CHAPTER 6

EVALUATION OF BENEFITS OF IMPLEMENT RENOVATION AND EFFECT OF FARMER-TRAINING

6.1 Introduction

Ploughs owned by most smallholder farmers are manufactured locally and have similar technical specifications. The major differences arise from handling and maintenance of implements by the owners. Findings in Chapters 4 and 5 indicate that most ploughs and cultivators were generally poorly maintained and incorrectly used. Farmers continued to use implements with missing and worn out parts. Farmers gained knowledge and skills in implement repair, correct setting and operation during the implement performance trials. The renovation costs were met by the project, and farmers were made to appreciate the cost of repair. They were expected to learn from the trials so that they could correctly carry out their own repair and maintenance in future.

This chapter assesses the cost of renovating implements that were evaluated during the field performance trials. It also presents the views of farmers on renovating implements, their attitudes and opinions towards implement maintenance, lessons learnt and the benefits of the trials.

6.2 Objectives

The main objective was to assess the impact of training farmers by demonstrating implement renovation and evaluate the benefits and knowledge gained by farmers from the trials. Specific objectives were:

a) To determine the costs of repairing ploughs and cultivators owned by trained households.
b) To assess the condition of ploughs and cultivators that had been renovated after two seasons of trials.

c) To quantify repairs done by participating households on their own after the implements were renovated and estimate cost of repairs.

d) To evaluate the benefit of renovating implements in terms of knowledge and skills gained for implement operation, repair and maintenance.

e) To establish if households still had any technical constraints with regard to operation, repair and maintenance of implements following training.

6.3 Materials and methods

Ploughs and cultivators were inspected and their technical specifications were recorded according to the procedure described in Chapter 4. Defects, faults, missing parts, deformations and modifications to implements were noted. Every farmer was made aware of the defects and wear on their respective implements as well as the likely causes of problems. Explanations on remedial action through correct implement repair, setting and operation were provided to respective farmers during the implement performance trials at each test site (Chapter 5.1).

The implements were renovated by replacing worn out parts, repairing deformed parts and replacing missing components. The total cost of new parts fitted on each implement was recorded then compared with the cost of a new implement as well as the Grain Marketing Board producer price for a tonne of maize at the time of renovation. An overall cost of renovating implements during each season was determined. Renovation costs were compared between sex of heads of households, age of implements and farmer resource categories. The benefit of renovating implements was measured in terms of farmers' opinions on quality of tillage, crop performance and knowledge gained for implement operation and repair. The price of a tonne of maize and the cost of a new plough were monitored so as to make a simple comparison between the two variables. This served the purpose to show the value of maize as a staple food as well as a source of income from where farmers got cash

for implements and spares. End of season evaluations were conducted with the respective groups and farmers expressed their opinions on the trials in terms of quality of tillage and crop performance.

The impact of training of farmers through the demonstration of implement renovation and operation was evaluated by conducting a survey of households who had participated in the trials. A questionnaire (Appendix 17), designed in SNAP (Mercator, 1998) was administered to 50 out of the targeted 53 participating households, in the study areas, in August 2002. The evaluation exercise was conducted 14 months after the implement performance tests had been completed. An assessment of the conditions of renovated implements was made as well as assessing the application of knowledge gained by households from the trials on implement use, repair and maintenance. The analysis of survey data was done using SNAP as described in Chapter 4.

6.4 Results

6.4.1 Cost of renovating implements

Tables 6.1 to 6.3 present information on cost of repairing ploughs based on household numbers, resource groups, sex of head of household and age of ploughs, respectively.

Table 6.1: Cost of renovating ploughs during implement performance trials

Season	Sample(N)	Mean age of ploughs	Mean cost of repair		
			Cost of repair (Z$)	Repair cost as % of a new plough	Repair cost as % of a tonne of maize
Spring 1999	16	19	753	30	18
Winter 2000	7	24	1211	45	22
Spring 2000	18	24	1213	40	22
Winter 2001	12	28	2094	52	28
Mean	**13**	**24**	**1318**	**42**	**23**

Table 6.2: Cost of renovating ploughs by farmer resource group

% cost of a new plough		
RG1	**RG2**	**RG3**
32	41	54

Table 6.3: Cost of renovating ploughs by age of ploughs

Repair cost as % of a new plough			
Age of ploughs (years)			
<6	**6-10**	**11-20**	**>20**
31	35	43	45

Table 6.4 shows plough repair costs for the 1999-2000 and 2000-2001 spring season trials by site and resource group and Figures 6.1 and 6.2 illustrate the cost of repair based on age of ploughs for the two seasons.

The mean cost of renovating cultivators was Z$531. A new cultivator cost about Z$5000 at the start of the 2000-2001 season. The BS221 cultivator cost slightly more than the BS41 by about Z$300 to Z$500.

Table 6.4: Cost of renovating ploughs by site and farmer resource group

		Cost in Z$			
Season	**Site**	**RG1**	**RG2**	**RG3**	**Site average**
1999-2000	Chedenje	422	94	1378	**631**
	Gari	819	430	249	**499**
	Mushagashe	1412	-	1220	**1316**
	Mushandike	771	407	-	**589**
	Mutangi	794	782	1051	**876**
	Nyimai	344	627	841	**604**
	Mean/RG	**760**	**468**	**948**	**753**
2000-2001	Chedenje	694	839	1281	**938**
	Gari CA	2045	1218	1795	**1686**
	Mushagashe	238	380	503	**374**
	Mushandike	886	734	918	**846**
	Mutangi	1286	734	2043	**1354**
	Nyimai CA	1543	2045	2032	**1873**
	Mean/RG	**1115**	**992**	**1429**	**1179**

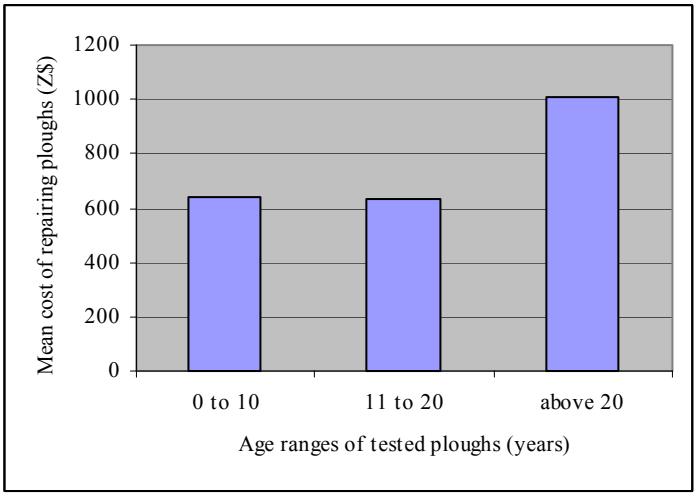

Figure 6.1: Mean cost of repairing ploughs at the start of the 1999-2000 season

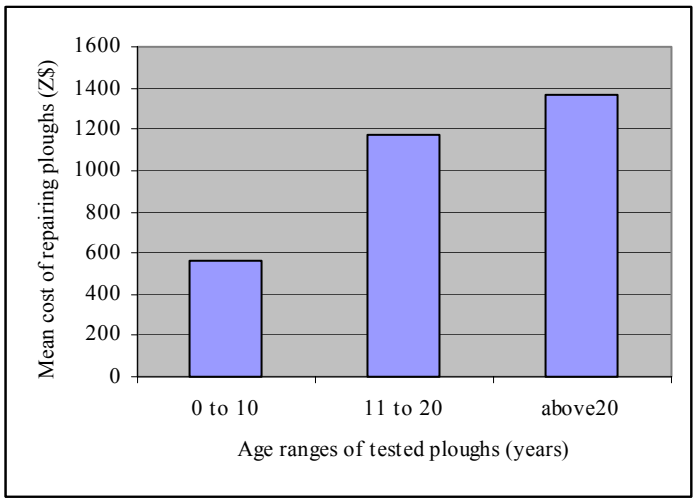

Figure 6.2: Mean cost of repairing ploughs at the start of the 2000-2001 season

6.4.2 Cost of implement spares and their supply system

Table 6.5 shows the cost of ploughs, cultivators and plough spare parts over the two seasons of trials.

Table 6.5: Cost of implements and spares between November 1999 and November 2001

Implement/part	Retail cost in Z$				
	Nov 1999	May 2000	Nov 2000	May 2001	Nov 2001
Share	94	147	153	229	422
Landside	110	160	155	268	562
Mouldboard	410	510	598	842	1830
Frog	288	329	418	554	1250
Drawbar	295	305	409	505	1100
Regulator (hake)	167	206	205	255	550
Adjustable bar holder	95	95	115	150	320
U-clamp assembly	75	75.	105	105	225
Wheel axle	17	30	48	50	116
Wheel	95	106	160	183	240
Wheel arms	103	131	166	220	514
King bolt	12	21	23	26	40
Complete plough	2500	2700	3000	4000	9000
Complete cultivator (BS 41)	3000	4000	5000	6000	13000

Implement spares were sourced from local general dealers/shops, large hardware shops and wholesalers in Masvingo and at Chivi and Ngundu rural business centers. The cost of a new plough and the price of a tonne of maize were compared over the study period. There was a very high correlation (r = 0.99) between the two variables as shown in Figure 6.3.

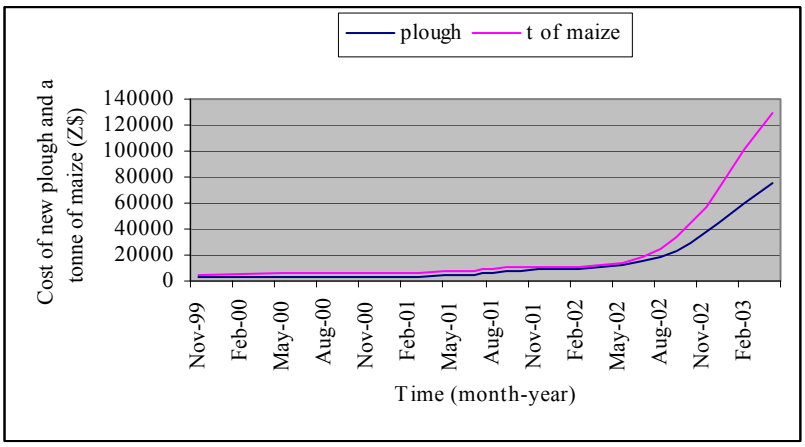

Figure 6.3: Relationship between cost of a new plough and a tonne of maize

Households gained knowledge in correct implement setting, adjustments, and functions of the different assemblies of the plough and cultivator. The opinions of farmers during end of season evaluations on the effect of implement renovation are summarised in Table 6.6.

Table 6.6: Farmers' opinions on plough renovation

Advantages		Disadvantages	
Tillage	**Crop**	**Tillage**	**Crop**
Better and more uniform soil inversion/weed burial	Better establishment and stand	Less amenable to TFP	Poorer emergence/germination
Deeper and wider furrows	Less wilting during the drought spells	Higher draught forces	More gap filling
Increased moisture retention	Stronger and healthier plants		
Less weed growth	Faster growth		
Easier plough handling and control	Bigger cobs and better yield		

6.4.3 Repairs carried out by farmers

A survey was carried out to assess the conditions of implements that had been renovated during tests conducted between November 1999 and July 2001. The survey revealed that the majority of households had carried out various repairs on implements. Five out of the fifty households had not made any replacements on their ploughs. No replacements were made on cultivators. Table 6.7 shows the maximum and average number of times each plough part had been replaced by farmers on their own after the project had terminated.

Table 6.7: The maximum and average number of times plough parts were replaced by farmers

Parts replaced per season (maximum/average number of replacements)				
Summer year 1	**Winter year 1**	**Summer year 2**	**Winter year 2**	**Overall**
Share (6/3)	Share (4/2)	Share (5/2)	Share (4/2)	**Share (6/2)**
Wheel (3/2)	Landside (2/1)	Wheel (3/1)	Wheel arms (2/2)	**Wheel (3/1)**
Landside (3/1)	Wheel (1/1)	Landside (2/1)	Wheel (1/1)	**Landside (3/1)**
Axle (2/1)	Axle (1/1)	Axle (1/1)	Axle (1/1)	**Axle (2/1)**
Wheel arms (2/1)	Wheel arms (1/1)	Mouldboard (1/1)	Landside (1/1)	**Wheel arms (2/1)**
U-clamp (1/1)		U-clamp (1/1)		**Mouldboard (1/1)**
		Left handle (1/1)		**U-clamp (1/1)**
		Frog (1/1)		**Left handle (1/1)**
				King bolt (1/1)
				Frog (1/1)

Shares, landsides, wheels, axles and wheel arms were frequently replaced and no repairs or replacements had been made to drawbar hitch assemblies, beams and handles. Parts that households rarely replaced included mouldboards, frogs, u-clamps, handles and king bolts. The cost of repairing ploughs ranged from Z$250 to Z$5760 with a mean repair cost of Z$1822.

6.4.4 Implement parts missing from ploughs since initial repairs

Implement inspections conducted revealed that some ploughs already had parts removed or missing since initial renovation. During the survey, 51% of the households had ploughs with at least one component removed/missing. Plough body, hitch and wheel assembly parts were found missing or removed on several ploughs. No parts were found missing on cultivators. Table 6.8 shows the number of missing plough parts.

Table 6.8: Number of missing plough parts

Missing part	Number of ploughs (%)
Stay beams	29
Set screw	20
Handle grips	12
Share	10
Wheel	10
Drawbar	10
Hake (regulator)	10
Axle	10
Wheel arms	8
Loose king bolt/other bolts	6
Mouldboard	2
Regulator bar holder	2
Brace	2
Right handle	2

6.4.5 Condition of implements

In general, the condition of ploughs had deteriorated compared to their condition after being renovated. Although the condition had deteriorated, they were at least better than before the initial repairs.

Before initial implement renovations, most ploughs were in poor condition. After almost two seasons of use since trials began, farmers had at least carried out their own repairs and maintenance on implements. Ploughs were in different conditions with the majority being average. This is illustrated in Figure 6.4. The condition of some of the ploughs that were inspected during the assessment survey is shown in Appendix 16.

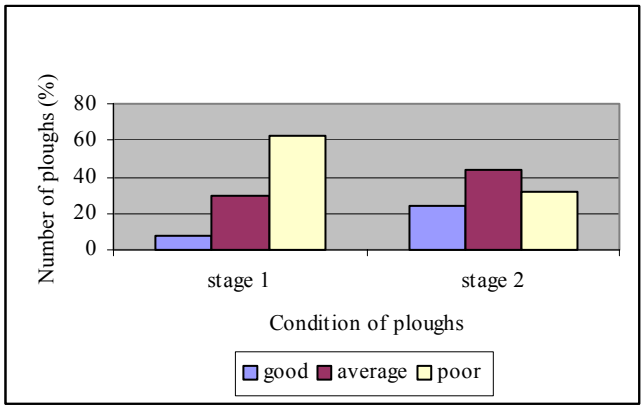

Figure 6.4: Condition of ploughs at two different stages
Stage 1 = before initial renovation; stage 2 = 1 to 2 seasons after renovation

6.4.6 Parts needed by households to repair ploughs

Households inspected their implements to identify missing and worn parts that needed replacement or defects that needed repair. Spare parts that were mostly required to repair ploughs were confined to plough body and wheel/arms assemblies. Parts that were needed most by households included soil-engaging parts that usually wore out quicker as observed during implement tests. Households that needed to replace drawbar assemblies were 10% as compared to 70% before initial renovations. Farmers still continued to use ploughs with seriously worn out parts. Figure 6.5 below shows the number of households requiring respective spares for their ploughs.

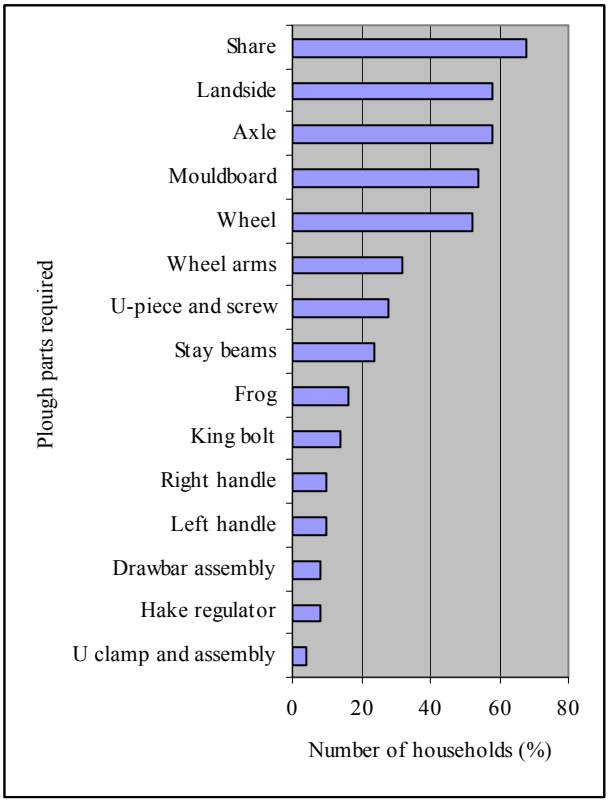

Figure 6.5: Number of households and respective plough spares required

6.4.7 Problems encountered by households while using implements

Households indicated problems they were experiencing with implements and their responses are summarised in Table 6.9.

Table 6.9: Problems experienced by households in using the plough

Types of problems	Number of households (%)	Remarks on problems
No problems	34	Farmers had gained skills
Expensive spares	20	Escalating costs
No reply	16	
Broken set screw	16	Poor quality of manufacture
Broken handle bar or brace	8	Farmers mishandling ploughs
Weak shares and wheels	6	Poor quality of shares. Wheel was being used for setting ploughing depth. More training needed.
Plough adjustment	4	Need for training
Difficult to control	4	Need for training, worn/missing parts
Shortage of DAP	4	Lack of access to resources, e.g. finance
Deformed frog	2	Stoney/stumpy field/sub-standard repairs
Plough not penetrating	2	No pitch and land suction or plough not properly set/factory defect
Broken stay	2	Mishandling of ploughs
Landside not compatible	2	Farmers own old plough/manufacturers need to be aware
Lack of spanners	2	Farmers need a set of good tools

6.4.8 Knowledge of households on implement setting and operation

Sixty-two percent of households sample now knew how to control the depth of ploughing using the adjusting bar on the regulator but the rest still used the wheel for depth control. About 87% of households correctly used the hake regulator to control width of ploughing and the remainder did not know how to regulate ploughing width correctly. One of the farmers used the wheel to control weeding depth on the cultivator and the other farmer was unsure. The adjusting lever was used for regulating width of work on the cultivator.

The knowledge of households on the function of the plough wheel was tested and different responses were given. Table 6.10 summarises what households thought was the main purpose of the wheel.

Table 6.10: Knowledge of households on the purpose of the wheel on the plough

Households' knowledge on the purpose of the plough wheel	Number of households (%)	Remarks
Stabilising the plough	36	Farmers gained knowledge
Depth control	36	Farmers did not gain knowledge
Other (reduce load-10, guide plough-2, better control-2)	24	Very little knowledge gained
Do not know	2	Need for training
No answer	2	Need for training

6.4.9 Lessons learnt by households on implement operation

Implement testing procedures used during the trials was one way of demonstrating how to repair, correctly set and use ploughs and cultivators. In order to have some idea of knowledge and skills gained in implement operation, households were asked to indicate what they had learnt from the trials. Responses from the different households on lessons learnt on plough operation are given in Table 6.11. Households that had conducted mechanical weeding tests indicated that they had learnt how to adjust and set tynes as well as repair and maintenance of cultivators.

Table 6.11: Lessons learnt on plough operation

Lessons learnt by households	Number of households (%)
Correct plough setting and use	42
Moisture conservation	32
Deep ploughing	24
Function of hitch assembly	20
No reply	20
Timely repair and maintenance	18
Easiness of implement control and handling	18
Improved yield	6
Uniform and good ploughing	6
Correct chain length	4
Winter ploughing	2
Less implement breakages	2
Less weeding	2
Estimating animal live weights	2
Use of correct tools	2

6.4.10 Topics on implements for which farmer-training was needed

Responses from households showed that very few of them (8%) were still in need of training related to plough and cultivator operation. The majority of them indicated that they had been adequately trained and did not need further training on implement use. Table 6.12 shows the topics on which households needed training.

Table 6.12: Topics on which households needed training

Topic	Number of households (%)
No training required	42
No reply	22
Plough setting and adjusting	8
Proper use of cultivator	8
Plough parts and their functions	6
Operation of ox-drawn planter	4
Wear limits of parts	2
Depth of planting for different crops	2
Constructing ridges	2
Time of planting	2

6.4.11 Member of the household responsible for repairing implements

In response to the question, “Which member of your household is responsible for repairing implements?”, it was found that the father, usually the head of household, was responsible for

repairing implements. Other members responsible for implement repair were sons, mother, uncles and male worker in that order. Figure 6.6 shows household members responsible for maintaining implements according to the responses of different households.

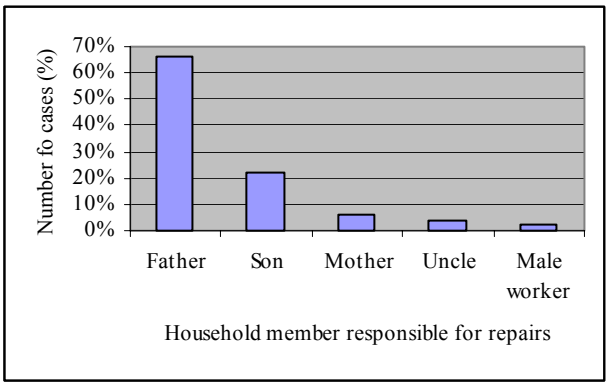

Figure 6.6: Member of household responsible for repairing implements

6.5 Discussion

The trials were used as a tool for training farmers by demonstrating the following:

How to inspect implements for worn out parts; how to carry out implement repairs; how to maintain implements properly; how to set and use the implements correctly; the functions and importance of plough parts especially drawbar hitch assemblies and stays that were usually removed.

Although most farmers gained knowledge in correct implement setting and use, a considerable number of farmers were still adjusting depth of ploughing using the wheel and would incur cost of frequent wheel replacement as a result of improper use. There still remained a training need for some farmers to grasp knowledge on the correct function of the wheel and basic plough setting principles. Correct use of the plough would reduce the frequency and cost of replacing parts. For example, under normal working conditions in sandy soils, a wheel is expected to be replaced after

ploughing about 10 ha (IAE, 1986b). This translates to about 3 years of use since smallholder farmers crop an average of about 3 ha. Thus, instead of replacing the wheel and axle once or twice every ploughing season, replacement can be done once in three years if the plough was used correctly. This can be a big saving for poorer farmers considering the escalating cost of spares.

From the trials, the mean cost of repairing ploughs and cultivators compared to the cost of a new plough and cultivator was 42% and 10%, respectively. It is expected that the repair cost can be reduced with regular maintenance and proper use and handling as not all assemblies will require replacing every season.

The average cost of repairing a plough at the start of the 2000-2001 season was Z$1179. A maize yield increase of 0.44 t/ha (24%) was equivalent to Z$2420/ha, since a tonne of maize cost Z$5500 at the start of the second season. To break even, one had to plant only 0.5 ha i.e. (Z$1179/Z$2420/ha) in order to produce a crop with a value to meet the cost of repairing a plough. The benefit of repairing a plough in terms of yield/ha was double the cost of repairing it at the beginning of the second season. Therefore the basic economics provides a convincing case that justifies implement repair. Since the cost of a plough was highly correlated to the price of a tonne of maize, any increase in the producer price of maize by the GMB would push up prices of implements and spares and vice versa.

Households indicated that renovated ploughs improved the quality of work, weed burial and reduced weeding burden through deeper ploughing. Knowledge and skills on implement repair and maintenance gained from the trials helped to reduce breakages, resulting in reduced repair costs.

Although farmers had gained knowledge in correct implement use and maintenance, affordability of spares and poor access to spares were some of the constraints that farmers were facing. Local shops stocked limited quantities of implement spares that were often more expensive than those from more reliable hardware shops at Ngundu, Chivi and Masvingo City. The increasing cost of spares inhibited proper maintenance of ploughs as expressed by 20% of farmers. Alternative sources of spares can be created by empowering rural blacksmiths who can provide easily accessible and affordable repair and manufacturing services to farmers.

Up to an average of 60% of farmers had not replaced worn out parts such as shares, landsides and wheels mainly due high cost of spares and other constraints mentioned above. When this evaluation was conducted, a year after the last set of renovations were done in June 2001, the cost of spares had more than trebled. Poorer farmers with low income were worst affected and could not adequately maintain their ploughs.

The frequency of replacing soil-engaging parts was consistent with observations made during implement performance tests. Shares and landsides required frequent replacement especially while working in abrasive soils with high percent sand as in the case with the majority of soils found in the study areas. Removal of parts on about half of the sampled ploughs indicated that some households still lacked repair and maintenance skills or the means to repair implements. The survey revealed that the condition of implements had deteriorated after renovations had been done during implement performance trials.

The problem with the hitch assembly was persistent due to the poor quality in the manufacture of the set-screw on the adjusting bar holder. Few farmers had removed drawbars after experiencing problems with the set-screw on the adjustable bar holder or were using wires to keep the drawbar in

place. The set-screw presented problems such as breaking while being tightened and wearing out of the screw thread. When a problem occurs, the whole unit, comprising the adjusting bar holder with set-screw, has to be bought as the set-screw cannot be bought as a separate spare part. It is recommended that the set-screw be available as a spare part from the manufacturer. Alternatively, the manufacturers need to produce a better quality adjusting bar holder and set-screw with an improved thread and strength.

The problem with the set-screw is found on the Zimplow Mealie Brand standard plough but not on the Silver Medal plough or the Haka plough made by Hästt Zimbabwe. The problems with the Mealie Brand plough hitch assembly could be overcome by modifying it to avoid the use of spanners. A simple and firm set of width and depth clevice attachments fitted on a modified hitching system at the front tip of the plough beam would suffice. The Silver Medal and Haka ploughs have modified but different hitch assemblies which eliminate the problem found on the standard Mealie Brand plough.

Other problems cited by farmers were poor quality of spares on the market, escalating cost of spares, lack of spanners and shortage of DAP. There was a problem with landsides whose length was not compatible with the frog design on older ploughs. Households had to cut off front tips of landsides for them to fit properly. It is recommended that manufactures reconsider the design of landsides and if possible, they could make landsides that are compatible with the old frog design. It is highly unlikely that farmers who own old ploughs would invest in a new plough or frog considering the current prohibitive costs of equipment and spares.

Implement repair was predominantly regarded a men's task. There were very few cases where women were responsible for carrying out repair works. Results showed that very few women had the capacity to repair implements even though they were involved in most farm activities. Women

need to acquire skills for basic repair and maintenance so that they can trouble-shoot and rectify some problems to prevent serious ones from occurring.

There was need for more practical training through demonstrations in implement operation, repair and maintenance for some households. A reliable and affordable implement and spares supply system was required for households to benefit from the acquired knowledge and skills.

Although farmers had acquired some knowledge and skills in setting, operating and repair of implements, more than a third of the implements were in poor condition with some in worse condition than before the trials. One major constraint was the high cost of spares which affected the resource-poor farmers most. Some of the benefits of the trials from the farmers' view point included improved tillage, better moisture retention, improved yield, better implement control and handling.

6.6 Conclusion

The trials demonstrated that farmers could realise benefits from implement renovation in terms of improved quality of tillage, reduced weeding burden, and improved crop yield despite the high cost of renovation.

Although most farmers had acquired knowledge and skills from the trials, some still lacked adequate skills in correct implement setting and operation. Resource-poor farmers could not adequately maintain implements due to poor access to spares and the high cost of spares. Results seem to suggest that farmers valued the practical training received through the trials as indicated by the positive comments on lessons learnt as well as the number of farmers who had been adequately trained and were not having problems with using implements.

From a training point of view, farmers were equipped with some practical knowledge in implement setting, operation and maintenance which they can use in their farming activities. However, the cost and availability of parts is likely to remain a major constraint especially for poorer households. Escalating cost of spares is likely to impact negatively on efforts made in this study to demonstrate implement renovation. A reliable and affordable implement and spares supply system is necessary for smallholder farmers to benefit from the acquired knowledge and skills in implement operation, repair and maintenance.

There is need for practical training that incorporates field demonstrations in implement operation, repair and maintenance. Emphasis should be placed on correct implement setting for farmers to fully appreciate how implements function. Effective farmer training on the use of DAP technology requires adequately trained and competent extension staff with the ability to practically demonstrate techniques.

The poor quality of manufacture and weak materials used in the manufacture of ploughshares, and hitch assembly components posed problems for which solutions need to be developed by manufacturers and researchers.