stations but only 5% of households changed fields. The reasons given for changes in planting stations were poor yields in the previous season, soil conditions preventing re-establishment, a pest outbreak and a lack of stover.

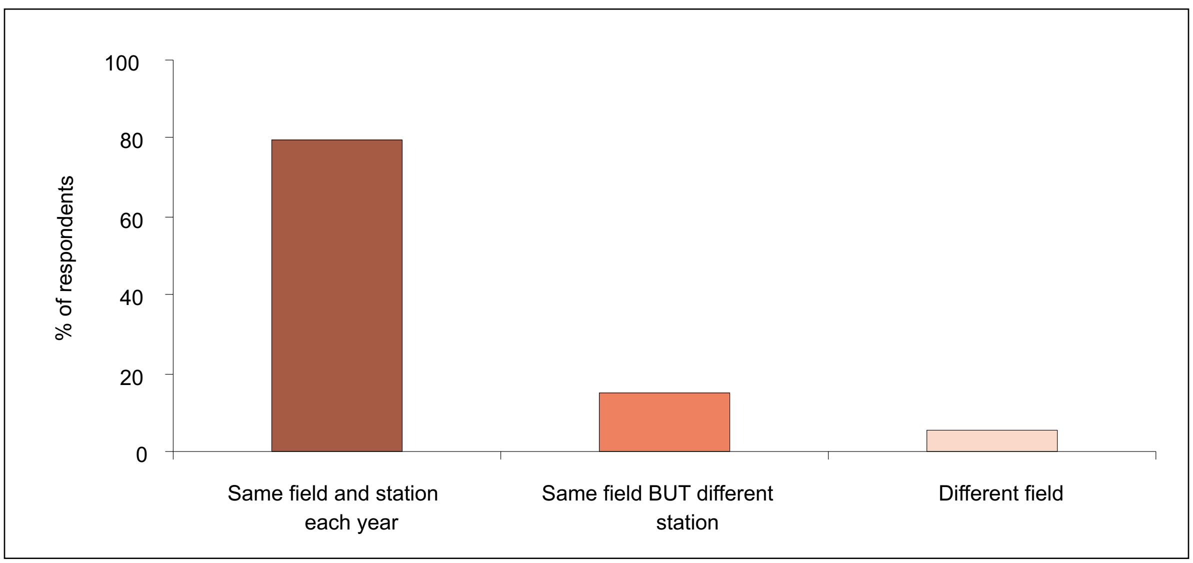

Figure 11. Level of farmers' compliance with the requirement of maintaining same planting stations over seasons (n=232).

3.5 Maize grain yield

Maize yield data was collected from 9 of the 12 districts surveyed and has been summarized by district basis in Figure 12. Yield data from the other three districts is not available. Irrespective of the Natural Region, CF plots (1570 kg ha^{-1}) consistently out-yielded FP plots (766 kg ha^{-1}). Even those farmers in the more marginal regions of Natural Regions IV and V harvested in excess of 1000 kg ha^{-1} of maize during the drought year of 2006/07.

These yield gains from planting basins were achieved because the technology used enabled the concentration of water and fertility within the basin, so reducing the risk of crop failure, even under drought conditions (see Section 3.3). Yield data collected in the 2005/06 season, which experienced above-normal rainfall, showed that CF out-yielded FP, with incremental increases in yield as the level of mulching was increased (Figure 13).

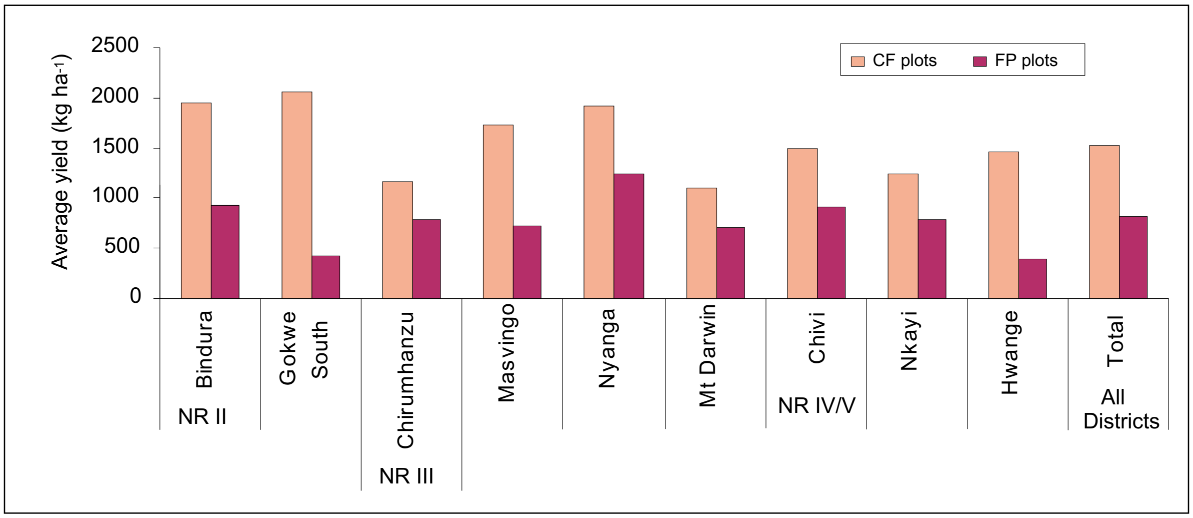

Figure 12. Average maize yields for CF and FP plots across nine districts, 2006/07.

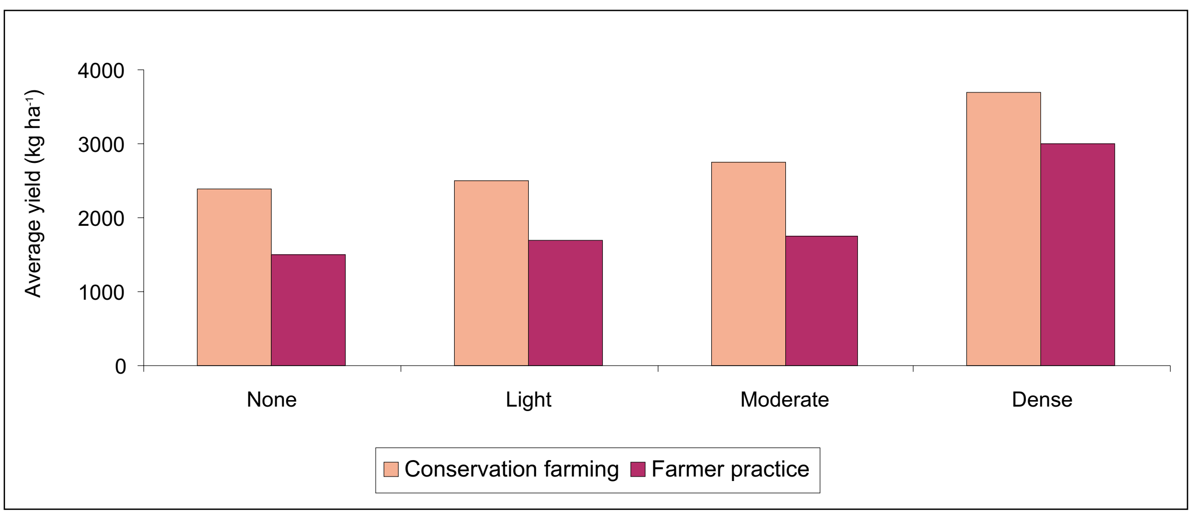

Figure 13. The impact of different mulch cover on maize grain yield across ten districts in the south of Zimbabwe, 2005/06 (Source: Twomlow and Hove, 2007).

3.6 Changes in areas under CF

On average, and across the 12 districts studied, farmers had expanded the size of their CF plots. Plot sizes in the 2004/05 season ranged from an average of 1450 m^2, increasing to more than 2000 m^2 in the 2006/07 season (Table 5). Farmers in Gokwe South, Nkayi and Hwange districts had the largest plot sizes in the 2006/07 season.

Farmers were, however, sometimes confused by NGO field staff as to the area of land they should allocate to CF. In some areas the plot size for CF was controlled by staff of the promoting agency who were concerned about household labor constraints. In addition, CF practitioners also made decisions on the size of the area under CF according to the amount of seed they could obtain.

Despite the 2006/07 season being classified as a drought year, farmers showed a growing enthusiasm for the Planting Basin Package, as indicated by the increasing plot sizes. Typically, farmers who had been practising CF for the past three seasons, irrespective of district, had increased their area under basins from an average of 1300 m^2 in 2005 to 1900 m^2 in 2007 (Figure 14). It is anticipated that farmers will increase plot sizes further as they respond to productivity gains, but reaching a threshold area that is determined by input constraints has yet to be determined. In West Africa, the area devoted to *Zai pits* is limited by the availability of basal soil fertility amendments, rather than labor (Harrington, *pers comm.)*.

The majority of farmers increased plot sizes in response to prospective yield gains and their search for food security. Less than 10% reduced plot sizes because of labor constraints, 17% did so only because they could not access adequate inputs (Figure 14). NGOs also encouraged some farmers to change plot sizes. In some areas, farmers initially adopted CF practices by learning from neighbors and were subsequently included in the NGOs' promotion of CF, which also resulted in size changes. Plot sizes also changed when farmers moved the CF plot to another location or were facilitating crop rotation.

Table 5. Changes in plot sizes across 12 districts, 2004/05–2006/07 seasons.

	Cropping season		
District	2004/05	2005/06	2006/07
Bindura	2173	1814	2143
Chirumhanzu	361	584	1047
Chivi	1000	1053	1000
Gokwe South	400	1830	3074
Hwange	3575	2967	3062
Insiza	1500	1686	1865
Mangwe	2282	1994	1356
Masvingo	700	1239	1209
Mt Darwin	1725	1993	2452
Murehwa	1000	969	1274
Nkayi		1934	4616
Nyanga	1233	1312	1164
Mean area	1448.9	1614.6	2021.8

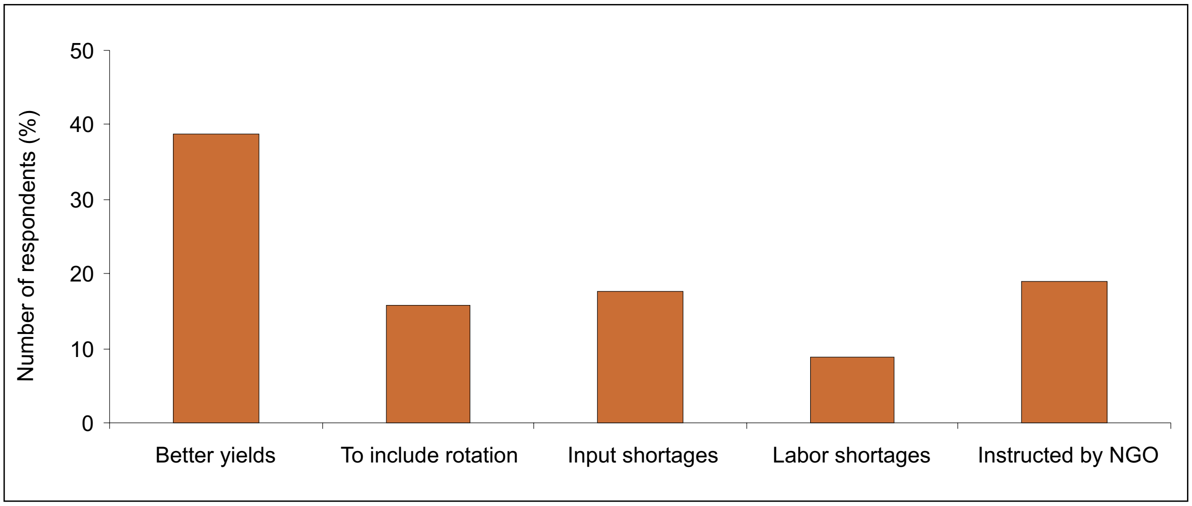

Figure 14. Farmers' reasons for changing CF plot size, 2006/07.

3.7 Contributions of CF to household food security

Although the yields summarized in Figure 12 are encouraging and show the potential of CF to help meet household food security needs in terms of cereals, the data does reveal the contribution that the large-scale promotion CF is making to food production in rural areas.

Contributions to all household food production are a function of plot size and yield. The percentage contribution the actual yields made towards households attaining 900 kg of cereals per year (Figure 15) was calculated using the average plot size per district (Table 5) and the average yields recorded per district (Figure 12). The greatest percentage contributions to household food security, i.e., those in excess of 60%, were recorded in Gokwe South, Hwange and Nkayi and coincided with the largest areas dedicated to CF for this season (Table 5). The lowest percentage contribution was found in districts with the smallest plot sizes.

The question that then arises is 'what CF target area size should farmers be encouraged to establish in order to achieve household food security for most seasons?'. Based on the available data, and the assumption of 900 kg of cereal grain per household, the answer is at least 0.6 ha, over time. If all eight components of the CF package were taken up, in good rainfall years this area would then actually produce a surplus. For all others, full drought years excepted, this same area would come close to meeting basic household food needs.

3.8 Adoption of different CF components

Farmers tend to disassemble technology packages such as CF, initially adopting only the most relevant parts and taking up additional components at later stages (Byerlee and Hesse, 1986). This was certainly the case with the CF promoted under PRP, which targeted households with varying resource endowments across different districts. In this instance, CF components were adopted in a variety of combinations.

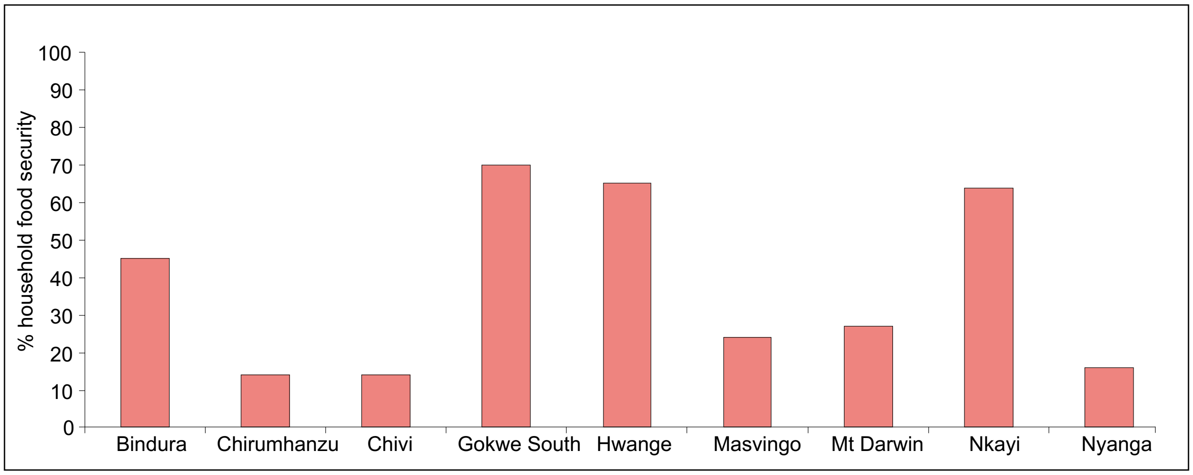

Figure 15. Contributions to household food security based on cereal requirements of 900 kg per year per household.

Apart from digging planting basins, the following components were practiced by at least 70% of the farmers interviewed: basal manure application, topdress and timely post-planting weeding (Table 6). The least implemented components were crop residue application, basal inorganic fertilizer application and crop rotation. The practice of winter weeding was limited, particularly in the first year of adoption, as some farmers only joined the program late in the agricultural season. Also, due to limited access to legume seed, less than 30% practiced crop rotation.

There has been a significant drop in both the application of basal fertilizer and timely weeding. This change in adoption patterns is primarily attributed to a decline in agency support; in the early years NGOs provided free inputs and technical partners closely monitored crop management practices. In addition, the increasing number of spontaneous adopters (who received no NGO support) may have also influenced this pattern. What does need to be established is whether or not component practice is related to the various promotional approaches used by the NGOs.

Table 6. Proportion of farmers practicing components of CF (%).

	Cropping season (n=232)		
Techniques	2004/05	2005/06	2006/07
Winter weeding	51.1	87.2	74.5
Application of crop residues	39.6	75.0	68.8
Digging planting basins	100.0	96.0	90.0
Application of manure	78.0	82.0	70.0
Application of basal inorganic fertilizer	66.7	68.8	43.8
Application of topdressing	90.0	92.0	74.0
Timely weeding	94.0	96.0	76.0
Crop rotation	7.5	30.0	25.0

3.8.1 *Determinants of CF adoption*

The socioeconomic factors that influenced the intensity of CF component adoption included both farmer and farm characteristics. The descriptive analyses of these characteristics are presented by agroecological region in Table 3. They are also listed in Table 7, along with hypotheses on how each one might affect the adoption of CF.

Head of household characteristics such as gender, age and farming experience have implications for the amount of farming knowledge gained over time and are important in the evaluation of new technology information. The age of the main decision-maker within a household may have a positive or a negative effect on technology adoption. Younger farmers are more likely to adopt all CF components, unlike older farmers, who are less likely to do so if they require extra physical labor.

Indeed, the availability of family labor can influence the adoption of most CF practices. For example, farming households that have recently experienced the impacts of HIV/AIDS and thus have fewer labor hours and resources to hand are likely to reduce the intensity of their CF practice. Farmers located in high-potential rainfall regions are less risk-averse and are more likely to have a higher intensity of CF adoption. Wealthier farmers or farmers with access to draft power may be reluctant to practice each CF component, opting instead for conventional draft animal tillage systems. Such farmers may also prioritize crop residues for livestock feed rather than for use as mulch on CF plots.

3.8.2 *Tobit Model estimates*

A score of 0 to 1 was used as the dependent variable for estimating CF adoption intensities. According to Table 8, 80% of the respondents practiced at least half the recommended CF practices. In Nkayi, Hwange, Insiza and Mangwe, survey teams covered a total of 17 households that had not practiced CF during the 2006/07 season. Murehwa and Bindura, where CF has been promoted for the longest period, had the highest incidence of adoption intensity scores above 0.7.

The regression model (Table 9) looks at the relationships between adoption intensity and household- and farm-level characteristics. It summarizes the results of the Tobit Model analysis and shows that male headed-households (GENDER) were more likely to adopt most of the eight components of the CF package. Age (AGE) and farming experience (FARMEXP) were unimportant factors for deciding which CF practice to adopt. There is, however, a strong positive relationship between experience (CFEXPER) of CF practice and the intensity of component adoption. The regression results suggest that the longer a household practices CF, the more likely it is to take up all eight components of the CF package.

Neither household labor availability (LABOR) nor the impacts of HIV/AIDS (ILLDEATH) appear to limit the uptake of the CF package, which justifies current NGO initiatives to promote CF as a means of combating food insecurity for the more vulnerable households in a community. The only area where there was any significant dis-adoption was Hwange, the NGO program promoting CF there having ceased operations in 2006.

CF adopters with larger plot sizes were also likely to practice most components of CF practice. As plot size was increased, the likelihood of implementing most of the package also increased as farmers responded to yield gains. Farmers in high rainfall areas implemented more CF practices

Table 7. Hypothesized determinants of the adoption of CF techniques.

Independent variables	Measure	H_0 Sign	Rationale
Gender	1=Male, 0=Female	+	Female farmers tend to have labor constraints and will omit some of the CF components.
Age	Years	+/–	Younger farmers with more energy and education are likely to adopt all CF techniques Older farmers with better farm experience are more likely to practice all CF techniques.
Farming experience	Years	+	More experienced farmers are more interested in new farm technologies.
Labor availability	Number of full time family labor	+	CF is labor-intensive.
Illness/death	1= Yes, 0=No	–	HIV/AIDS impacts negatively on the intensity of CF adoption.
Draft access	1=Yes, 0=No	–	Draft animals are not used in CF practices. Stover is reserved for livestock feed.
NGO seed	1=Access, 0=No access	+	Free NGO seed provides an incentive for adopting CF techniques.
NGO basal fertilizer	1=Access, 0=No access	+	Basal fertilizer application is an important component of CF, thus free access to it is an incentive to incorporate it in CF.
NGO topdressing	1=Access, 0=No access	+	Topdressing application is an important component of CF, thus free access to it is an incentive to incorporate it in CF.
Extension access	Number of meetings per growing season	+	Extension agents hosted more meetings to encourage adoption of all components of CF.
NGO promoting CF	1=CF promoted by NGO, 0= No promotion from NGO	+	Spontaneous adopters lacked some of the technical information and inputs required to practice every CF component.
CF plot size	m^2	+	Farmers realizing significant benefits from CF have increased CF plot sizes and tend to practice most CF techniques.
Experience of CF	1=2nd + year, 0=1st year	+	Farmers who have practiced CF in the past have since adopted all components of CF.
Rainfall region	1=High rainfall, 0=Low rainfall	+	CF farmers in high rainfall regions practice most CF components. Farmers in high rainfall areas have more experience with fertilizer use and, due to higher yield gains, are likely to have better access to stover.

Table 8. Distribution of CF adoption intensity by survey district.

	Adoption intensity score											Respondents
Districts	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	(N)
Nyanga				1		5		5	8		1	20
Murehwa								1	5	7	7	20
Bindura									6	3	11	20
Mt Darwin			1			1		1	8	5		16
Gokwe South			1		2	5	2	2	3	1	2	18
Chirumhanzu					4	5		4	3			16
Masvingo				1		4		7	7	2	1	22
Chivi				1	1	7		1	4	5		19
Nkayi	1					7	1	4	4	1	2	20
Hwange	8			2	3	5		1			1	20
Insiza	1				3	9	1	1	3	2		20
Mangwe	7			2	6	2		1	2			20
Total	17	0	2	7	19	50	4	28	53	26	25	231

Table 9. Tobit Model estimates of percentage adoption of CF components.

Variable	Coefficient estimate	Standard error	Asymptotic t-ratio
CONSTANT	−0.091	0.078	−1.168
GENDER	0.050	0.028	1.782
AGE	0.001	0.001	0.782
FARMEXP	−0.00005	0.0001	−0.458
LABOR	0.038	0.033	1.140
ILLDEATH	−0.007	0.026	−0.250
DRAFT	0.041	0.027	1.516
SEED	0.021	0.019	1.118
BASAL	0.048**	0.019	2.528
TOPDRES	0.034	0.029	1.716
EXTN	0.018***	0.004	5.071
NGO	0.191***	0.038	5.042
PLOTSIZ	0.071***	0.020	3.638
CFEXPER	0.062**	0.028	2.178
RAINFAL	0.112***	0.030	3.762

Log likelihood function = 30.363
Number of observations = 232
** Significant at 5% level
*** Significant at 1% level.

than those in low rainfall areas. A portion of the farmers interviewed in high rainfall areas were trained by RoL and had longer experience with CF, which is in itself a contributing factor to the intensity of CF component adoption. In addition, in high rainfall areas, due to higher crop yield gains, farmers are likely to have sufficient stover for both CF plots and livestock feed.

3.8.3 *Constraints to CF adoption*

During the FGDs, participants discussed a number of issues associated with adopting all eight CF components. Below is a summary of the major constraints that farmers highlighted.

3.8.3.1 *Labor availability*

Farmers expressed concerns about numerous activities associated with CF implementation, although not one was actually confirmed by the regression model. Access to labor does *not* have a significant effect on CF adoption decisions. Moreover, the labor demand for CF practice should decline as the farmer gains experience with the technology (Figure 16). Many farmers also felt that the operations required for CF (multiple weeding, digging of basins, mulching, and the precision application of soil fertility amendments) were too numerous compared to those for FP. However, experienced CF farmers should save at least five days of basin establishment time compared to first-year farmers. Labor for weed control declines with successive weedings and weed density is lower for plots that have previously had basins. It is also important to note that in the first year of adopting CF, farmers are unlikely to practice winter weeding or place mulch in their plots.

3.8.3.2 *Crop residue management*

CF plots that are inadequately protected or fenced are vulnerable to invasions by animals likely to damage or destroy basins and/or eat most of the stover left for mulch. Some farmers also place higher value on feeding stover to livestock than reserving it for mulching. And, when stover is left in fields, it can be susceptible to termite damage.

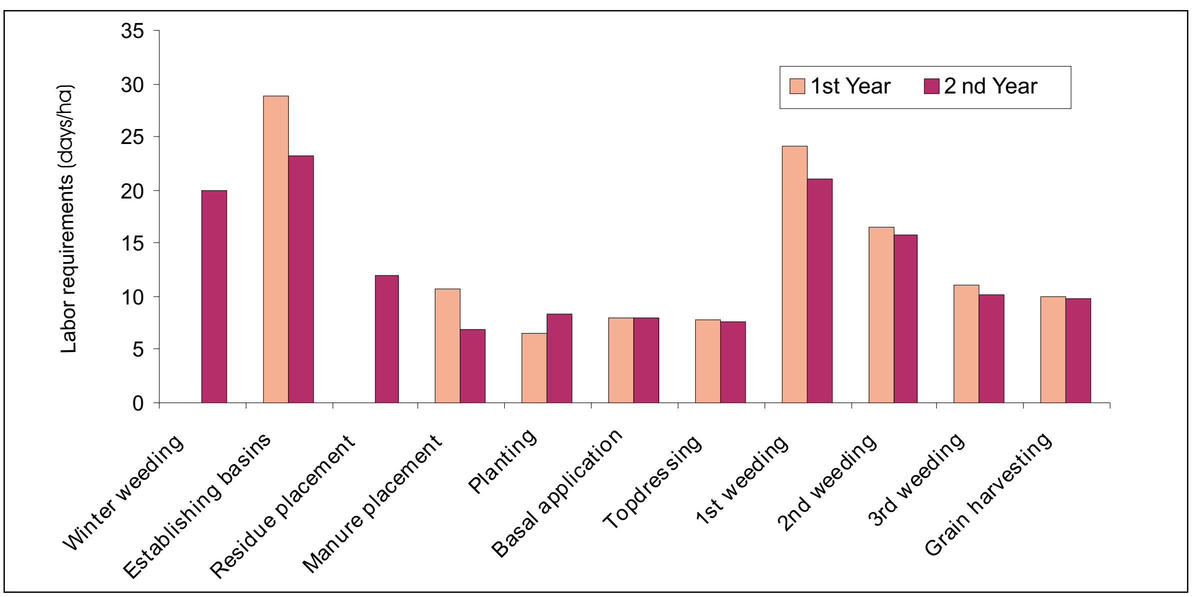

Figure 16. Average labor requirements for CF.

A critical problem faced by CF practitioners is how to obtain enough residues to ensure a good mulch (Figure 17). Residues are a secondary product of maize production and during the survey no farmer had acquired the product off-farm, for example, from a local market. In order to place a value on crop residues to be used for mulching, they can be considered exclusive or non-exclusive products (Erensten and Cadena-Inguez (1997). In situations where farmers have enclosed fields, crop residues become exclusive; those who are not prepared to pay for their use will have no access to them. In unfenced fields, crop residues become non-exclusive, and it is difficult to prohibit access by users who do not want to pay for them, particularly when free grazing is practiced, as is common in Zimbabwe's smallholder farming sector. Exclusive residue retention may require considerable investment in terms of collecting and transporting the residues and fencing the fields. The value of crop residue can be assumed to be reflected in the costs of fencing the fields and additional labor requirements on collection and transport of residues.

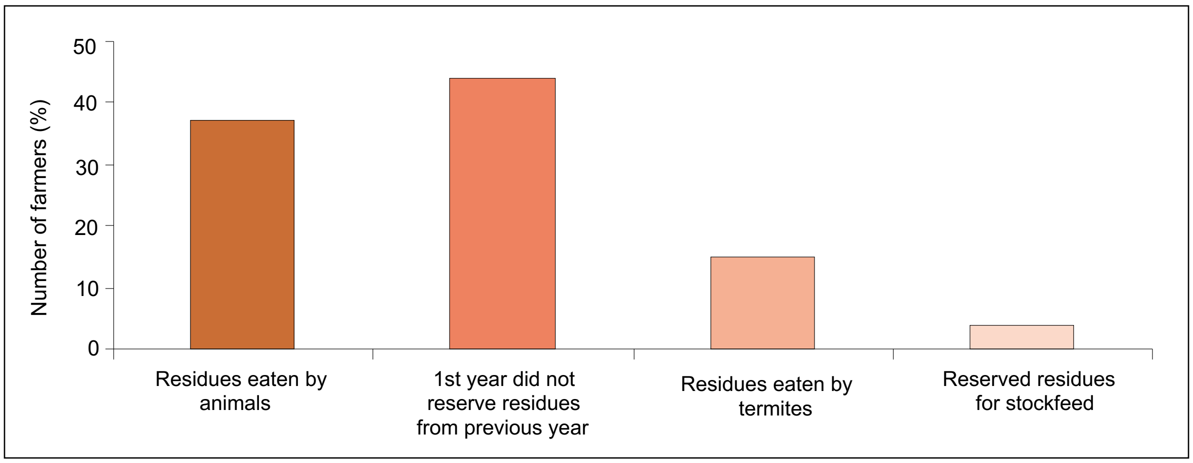

Figure 17. Farmers' reasons for not applying crop residues as mulch in CF plots.

3.8.3.3 *Crop rotation*

The CF package requires that farmers rotate cereals with legumes. For the majority of the farmers covered by this study, this was impossible because of the general national shortage of legume seed as well as the common understanding that legumes should only be planted in shallow furrows. However, there were isolated cases where crops had been successfully rotated, especially in areas where farmers had been practicing CF for longer than the rest of the survey districts. Another constraint to crop rotation is that staple cereals tend to be given priority over other crops, legumes included.

3.8.3.4 *Institutional factors*

In some areas, NGOs tended to promote CF with only limited participation from local AREX officers. Figure 18 shows that only 27% of all farmers practicing CF received any technical advice from AREX.

The Tobit Model has shown the effectiveness of institutional support for CF adoption; farmers who had received continued support from both NGOs and AREX tended to increase their

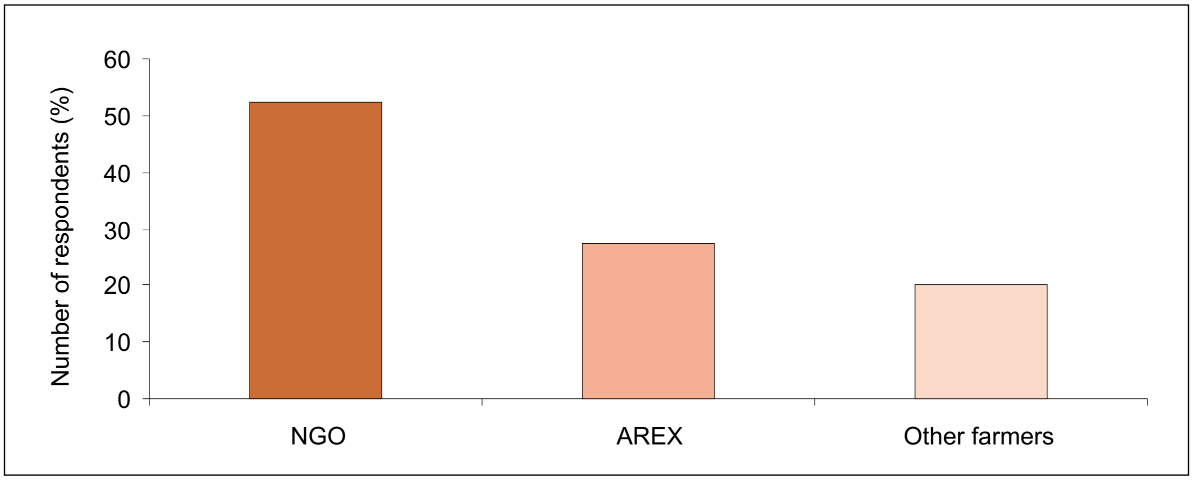

Figure 18. Farmers' sources of technical advice on CF.

CF practices. NGOs also provided free inputs, which encouraged the application of fertilizer to basin plots. In future, actively engaging AREX at earlier stages should ensure ongoing CF practices and wider adoption by farmers who were not included in the initial CF promotions. The latter is critical, particularly if and when NGOs withdraw support.

3.8.3.5 *Access to inputs*

Input markets influence the adoption of all agricultural technologies. With CF, access to NGO-provided seed and fertilizer increased the intensity of its adoption. Indeed, during FGDs, farmers cited restrictions on input access as a major determinant of plot size. Seed, fertilizer and fencing material shortages in rural retail markets constrained the farmers' ability to expand areas under CF and protect fields from animal invasions. Basal fertilizer was commonly unavailable, resulting in the use of manure as the only basal fertility dressing. In the absence of NGO provision of agricultural inputs, local retail outlets must be encouraged to stock the seeds and fertilizers that are necessary for CF.

3.9 Profitability analysis of CF

The input variable costs and revenue values for the profitability analyses for various groups of CF adopters, as well as a range of assumptions, are summarized in Tables 10, 11, and 12. The profitability analysis of CF is based on different groups of CF adopters and on farmers practicing conventional draft animal tillage systems. Maize was chosen as the study crop, it being the most common field crop in Zimbabwe. To facilitate interpretation and comparison, inputs that did not differ significantly across different groups were kept constant; for example the cost of land. Fencing costs were not included in this analysis. As farmers need to invest in protecting the stover produced in their fields, crop residues gain an opportunity cost through the cost of fencing. Crop residues are also an output of grain harvest.

The components of the budget analysis are discussed in the following sections.

Table 10. Enterprise budget analysis, 1ha maize, 2006/07 season, NR II.										
			Conservation Farming (CF)				Farmer Practice (FP)			
			First Year		Second+ Year		No Fertilizer		With Fertilizer	
Item	Unit	Price/ Unit	Quantity	Amount (USD)	Quantity	Amount (USD)	Quantity	Amount (USD)	Quantity	Amount (USD)
A. Revenue										
Maize grain	kg	0.4	2000.00	800.00	2650.00	1060.00	678.00	271.20	1120.00	448.00
Stover	kg	0.12	0.00	0.00	0.00	0.00	237.30	28.48	392.00	47.04
Total revenue				800.00		1060.00		299.68		495.04
B. Variable costs										
B1. Inputs										
Maize seed	kg	0.47	20.00	9.40	20.00	9.40	20.00	9.40	20.00	9.40
Basal fertilizer	kg	0.33	0.00	0.00	92.50	30.53	0.00	0.00	0.00	0.00
Topdressing	kg	0.35	83.30	29.16	83.30	29.16	0.00	0.00	83.30	29.16
Plowing services	ha	22		0.00			1.00	22.00	1.00	22.00
Total inputs				38.56		69.08		31.40		60.56
B2. Labor										
Winter weeding	day	0.88	0.00	0.00	17.00	14.96	0.00	0.00	0.00	0.00
Winter plowing	day	0.88	0.00	0.00	0.00	0.00	6.25	5.50	6.25	5.50
Summer plowing	day	0.88	0.00	0.00	0.00	0.00	8.20	7.22	8.20	7.22
Establishing basins	day	0.88	30.38	26.73	25.42	22.37	0.00	0.00	0.00	0.00
Residue placement	day	0.88	0.00	0.00	12.39	10.90	0.00	0.00	0.00	0.00
Manure placement	day	0.88	12.10	10.65	0.00	0.00	12.20	10.74	12.20	10.74
Planting	day	0.88	7.16	6.30	9.73	8.56	5.00	4.40	5.00	4.40
Basal application	day	0.88	0.00	0.00	8.91	7.84	0.00	0.00	0.00	0.00
Topdressing	day	0.88	7.63	6.72	7.44	6.55	0.00	0.00	6.46	5.69
1st post-planting weeding	day	0.88	25.09	22.08	22.61	19.89	19.25	16.94	19.25	16.94
2nd post-planting weeding	day	0.88	17.04	14.99	16.40	14.43	14.38	12.65	14.38	12.65
3rd post-planting weeding	day	0.88	12.50	11.00	11.10	9.77	0.00	0.00	0.00	0.00
Harvesting grain	day	0.88	10.00	8.80	10.00	8.80	16.13	14.19	16.13	14.19
Total labor			121.89	107.27	140.99	124.08	81.40	71.63	87.86	77.32
Total variable costs				145.82		193.16		103.03		137.88
C. Returns										
Gross margin	US$/ha			654.18		866.84		196.64		357.16
Cost per kg	US$/kg			0.07		0.07		0.15		0.12
Returns to labor	US$/day			6.25		7.03		3.30		4.94
Labor productivity	kg/day			16.41		18.80		8.33		12.75

Table 11. Enterprise budget analysis, 1ha maize, 2006/07 cropping, NR III.

			Conservation Farming				Farmer Practice			
			First Year		Second+ Year		No Fertilizer		With Fertilizer	
Item	Unit	Price/ Unit	Quantity	Amount (USD)	Quantity	Amount (USD)	Quantity	Amount (USD)	Quantity	Amount (USD)
A. Revenue										
Maize grain	kg	0.4	1750.00	700.00	2200.00	880.00	560.00	224.00	728.00	291.20
Stover	kg	0.12	0.00	0.00	0.00	0.00	196.00	23.52	254.80	30.58
Total revenue				700.00		880.00		247.52		321.78
B. Variable costs										
B1. Inputs										
Maize seed	kg	0.47	20.00	9.40	20.00	9.40	20.00	9.40	20.00	9.40
Basal fertilizer	kg	0.33	92.50	30.53	92.50	30.53	0.00	0.00	0.00	0.00
Topdressing	kg	0.35	83.30	29.16	83.30	29.16	0.00	0.00	83.30	29.16
Plowing services	ha	22		0.00			1.00	22.00	1.00	22.00
Total inputs				69.08		69.08		31.40		60.56
B2. Labor										
Winter weeding	day	0.88	0.00	0.00	15.00	13.20	0.00	0.00	0.00	0.00
Winter plowing	day	0.88	0.00	0.00	0.00	0.00	5.50	4.84	5.50	4.84
Summer plowing	day	0.88	0.00	0.00	0.00	0.00	8.30	7.31	8.30	7.31
Establishing basins	day	0.88	28.75	25.30	23.00	20.24	0.00	0.00	0.00	0.00
Residue placement	day	0.88	0.00	0.00	10.88	9.57	0.00	0.00	0.00	0.00
Manure placement	day	0.88	11.40	10.03	0.00	0.00	11.00	9.68	11.00	9.68
Planting	day	0.88	6.30	5.54	8.31	7.32	4.90	4.31	4.90	4.31
Basal application	day	0.88	0.00	0.00	6.79	5.98	0.00	0.00	0.00	0.00
Topdressing	day	0.88	6.70	5.90	7.46	6.56	0.00	0.00	7.75	6.82
1st post-planting weeding	day	0.88	23.88	21.01	21.50	18.92	15.96	14.04	15.96	14.04
2nd post-planting weeding	day	0.88	17.24	15.17	16.43	14.46	12.50	11.00	12.50	11.00
3rd post-planting weeding	day	0.88	11.12	9.79	10.10	8.89	0.00	0.00	0.00	0.00
Harvesting grain	day	0.88	9.95	8.76	9.80	8.62	13.83	12.17	13.83	12.17
Total labor			115.34	101.50	129.27	113.75	71.98	63.35	79.73	70.17
Total variable costs				170.58		182.83		94.75		130.72
C. Returns										
Gross margin	US$/ha			529.42		697.17		152.77		191.06
Cost per kg	US$/kg			0.10		0.08		0.17		0.18
Returns to labor	US$/day			5.47		6.27		3.00		3.28
Labor productivity	kg/day			15.17		17.02		7.78		9.13

Table 12. Enterprise budget analysis, 1ha maize, 2006/07 cropping NR IV/V

			Conservation Farming				Farmer Practice			
			First Year		Second+ Year		No Fertilizer		With Fertilizer	
Item	Unit	Price/ Unit	Quantity	Amount (USD)	Quantity	Amount (USD)	Quantity	Amount (USD)	Quantity	Amount (USD)
A. Revenue										
Maize grain	kg	0.4	1520.00	608.00	1780.00	712.00	368.80	147.52	400.00	160.00
Stover	kg	0.12	0.00	0.00	0.00	0.00	129.08	15.49	140.00	16.80
Total revenue				608.00		712.00		163.01		176.80
B. Variable costs										
B1. Inputs										
Maize seed	kg	0.47	20.00	9.40	20.00	9.40	20.00	9.40	20.00	9.40
Basal fertilizer	kg	0.33	0.00	0.00	92.50	30.53	0.00	0.00	0.00	0.00
Topdressing	kg	0.35	83.30	29.16	83.30	29.16	0.00	0.00	83.30	29.16
Plowing services	ha	22		0.00			1.00	22.00	1.00	22.00
Total inputs				38.56		69.08		31.40		60.56
B2. Labor										
Winter weeding	day	0.88	0.00	0.00	13.00	11.44	0.00	0.00	0.00	0.00
Winter plowing	day	0.88	0.00	0.00	0.00	0.00	7.59	6.68	7.59	6.68
Summer plowing	day	0.88	0.00	0.00	0.00	0.00	7.50	6.60	7.50	6.60
Establishing basins	day	0.88	27.63	24.31	21.08	18.55	0.00	0.00	0.00	0.00
Residue placement	day	0.88	0.00	0.00	12.90	11.35	0.00	0.00	0.00	0.00
Manure placement	day	0.88	8.57	7.54	0.00	0.00	9.90	8.71	9.90	8.71
Planting	day	0.88	6.00	5.28	7.07	6.22	4.38	3.85	4.38	3.85
Basal application	day	0.88	0.00	0.00	7.98	7.02	0.00	0.00	0.00	0.00
Topdressing	day	0.88	9.09	8.00	7.87	6.92	0.00	0.00	8.00	7.04
1st post-planting weeding	day	0.88	23.38	20.57	19.25	16.94	13.75	12.10	13.75	12.10
2nd post-planting weeding	day	0.88	15.38	13.53	14.69	12.93	11.88	10.45	11.88	10.45
3rd post-planting weeding	day	0.88	9.38	8.25	9.00	7.92	0.00	0.00	0.00	0.00
Harvesting grain	day	0.88	9.78	8.61	9.40	8.27	14.34	12.62	14.34	12.62
Total labor			109.19	96.09	122.23	107.57	69.33	61.01	77.33	68.05
Total variable costs				134.64		176.65		92.41		128.61
C. Returns										
Gross margin	US$/ha			473.36		535.35		70.60		48.19
Cost per kg	US$/kg			0.09		0.10		0.25		0.32
Returns to labor	US$/day			5.22		5.26		1.90		1.50
Labor productivity	kg/day			13.92		14.56		5.32		5.17

3.9.1 Revenue

Despite the 2006/07 season being classified a drought year, CF plots gave five times more yield than FP plots in Natural Regions IV and V. Income was earned from crop sales (grain) and the opportunity costs of crop residues when reserved for personal livestock feed. Crop residue earnings have only been included for non-CF farmers who were assumed to own livestock that would feed on these residues. Grain cost was based on the local market selling price.

The study sample was drawn from households who (i) were largely food insecure and thus predominantly reliant on food purchases and (ii) barely participate in the market as input sellers. The maize selling price was set at US$ 0.40/kg across all categories of farmers. Because of the superior yields gained through CF practice, adopters of this practice earned significantly higher revenues than those involved in FP.

3.9.2 Variable costs

The variable costs of maize production were distinguished as inputs (seed and fertilizer) and labor costs. For FP, tillage services were valued at the cost of hiring ox-drawn plowing services. The results in Tables 10, 11, and 12 show that input costs for CF adopters were double those of FP as the latter did not apply fertilizer. Compared to FP, labor costs for CF were also double, CF requiring higher labor requirements for basin establishment, weed control and the management of crop residues. However, it is expected that the labor demands of CF will decline over time, as the farmer becomes more experienced with CF techniques, thereby improving efficiency in different operations.

3.9.3 Returns

Farmers practicing CF for the first time had a gross margin six times higher than that which could be obtained with standard FP with no fertilizer use. The more experienced conservation farmers earned an even higher gross margin (Table 13). These results are firm, despite the fact that digging planting basins is labor intensive, requiring 30 days/ha for basin establishment alone. The results also confirm the higher labor returns from maize production under CF compared to conventional FP.

3.9.4 Sensitivity analysis

The budget analysis shown in Tables 10, 11, and 12 represent an approximation of costs and benefits of maize production in Natural Regions II, III and IV/V, respectively. The three classifications enabled a sensitivity analysis to be carried out that showed the potential viability of CF across different agroecological regions and were used to reflect on different rainfall patterns (Table 9). All other production costs were held constant, meaning that they were independent of yield levels. The results from the sensitivity analysis show that CF remained viable in all rainfall conditions, even when significant yield gains from FP can be achieved in Natural Region II using good agronomic practices and N topdressing.

Table 13. Sensitivity analysis.

			Conservation farming (CF)		Farmer practice (FP)	
			First year	Second + year	No Fertilizer	With Fertilizer
High rainfall (NR II)	Maize grain	Kg/ha	2000.00	2650.00	678.00	1120.00
	Gross margin	US$/ha	654.18	866.84	196.64	357.16
	Cost per kg	US$/kg	0.07	0.07	0.15	0.12
	Returns to labor	US$/day	6.25	7.03	3.30	4.94
Medium rainfall (NR III)	Maize grain	Kg/ha	1750.00	2200.00	560.00	728.00
	Gross margin	US$/ha	529.42	697.17	152.77	191.06
	Cost per kg	US$/kg	0.10	0.08	0.17	0.18
	Returns to labor	US$/day	5.47	6.27	3.00	3.28
Low rainfall (NR IV/V)	Maize grain	Kg/ha	1520.00	1780.00	368.00	400.00
	Gross margin	US$/ha	473.36	535.35	70.60	48.19
	Cost per kg	US$/kg	0.09	0.10	0.25	0.32
	Returns to labor	US$/day	5.22	5.26	1.90	1.50

4 Envisioning CF

Farmers' views on future technical and institutional developments that would support the expansion of CF were obtained through FGDs. The highlights are presented below:

4.1 Input market development

The increased adoption of CF practices should be complemented by the active participation of local retail outlets in the supply of agricultural inputs. Retailers in marginal areas should be encouraged to stock seeds, fertilizers, herbicides and other necessary farm implements. Such access to inputs in local retail shops would reduce transport costs and farmers might be able to purchase them even if NGO aid is withdrawn. This would also benefit farmers who are not supported by relief interventions. Strengthening local retailer ability to provide agricultural inputs does require a clear exit strategy from the local NGO that had previously been providing these inputs. A possible interim solution – given the economic status of many households – is the use of vouchers that can be redeemed at local shops.

4.2 Encourage herbicide use

The use of herbicides as an option to offset the high labor costs associated with a higher weeding frequency should be explored. Intensive farmer training on herbicide types, suitability and residual effects should accompany any promotion of herbicide use. This is critical, as herbicide persistence in the soil may affect subsequent crop rotations.

4.3 Allow farmer flexibility on plot sizes

CF farmers should be allowed flexibility on plot size. Some communities believe there is a mandatory plot size for CF practices, particularly if farmers are receiving inputs from NGOs. Areas allocated to CF should be determined by each farmer's resource endowments and budget constraints. Allowing farmers to make their own decisions about CF technology is critical and empowering, giving farmers ownership of the package, which should ensure sustainability. If the goal is household food security, results from the study recommend a long-term target area of at least 0.6 ha of cereals per household.

4.4 Initiating fencing projects around CF plots

Farmers should be encouraged to establish fencing projects, either on their own or through farmer groups, to protect plots from animal invasion. This requires community cooperation, as farmers who do not practice CF may fail to appreciate the benefits of fencing off land.

4.5 Encouraging farmer-to-farmer training

Farmer-to-farmer training on CF would likely enhance the adoption of CF practices throughout Zimbabwe. In most areas, farmers have already formed CF groups or clusters. Such associations afford them access to information and to share experiences more easily. Belonging to a group can influence a farmer's decision to adopt CF. Extension agents also find it easier to train groups rather than individual households. Extension agents should assess the relevance of existing farmer groups in influencing CF adoption. Where necessary, groups should be mobilized and trained on group governance, leadership and management.

5 Conclusions

Despite concerns about CF having higher labor demands, the technology can be used by vulnerable households including those affected by HIV/AIDS, to ensure food security. Farmers with no draft power can start preparing basins in winter, spreading out the labor demand, so enabling the use of any early rains. Although labor requirements are higher on a per hectare basis, they are easily outweighed by grain yields. All in all, CF makes household labor more efficient.

Between 73 and 95% of all households interviewed received direct support from NGOs; the remaining households were spontaneous adopters. Currently, ICRISAT does not know the exact total number of spontaneous adopters, and there is evidence that they are increasing in number, particularly in higher rainfall areas. Future studies should focus on CF uptake by this category of farmer.

Timely weeding is a key component of CF, and consistent weeding will lead to a decrease in weed density over time. Despite the fact that CF is labor intensive, weed management in CF plots was generally better than FP plots. Expectations of higher yields and meeting NGO requirements could have encouraged farmers to invest more time in weeding. Further studies are required to identify the variables associated with improving efficiency in weed control.

There are still challenges in ensuring that farmers adopt all eight components of the CF package. Compliance remains low for winter weeding and crop rotation practices. Future research and extension efforts should aim to address these challenges.

Experience with CF is critical to the adoption of key practices such as timely weeding and mulching. It is important that NGOs and AREX continue to provide technical support for CF. NGOs need to be clear about the flexibility of CF practices, including changes in plot sizes. It is difficult to tell whether or not farmers will continue with CF after the current donor-funded programs have been completed. Further detailed studies of spontaneous adopters are required in order to understand why they are willing to 'risk' adopting CF technology without any training or support.

CF leads to improvement in soil physical and chemical properties in the planting basins. The improved infiltration rate and amount of water retention lead to more effective use of rainfall, and a lower bulk density enables better root growth. The precision application of manure and fertilizer, as well as decomposing roots, to basins will build fertility in the top 20 cm of the soil. Further investigations are required to determine (i) if CF leads to higher availability of important nutrients as N and P, and (ii) the effect of CF on water retention across agroecosystems.

Higher yields were realized irrespective of the agroecological zone. These yield gains have offset the high labor costs associated with CF plot management. According to the enterprise budget analysis, CF is more profitable than FP. Future studies should include a cost–benefit analysis of investments in stover management, including the fencing CF plots.

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Annex 1

Protracted Relief Programme
PRP

GUIDELINES FOR PRP PARTNERS

These guidelines have been prepared in consultation with PRP Technical and Implementing Partners, particularly River of Life, incorporating the best practice known at the time of preparation. The Guidelines will be updated as necessary to include new knowledge and improved practices.

No.1

CONSERVATION FARMING FOR VULNERABLE HOUSEHOLDS

Revised August 2005

1. Purpose

To improve food security of vulnerable households through promotion of a package of improved soil and water conservation techniques known as Conservation Farming (CF).

2. Expected Benefits

- Improved production
- Soil and water conservation
- Reduced labour requirements after year 1
- Labour requirements spread over time

3. Constraints

- Possible extra labour requirement in year 1
- Requires higher level of management

4. General Principles

- Ensure community are fully involved in change process
- Brief RDC and local authorities and traditional leaders
- Involve AREX at all stages
- Train AREX staff
- Follow CF Fundamental Principles
- Follow the CF Calendar
- Keep it small and simple and manageable
- Require dedicated staff with agricultural background at field level

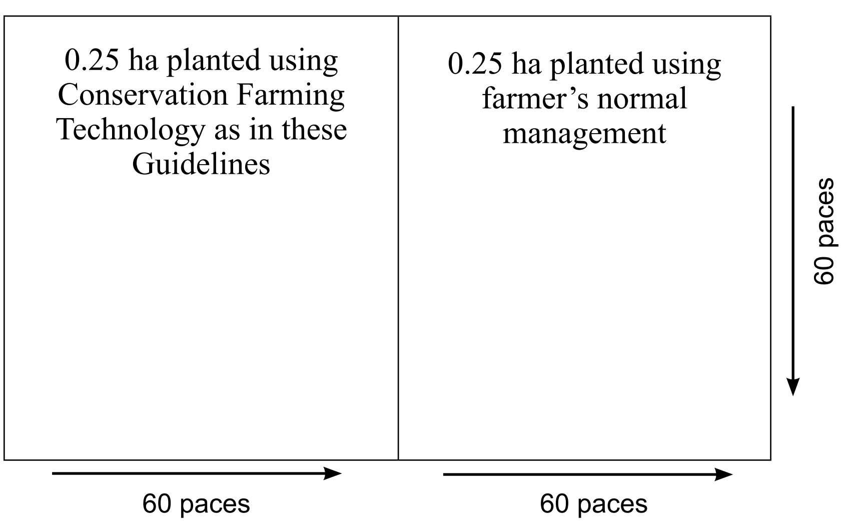
5. Fundamentals of Conservation Farming

- No burning
- No appreciable soil inversion (ploughing) at any stage
- Weeding throughout the year
- Precision marking out and planting
- Rotation to include 20% legume
- Use of same plots and planting stations each year
- Precise, careful management – particularly placement of fertilizer and covering of seeds
- Timely
    - ♦ Delivery of inputs
    - ♦ Training of staff and farmers
    - ♦ Land preparation
    - ♦ Planting relative to rain
    - ♦ Weed control

6. Targeting

The targeted beneficiaries are vulnerable households with access to 0.25 ha of cultivable land, and who are capable of working the land, or are enabled by the programme to work the land.

- For every ten beneficiaries the NGO should select at least one Lead Farmer per village/ cluster who will assist the poorer households
- The Lead Farmer should be:
    - ♦ Chosen by community
    - ♦ Capable and interested
    - ♦ Preferably able to read and write
- The Lead Farmer should maintain a "control" plot with conventional management for comparison with the CF plot as illustrated below.



7. Site Selection

- Choose site under current cultivation in the previous season without serious production problems i.e. no major infestations of couch grass or witch weed (striga)
- If possible the site should be secure from livestock to protect stover if available
- Ensure that the Lead Farmer site for the demonstration plot is representative of farm conditions, is accessible and visible and can be used by the group for lesson sharing and learning

8. Scale

Year 1

- One Lead farmer for 5 to 10 Vulnerable Farmers (VFs) in each cluster
- The optimum is 50 farmers per NGO per District (e.g. 5 Lead farmers and 45 VFs). For NGOs with extensive experience in CF the maximum can be up to 100 farmers per NGO per District

Year 2

- Maximum of 20 Lead Farmers depending on evaluation results at end of year one

Year 3

- Maximum of 40 Lead Farmers, but could be a lot more if AREX are fully involved.

9. The Technical Package for Year 1

PRP Yr 1 Package	NR I, II and III	NR IV and V
Plot Size	0.25 ha (see note 1)	0.25 ha
Cereal	Maize	Maize or Sorghum or Pearl Millet (see note 2)
Cereal area	0.20 ha	0.20 ha
Cereal seed quantity	5kg maize	5 kg maize or 2 kg sorghum or 1 kg Pearl millet
Cereal fertilizer	Compound D 130 kg/ha or Manure 5 mt/ha *(see note 3)*	Compound D 50 kg/ha or Manure 5 mt/ha
	AN 130 kg/ha or CAN/LAN (28%N) 150 Kg/ha *(see note 4)*	AN 50 kg/ha or CAN/LAN (28%N) 75 kg/ha *(see note 4)*
	Lime 130 kg/ha (see note 5)	
Legume	Groundnuts or cowpeas	Cowpeas
Legume area	0.05 ha	0.05 ha
Legume see quantity	4kg groundnuts or 2kg sugar beans	2kg cow peas
Legume fertilizer	Compound D 130kg/ha or Manure 5mt/ha	Compound D 50kg/ha or Manure 5mt/ha
	Lime 130 kg/ha	
Spacing	75cm x 60cm	90cm x 60cm or 75cm x 75cm (see note 6)

NOTES TO TECHNICAL PACKAGE

Note 1:	Metric units are used for calculations. In dealing with farmers use units of measure they are familiar with in that area. E.g. acres, bottle caps, coke cans
Note 2	The choice of different cereals is intended to cater for farmer preference in different areas
Note 3	Where manure is available it can replace Compound D. and may also help to reduce soil acidity
Note 4	CAN/LAN FROM RSA IS 27-28% N. N content from other sources should be checked in tender evaluation. For simplicity and practicality the package distributed to farmers is the same whether AN or CAN/LAN is used.
Note 5	Line should be limited to higher rainfall areas and to areas within 50-100km of lime source.
Note 6	90cm row spacing will allow access by draught animals for weeding or for later conversion to ripper based CF. The 75cm row spacing is suitable for hand weeding and is likely to give earlier crop canopy cover which will be beneficial in better weed suppression, less evaporation and greater soil protection.

In following years the inputs may change, for example:

- A greater area of legume is included
- Cash crops may be introduced,
- Fertilizer rates max increase as the level of management improves

10. The Vulnerable Household Package

	NR I, II and III	**NR IV and V**
Cereal seed	5kg maize	2kg sorghum or 1 kg pearl millet or 5 kg maize or Combination – farmers choice
Legume seed	4kg groundnuts or 2kg cowpeas	2kg cowpeas
Compound D (Or manure – not supplied)	25 kg	12.5 kg
Manure		
N Fertiliser	25 kg	12.5 kg
Lime	25 kg	Nil
Measuring rope	1	1

11. Farmer's Measures

Farmers Measures	Nr I, II and III	NR IV and V
Total Plot Size	60 paces X 60 paces	
Cereal area	60 paces X 48 paces	
Legume area	60 paces X 12 paces	
Spacing	Use measuring rope supplied	
	Amounts per Basin	
Maize seed	3 seeds per basin	
Sorghum seed	5 seeds per basin	
Millet seed	10-15 per basin	
Groundnut seed	8 seeds per basin	
Cowpea seed	8 seeds per basin	
Manure	Double handful per basin	
Compound D	1 heaped bottlecap	1 level bottlecap
N Fertiliser	1 heaped bottlecap	1 level bottlecap
Lime	1 level bottlecap	Nil

12. Resources Required

Resource	Quantity	Source	
		Vulnerable Farmers	**Lead Farmer Demo plots**
Land	>0.25 ha	0.25 ha Farmer	0.25 ha Farmer
Labour	Sufficient for 0.25 ha	Farmer/PRP/WFP	Farmer
Food	Sufficient until harvest	Farmer/PRP/WFP	Farmer
Hoe	>1 decent hoe. Depends on size of family	Farmer	Farmer
Planting strings	1 set per HH	PRP	PRP
Rain gauges	1 per lead farmer	PRP	PRP
Bottle caps or Fertilizer cups	Dependent on fertilizer requirements	PRP	PRP
Cereal Seed	Maize/sorghum/millet as per package	PRP	PRP
Legume seed	Cowpeas/groundnuts/ sugar beans as per package	PRP	PRP
Basal fertilizer	Compound D or manure as per package	PRP	PRP
Nitrogen fertilizer	AN, CAN or Urea as per package	PRP	PRP
Lime	Ground limestone as per package	PRP	PRP
Training	As per calendar	PRP	PRP
Training aids	1 set per NGO/APED trainer	PRP	PRP
Dedicated Agricultural staff	At least 1 per operational area	NGO	
Transport	Sufficient for field staff mobility	NGO	

1.3 Training

- Training curriculum prepared by River of Life (RoL)
- Training programme agreed between RoL and TLC
- Training of NGO staff and on-training of farmers is carried out according to the calendar
- Ensure AREX staff are trained and involved in farmer training
- NGO Agriculturalists have responsibility for farmer training and quality control in each district. How many groups per extension worker
- The NGO in collaboration with AREX should undertake the training of the group at village level
- Training for farmers should be DECENTRALISED to farmers' fields using Farmer Field School concept and the Lead Farmers.

14. Follow up visits

- During the year of inception the NGO should make follow-up visits to beneficiaries at least once a month for the first crop season to ensure timely implementation of land preparation, planting, and subsequent weed control.
- During the following dry season follow-up visits should continue on a monthly basis to encourage basin preparation, control of dry season weeds and management of stover.

15. Monitoring and Evaluation

- NGOs will be responsible for regular monitoring of Lead Farmers and beneficiary plots using the agreed monitoring checklist
- NGOs will be responsible for reporting to TLC on progress/impact against agreed indicators
- River of Life have developed a practical garden monitoring checklist which is available from TLC
- Technical Partners (FAO/ICRISAT/UZ) will be responsible for independent monitoring and evaluation with technical input to survey design by TLC.

16. Activity Calender

Conservation Farming Calendar														
Farmer Activities	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Harvest	X	X												
Clean weeds at havest time	**X**	X	X									X	X	
Mark out				X										
Mulch managemet	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dig basins				X	X	X								
Weed field if necessary			X		X		X		X	X	X		X	
Apply menur/basal (lime where necessary)							X	X						
Plant								X	X					
Apply N topdressing 5 to 6 leaf stage										X	X			
Harvest													X	X
Implementing Partner Activities														
Contact and sensitising communities	X		X		X		X		X		X		X	
Needs assessment and planning	X	X												
Targeting		X	X											
Order inputs			X	X										
Deliver inputs				X	X	X								
Attend training of Trainers @RoL			X		X		X		X		X		X	
Field days/cross visits	X	X									X			
Farmer training Method Demos														
Weeding	X		X		X		X		X		X		X	
Land preparation/mulching			X		X									
Application basal					X		X							
Planting							X	X						
Topdressing								X		X				
Follow up visits/monitoring	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Field days /Result Demos												X	X	
Technical Partner Activities	RoL/ICRISAT/FAO													
Advocacy with IP Directors	X	X		X								X	X	X
Field days for Ips	X	X											X	X
Provide ToT to Ips			X		X		X		X		X		X	
Post planting monitoring UZ/ICRISAT										X				
Post-harvest monitoring UZ/ICRISAT														X

Annex 2

Confidential

Conservation Agriculture (CA) Survey, 2006/07

ICRISAT – Matopos Research Station

Please ask the household whether they are willing to participate in this survey interview. Explain that we are interested in looking at opportunities for improving crop management. Respondents should understand that participation in this survey, and the answers provided, will not influence whether their household will receive assistance of any sort in the future. All data is kept confidential. The results will help ICRISAT improve its technical support for farmers throughout the drier regions of the country.

If this household does not want to participate, this should be noted on the sample list.

Respondent Code: ______________ **GPS Reference:** ____________________

Date: _________________________ Enumerator: ______________________

Province: ______________________ District: __________________________

Ward: __________________________ Village: __________________________

Respondent should be an adult who is a main decision-maker on cropping activities for this household. If husband and wife jointly manage the crops, both should be interviewed together. Participation by the wife should be encouraged.

1. Name of respondent(s)

Name	Status 1= Male household head 2= Female household head 3= Spouse 4= Other (SPECIFY)	Gender *1= Male* *2= Female*	**Age** (Years)	**Year started farming on his/ her own?**

2. What area was farmed with planting basins in the past?

Cropping season when CF was implemented	Was CF promoted by an agency? 1= Yes 2= No	Name the agency that supported this CF practice 1= NGO (name this) 2= AREX 3= Adopted from other local farmers 4= Adopted from farmers outside this ward 5= Other (Specify)	Is this agency still active in promoting your CF practices? 1= Yes 2= No 3= N/A	Type of CF practice 1= Panting basins 2= Ripper Lines 3= Hand/ hoe furrow lines	Crops grown in basins? 1= Maize 2= W. Sorghum 3= R. Sorghum 4= P. Millet 5= Groundnuts 6= Cowpeas 7= Bambaranut 8= Cotton 9= Other (SPECIFY)	Area under basins[1] (State units in acres or hectares)	**If there have been changes in CF area size, please explain why** (this is best asked starting from earlier years, e.g. 2003/04 to 2004/05 – why change in area under CF)
1= 2006/07							
2= 2005/06							
3= 2004/05							
4= 2003/04							

3. If you have applied the CF practice of planting basins for two years or more, have you maintained the same plots each year?___________ 1= Yes, 2= No

3a). If not, why not? ____

3b). If yes, have you maintained the same planting stations (dug basins in exactly the same spot each year)?

Technique	**Location of application** 1= Same field and station each year 2= Same field but different station 3= Other (SPECIFY)	**If station has changed, why?**
Basins		

4. What components of basin-planting techniques that you have applied since you started CF practice. (Let the farmer list the practices – only prompt if some are not mentioned.)					
Technique	**Have you applied this practice since you started practicing CF?** 1= Yes 2= No				**Are any changes from the standard recommendations for CF?** If so, ask the farmer to explain what he/she has done, check for modifications and record them here
	2003/04	**2004/05**	**2005/06**	**2006/07**	
1= Winter weeding *(Between harvest and September)*					
2= Application of crop residues *(All left in field from previous crop)*					
3= Planting basin *(90 cm between rows; 60cm in-row; approx 15×15×15 cm)*					
4= Precision application of manure *(Handful in the basin)*					
5= Precision application of basal fertilizer *(Bottle cap + in the basin)*					
6= Precision application of top dress fertilizer *(Bottle cap + in the basin)*					
7= Timely weeding *(Field kept largely weed free)*					
8= Crop rotation *(Cereal then legume in year 2)*					
9= Other (SPECIFY)					

5. IF you are digging planting basins, but not applying either manure or basal fertilizer or top dress fertilizer, please explain why.	
Basin dug, BUT	Why?
No manure	
No basal fertilizer	
No top dress fertilizer	

6. IF you are digging planting basins, what are the primary factors limiting the area you have allocated to planting basins?
[For example, you are still learning about or experimenting with the technology; labor constraints; crop residue constraints; fertilizer constraints; Agency promoting technique said this area; etc.]

Most important factor	
Second most important factor	

7. Next, we would like to know what you consider to be the advantages and disadvantages of each practice in planting basin. This should include comments about what makes one or another practice difficult to apply.		
CA Practice	Advantages	Disadvantages
1. Winter weeding		
2. Application of crop residues		
3. Digging basins in dry season		
4. Precise application of manure/compost		
5. Precise application of basal fertilizer		
6. Precise application of top dress fertilizer		
7. Timely weeding		
8. Rotation with legumes		

N.B. – Cross-reference this group of questions with Group 4

8. Could you tell us about the different sources of technical advice (IF ANY) you have received on your CF practices?
Which are your <u>three</u> most valuable sources of technical advice;
what sorts of advice have they provided; how often have they provided assistance in the past?

Source of advice 1= Other farmers 2= AREX 3= ICRISAT 4= NGO (name this) 5= Other (SPECIFY)	**Relative importance** 1= Most useful 2= Second most useful 3= Third most useful	**Sorts of advice provided**	**Frequency per season** 1= Once ONLY 2= Two-three times ONLY 3= Once a week 4= Once a month 5= OTHER (Specify)			
			2003/04	2004/05	2005/06	2006/07

9. Do you have any particular questions about CF? If so, what are they?

a) ____

b) ____

c) ____

NB – The responses from this group of questions will be cross-referenced with responses from the focus group discussions – particularly issues such as what will happen to the conservation area if the NGO pulls out.

10. If you could recall, please tell us what inputs you used this season and where you got them from to support your farming? Were these inputs used for CF practices? (Main focus on this last season, but if the farmer can remember other seasons, good)

Cropping season 1= 2006/07 2= 2005/06 3= 2004/05 4= 2003/04	**Inputs used** (list each separately) 1= Seed (identify crop) 2= Basal fertilizer 3= Topdress fertilizer 4= Other (SPECIFY)	**Who provided**	**Quantity received** (state units)	**Were these used on the CA plot?** 1= All used on CA plot 2= Some used on CA plot 3= None used on CA plot	If not, why not?

Household Data

11. We would like to review the size and membership of this household. This will include people who normally reside here for more than two months per year.

Age group (Years)	*Gender*	Household size 12 months ago	Changes in household size				**Household size <u>Current</u>**	How many members have been chronically ill *(sick more than 40 days)* in the past 12 months?	How many members are currently contributing to FULL time on farm labor?	How many members are currently contributing PART-time to farm labor?
			Birth	**Deaths**	**Left household**	**Moved into household**				
0-6	Male									
	Female									
7-17	Male									
	Female									
18-65	Male									
	Female									
Above 65	Male									
	Female									

12. Finally, could you tell us whether you have reliable access to draft power, either through ownership or sharing arrangements with other farmers? Has this changed during the past 5 years?

Access 1= Own draft power and plow 2= Own some draft animals and borrow others but own plow 3= Borrow draft animals and own plow 4= Borrow draft animals and plow 5= Other (SPECIFY)	**Description** (Number and types of animals – cattle and donkeys)	**Comments** (Reliability; accessible when needed?)	**Change during past 5 years?** 1= Access improved 2= Access worsened 3= Little change in access 4=Other (SPECIFY)

Please thank the respondent for his/her assistance. Ask if he/she has any questions for us. Record these questions.

12. Finally, could you tell us whether you have reliable access to draft power, either through ownership or sharing arrangements with other farmers? Has this changed during the past 5 years?			
Access 1= Own draft power and plow 2= Own some draft animals and borrow others but own plow 3= Borrow draft animals and own plow 4= Borrow draft animals and plow 5= Other (SPECIFY)	**Description** (Number and types of animals – cattle and donkeys)	**Comments** (Reliability; accessible when needed?)	**Change during past 5 years?** 1= Azccess improved 2= Access worsened 3= Little change in access 4=Other (SPECIFY)

Please thank the respondent for his/her assistance. Ask if he/she has any questions for us. Record these questions.

Annex 3

Focus Group Discussion – Checklist

Participants at the Focus Group Discussion (FGD)

- Identify with local extension agent/FA, individuals known to be key informants in CF practices
- Select 10-15 farmers known to practice CF, possibly with equal number of men and women
- Where possible, include spontaneous adopters.

Targeting

- How were households selected for participating in CF promotions?
  – What were the selection criteria for the area, and for individual households
- How long have local farmers been practicing CF, e.g. planting basins
- Which agency/NGO has been promoting CF in this area?
- Have there been other households that have taken up CF on their own initiative? If yes/no, why?

Technical issues

- Have farmers maintained the same plot on CF over the years? If yes/no, why?
- What level of technical support do they receive? Who from, i.e., AREX, NGOs, ICRISAT, and other farmers.
- What technical improvements do farmers want implemented on the CF practice?

Institutional issues

- Do CF farmers receive regular visits from AREX/NGOs/ICRISAT?
- Are there any local committees that provide support on CF?
  – What are the functions of these committees?
  – How can their operations be improved
- What level of support do CF farmers get from their neighbors?
- What are the impacts of NGOs pulling out support for CF?

Demand for CF practices

- Has there been an increase in the number of local farmers willing to join CF? If yes/no, why?
- Have farmers expanded/reduced CF plot sizes? If yes/no, why?

Labor for CF operations

Labor availability within a household:

1. How big is a household?
2. Composition – No. of adult males able to work in fields, adult females able to work in fields (assume female equal to a male), adults unable to work in fields, children (0.5 of an adult male in terms of ability to work)?
3. How many hours can they work in a week, in a month, in a year?
4. Number of working days in a week a household can work on the land? (Check number of Chisi days, market days etc. Rarely more than 5 working days in a week.)
5. Assume a household can work 4 labor days per week for crop production (not work on Chisi day or Sunday. At least 0.5 days lost per week due to markets, tending animals, collecting water, firewood, attending meetings).
6. Based on household data collected from various studies, a typical household has 3 adults of working age and 2 children that can work productively in the field. Therefore, a typical household possesses 4 adult labor days per working day.
7. Assume a typical adult labor day is eight hours.
8. Therefore typical household has 32 labor hours per day.
9. 128 labor hours per week.
10. 512 hours per month.
11. 3,074 hours in a six-month cropping season.
12. 6,144 hours per year.

Collecting data through an FGD

a. Begin with current farmer practice:
   - i. Get group to list the various activities – prompt if necessary.
   - ii. Get group to discuss how long each activity takes – see if they have groups under no draft, some draft, full draft.
   - iii. Do all HHs have enough labor for all operations? If not, why not?!

b. CF:
   - i. Get group to list various steps – review reasons for each step. ID which ones are missed – try and find out why they are missed out.
   - ii. Get group to discuss how long each activity takes.
   - iii. Does time decline over years?

Labor requirements for CF hours per 0.25 acres (0.1 ha or 20 × 50 m plot)			
Operation	First Year	Second Year	Third Year
Land preparation[2]			
Digging basins			
Fertilization[3]			
Stover management[4]			
Planting			
First weeding at 5-6 leaf stage			
Topdressing at 5-6 leaf stage			
Second weeding six weeks after emergence			
Third weeding prior to harvest[5]			
Harvesting			
Chopping of crop residue to form new mulch			
Winter weed control[6]			
Total			

3 Marking out the field – planting lines, etc.
4 Fertilization – do we include time spent collecting fertility amendments?
5 Stover management – is stover removed from field or not? Evenly spreading stover, collecting it from woodlands.
6 Third weeding at crop maturity – it is interesting to see who does this.
7 Winter weed control – it is interesting to see what comes up.

About ICRISAT®

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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