CHAPTER 7

GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

7.1 General discussion

This study was undertaken as part of a broader project framework with a goal to improve the performance of livestock (including draught animals) in crop-livestock production systems. The focus was on evaluating the utilisation of DAP at smallholder level in crop production systems in semi-arid areas so as to identify options in management and utilisation of available resources.

Results from this study provided information on capital resource base of smallholder farmers, attitudes and problems in using DAP and animal-drawn implements, constraints in use and maintenance of implements, typical condition of farmers' ploughs and cultivators, typical costs of renovating ploughs and cultivators, effect of plough condition on field performance and soil physical characteristics, operator comfort, benefits of implement renovation, problems due to manufacture of implements and spares, limitations in training and extension on DAP technology utilisation and differences between resource groups with respect to the preceding characteristics.

Household capital was related to physical assets to which the different resource category of farmers had access. Poorer households were more constrained as they were most seriously affected by lack of finance, shortage of DAP, poor access to implements and labour.

The plough was the most important implement owned by almost all smallholder farmers and cultivators were owned by well-resourced households only. However, up to 60% of implements were poorly maintained with poorer households owning older and in worse condition than better-resourced farmers. Due to lack of knowledge and financial resources, farmers continued to use

implements with seriously worn out parts. The poor condition of implements was attributable to old age of implements, high cost of spares, lack of technical training in implement use and poor access to spares.

The trials provided an estimate of the cost of keeping ploughs and cultivators in reasonable condition and demonstrated that the outlay would be recovered through improved yield. The advantages of plough renovation were reported by farmers to clearly outweigh the disadvantages. The improved yield was the outcome of correct implement setting and deeper ploughing which resulted in improved quality of tillage.

The implement performance tests demonstrated how available draught energy could be best used to improve crop productivity. Correct setting and use of implements reduces unnecessary wear on parts such as the wheel and arms assembly. Wearing parts can last longer and fewer breakages are likely to occur, thus reducing replacement costs. Other advantages, not easily expressed in economic terms, were less stressful, longer working hours and physically demanding working condition and better control of draught animals and implements. Although subjective information indicated that operators were less stressed, as ploughs became easier to handle and control while quality of ploughing improved, this needed to be substantiated with objective data using a larger sample.

The value of proper implement maintenance and setting in achieving improved returns from the use of DAP for land preparation were demonstrated. It therefore meant that if the limited available DAP was correctly used, the performance of the crop/livestock systems would improve.

Farmers expressed concern on the quality of manufacture and strength of implement and spares parts such as drawbars, set screws on the adjustable bar holders, shares, landsides and u-clamp assemblies. If the quality and durability of implements and spares were improved, then smallholder farmers would reduce expenditure on repair and maintenance. Downtime can also be reduced.

Although the different study sites provided a broad range of socio-economic and biophysical conditions, timing of some field operations needed to fit in a small space of time that was available under varying weather and field conditions. This was not always possible as some sites were inaccessible especially during the wet season hindering constant monitoring of trials. Trials were conducted in two consecutive seasons that were not normal in terms of rainfall distribution due to meteorological events. The first season was very wet due to Cyclone Eline, resulting in water-logging of some plots. The second season had a long midseason dry spell that affected crop growth.

Owing to the scope of the study, it was not possible to establish whether draught teams could sustain the increase in load during ploughing in a typical 6-hour day. A fatigue scoring system could have been used to determine the work load on draught animals by measuring respiration, heart rate and rectal temperatures. It would have been ideal to use recommended harnessing systems with draught teams that had donkeys but animals and operators would require to be trained first for them to get acquainted to a new harnessing system.

The study however managed to investigate various factors associated with the operation, repair and maintenance of animal-drawn ploughs and cultivators and it quantified the potential benefits of effective utilisation of DAP for improved crop productivity.

Depending on how farmers access resources, DAP utilisation can be enhanced by improving implement condition and harnessing systems as starting points. Despite limitations in funding, project duration, difficulties caused by meteorological events and logistical constraints, the study demonstrated the value of implement renovation, correct implement setting, operation, repair and maintenance in achieving better return from the use of DAP in crop production systems at smallholder level. Options on improving the other components of the DAP tillage system need to be developed and integrated in order to ensure that gaps that were identified during the study are reduced so as to alleviate poverty and ensure food security.

7.2 Conclusions

Some of the major constraints to effectively utilise DAP at smallholder farmers include use of old and poorly maintained implements, increasing cost of implements and spares, poor access to implements and spares, poor harnessing systems (particularly where draught teams include donkeys), shortage of DAP and lack of knowledge and skills in correct operation, repair and maintenance of implements.

The study demonstrated the value of implement renovation, correct implement setting, operation, repair and maintenance in achieving better return from the use of DAP in crop production systems at smallholder level. Although implement renovation is costly, the expenditure can be recovered from yield gains. The advantages of implement renovation clearly out-weighed the disadvantages. Quality of tillage, moisture retention, weeding efficiency, specific draught, crop stand and yields improved with implement renovation. Though subjective, farmers' opinions indicated that implements were easier to control and handle after renovation and correct setting.

Training in the correct use, repair and maintenance of implements improved the farmers' knowledge and skills, thereby enhancing the use of DAP by smallholder farmers. Resource-poor farmers, however, were financially constrained to adequately maintain implements in good condition. Therefore training needs to be complemented with appropriate, reliable and affordable implement and spares supply systems to improve access to equipment. Rural blacksmiths can be trained to empower them to provide alternative and affordable repair services to farmers.

Results from the trials showed that it was correctly hypothesised that renovated ploughs and cultivators produce better field efficiency, better field capacity, improve weeding efficiency, improve both tillage and crop yields than implements that are not renovated. The hypothesis that training improves farmers' attitudes and skills in correct implement setting, use, repair and maintenance can also be accepted.

7.3 Recommendations

A number of gaps in the utilisation of DAP technology in cropping systems at smallholder level were identified during the study. The following recommendations are being made for improving DAP tillage systems:

1. Suggested improvements to draught animal systems are:

- **Implement operators**

Training of farmers in DAP technology utilisation remains a high priority to increasing both livestock and crop productivity. Training is required in the following areas:

a) Selection, training and management of draught animals

b) Basic principles and techniques for ploughing and weeding with draught animals. The use of the plough as a weeding implement needs to be encouraged to save labour for farmers without cultivators. It can be an appropriate method since most farmers have access to a plough.

c) Manufacture and use of correct and appropriate harnessing systems for donkeys

d) Making of neck yokes that conform to recommended specifications for ploughing, cultivating and carting operations. Multi-purpose yokes, i.e. with skeis centres for both ploughing and carting specification can be used

e) Correct setting, operation, repair and maintenance of implements. Training should emphasise on the correct functions of implement assemblies and parts.

Better knowledge on the correct functions of implement parts may lead to an awareness of the importance of parts that are usually removed by farmers. Operation of implements must be regarded as a technical skill that has to be acquired and applied systematically, rather than being viewed as just another household task.

- **Implements**

Implements should be kept in good condition and for them to function properly, they require regular and seasonal maintenance. Operators need to inspect implements, replace worn parts and repair faults timely. It is recommended to clean and store implements under a shed after use. Farmers can avoid delays if repairs have to be done in the field by keeping essential spares. Smallholder farmers require appropriate, reliable and affordable implement and spares supply mechanisms at rural service centers nearer to them. Options for crop establishment such as the use of conservation tillage techniques that reduce draught demand and labour, increase soil and moisture conservation, improve yields should be disseminated to smallholder farmers.

- **Harnessing and traction systems**

Double neck yokes are inappropriate for donkeys, but suitable for cattle. Therefore they should not be used to harness donkeys. There is need to enforce laws that prohibit the yoking of donkeys through public awareness by law enforcement and agricultural extension agencies. Breast band and collar harnesses are types of donkey harnesses that can be promoted for use by farmers who own donkeys. Spanning a donkey and a cow/ox should be avoided and if farmers have to use cattle and donkeys in a draught team, spans must be either cattle or donkeys only and it is recommended to appropriately harness donkeys and put them in front of cattle.

The centre distance of skeis for the yoke nearest to the implement (i.e. the rear yoke if two or more spans are used) must be short as possible allowing animals to be close to each other depending on how fat the animals are and how long their horns are. This ensures that the plough is close to the last furrow and does not leave "banks" during ploughing. However, animals must be comfortable and must not rub against each other. The length of trek chain should be adjustable to suit size of animals and soil conditions. Depending on how the plough should work, the adjustable hitch allows the position of the trek chain to be changed but maintaining the line of pull to point to the centre of resistance of the plough.

- **Draught animals**

Draught animals should be carefully selected, trained and kept healthy and fit for draught work. Depending on availability of resources, animal nutrition may be improved through adequate and strategic supplementary feeding to improve and maintain body condition. Carbohydrates (cereals), fats (oilseeds), proteins (legumes), minerals and vitamins are some of the nutritive requirements for draught animals (IAE, 1986a). Recommended vaccinations, dosing and dipping schedules should be maintained to keep animals in good health. Animals that are regularly subjected to draught work

after being trained become used to work. Draught animals can be kept fit by giving them other tasks such as threshing, water-lifting as a way of reducing idle days in the year. Trained draught animals can respond to commands and are easy to control. It is then possible to reduce the number of people working with draught animals in order to use limited labour more efficiently. Efforts to alleviate the DAP shortage problem may focus on restocking to re-build the national herd. Programmes that facilitate farmers to access heifers need to be supported and expanded to reach as many needy households as possible.

- **Soil condition**

Ploughing and weeding operations are best carried out when soil conditions are moist, soft and friable for better penetration and reduced draught. Farmers with access to DAP need to utilise animals properly by correctly timing tillage operations when conditions permit. Winter/autumn ploughing, at harvest, has a number of advantages for soil, water, weed and nutrient management as well as utilising draught energy when animals are in good condition. Deep ploughing reduces runoff, controls weeds, improves moisture retention and increases crop yields.

2. Training of agricultural extension staff in the use of DAP and animal-drawn implements is necessary so that the farm machinery component in the Master Framer Training programme is given priority as farm machinery use is a major component of cropping systems.

3. Rural blacksmiths require a practical oriented training programme that would assist in upgrading their technical skills to improve their service, workmanship and quality of repairs as well as the manufacture of spares that conform to standard specifications. They also need access to finance so that they can procure the correct materials and be able to upgrade workshop equipment

and tools. Blacksmiths can be empowered if their access to or ownership of workshop tools and raw materials is improved.

4. Local manufacturers of animal-drawn implements need to respond to the needs and suggestions from farmers in order to improve the quality, strength and durability of implements and spares. During the course of this study, farmers raised concerns on the poor strength of materials used in the manufacture of shares, mouldboards, u-clamps and adjusting bar holders with set screws on hitch assemblies for the Mealie Brand VS standard single-furrow ploughs. The current design and quality of the hitch assembly requires to be improved by the manufacturer as this is one of the sources of problems associated with the removal of drawbars from ploughs. There is need to improve linkages between researchers, farmers, extension staff, manufacturers and retailers so that important aspects in the use of DAP technology are shared between these stakeholders.

5. National rural and agricultural development policies and programmes need to address the problem of DAP shortage. Households in the poor and very poor resource categories, who constituted about 30% of households in this study require more attention and support as they are most affected by lack of access to DAP, implements and spares.

6. National mechanisation policy and strategy are needed to address the problems surrounding the access to and use of DAP technology as the majority of smallholder farmers rely on animal draught for farm operations. With the current economic hardships prevailing, the use of DAP will remain the main and most reliable option for mechanising smallholder farming activities. There is therefore need to prioritise DAP technology utilisation at policy level so as to improve agricultural productivity and reduce poverty.

- **Suggested future work on DAP technology**

Further work on DAP technology is suggested in the following areas:

a) There is need to ascertain if the size of draught animals owned by smallholders can sustain a typical working day pulling a renovated plough.

b) A collaborative research approach in solving some of the technical problems associated with the design and manufacture of plough parts such as the hitch assembly on the Mealie Brand plough.

c) Dissemination of improved draught animal harnessing systems to smallholder farmers.

d) Implement operator heart rate measurements may need to be done using a larger sample and working at different depths to obtain more information. A full ergonomic study is necessary to obtain a good picture of the interaction of the components of a draught animal tillage system.

e) Tests on implements working at different depths, different speeds in different soil types can be conducted to obtain information on the relationships between depth of cut, speed of operation and soil types in order to formulate training guidelines for extension staff and farmers.

f) The production of implement operating and maintenance instructions for both extension staff and farmers to cover the common implements owned by farmers may be necessary. Information can be presented in the form of fact sheets for extension staff, while guidelines or manuals in vernacular, with more illustrations than for extension staff could be developed for farmers.

g) Manufacturers need to be made aware of the need for them to provide operators manuals for all implements that are on the market.