

Water for Agriculture in Zimbabwe

Policy and Management Options for the
Smallholder Sector



Edited by
Emmanuel Manzungu, Aidan Senzanje and Pieter van der Zaag

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September 1998

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CHAPTER 5

Options in the furrow

Differential adoption of the tied up furrow technology in Ndowoyo Communal Lands, south-east Zimbabwe

E. P. MAZHANGARA, E. MANZUNGU AND E. KAMBA

The south east lowveld of Zimbabwe falls under Natural Region V. It is characterized by low and erratic rainfall which averages 400–500 mm per annum. Differences in crop production in the region are striking. Individual, parastatal estate and company estate commercial farms achieve medium to good yields of cotton, wheat, sugar cane and horticultural crops. On the other hand, are communal areas where poor yields of maize, cotton and sorghum are common. The differences between the two sectors is due to water availability, which is critical to crop production in this semi-arid part of Zimbabwe. Communal farmers mostly grow their crops rainfed as they did not benefit from the massive (mostly government) investments in irrigation infrastructure as happened in the commercial farming sector (see Mlambo and Pangeti, 1996). Good agricultural seasons occur about twice in every five years. Such is the fate of Ndowoyo Communal lands in the Save Valley where the naturally rich vertisol cannot guarantee good agricultural production.

Communal areas, such as Ndowoyo, have also suffered another setback. Up to independence in 1980, these areas were neglected by government research institutions, which could have provided the much-needed technological solutions to their problems. The research institutions servicing the region, the government-funded Lowveld Research Stations (part of the Department of Research and Specialist Services — DR&SS) comprising Chiredzi, Chisumbanje and Save Valley and the Zimbabwe Sugar Experiment Station funded by Zimbabwe Sugar Association, a private organization, all targeted the commercial farming sector. After independence there was an interest to service the communal areas. Chiredzi and Chisumbanje Experiment Stations (see Figure 4.1, Chapter 4) started research in the once neglected areas in the early 1980s. In this chapter we report attempts by these two stations to improve the situation by tackling the problem of limited moisture available for crop production.

Since irrigation development requires huge capital outlays, it was considered that the better alternative was to conserve water at the field level and concentrate

as much of it within the crop root zone. The tied furrow technology (TFT) which after years of experimentation by the Lowveld Research Station staff had shown potential was chosen for extending to farmers. The technology is based on a simple rationale. Since water available for crop growth is limited, this should be conserved as much as possible in the root zone. This cannot be done, for example by growing plants on the flat, as is the convention, as the water easily flows off as runoff without adequately wetting the soil profile. To concentrate the water within the root zone, ridges and furrows are opened up. Plants are planted on the side of the furrows so that the water that is collected in the furrow is available to the neighbouring plants. To concentrate the water, mounds of earth called cross ties, are placed across the furrows at regular distances, say two to four metres. The cross ties give the technology its description of tied furrow. Apart from the land formation aspects the technology is also complemented by such agronomic aspects as plant population, and fertility (see Nyamudeza in this volume).

Ndwoyo communal area near Chisumbanje Experiment Station, was one of the target communities where farmers were brought face to face with the technology.

This chapter looks at the dynamics of the adoption of the technology by some of the farmers. It shows that agronomic aspects received most attention while other aspects which were just as important (see below) were not that apparent to researchers in the early stages of the technology. As this fact came to be realized this ushered attempts by experts (scientists) and farmers to find the suitable engineering equipment. Failure to find suitable equipment to match the agronomic recommendations meant that the technology had to be revised 'downwards' as conventional farm equipment replaced the expert option that had been promoted. As the practical implications of the technology came under further scrutiny, it was realized that the technology incorporated agronomic, hydrologic, engineering, capital and social aspects. The technology was therefore not as simple as it was originally thought. Thus the success of the technology depended on not only the technical details but also on the organizational skills in terms of mobilising draught power, labour and the necessary finance. Moreover these had to be deployed at the right times. Taking one aspect out of this "mix" was likely to disturb the equilibrium and threaten the advantages of the technology.

The argument in this chapter is that the tied furrow technology, like any technology, does not follow a predetermined path.¹ Rather, technology opens up options which individuals can choose to pursue. This is to say that the tied furrow technology could have benefitted from this 'holistic' view of technology. A holistic view brings to focus that technology has four aspects: (a) the physical artefacts often referred to as the hardware (b) the skills and knowledge that enables artefacts to be used (c) certain forms of social organization needed to

make use of the hardware and (d) the product itself, whether it produces the required service or not (Croxtton and Appleton, 1995, 10). The skills and knowledge and forms of social organization that exist represent the technical capacity of the people to use the technology. It will be shown that this understanding of technology was not applied in the development of the tied furrow. Instead a linear approach was applied where a technology that is developed at a research station is 'extended' to the farmer's field without significant alteration. These issues will be highlighted subsequently by tracing the history of the technology as well as on focusing on some farmers who adopted (a) the whole technology, (b) a part or components of the technology and (c) initially took up the technology and later abandoned it.

It will also be shown in the chapter that the history of the technology produced unintended messages where the technology was assigned meanings by farmers on the basis of how they came into contact with it. That is to say while researchers thought that technology was defined by a set of techniques e.g. planting in the furrow, farmers read much into how the furrows were made. The case shows that developing or helping to develop technologies for communal farmers requires a much wider scope than any one discipline.

THE SEARCH FOR THE APPROPRIATE TECHNOLOGY

Field water conservation research was embarked on by the Agronomy Section of the Lowveld Research Stations at Chiredzi Research Station and Chisumbanje Experiment Station in 1982/83. The research work pursued a number of leads. The first one attempted to find out which landform was more effective in conserving moisture. Basins or furrows (they were constructed as ridge and furrows but the crops were sown in the furrows where water would be concentrated) of different dimensions were tried. Preliminary results indicated the merits of water conservation techniques and proved that basins were not easy to make. They were subsequently dropped. This paved way for the development of the furrow technology where 1m, 1.5 and 2m spacings were tried. Relevant agronomic aspects, plant population and soil fertility were also investigated (for more details see Nyamudeza in this volume).

In 1983/84, on-farm observation trails were set up in a number of communal areas including Ndownoye Communal areas. One metre, 1.5 and 2 metre tied furrows were tested. In 1985/86 some treatments of the on-farm research programme were then included in formal experimental trials (Nyamudeza and Mazhangara, 1993). The 2 metre furrows were discarded in the fifth season because of construction and (structural) maintenance problems. The 1.5 m spaced tied furrow landform was deemed more suitable for Ndownoye based on its ability to survive the beating action of rain than the 1m. The ease with which the subsequent land preparation of ripping or ploughing out the old

crop in the furrow and then rebuilding the ridges was also considered. It was also concluded that 1m furrow would require full ploughing and complete rebuilding of ridges annually (Nyamudeza *et al.*, 1993).

The ridge-and-furrow landform came to be known as the "tied furrow technology (TFT)", and involves making ridges and furrows across the slope and cross tying at 5–10m intervals before the onset of the rainy season. Planting is in the furrow one third up the slope to take advantage of the moisture conserved in the furrow. With this technology crop yields of the magnitude indicated in Table 5.1 can be achieved. Throughout the period indicated in Table 5.1, much effort was put into trying the technology on several sites in Ndowoyo. The aim was to disseminate information about the technology to more farmers. This chapter reports on one such dissemination effort in the vicinity of Chisumbanje Experiment Station. The dissemination efforts were however against a backdrop of emerging problems associated with the technology.

Table 5. 1: Yield (kg/ha) of sorghum and maize on flat vs tied furrows 1983/84–1989/90

	Rainfall (mm)	Sorghum		Maize	
		Flat	Furrow Effect	Flat	Furrow Effect
1983/84	289	353	+136	57	+22
1984/85	669	3 701	+57	2 488	+44
1985/86	384	1 647	+586	1 821	+288
1986/87	271	1 570	+530	515	+112
1987/88	554	3 380	+357	1 590	+2 194
1988/89	279	928	+296	507	+568
1989/90	485	1 510	+518	1 093	+201

Source: Mazhangara (1993)

This was because, during the early development of the technology, agronomists were the main actors. As can be expected, the evaluations made tended to be agronomic and did not cover other relevant aspects. When the technology was put through on-farm testing and farmers began to put in their assessments, their opinions were either explained away or ignored. But one thing that could not be explained away or ignored was the slow adoption of the technology. This prompted the hiring of an economist to do some socio-economic evaluations. His first assignment was to conduct periodic visits into Ndowoyo for eighteen months so as to understand the farming system and to hold informal interviews with farmers on their perceptions of the technology. These visits established the fact that farmers were well aware and convinced about the moisture retention advantage of the technology but had a grave concern over the lack of appropriate implements to make the furrows and tied

ridges. Tractor-drawn implements had been used on trial plots. In response to issues raised by farmers, an engineer from the Institute of Agricultural Engineering of Agritex, who was a collaborator on the project, started working on various designs of ox-drawn implements for making the ridges and furrows. The success was very limited. Later, the Lowveld Research Stations extended the wings of a conventional 1m ridge to make 1.5m ridges which earned it the nickname "Big Bird". This worked well but farmers' impression was that it was very heavy for the weak oxen they had.

In April 1991, a follow-up formal survey was then conducted on early adopters and non-adopters with a view to determining factors affecting the adoption of the technology. Source of traction, implements, labour and technical knowledge were found to be the main constraints (Mazhangara, 1993). Recommendations were made to focus more on appropriate implements and supplementary low-cost livestock feed for the survival of livestock and in particular draught animals.

From 1991 to 1994, economics verification trials were then conducted on farmer-managed plots. Each trial site comprised three plots each of 0.1 ha; flat, 1m furrow and 1.5 m furrow. Ox-drawn ridgers were used on these plots. The plots were large enough to give farmers a first hand experience on working with the TFT. These indicated that farmers were able to construct and rebuild and maintain ridges and cross-ties using their own labour and draught power. The main constraints to adoption were confirmed to be draught animal power and the cost of the ridge. The extra labour for ridging, cross-tying and weeding were also of concern to some farmers. Most farmers, however, believed that the higher crop yields did justify the extra effort (Brown and Kamba, 1994). Six ridgers were sold at a subsidized rate to individual members or farmer groups as part of the verification trials programme. Although the findings of the surveys and trials provided some useful information, there were still some gaps as to the real situation on the ground. These gaps necessitated a revisit on issues pertaining to the uptake of the TFT. The next section looks at the objectives of the study as well as methodological issues.

OBJECTIVES AND METHODOLOGY OF THE STUDY

The broad objective of this research was to conduct an adoption profile study in Ndowoyo so as to find out who did (not) adopt the technology and why. Initially the study was going to be confined to one village near the station. In the end four villages in southern Ndowoyo were chosen so as to cover a broad range of issues.

Four villages; Konjana, Magwegwe, Vheneka and Mtandahwe, were chosen and a total of six farmers were closely interviewed. Konjana was selected mainly because it borders the research station. Most of the villagers in Konjana had a lot of exposure to the technology. The village also housed a number of station

employees and other people employed by other local institutions. Magwegwe is far away from the station. It is a typical rural farming area. Most of the residents are farmers. Being far away from the main road, Magwegwe was strategic to determine the extent of the spread of the technology. Vheneka had a number of on-farm trial sites in the area closer to the main road. Mtandahwe was another area far away from the station.

A total of 12 farmers were interviewed in September 1995 from six groupings of farmers which had exposure to the TFT at some point along its research and development. The groupings were:

- current employees who were part-time farmers;
- relatives of station employees or former station employees;
- a group of 12 farmers who had one acre plot each of 1.5m tied furrows made for free in 1990/91 using a tractor financed using International Board for Soil Research and Management (IBSRAM) funds;
- research station on-farm trial host farmers;
- economics verification trial host farmers;
- one hundred farmers who benefitted from an offer by Triangle Ltd in 1990/91 to ridge 100 ha to be planted cotton for its ginnery at half the commercial ridging rate, an offer which was over-subscribed one month before operation began.

The adoption profile study was done using informal interviewing looking deeper and more critically at issues arising in a discussion. A general checklist to the study had the following points:

- area or village;
- distance to station;
- year when first exposed to the technology;
- circumstance under which the farmer came to know about the technology;
- field day attendance;
- membership of farmer clubs;
- exposure to tractor hiring for ploughing or ridging;
- the strength of extension advice/encouragement to use TFT;
- year when started ridging;
- any modifications on the technology.

This was used to get a basis for broader comparisons. More time was spent on following up issues that emerged from the discussions.

SOME GENERAL OBSERVATIONS

Overall the study revealed that only a few farmers had adopted the technology. Most of the early adopters estimated at 150 by Nyamudeza *et al* (1993) later quitted reducing the proportion of adopters to a quarter of the earlier estimate. About 60 percent of the farmers who adopted the TFT are either former

employees of the station, relatives or spouses of current employees or current station employees who are farmers in their spare time.

All farmers who bought the ridgers under the Economic Verification Trial Programme (EVTP) have adopted the technology. Those who bought in groups are using the ridgers to a limited extent because of sharing problems. In Vheneka, one farmer who borrowed the ridger experienced problems when it broke down and could not have it repaired. The other members did not come together to help fix 'their' ridger; instead, they kept blaming the poor farmer and waited for him to rectify the error. In the end, the other farmers gave up on both the concerned farmer and the ridger.

During the years of development of the technology, most of the ridges were made using tractors. In the researcher's mind, the aim was to construct durable structures which could demonstrate the benefits of conserving soil moisture or field water. Farmers seem to have received this with another unspoken message: ridges made by tractor-drawn implements were the 'real' ridges while those made by ox-drawn ploughs or ridgers were not. Efforts to use ox-drawn implements did not go far and wide. Many farmers who did ridge in the past were business people or monthly income earners who use hired tractors. A number of farmers therefore still thought that the technology was not for them because they could not afford to hire tractors to ridge their fields.

Meanwhile the positive effects of the technology on yield had caused an unforeseen problem, land disputes. Land disputes became common on several fields which had the TFT in place. Two clear examples involved one of the farmers who hosted the IBSRAM trial near the station and another farmer who had one hectare ridged by Triangle Company. After hosting two seasons a dispute arose between the IBSRAM host farmer and one man who claimed that the land belonged to his father who was now late. He was arguing that the IBSRAM farmer was only temporarily given the land by his father and now he wanted it back. Death threats were made. This is still a pending case with the local authorities. A second case involved another farmer who had one hectare ridged by Triangle. Again in this case he had acquired the land through the village head, commonly called kraalhead and used it for several seasons. When he had the technology on the field and crops were looking good, a dispute arose with another villager who claimed the land was his. This farmer pulled out after one season because he did not want any disputes. The farmer who had started the dispute came in the next season but did not understand TFT. He has since not used the field. Nearly 20% of the group of 150 estimated to have started using the technology abandoned it because of land disputes.

In the next section a closer look is taken at differential uptake of the technology. This is done by looking at individuals in three groups of farmers; (a) those who took up the technology as a whole, (b) those who adopted components of the

technology, and (c) those who initially took up the technology and latter abandoned it.

INSIGHTS INTO THE DIFFERENTIAL UPTAKE OF TECHNOLOGY

The insights into the differential uptake needs to be prefaced by a brief description of the three categories.

Adopters of TFT: As noted earlier many of those farmers who adopted the technology had direct links with the research station, were generally wealthy and could afford to hire tractors, grew cotton and or were individuals who had bought ox-drawn ridgers from EVTP and have the draught power.

The modifiers: The main forms of modification of the TFT pertains to not cross tying, not rebuilding the ridges and making cross ties after weeding. The other modification went hand in hand with farmers who used draught animal power together with an ox-drawn plough. The TFT was supposed to be put in place in the dry season to capture much of the early rain to gain from re-wetting of the profile at the time draught animal power animals were weak to pull the ridger. If the storms were heavy, the vertisol became unworkable for sometime and farmers lost part of the season length.

Early adopters who later quitted: The common denominator for this group was lack of resources and appropriate implements. The majority of these people were those that received the technology for free or at subsidized rate, got a feel of its usefulness and then could not get resources to continue. Other cases were those of farmers who got an acre ridged from IBSRAM funding on an experimental basis. Table 5.2 shows the details of the three representative cases presented below.

Table 5.2: Details of the representative cases

Farmer's Name	Mrs Moyo	Mr Mabhunu	Mr Ngwana
Area	Konjana	Vheneka	Vheneka
Distance to station	less than 5 km	12–15 kms	15 kms
Year when first exposed to TFT, year of first ridging	since start of research in 1982/83	1986/87; 1987/88	1988/89; 1990/91
Circumstances of first exposure	spouse is a current station employee	attended a field day on one of the on-farm trial sites in Vheneka	local field day in Vheneka
Field day attendance	most of them since inception of project	attended some at the station after 1986/87	No

Table 5.2 (continued)

Membership of extension T & V group	Yes	Yes	Yes but not regular
Hired tractor before	Yes	No	No but got free DDF tractor-ploughing after drought
Extension encouragement	--	strong	--
Modification	--	opens furrows & plants in the dry season using plough, 1m spacing. Only cross-ties steep areas; destroys cross ties at first weeding	--
Draught power ownership and condition	very few and very poor	2 in a fair condition	--
Crops grown in modified TFT plots	maize and sorghum	cotton	cotton

Mrs Moyo

The husband works at the Experiment Station but lives in the surrounding village of Konjana. Though Mrs Moyo is registered in the extension club, Mr Moyo makes all the decisions about the farm since he commutes from his rural home to work. The couple used to have draught animals before the 1991/92 drought. They have since been able to buy two replacements from the husband's income. The couple started experimenting with the idea of tied ridges alongside the station programmes. However, they were then using a mouldboard plough to make ridges. When the option to buy the ox-ridger came, other members encouraged Mrs Moyo to buy it because they knew she understood the technology more than the rest of the club members. She consulted with her husband and they gladly bought it.

The husband praises the technology a lot and takes pride in having been a part of its development. The greatest advantage this couple has is being able to plant at the same time with the station programme. There are many false season starts in Ndowoyo and many farmers lose money through replanting after poor germination. The station programmes only plant after a cumulative rainfall total of 45 mm the last 20 of which must have fallen in less than two days to

have the correct soil moisture balance. Since the station uses rain gauges, the Moyos time their planting with that of the station.

After using the ridger successfully for two seasons, one of their neighbours asked for the ridger to try it. The Moyos reckoned that if the demand arose they would charge \$8 per furrow regardless of length which is twice what they normally charge for opening planting furrows with a plough. The only problem would be the ridger which was heavy for their animals.

Mr Bhunu

Mr Bhunu was exposed to the TFT through Agritex/DR&SS field days at Vheneka. By that time the ridges were being made by tractor-drawn implements. He made an attempt to make furrows by making two opposite runs in the same furrow and found it time consuming. He then started using a plough making one furrow but then did it across the slope. He then planted in the furrow in such a way as to leave a furrow line for water to collect. The idea of cross tying only appealed to him for very steep spots in his field. The labour required to cross tie is a major constraint, according to his assessment. At first weeding, he used a cultivator and therefore destroys the cross ties. He decided against investing labour to rebuild the cross ties because other crops needed attention.

When his club bought a ridger from the EVTP, he used it annually on the cotton crop until 1992/93 when it broke down in the hands of another farmer. From then on he has reverted to his own way of making the TFT. He intends to build his own ridger from a spare plough he has.

Mr Ngwana

Mr Ngwana is one of the 12 farmers who got an acre of 1.5m tied furrows ploughed for free using IBSRAM funding. He grew cotton in the first season (1990/91) which yielded six bales of cotton. He estimated that there was a threefold increase in yield comparing the acre of TFT and to that on the flat. The following season was the historic drought year. He drove his cattle into Mozambique and camped there feeding them to escape the drought. He came back only after the start of the 1993/94 season. In 1994/95 he planted the area using the conventional means. The reasons he stated for quitting the technology are high labour requirements and lack of cash to purchase an ox-drawn ridger. He pointed out that TFT required more work at cross tying and weeding. Cross tying the ridges with a shovel was very laborious. He also felt that women alone could not do the work. During weeding he found a severe labour bottleneck because he needed to weed manually since a mechanical cultivator would destroy cross ties. At weeding time most children would be in school and he would tend the cattle. Only his two wives would be available to weed manually. He raised his hands in despair when he imagined that.

Mr Ngwana felt that he would not hire tractors to ridge because he does not have the money to do so but felt that ox-drawn ridgers might be an option if they were affordable. When we indicated how much this might cost he raised his hands again and said 'you see what I mean, where do I get such money?' When we mentioned the prospects of using the mouldboard plough he said the labour demands would prevent him from doing so stating that for that to work he would need to winter plough first creating more work for him and his draught animals.

DISCUSSION

The first pertinent comment relates to the nature of the research process that led to the development of the technology. We notice that a linear projection was preferred where agronomists, engineers and economists contributed to technological development in that order. Farmers were then the recipients of the 'proven' technology. This in itself is a paradox given that the acclaimed merits of multidisciplinary team efforts in which farmers' interests are supposedly well catered for was espoused in the research department. Instead the prevailing attitude of saying 'you wait until we come up with something' is still prevalent.

To reiterate the point, farmers were at the end of the development process. When farmer input came at a later stage it was either explained away or not taken very seriously. For example farmers' concern that the 1.5 m furrows wasted space was not taken into account because the researchers were keen to have low plant populations. Besides researchers had "statistics"² to back themselves up. But the issue of 1.5 m versus 1.0 m furrows came back on the agenda from another perspective — the draught power problem. This only became topical after agronomists had tried to enrol engineers to justify the 1.5 m furrows. This was a failure because the engineers failed to come up with the appropriate equipment to make the ridges. Faced with this situation agronomists had to scale down the recommendations and endorse the 1.0 m furrow.³ When the 1 m standard ridgers were sold they were readily accepted by farmers. The only problem was the lack of matching draught power to pull them.

Labour

The high labour requirement of the technology was a point mentioned by many farmers as a deterrent to its adoption. Cross-tying, for example, was an aspect of labour that was peculiar to the technology. Apart from the fact that this was a new labour aspect, the fact that it inhibited mechanical cultivation, a labour saving device, was a disadvantage. For farmers then this constituted a step backwards in that the technology dictated a de-mechanization of their farming operations. Farmers who depended on manual weeding were not better off

either. One farmer in Machona used to hiring casual labour to weed his farm reported problems. When he first put in the technology, the labourers destroyed the ridges and cross ties at weeding. During the second season he taught them to weed in such a way as to spare the ridges and cross ties. The casual labourers complained that it was too involving and time consuming. They started opting to go elsewhere because the opportunity cost of the labour was high.

Implements

A lack of appropriate animal-drawn implements were underscored by numerous farmers. Much has also been said of implements that came to farmers courtesy of researchers be it Triangle or IBSRAM for example. The non-governmental organizations (NGOs) were not left out of the fray. An NGO operating in the area had been ploughing farmers' fields for \$120/ha. On a field day which the NGO organised, the Experiment Station staff advised the NGO to acquire a ridger for farmers who wanted ridging done on their fields and it gladly did. However, the ridger had a planter which planted on the ridge. Because farmers were getting two activities done for the price of one, they were trading off money for the wrong technology until Experiment station staff advised the NGO to remove the ridger-cum-planter.

Of knowledge and status

The fact that the majority of adopters of the technology today were former or current research station employees and their relatives has two implications. The first is simply that there is a certain meaning of prestige this group of farmers attached to utilising this technology. The second is that they definitely had more information about the technology having been at the cutting edge of its development. For example Mrs and Mr Moyo depended on the rain gauge at the research station to time their planting because Mr Moyo worked on the station. This is a very significant point given that the timing of the sowing is critical to the success of the technology. Planting prematurely spells disaster in that the plants might fail to germinate or be scorched off due to insufficient moisture in the furrows. Delaying planting means a loss of some moisture that should have made a difference. While the research staff did have rain gauges to guide them, farmers did not. Furthermore, this particular aspect was not given due consideration during the promotional exercises. The question then remains: how are farmers meant to master this delicate agronomic-hydrologic interface?

One way out of this is to note that the technology was not really complete. That is to say that farmers still needed to find out how the technology suited their particular circumstances through observations and trying it out. This point was realized by a good number of farmers interviewed who modified the technology. These acknowledged that they started improvising ridges around the starting time of the rainfed agronomy research programme.

Extension Involvement

The involvement of extension in the research and development of the TFT has been one of 'soccer linesmanship'. The adoption profile study has shown that most local extension workers have not been disseminating information about the technology with vigour at all, save for those along the main road. In Magwegwe, farmers pointed out that they only see their extension worker when there was a field day. The local club chairman became the extension worker of the area. In Mtandahwe, the extension worker mentioned that while dishing out information on the technology, this was just food for thought because the implements were not available at all. It was clear from this that the blame could not be on extension or research alone but on both.

CONCLUSION

Throughout the chapter it was shown the technology could be described in four related aspects i.e. (a) the physical artefacts often referred to as the hardware (b) the skills and knowledge that enables artefacts to be used (c) certain forms of social organization needed to make use of the hardware and (d) the product itself, whether it produces the required service or not (Croxtton and Appleton, 1994, 10).

The fact that a piece of hardware (equipment) was needed and that a specific configuration of the soil (landform) was necessary to realize the benefits of the technology illustrates the (a) point. But as we saw, these on their own were not enough. This was illustrated by Mr Moyo who timed his planting at the same time as the research station which illustrated the importance of soil moisture management. Even though he might not have mastered all the intricate technical details of residual moisture etc, he knew it was important to tap the knowledge that was available highlighting point (b). It was also necessary to know the 'correct' plant population which of course could really not be determined for certain since no-one can precisely say what the season would turn out to be. This underlined the importance of experience. The requisite skills and knowledge and forms of social organization represent the technical capacity of the people to use the technology. It is also obvious that there was a need for organization to be undertaken at the farm level illustrating the validity of point (c). This organization related to having the cash to purchase the necessary equipment and mobilising labour for example.

On point (d) it was observed that farmers were convinced of the technology. But there were a number of provisos. In short the technology, which at face value looks simple is really not that simple. Many aspects were involved. Recasting the development and the adoption of the technology in this light would have resulted in appreciating the fact that the technology incorporated hydrologic, biological, engineering and financial aspects. The linear approach

that was applied to the technology, which did not recognize this fact, cast a dark shadow on the future of the technology.

On a positive note it can be said that the technology changed perceptions towards land. The technology resulted in the value of land appreciating as shown by the land disputes. Does this imply that the care of land might be through successful technologies which make farmers realize the usefulness of the poor land they possess?

NOTES

1. In simple terms the belief that technology follows a determined path is called technological determinism.
2. In fact this is not strictly true. The 1.5 m furrows were massively encouraged by an expatriate researcher who was instrumental in setting up the project. He had been unwilling to consider the evidence that the 1.0 m furrows were no different from the 1.5 m furrows.
3. It was at this juncture that it was confirmed that the differences in yields between the 1.0 and 1.5 m furrows were not significant.

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