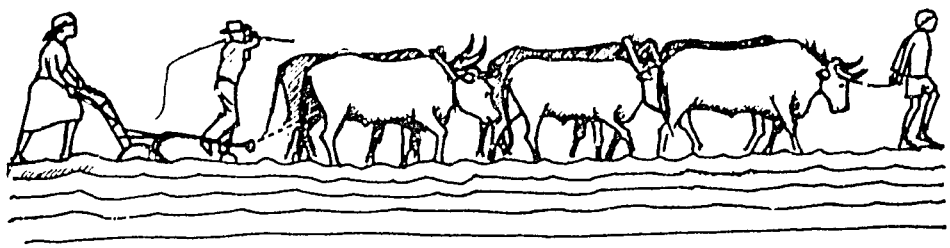
AGRICULTURAL TECHNOLOGY IMPROVEMENT PROJECT (ATIP)

TECHNICAL SUMMARY OF ATIP'S ACTIVITIES 1982-90: PROMISING GUIDELINES

ATIP RP-6



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AGRICULTURAL TECHNOLOGY IMPROVEMENT PROJECT

ATIP

TECHNICAL SUMMARY OF ATIP'S ACTIVITIES, 1982-90:

PROMISING GUIDELINES

ATIP RP 6

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PREFACE

The Agricultural Technology Improvement Project (ATIP) has primarily a farming systems research orientation and has been in operation for a period of eight years (1982-1990). The project has been sustained through funding on the part of the Government of Botswana (GOB) and the United States Agency for International Development (USAID). The USAID funding has been mainly channelled through the contractor, the Mid-America International Agricultural Consortium (MIAC) with Kansas State University (KSU) as the lead institution. With the scheduled end of the KSU/MIAC contract in September 1990, it was considered desirable to produce a Technical Summary of ATIP activities. This compilation is available in three parts. These are as follows:

(a). Technical Summary of ATIP Activities, 1982-1990: Research Results [ATIP RP 5].

(b). Technical Summary of ATIP Activities, 1982-1990: Promising Guidelines [ATIP RP 6].

(c). Technical Summary of ATIP Activities, 1982-1990: Research Extension Liaison Office Achievements [ATIP RP 7].

This report is the one listed under (b) above.

It is anticipated that report (a) will be of most relevance to those interested in research, while report (b) will be more relevant to extension staff interested in undertaking widespread testing of promising technologies and approaches. Report (c) will be of interest to those concerned about fostering linkages between research and extension by means of a Research Extension Liaison Office (RELO).

The staff of ATIP would like to express their appreciation for the support given by the leadership in the Ministry of Agriculture, by USAID personnel, by MIAC/Kansas State University staff and, above all, by the many farmers who have enthusiastically participated in the multiple trials, studies, surveys and training courses undertaken by ATIP, often in association with other agencies in the Ministry of Agriculture.

This particular report has been published with the approval of the Director of DAR, Dr. L. Gakale, the Chief Animal Production Research Officer, Dr. L. Setshwaelo, and the Acting Chief Arable Research Officer, Mr. O. Mmolawa.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION AUTHORS

Major responsibility for each section of this report was as follows[1]:

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T. THEDFORD	Sections:	2.4	3.3		

[1]. Where there was more than one major contributor, the section is listed more than once.

CHAPTER 1: INTRODUCTION

A number of promising approaches and technologies which have resulted from work carried out by ATIP staff, or from collaborative efforts with others outside of the project, are presented in this report. Detailed results that form the basis for deriving these promising technologies and approaches are summarized elsewhere [ATIP RP 5].

Because it was believed that these technologies and approaches could benefit from more extensive testing at the farm-level before being approved for publication as **Extension Bulletins** (in the case of approaches) or **Agrifacts** (in the case of technologies). Therefore, in order to provide easily understood instructions to facilitate further testing, a series of proposed leaflets called **Promising Guidelines** are presented in this document. It is hoped that these will be widely circulated amongst extension staff and that they will use at least some of them in their work with farmers.

In terms of **technologies**, a total of nine guidelines have been prepared. These guidelines are classified under a number of themes, namely:

(a). Soil moisture enhancement (early plowing, contour strip tillage, water conservation terraces; see Sections 2.1.1 to 2.1.3).
(b). Planting and weeding (row planting and mechanical weeding, rotary injection planter, Maun cultivator; see Sections 2.2.1 to 2.2.3).
(c). Specific crop activities (cowpeas -- see Section 2.3.1).
(d). Specific livestock activities (control of lice on goats and goat kraal construction; see Sections 2.4.1 and 2.4.2).

Similarly, in terms of **approaches**, a total of eight guidelines have been prepared. They can also be presented according to a number of themes, namely:

(a). Farmer involvement (extension-oriented farmer groups, farmer training courses, conducting farmer field days and competitions at Agricultural Shows; see Sections 3.1.1 to 3.1.4).
(b). Encouraging cooperation (between farming systems research (FSR) and station-based research and between research and extension; see Sections 3.2.1 and 3.2.2).
(c). Techniques (estimating tswana goat weight with a tape measure and the use and care of the bloodless castrator (Burdizzo); see Sections 3.3.1 and 3.3.2).

In addition, two **Agrifacts**, not presented in this report, have resulted from work which ATIP has contributed to greatly. One of these refers to donkey draft [Horspool and Gray, 1987], while the other **Agrifact** is concerned with double plowing and should soon be available for distribution.

CHAPTER 2: TECHNOLOGIES

2.1 SOIL MOISTURE ENHANCEMENT

2.1.1 EARLY PLOWING

2.1.1.1 What Is Early Plowing?

Early plowing is plowing without planting before rainfall that is utilized as the planting rain. Farmers who early plow must be prepared to plant separately from early plowing. Planting might involve row planting or broadcasting seed and second plowing (double plowing). For the purpose of this guideline on early plowing, the alternative of plow/planting on a single day refers to both broadcast single plow/planting and to row planting for which plowing and planting are not separated by a planting rain.

2.1.1.2 Purpose Of Early Plowing

Early plowing is intended to improve the management of rainfall. It will increase infiltration from early showers. Early plowing will also reduce the early season weed growth that is found on uncultivated land. If early plowing is carried out in the autumn or consistently near the beginning of spring rains, the farmer might expect a large increase in the amount of water stored and made available for crop growth during the main part of the season. If it occurs during the season and just prior to the planting rain, the farmer would not expect to have as much additional water stored. However, the improved infiltration of even a single planting rain will provide greater moisture for the seedbed which would benefit germination and seedling vigor.

The average planting moisture can also be expected to improve with early plowing because the separate planting (row planting and, to a lesser extent, double plowing) can occur more rapidly than under the single plow and broadcast system. A rapid planting without the need to do the first tillage at the same time allows the farmer to plant more land on good soil moisture. Early plowed ground tends to stay wet longer than untilled land after a rain, which can help to increase potential planting opportunities.

2.1.1.3 Farmer And Researcher Evaluation

In research plot comparisons, early plowing and later planting have generally performed better than plowing plus planting at the same time. Equally important is an advantage which doesn't reveal itself in plot comparisons. That is, early plowing with rapid planting will permit more timely planting over a large field area than plowing plus planting at the same time.

Farmers generally recognize the potential benefits of early plowing. But they recognize, as do researchers, that problems and risks are also generated by this practice. Many resource poor farmers feel that early plowing is not suited for them because they do not have the plowing and planting resources to deal with these potential problems.

When early plowing has been tested in plots, farmers have tended to early plow at times

when they could also effectively plow plus plant. This reduces the advantage of early plowing because the opportunity for using the conventional system is good. Efforts have been made to outline procedures by which farmers could minimize the opportunity cost of early plowing, that is, do early plowing at times when planting would not normally be done.

2.1.1.4 Risks With Early Plowing

After early plowing is completed, the farmer is dependent on rainfall and draft resources to be able to complete planting. There is a risk that during this wait, weed growth on the plowed land may become excessive. These weeds could affect the ability to plant the land or the amount of weeding labor required at weeding time. Early plowed land that is waiting for planting may also slump which reduces tilth for planting. Both slumping and weed growth are related to the interval of time or to the amount of rainfall separating early plowing and planting. Both of these problems with early plowed land are circumstantial and no exact recommendation on the number of days or number of rains that should separate early plowing and planting, can be specified. Circumstances include, temperature, nature of the rainfall, quality of the first plowing, and so forth. By and large, farmers who can plant quickly after the first planting rain will not experience these difficulties.

Farmers who double plow run a much smaller risk because the bad land condition can be corrected with the second plowing. The risk of bad land condition is greatest for farmers who row plant.

Some row planting, particularly following early plowing carried out early in the season, may require some type of secondary tillage (ST). Secondary tillage increases the cost of production and will not always be possible for many farmers if they expect to plant the entire field.

Another risk in early plowing is that farmers may not find later planting opportunities with good soil moisture. If early plowing is late or if the farmer has poor access to traction, the risk of not being able to plant in an opportune manner may be increased.

Clearly, the risk factors of early plowing are related to the time of the year and to the ability of the farmer to plant in a timely manner. In some cases, the farmer must also be able to perform secondary tillage to correct land condition problems.

2.1.1.5 Reducing The Opportunity Cost Of Early Plowing

Early plowing is best carried out on days when plowing and planting would not produce a good result. The time of season is also an important consideration. The opportunity cost of early plowing is lowest following rainfall very early in the season. Later, the cost of early plowing increases progressively.

The resource position of the farmer is important when evaluating different early plowing options. Farmers who own traction and are able to do a large amount of plowing and planting, can afford to take the risk of plowing at the earliest opportunity. These farmers, often with their own tractors, can till the land again before planting if this becomes necessary. Most farmers using animal traction and shifting to row planting would not be able or willing to do much secondary tillage. These farmers should not early plow much before they are prepared to begin planting. Farmers who hire plowing may not be readily able to adopt an early plowing system. However, these farmers can use early plowing when the opportunity is present. If soil moisture is poor when plowing is done, and it is still

early in the season, the farmer could plant at some future date -- with row planter, by hand planting, or by broadcasting plus second plowing. In general, the greater the plowing and planting resources, the more likely early plowing can be used to improve rainfall management.

If by mid- or late season, farmers have not yet had many planting opportunities, the farmer's first priority should be planting, whether or not they had any early plowed land available.

2.1.1.6 Guidelines To Incorporate Early Plowing Into The Plowing System

The following plan summarizes a flexible and practical approach to using early plowing. This plan is consistent with using early plowing in low opportunity cost situations and targeting early plowing to farmers with resources that permit them to take certain risks.

The plan is presented as a decision matrix (Table 2.1). At each decision point, which is based on time in the season and soil moisture on the day of operations, the options of early plowing, plowing and planting, and planting previously plowed land are ranked from highest priority to lowest. Obviously, planting previously plowed land is only an option when previously plowed land is available. Under comments/conditions/targeting, the target group of farmers for whom this type of early plowing can be suggested, is indicated.

2.1.2 CONTOUR STRIP CULTIVATION

2.1.2.1 Background And Purpose

Research results for contour strip cultivation have not, to date, been very promising. However, farmers have shown an interest and have provided useful suggestions to solve certain technical problems. This guideline describes the implementation of the system, incorporating the farmer's suggestions. Research is continuing on the proposed modified system.

Contour strip cultivation[1] is designed to increase the efficiency of plowing for rainfall management. This is accomplished because farmers who use contour strip cultivation can plow over a larger portion of the field, earlier in the season, than with normal plowing using the same plowing resources. This is possible because portions of the field are left as unplowed fallow strips between cultivated strips.

This system addresses two problems of arable agriculture in eastern Botswana. The first is the inadequacy of plowing resources found in most households. The second is the risk of inadequate soil moisture for crop growth.

(a). Nearly all farming households face a plowing resource constraint. Even farmers who do their own plowing are often not able to plow as much land as early in the season as they would like. Because plowing in strips can more quickly cover a large area, a greater portion of the field can be made receptive to rainfall infiltration earlier in the season.

(b). Because soil moisture is often a constraint for crop growth, crops sometimes fail even on land that has been plowed early. Strip cultivation should improve the

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[1]. Also known as contour band plowing.

TABLE 2.1: GUIDELINES AS TO WHEN TO EARLY PLOW[a]

TIME OF SEASON	OPTIONS IF SOIL MOISTURE IS			COMMENTS/CONDITIONS/TARGETS RELATED TO EARLY PLOWING
	OPTIMUM	MODERATE	POOR	
Early	1. EP	1. EP	1. EP	Early plowing for owners of traction. Standard operation on a large scale for tractor owners. Animal owners must prepare teams and can usually only work part of the field.
Early-Mid	1. PL 2. PG/PL	1. PG/PL 2. EP	1. EP	Early plowing is useful for the widest range of farmers at this stage, even for farmers who hire traction, provided soil moisture isn't the best and the farmer is certain to have further access to traction.
Mid	1. PL 2. ST/PL 3. PG/PL	1. PG/PL 2. EP	1. EP	Early plowing is becoming less useful for farmers with weaker access to plowing and planting resources. These farmers will find it most difficult to stay on schedule with their operations and stand the greatest risk of not profiting from early plowing.
Late	1. PL 2. ST/PL 3. PG/PL	1. PG/L		Early plowing, even on the worst soil moisture, is generally too risky for all farmers at this late date in the season.

a. A key to the abbreviations and terms used in the table is as follows:

For seasons:

Early season:	September to early October.
Early to mid-season:	Mid-October to end of November.
Mid-season:	December.
Late season:	January onwards.

For operations:

EP	Early plowing.
PL	Planting on early plowed land (row planting or double plowing).
ST/PL	Secondary tillage before planting early plowed land (double plowing, cultivating, harrowing).
PG/PL	Plowing and planting without rainfall separating them.

For soil moisture (subjective assessment by farmer):

Optimum	Plant establishment is possible on existing soil moisture.
Moderate	Intermediate.
Poor	Plant establishment requires post-planting rainfall.

1, 2, 3 refer to different possible strategies for that particular time of season and soil moisture level.

availability of soil moisture because water infiltration in the plowed strips includes water harvested from the fallow strips. This harvested water can mean that there will be more reliable quantities of soil moisture for crop growth. Water from the fallow area is harvested for as long as it remains unplowed.

Because research has shown that farmers who use this system will frequently encounter a problem with weed control on the fallow under normal rainfall, the fallow should be also be plowed and planted but only after the entire field has been crossed with strips and some water harvesting has taken place.

2.1.2.2 Establishing Contour Strips In The First And Following Seasons

Implementing the contour strip is more easily achieved with a tractor. The guidelines are as follows:

(a). The position of the strips in the field is intended to be permanent. This means that plowing should always follow the same pattern year after year. Advantages for having the strips permanently placed are the following:

i. Contour lines do not need to be re-established every year.
ii. Soil building amendments can be concentrated in the strips. Amendments such as manure should be placed on the strip before plowing.
iii. Production strategies such as crop rotation can be readily managed.

(b). Plowing of the strips should be done as early in the season as possible. The strips are made by plowing three passes with a two furrow plow in each direction, plowing the soil towards the middle of the slope. The width of the strip should be measured so that it can accommodate four planted rows. By plowing in this way, a strip with a slightly raised ridge running along the center is created. With this pattern of plowing, dead furrows are left at both margins of the cultivation strip which serve as collection furrows for run-off from the fallow strips.

(c). Strips should be placed as close to contour lines as possible, when the system is on fairly flat ground. The question of whether or not the strips should be on a gradient, in other situations, is still a research issue. The strips will need to be plowed in a way that gives the best fit to the contour for a large number of strips. To allow the plowing to be practical, all strips should run parallel with each other.

(d). Cultivated strips should be placed so that about one meter of fallow separates them. This meter plus the two dead furrows provide enough space for a tractor to pass for plowing the fallow when that is needed.

(e). Following a useful planting rain, strips should be row planted. Row planting helps ensure better placement of plants and a more reliable plant establishment (see Section 2.1.2.5). Reliable plant establishment is very important in this system given that an effort is made to concentrate water in defined zones. Each cultivation strip must be wide enough so that row planting can be accomplished without putting seed near the edges of the strip. It has been observed that rows planted too near the dead furrow suffer from water logging. Four rows should fit on the strip but still leave enough room on each outside edge to pass with a cultivator.

(f). Weeds can be controlled in the cultivation strip by using an inter-row cultivator. The edges of the strips should also be cultivated to prevent weeds from encroaching

from the fallow.

2.1.2.3 Plowing And Planting Strategy In Dry Seasons

If by the later part of the plowing and planting season, below average rain has fallen, the fallow strips should be left unplowed. The fallow will continue to serve as a watershed for the cultivation strip during subsequent rains. It has been observed that during dry seasons, the problem of weed growth on unplowed land is much reduced.

2.1.2.4 Plowing And Planting Strategy In Wet Seasons

If rainfall is normal by the mid- or late planting season, weed growth can become heavy on the fallow strips. With good rainfall, farmers are also more likely to have completed plowing on most of the field. In this situation, the farmer can choose between two approaches to control weeds on the fallow. These are:

(a). The fallow strips are weeded but left as a watershed for the cultivation strip. The fallow strips should be weeded before the weeds are well established. This is earlier than conventional weeding. Early weeding can be by hand hoe or by using a spike-tooth harrow. If weeding is delayed and weeds are well established, a hand weeding is necessary. Most farmers find weeding the fallow unacceptable.

(b). Relay plow and plant the fallow areas. Relay plowing of the fallow is only done if rainfall is good and weed growth an issue. In wet years, water harvesting would not be needed as much as good weed control. When there is good rainfall, farmers also wish to plant over larger areas and are more reluctant to leave fallow areas. The decision to relay plow and plant the fallow would be made after plowing and planting is completed on the rest of the field. Depending on the time of the season this decision is made, the fallow could be planted to long, medium or short cycle crops. Short cycle legumes and maize are suggested as the best choices for late planting on good soil moisture conditions.

The fallow strips should be made to a width that will readily permit relay plowing. For tractor plowing, the tractor tires can fit into the dead furrows of adjacent cultivated strips. In this way, the tractor can pass up once and down once to complete plowing with a dead furrow in the center. Two rows can be planted in this space.

Relay plowing and planting has been suggested and strongly supported by farmers. With relay plowing, weed control becomes less of an issue and fallow is only left in dry seasons. With these changes, farmers have shown enthusiasm for the contour strip system. The relay plowing method will be tested for the first time in the coming season.

2.1.2.5 How To Plant On Strips

The strips should be single plowed, followed by row planting as soon as soil moisture is ideal. Single plowing (possibly before the planting rain) is suggested because strip cultivation is designed for farmers with limited plowing resources. Strips can be mechanically weeded as soon as the plants are established.

If farmers are not able to row plant, strips can be double plowed. The strips should still be

plowed early without planting. After a satisfactory planting rain, seed can be carefully broadcast along the strip and the strip plowed a second time. When broadcasting, special care is necessary to distribute seed evenly throughout the narrow strip.

2.1.2.6 Which Farmers Could Use Contour Strip Cultivation

Contour strip cultivation would be suitable for any farmer with sufficient access to plowing resources to be able to plow strips and relay plow fallow when this is necessary. It would also be preferable for these farmers to row plant. There is no indication that soil type or slope will influence the usefulness of contour strip cultivation. Even on flat land, water moving in the micro-topography collects in dead furrows on either side of the fallow.

2.1.3 WATER CONSERVATION TERRACES

2.1.3.1 Background And Purpose

Water conservation terraces are designed to provide nearly complete capture of rain falling on the terrace itself, even before the land is plowed. The design for the water conservation terraces described in this guideline is adapted from high precision designs that were developed for the semi-arid Great Plains of the USA. For Botswana, a sequence of relatively narrow terraces that are placed on the contour have been tested.

Part of the justification for working with water conservation terraces in Botswana came from the observation that particular sites within the landscape gave comparatively high yields during both drought and good rainfall. Water conservation terraces have been proposed as a technique for creating high potential zones of this type within the field. These zones are characterized by water run-on potential and deeper soils with high water holding capacity.

The initial construction of terraces is far more difficult than is the maintenance or crop management of terraces that are well established. This guideline covers procedures to help small farmers implement terraces.

2.1.3.2 Farmer And Researcher Evaluation

Research results obtained from the construction of terraces indicate that:

(a). Plant establishment is generally good in the terrace, often better than with double plowing.

(b). Water run-off leading to channeling and originating in the terraces is less than channeling from cultivated areas on the flat elsewhere in the field.

(c). The construction of terraces is best on land with more than 1-1.5 percent slope.

(d). There is a definite soil build-up at lower portions -- three to eight meter width -- of terraces following repeated plowing in one direction. This terrace bench offers an excellent cropping strip.

Terraces have not been tested under very dry conditions. Farmers indicate an appreciation of the concept of water conservation terraces. They see that more water can be retained in the field and that the lower bench portion of a well constructed terrace will have high yield

potential.

2.1.3.3 How To Establish Water Conservation Terraces

Two elements of the terraces are difficult or costly to implement. First, the construction of base ridges for each terrace will require the use of good traction on days with adequate soil moisture. Some farmers feel this work should be done using hired tractor. Researchers and most farmers note that an adequate ridge can be built using an animal drawn single furrow plow. Second, repeated plowing in one direction through the entire terrace is required until a satisfactory bench is created at the lower zone. The plowing phase of construction can be done either with tractor or animal traction. The steps involved are as follows:

(a). In the first season, ridges, or other barriers, are built along the contour with a 15 to 20 meter separation between them. This ridge provides a base against which soil is moved by plowing. The first terraces should be close to the upslope side of the field to minimize run-off water accumulation above the terrace. Usually one, or at most two, terraces are built at a time.

(b). Base ridges can be made with either tractor or an animal drawn single furrow plow. These ridges should be more than 30 centimeters high. Tractor plowing builds the larger ridge.

(c). Initially, the plowing phase of construction for water conservation terraces was planned to take place over a three or four year period. This time period was suggested because three or four single plowings were generally required to create a satisfactory terrace with bench. More plowings would be necessary if the slope was more than two percent. It is now suggested that the plowing phase be completed in a single season.

(d). During construction, plowing is always in the direction of moving soil to the ridge. An eventual build-up of soil occurs above each base ridge creating a zone with deeper soil, and provided there is sufficient slope, some water run-on potential. The deeper soil area at the lower side of the terrace is called the bench. Plowing is used to make the bench somewhat level.

(e). To help make plowing in one direction more efficient, repeated plowing in a new terrace can be coupled with return plowing below the terrace on land that has not yet been terraced. The narrow terrace can be plowed three to four times in one direction. The return plowing is used to single plow over an area that is three to four times as large.

2.1.3.4 Main Problems And Suggested Solutions

The following information relates to issues that arose from the construction of terraces and some possible solutions:

(a). Farmers have indicated that where slopes are well defined, they could mark out contours on their fields. Because terraces represent a long-term investment on the field, farmers should consult with their Agricultural Demonstrators (ADs) or the Regional Soil Conservation unit about marking contour lines before beginning to construct the terraces.

(b). Construction of the base ridge for each terrace has been done with tractor drawn graders. This equipment is generally not available in the farming community. However, farmers agree that the base ridge of a terrace could be constructed with a standard plow -- tractor or single furrow animal drawn[2] -- once the contour line is marked.

(c). The biggest concern in the construction of terraces is with the one-way plowing pattern required to move soil in a downward slope direction so that a bench is created. One-way plowing is not efficient because the return trip is without plowing. It has been suggested that the return trip be used to plow flat cultivation below a new terrace. In this way, a narrow terrace can be repeatedly plowed in one direction whereas the return plowing will single plow over a larger area.

2.1.3.5 Cropping Practices On Established Terraces

The following steps outline what should be done once the terrace with its bench is created:

(a). Plowing can again be as normal provided there is no drastic movement of soil within the terrace. The 15 to 20 meter wide terrace can be treated as a traditional plowing plot or "acre".

(b). Weed control and other management issues are no different than that for flat cultivation. Row planting and mechanical weeding are suggested as the best means of utilizing the water conservation and deep soil in the bench.

(c). Because of the yield potential of the bench in both dry and wet seasons, a more reliable return to fertilizer, manure, crop rotation, and so forth can be expected; these inputs can be applied over the entire terrace. But the most reliable would be expected in the bench area.

2.1.3.6 How To Maintain Water Conservation Terraces

Finally, the last steps entail how to best maintain the terraces.

Well constructed terraces should survive the dry season even when livestock are permitted to graze on crop residues. Allowing weeds, particularly spreading grass, to grow on the base ridge of the terrace is advisable. This will increase the strength and longevity of the terrace.

2.2 PLANTING AND WEEDING

2.2.1 ROW PLANTING AND MECHANICAL WEEDING

2.2.1.1 Introduction

Recommendations concerning row planting have been available in **Agrifact** form for many years. In addition to the direct benefits of row planting, the technique has an important indirect benefit, in reducing the time required for weeding if mechanical weeding is

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[2]. Animals need to be well trained so that the ridge placement is accurate.

undertaken. In fact, the weeding operation by hand is often not adequately done. Consequently, mechanical weeding -- if done properly -- may have indirect positive impact on crop yield by decreasing the weed competition effect. In recognition of this, ALDEP have increased efforts to get farmers to purchase a row planter and inter-row cultivator together, in order to maximize the potential benefits to be achieved from row planting.

The object of this guideline, is to stress the importance of combining row planting with mechanical weeding. At the same time, it is important to recognize that there is considerable skill in implementing successful row planting and mechanical weeding. Consequently, it is strongly recommended that farmers receive practical training on how to do these operations when they acquire the necessary equipment.[3]

2.2.1.2 Planting

A good seedbed is the basis for establishing a good crop. The seed is placed at the proper depth, it is well covered during planting and early root growth is enhanced. It is essential that plowing be deep enough to allow effective weed control and good water infiltration. It is advisable to plow as early as possible so that planting can be accomplished in good time.

Harrowing is usually not necessary, but may be required when clods are a major problem, or when there are weeds (e.g., Cynodon dactylon) that need to be removed.

Row planting should be done on good soil moisture. The seed should be placed in moist soil as this will enhance establishment. This will contribute to producing a successful plant stand and yield. When the soil moisture becomes too low for planting, farmers could try another approach, and continue plowing if it is possible. Planting could resume immediately after a good rain. Sometimes this can be done without further cultivation if the soil is not too compacted, the seedbed is not too rough, and there are not many weeds. Weeds and soil compaction are often not problems unless there is a long delay between plowing and planting.

It is important to use good quality seed. The seeding rate is controlled by selecting the correct seed hole number and watching the seed as it drops. In general, it is suggested that a low to medium plant population density should be targeted. A sorghum population of 25 to 60,000 plants per hectare can give excellent yields even when the rains are poor. One of the advantages of row planting is that it is easier to select seed rates that result in particular plant populations, therefore saving seed compared to the broadcast system.

Results have shown that even though late plantings can be successful, the best chance for high yields arise when planting is in November or December.

Since the row planting operation involves more resources than the traditional broadcast system, it is important that it is done properly. The field needs to be prepared in a timely manner, the necessary traction,[4] equipment and labor must be available, and planting must be

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[3]. One possible way is through a Farmer Training Course, a **Promising Guideline** for which is given in Section 3.1.2.

[4]. An alternative to using traction is to use a hand row planter, which is particularly useful for planting small areas, and/or for families who don't have good access to traction. A hand row planter that has been extensively tested in Botswana is described in Section 2.2.2.

done on good soil moisture.

2.2.1.3 Mechanical Weeding

An inter-row cultivator kills weeds that grow between rows. This relieves much of the burden of hand hoeing. Different cultivators have been compared in Botswana. These are the:

(a). Mahon cultivator which can be effectively pulled by three or more donkeys.
(b). Scrapper pulled by two donkeys.
(c). Maun cultivator designed to be pulled by one donkey.

The Mahon is widely used but it is heavy, and it disturbs the soil more, while the scrapper is most suitable when weeds are still small. The light weight Maun cultivator has proved to be particularly suitable in many situations, although it does not have an expandable row width.[5] The lack of variable width on this cultivator means that the row width must be carefully chosen at planting time, so that it corresponds to the width of the cultivator.

2.2.2 ROTARY INJECTION PLANTER

2.2.2.1 Background And Purpose

The rotary injection planter (RIP) was originally developed at the International Institute for Tropical Agriculture (IITA) in Nigeria. It is a row planting machine that is pulled (or pushed) by hand. It consists of a central wheel, with six soil openers equally spaced around the wheel. A seed box and seed metering device are attached to the center of the wheel by a central axle. Also attached to this axle are a seed covering device and press wheel which covers the seed and compacts the soil on top of the seed after it has been placed in the ground. Additionally a long handle is attached to the central axile, and this handle can be adjusted so that the planter can be either pushed or pulled over the ground.

The RIP was introduced to Botswana to enable farmers to row plant without necessarily using animal draft power. Thus it is primarily for use by people who wish to row plant but do not own draft power, or for various reasons cannot or do not use the draft power they have available. For example, people who have cattle but no labor to manage the draft team, or people whose oxen are not sufficiently well tamed to pull a row planter in straight lines, might be able to use the RIP.

2.2.2.2 How To Use The RIP

The soil openers are not adjustable, so the depth of seed placement is fixed, and so is the distance between seed holes in the row. The only way to adjust the seeding rate within a row is by the use of different seed wheels. Different seed wheels have different sized holes. By selecting different wheels, the number of seeds coming out of each hole can be adjusted. The number of seeds per row can also be controlled by blocking some of the holes in the seed wheel to reduce the amount of seed coming out of the machine.

(a). *Setting The Seeding Rate.* The plant population per hectare can be altered by

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[5]. Details on how to use the Maun cultivator are given in another section (Section 2.2.3).

controlling the amount of seed coming out of the soil openers of the machine, and also by adjusting the distance between the rows in the field. The distance between rows is controlled by the person operating the machine. It is done by the person pulling the machine maintaining the correct distance from the previously planted row.

(b). ***Changing The Seed Wheel.*** To change the seed wheel it is necessary to disassemble the machine, and replace the seed wheel inside the machine. To do this, it is first necessary to remove the central axle. Changing the seed wheel often seems complicated at first, but becomes relatively easy with practice.

(c). ***Selecting The Correct Seed Wheel.*** The best way to select the correct seed wheel is to first determine how many seeds should be planted in each hole. Once that is done, a seed wheel with holes that are approximately the correct size is selected and placed in a bag of the seed which is to be planted. By holding the wheel upright and turning it slowly -- so that the wheel is passing through the seed in the bag -- the number of seeds being collected in each hole can be observed. This should be the same number of seeds that will be planted in each hole. If the number of seeds being collected is not the desired number, another seed wheel is selected and tested in the same manner. This process is continued until the correct wheel is identified. The correct wheel is then fitted in the machine.

(d). ***Checking Seed Output.*** Once the wheel has been placed in the machine, the seed output from the wheel may be slightly changed. It is therefore necessary to re-test the seed output of the machine once more before it is used in the field.

To check the seed output from the RIP, a hard cleared piece of ground is first selected. Then seeds are poured into the seed hopper and the machine is pulled very slowly over the hard ground. The machine is stopped every time the soil openers open, and the number of seeds that drop out into the hole are counted. In this way, the exact amount of seed going into each hole will be known. This is very important because once the RIP is in use in the field, it is very difficult to determine how much seed it is putting out.

Again, because the operator cannot see the seed being planted it is very important to check that seed is still coming out of each soil opener after every row. Seeds can sometimes become lodged in the seed hole, and the soil openers become blocked with soil. Unless the operator checks regularly, he or she may not learn that the machine is not planting until long after the blockage has happened. This can result in a lot of wasted effort. To avoid such a situation, the operator of the machine should check that the seed is coming out by running the machine over hard ground at regular intervals.[6] If the operator finds that the machine is not putting out the seed as desired, he or she should stop and fix the problem.

2.2.2.3 Soil Conditions And Soil Moisture Requirements

On hardvelt soils, the soil must be plowed at least once -- to kill weeds and loosen the soil -- before the RIP can be used. To ensure a good result, the soil must also be as moist

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[6]. Seed sometimes falls out the side of the seed openers. This should not cause concern unless it is a considerable amount of seed.

as possible, without being so wet that it blocks up the planter. The best conditions for using the RIP are when the field has been well plowed so that the surface is not too rough, and there is good moisture for planting. In all cases the operator should make sure, at regular intervals, that the seed is being placed in moist soil and that it is being covered and compacted properly.

2.2.2.4 Suggestions For Using The Machine

Experience with the machine has resulted in the following suggestions:

(a). The RIP is generally easier to pull than to push, because the whole weight of the person can be used to move the machine.

(b). The machine should never be pushed in reverse, even for a small distance, because this will instantly block the soil openers with soil. To move the machine backwards it should be lifted out of the soil and pushed on the press wheel.

(c). To transport the machine over hard ground, the machine should be either carried or pushed on the press wheel. For long distance travel, the machine can be taken apart and strapped to the back of a bicycle. Running the soil openers over hard ground for long distances -- 50 meters or more -- may bend the openers and damage the machine.

2.2.2.5 Advantages And Disadvantages Of The RIP

Advantages of the RIP include the following:

(a). Using the RIP provides all the normal benefits of row planting. These include:

i. More even distribution of crop plants in the field.
ii. Seed placement at uniform, optimal depths.
iii. Usually more rapid and uniform seedling emergence.
iv. The option of mechanical weeding.

(b). The RIP does not require draft animals for use. This means that users can be very prompt with the planting operation because they do not need to hire or look for their own draft animals before they can plant, after a rain. It also means that row planting requires less labor, because no one is needed to manage a draft team. Lastly, the RIP can easily be used by people who do not own draft power.

A disadvantage of the RIP is that some farmers who have used the machine complain that it is somewhat heavy, and say they would not like to use it on large areas. Pulling the machine can be made easier by:

(a). Doing a good job of plowing to ensure a smooth seedbed.
(b). Harrowing a rough seedbed to make it more smooth.
(c). Having people take turns pulling the machine. Also two people instead of the usual one could be used to pull it.

2.2.3 MAUN CULTIVATOR

2.2.3.1 Description

The Maun cultivator is a light weight design, of non-adjustable width. It has an adjustable wheel at the front, and several different positions for attaching the pulling chain. Weeds are removed by five "duck-foot" tines mounted on a low V-shaped frame. There are two handles at the back for controlling the machine. This cultivator, originally designed by Malapo Development (MDP) staff, is made by Zimplow in Zimbabwe.

2.2.3.2 Evaluation

The Maun type cultivator has several advantages over the well known Mahon cultivator. These include the following:

(a). It is considerably lighter and can be pulled by only one or a maximum of two donkeys -- assuming the soil is not too dry. This makes it easier to control the draft animals in the field.

(b). Because it is light, and has a wheel at the front, it is easy for a farmer to lift the machine out of operation. This means that few crop plants are lost when the draft team moves out of line, or when crop rows are not straight and come too close together for the machine to pass between them.

(c). The machine provides the normal advantages of mechanical weeding -- namely more rapid and more timely removal of weeds as compared to hand weeding.

(d). The cost is low, which makes it affordable to many farmers.

The primary disadvantages of the Maun cultivator are that:

(a). It is not adjustable in width, which means that farmers have to plant using row widths which fit the machine -- usually 80 to 85 centimeters between rows.

(b). Since it is quite light, it is best suited for removing small weeds in moist soil conditions. It cannot be used effectively on large weeds, or used when the soil is hard. This means that farmers can only use the machine at certain times when field conditions are right.

The machine is currently undergoing some modification of the soil-engaging parts at FMDU, and improved versions may be released for testing in the future.

2.2.3.3 Hitching Arrangements

To date, farmers have used several different hitching arrangements to pull the cultivator. These include hitching:

(a). One donkey in front of the machine using a harness or donkey collar.
(b). Two donkeys, one in front of the other, using harnesses or collars.
(c). Two donkeys side-by-side, using harnesses, collars or yokes.

Using one donkey, or two donkeys in line, is the easiest because it allows the animal(s) to walk between rows directly in front of the cultivator.

2.2.3.4 Adjusting The Depth Of Cultivation

To make pulling the machine easier, the cultivator should operate at the minimum depth required to up-root the weeds. The larger the weeds, the deeper the cultivation necessary. Consequently, it is easier to cultivate early, while the weeds are still small. If the soil is somewhat dry, it may be necessary to set the machine for a deeper depth in order to keep it from riding on the soil surface.

The depth of operation of the cultivator can be adjusted in several ways. These are as follows:

(a). The best method is by selecting the appropriate hole for attaching the pulling chain. The higher the hole, the deeper the machine will operate.

(b). Another method is by altering the distance between the animals and the cultivator. Decreasing the distance will reduce the depth, while increasing the distance will increase the depth of cultivation.

Finally, the front wheel must be adjusted to allow the machine to operate at the proper depth.

2.2.3.5 General Use

The cultivator can be used in any row planted crop where the row spacing is at least a few centimeters wider than the machine. In a field with very wide rows (e.g., more than a meter between rows) two passes may be required in each row for proper weed control. In fields where the rows are not exactly straight, the machine can easily be lifted over crop plants when necessary. In addition it can be steered in much the same way as a plow is steered -- that is, leaning the cultivator to the right will make it move to the left.

In general, the cultivator should be used as soon as possible after planting because it will be easier to use when weeds are small, and because the sooner weeds are removed from the field, the less competition they will give the crop. However, as with any cultivator, weeding cannot be done until the crop plants are well established. That means that the crop should be at least 25 to 30 centimeters high before weeding.

On heavy soils, the cultivator will tend to slide on the soil surface when the soil is dry and hard. It is therefore necessary to cultivate these soil types when they are slightly moist -- but preferably not "wet". On lighter textured soils where the soil does not become hard when it is dry, it may be possible to cultivate regardless of soil moisture conditions.

2.2.3.6 Farmer Observations

To date, this cultivator has been used by a limited number of farmers. It usually takes some experience before farmers learn how to use the machine properly. Farmers need training in how to adjust the depth of operation and need some practice in their own fields before they learn the right field conditions for using the machine. However, once skills have been mastered, farmers generally find that machine is effective and easy to use.

2.2.3.7 Future Testing Needs

This cultivator is sufficiently developed to be used by farmers at present. Indeed, some have been purchased and are being used by farmers. However, as with most things, the cultivator could probably be further improved. Future testing and development needs to include the following:

(a). Follow-up studies should be done with farmers who have purchased cultivators to determine how much they are using them, what further problems they have experienced, what recommendations they have for improved usage, and what modifications they can suggest in terms of design.

(b). Researchers at the Farm Machinery Development Unit (FMDU) should continue studying ways to improve the stability and efficiency of the soil-engaging parts.

(c). Wide-scale farmer testing should continue, to verify the usefulness of the machine in different regions. For example, would the machine be practical in southern region where Cynodon dactylon is a major problem?

2.3 SPECIFIC CROP ACTIVITIES

2.3.1 COWPEAS

2.3.1.1 Background

The following guidelines for cowpea production have been developed from four years of on-farm trial results and observations in farmers fields. Because not all of the suggestions are the direct result of specific trials, they must be considered simply as guidelines, not as direct recommendations. Furthermore, because of the great climatic variations that occur between years, and the differences that exist among farmers in terms of interests and resources, these guidelines must always be adapted to fit specific farm circumstances. The following guidelines represent the current best interpretations of on-farm research with cowpeas.

2.3.1.2 Variety Selection

In variety trials that compared the productivity of determinate (usually short duration) and indeterminate (usually long duration) cowpea varieties, the longer duration varieties always yielded the same or better than the determinate types. This is because the long duration varieties could survive stress periods -- like drought or aphid attack -- and produce a grain yield when growing conditions improved. Thus for general cowpea production situations, long duration varieties are probably the best choice. This is particularly true for farms that have few resources and where crop husbandry standards are likely to be low. Long duration variety options for Botswana include the improved Tswana variety and the traditional varieties.

However, shorter duration determinate varieties also have uses. For example, farmers may wish to plant small portions of determinate varieties fairly early in the planting season, in order to ensure at least some production in cases where mid-season droughts occur, and to provide some early grain and leaf production as a food source before cereal grain harvest occurs. For example, Blackeye cowpeas planted in mid-November could be ready for harvest at the end of February. Two determinate varieties of cowpeas are currently available on the market in Botswana, Blackeye and ER-7. Of the two, Blackeye would probably be

most suitable for early season planting because of its good leaf production and excellent seed quality.

Determinate cowpea varieties are also an excellent choice for planting in situations where planting opportunities have been few, and farmers wish to continue planting crops in late January or early February. In such cases, ER-7 would probably be the most suitable variety. This is because the length of the growing season is unpredictable, so varieties that mature the fastest are likely to be the best.

2.3.1.3 Weeding And Pest Control

The cowpea crop produces both leaves and grain for farm households, and both contribute to improving the quality of the diets of farm households. In addition, cowpeas often sell for high prices in rural areas. For example, cowpea grain is often sold for P1.00 per large tea cup full. This may amount to over P100.00 per bag, or more than four times the value of a bag of sorghum.

For these reasons, cowpeas can be considered a high value crop. It is therefore usually worthwhile for farmers to invest extra effort in looking after the crop.

As a first step in this direction, farmers should try to ensure that the cowpeas are weeded promptly to reduce competition for soil moisture and nutrients.

In wet years, the parasitic weed, mololwane, also known as matibilo (Alectra vogelii), has been observed to be a major constraint to cowpea production in some fields. At present there is no easy way to control this weed. Where alectra is a major problem over many years, farmers should switch to another crop.

Aphids have been a major pest on cowpea crops during the last few years, at least. Observations indicate that aphid populations build up during dry periods in the rainy season, but are often greatly reduced by periods of good rainfall. When farmers observe aphid populations starting to build up on their crop, they will often do nothing, and just hope that it will rain heavily before the aphid population does serious damage to the crop. This is a very risky way to proceed, because long dry periods are common during the rainy season. Instead, farmers should be encouraged to spray the crop with dimethoate, using a sprayer from the AD if they do not have their own, as soon as possible after the aphid build up has been observed. Given the value of the crop, and the destructive potential of the aphids, the spraying activity is likely to be quite profitable.

In very wet years, pod sucking insects have been observed. This type of insect can cause severe grain losses when they occur in large numbers and in the early stages of pod development. However, they do not appear to be as common a problem as aphids.

It should be noted that chemicals used to control insect pests can be quite dangerous if not handled correctly, and if proper safety procedures are not followed. Protective clothing and rubber gloves must be worn while using the chemicals. Hands and clothes should be thoroughly washed after spraying. No part of the crop should be eaten for ten days to two weeks after spraying -- depending on the chemical used -- and in any case, crops which have been sprayed should be thoroughly washed before use. A full list of safety precautions should be obtained by the AD and presented to the farmer before spraying is recommended. Safety precautions are usually listed on the chemical container, and can also be obtained from the Regional Agricultural Office. In addition, the proper procedures for chemical storage and disposal must also be obtained and observed. Chemical pest control is only

beneficial when it is used safely, and it is the duty of the person recommending the use of chemicals to ensure that the farmers have a clear understanding of all the safety precautions required. Under the proper circumstances, however, the use of chemicals to control insect pests on cowpeas can be extremely beneficial.

2.3.1.4 Sole Planting

Limited studies comparing cowpeas in intercropping and sole cropping systems have not shown any yield benefits from sole cropping. However, as stated above, cowpeas are a high value crop, and therefore some special attention to cowpea production systems is likely to be profitable. For example, cowpea seed for planting may be more expensive than cereal seeds. Farmers will therefore want to be sure that the seed will give a good stand. To do this, the seed must be planted under the best possible soil moisture conditions, and farmers may want to take the time to row plant the crop. Furthermore, farmers may want to apply fertilizer or manure, and may want to be sure that weeds are well controlled. They may also need to spray the crop at some point. All of these activities will be easier to perform if the crop is sole planted.

Given the high value of the cowpea crop, it would probably be profitable for farmers to invest more time and inputs in cowpeas than they do for cereal crops. It is also easier for them to do this because cowpeas are a minor crop, and could be concentrated on a smaller area. Sole cropping would be necessary for farmers who wish to give special attention to cowpea production.

2.4 SPECIFIC LIVESTOCK ACTIVITIES

2.4.1 CONTROL OF LICE ON GOATS

2.4.1.1 The Problem

Sucking lice, Linognathus africanus, on goats are a common problem in Botswana. These external parasite pests become active and cause their most severe symptoms during the cool dry season starting in May or June. They build up in numbers and increase damage done to goats as the season progresses. They reach their peak in September to November before the weather warms up and the rains start.

Sucking lice cause disease in goats by sucking blood and body fluids from the goat through tiny bites in the skin. This is an especially severe problem in young kids -- most of which are born during the period from July to November -- as their body mass is small and they are not usually receiving adequate nutrition during this time of the year. Numbers of lice on goats can get quite high by October, increasing the damage done, simply by increasing the amount of body fluids removed from the goats.

2.4.1.2 Symptoms

Goats infested with lice will become weak, be poor in condition, anemic (pale pink or white eyes, gums and lips) and are very likely to succumb to other sicknesses, such as infectious diseases, internal parasites, or severe weather stress. The skin in the area between the legs and up on the neck and head will show small grey or blue colored parasites that can be seen to crawl. These can be seen with the naked eye. In addition, the egg cases or "nits",

small white structures, will be attached to individual hairs in this same area. These animals will almost constantly be scratching, due to the itching and irritation caused as these parasites bite while they feed. This itching of the goat will be exhibited as biting or chewing on themselves and rubbing on trees, bushes or the kraal wall.

2.4.1.3 Treatment

Lice are not difficult to control. Almost any insecticide will kill them, but it must be applied regularly. That is, it should be applied about every three weeks for severe infections because lice eggs (nits) may not hatch for 14 to 21 days after they are laid, thus avoiding the effective period of most insecticides.

Lice infestation can be controlled by using the compound Ivermectin which is sold under the trade name "Ivomec". This product will control these pests when injected at a rate of 200 micrograms per kilogram of body weight. This amounts to about:

1 milliliter for adult goats,
0.5 milliliter for yearling goats, and
0.25 milliliter for very young kids.

This will kill all feeding lice, and usually control those hatching in the first two weeks after treatment. The complete herd should be treated to reduce the possibility of transfer to newborn kids. The drug will also control internal parasites (worms), as this is its main purpose.

Any treatment for lice infestation should be carried out at the start of the cool dry season -- late May to late June. The treatment can be repeated again in 14 days if infestation is severe, or can be postponed until late in the dry season, October. This treatment will deal with those parasites carried over through the warm months and reduce problems for the next cool dry season. Treatment should be done at least once a year.

2.4.2 GOAT KRAAL CONSTRUCTION

2.4.2.1 Purpose

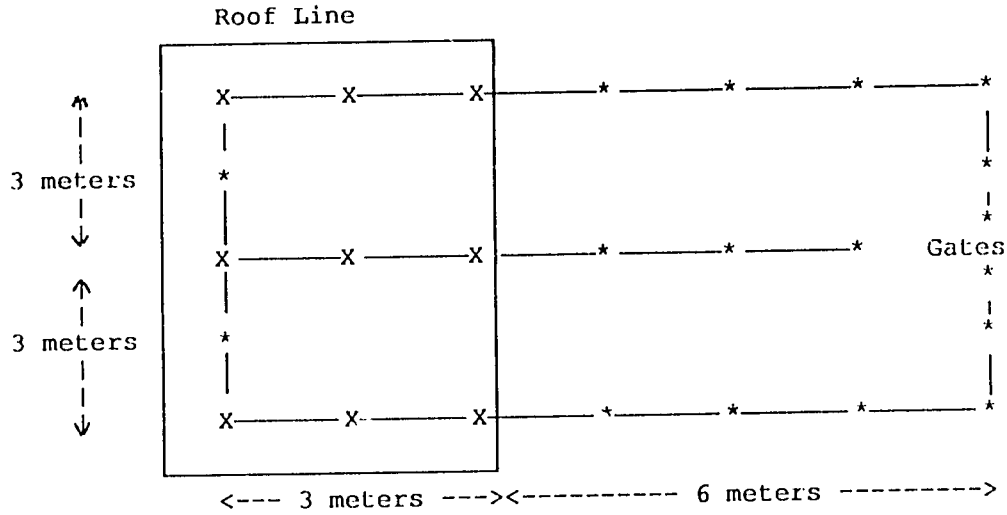
Confinement of animals at night to protect them from predation and straying is a traditional practice. Provision of shelter to protect animals from the environment and storage of feed for later use are technologies proposed to improve the health and productivity of goats.

2.4.2.2 Procedure

The shelter and kraal as drawn in Figure 2.1 constitutes a simple design that is functional and inexpensive, and can be built by farmers or village craftsmen. It will accommodate a maximum of about 50 goats, allowing one square meter per goat. It is divided into two equal sized compounds so that feeding or separation of goats for various purposes can easily be done. The fodder storage area can accommodate 18 cubic meters of fodder or about 720 kilograms of fodder if fairly well packed

FIGURE 2.1: SUGGESTED DESIGN OF KRAAL AND SHELTER

A. VIEW FROM THE TOP



B. VIEW FROM THE SIDE

Using purchased materials as listed in Table 2.2, this structure can be built for about P650.00 based on 1990 prices. If the farmer can cut and collect local material, do the construction and use thatch for the roof, the price can be reduced to under P100.00.

This structure will protect goats and fodder from inclement weather and will contain at least the average sized village herd. It is robust and should last for at least 10 years with minimal maintenance.

TABLE 2.2: AVERAGE REQUIREMENTS AND COST PER ITEM OF BUILDING MATERIALS, FRANCISTOWN, 1990

Roofing -- 4 meters long @ P30.83 per sheet -- 10 sheets	P308.30*
Mophane poles and droppers	P155.00*
4 mm heavy wire @ 0.13t per meter – 150 meters	P 20.10
2 mm tie wire -- 25 kg. @ P66.96 per 50 kg.	P 33.48
Roofing nails -- @ P10.15 per 100 -- 100	P 10.15*
150 mm. common nails -- @ P2.64 per kg. -- 4 kg.	P 8.80
400 mm. staples @ P2.00 per kg. -- 4 kg.	P 10.56
Cement @ P7.99 per 50 kg. -- 100 kg. or 2 bags	P 15.98
Labor	P 75.00*
PRICE WHEN ALL INPUTS WERE PURCHASED	P637.37
IF FARMER DID ALL OR PART OF THE WORK HIMSELF:	
By removing those costs marked *, cost if farmer cuts poles and builds it himself/herself.	P407.37
By removing those costs marked * and ', cost if farmer cuts poles and builds it himself/herself, and uses native thatch or grass for roofing, and collects it and roofs it himself/herself.	P 88.92

Source: ATIP WP 27

CHAPTER 3: APPROACHES

3.1 FARMER INVOLVEMENT

3.1.1 EXTENSION-ORIENTED FARMER GROUPS

3.1.1.1 Purpose

The primary objectives of Extension-Oriented Farmer Groups (EOFGs) are threefold:

(a). To allow technical assistants (TAs) -- that is mainly ADs -- to work with more farmers in a shorter amount of time (i.e., to increase efficiency);

(b). To obtain greater farmer participation in extension activities;

(c). To provide a forum in which extension, research and farmers can work together, at the field level, to address production constraints.

3.1.1.2 Approach

Efficiency is improved through working with groups of farmers instead of individuals. In order to stimulate farmer interest and participation, farmers opinions are sought regarding what problems the group should address. After problem areas are identified, TAs, farmers and scientists work together to develop a range of possible technical solutions to those problems. Then individual farmers select and test the options that are most appropriate for their particular problems, and their own resources. The groups -- farmers, extension and research personnel -- meet monthly throughout the season to exchange information on how the tests are going and discuss ways to overcome problems that arise. During the meetings, all farmers have the opportunity to have their queries discussed by the group, and to contribute to developing solutions for other people's problems. All can learn from the tests that other participants are conducting. As harvest approaches, tests that are showing interesting results can be used for exhibits in a field day. At the end of the season, final assessments are made on how the different technology options have performed, and plans are made for the coming year.

3.1.1.3 Starting And Operating An EOFG

Several important technical steps for starting and operating an EOFG are listed below:

(a). Because the TA will need backup support from the district and regional extension staff, as well as research -- if there is a farming systems team in the region -- it is important that the TA should contact the District Agricultural Officer (DAO), the Regional ALDEP Officer and any regional research officers available before starting the group. These district and regional staff can provide guidelines, technical support, equipment and inputs that will be necessary for running the group.

(b). Once official approval and support for the group has been obtained, the TA should address an open kgotla meeting, explain the purpose of the group, and invite interested farmers to attend an organizational meeting. This should be done in late August or early September, to allow time to organize before the planting season

starts. The date for the organizational meeting should be arranged for a time when the DAO or at least one District Agricultural Supervisor (DAS) can attend. Local research personnel should also be invited to attend.

(c). At the organizational meeting the TA and other government personnel present should try to find out which major topics the farmers are interested in learning about and testing. If there are special topics that extension personnel wish to promote, they may also discuss these with farmers, to see if the farmers are interested in trying them. By the end of the meeting, a list should be developed which includes all the topics that the group will address. Also, a date should be set for the next meeting, where a list of options for addressing these topics will be reviewed and discussed.

(d). Once the list of topics has been developed, the TA should meet with the district staff, the Regional ALDEP Officer and research personnel -- if available -- to discuss what technical options exist to address the topics. For example, if farmers are interested in row planting, then a list of all possible row planters available through ALDEP should be made. These might include Safim Planters, the Sebele Standard Planter, hand row planters, the Sebele Plow Planter, etc. If farmers are interested in fast maturing sorghum varieties, then 65D and 8D might be listed.

Examples of all of these possible items should be collected, so that they can be shown to farmers at the next meeting, and their uses explained. Equipment might be provided through the district office or ALDEP, and seeds and/or fertilizers might be provided through ALDEP. These details can be organized on a case by case basis.

(e). At the next group meeting -- before the planting season -- all of these options should be shown to the farmers. The method of operation should be explained, and the advantages and disadvantages of each should be discussed. This should be done by the TA, but senior officers should also be present to provide backup for the TA.

When all of the technology options have been reviewed with the farmers, each farmer should select which options he or she wishes to test. This can be done during the following week, by asking farmers to record their choices with the TA; once they have made their decisions. The TA should keep a record of farmer selections so as to know what equipment and inputs the group will require during the season.

(f). Once farmers have made their selection, TAs should estimate how much equipment and inputs will be required. For example, if there are three farmers that wish to test the Sebele Plow Planter, then one unit might be enough, since the farmers could share it and test it at different times. However, if there were ten farmers who wish to test the hand row planter, then three hand row planters might be required. Equipment can be shared, but one piece of equipment may not be enough to satisfy the needs of all the farmers who wish to test it.

When farmers are testing equipment, the equipment should probably be provided on a loan basis by the government. However, farmers are usually asked to use their own seed and draft power for these tests. When testing new fodder crops, or new crop varieties, the government may need to provide small amounts of seed (e.g., 1 kilogram, per farmer). The question of which items the government can supply for testing, how much seed or equipment is necessary, and where it will come from, should be decided by the TAs through discussions with district and regional officers.

All inputs to be used in the testing should be collected at the TA's compound in the

village well in advance of the planting season. This is necessary so that the items are available to farmers when the farmers are ready to use them. If the materials are not available when farmers are ready to plant, the farmers will be forced to delay the tests, and may never manage to plant them. A delay at this stage will be frustrating to farmers and will reduce the effectiveness of the group program.

Once farmers have made their selections and the equipment and inputs have been collected at the TA's compound, farmers can start their tests. The TAs should keep good records of the items that each farmer has taken from the compound, and what tests each farmer is doing.

In general, the farmers implement the tests on their own, but the TAs should always be available in case farmers have problems with implementation.

Once the farmers have started their tests, the TAs primary work will simply be to organize and lead the monthly discussion meetings, and to visit the farmers' fields as time allows.

(g). Monthly meetings should be fixed for specific days of the month. For example, the meetings might be held at 9:00 am on the first Friday of every month. This allows farmers to know when the meetings will be, without being called every time by the TA.

Meetings should be attended by the TA (chairperson), farmers, a more senior district level officer and possibly researchers. At each meeting, each farmer participant should have the chance to explain what they have been doing with the trial, state their observations on the technology option in question, and to raise any problems they have encountered. These problems can be addressed by fellow farmers, by the TA, or by more senior staff when necessary. Through these tests and discussions, farmers learn about many different technology options, and can work together to overcome problems encountered in their use.

These meetings can be used for other purposes as well. Other items might include lessons by regional specialists on certain topics (e.g., how to plant trees on National Tree Planting Day), and demonstrations on special topics like spraying for aphid control on cowpeas.

Meetings generally conclude by reconfirming the date of the next meeting.

(h). The TAs should try to visit each farmers' field at least once during the growing season to see how the technologies are performing. Sites that are producing interesting results can form the basis for field days. The TAs can work with district level staff and ALDEP to develop field day programs, organize transport, etc. However, it is usually best to allow the farmers who have done the tests to present their own work to visiting farmers during the field days. This is because farmers tend to learn best from other farmers. Also, a farmer who has done well will usually enjoy the opportunity to show his or her field to other farmers and explain how it was done.

(i). At the end of the growing season, the last meeting should focus on how the various technologies have performed, and what activities the participants would like to try in the coming year.

The TAs should try to record farmers' observations about the various technologies

tested, so that trends can be observed over years.

(j). At this time, also, farmers who have tested certain types of equipment may wish to purchase their own equipment through the ALDEP subsidy scheme. These applications should be processed promptly, so that the farmers can obtain the equipment before the next planting season.

(k). It is important for the TA to keep some records. These can be kept in one large note book. Important items to record include:

i. The names of all farmers participating in the group.
ii. What tests each farmer has done.
iii. The dates when each farmer planted the test, weeded and harvested.
iv. The dates of all group meetings, officers in attendance and the number of participating farmers.
v. Notes on farmers' perceptions regarding the various technologies they are testing.
vi. Final assessments of technologies by the group at the end-of-season meeting.
vii. A list of new equipment purchased by group participants.

As a final note, it should be mentioned that since one of the purposes of the group is to better address farmer needs, the management of group activities should be flexible, and responsive to farmers' interests. For example, if farmers want to meet more often or less often than once a month, changes should be made.

Further, the EOFG approach can be combined with other extension activities. For example, where District Demonstration Farms (DDFs) are being developed, an EOFG could be formed around the DDF, using the DDF as a focus for discussions. The groups can also form a basis for special training courses held at the village level. The TAs should use the group format as a tool for improving the efficiency and effectiveness of the extension system, and for better addressing farmers needs and interests. To do this it will be necessary to adapt the EOFG approach to the local situation.

3.1.2 FARMER TRAINING COURSES

3.1.2.1 Introduction

The extension service in the country is being actively supported by the regional Rural Training Centers which provide in-service training of extension staff and farmers. In the Central Agricultural Region, farmer training at the Mahalapye Rural Training Center has been supplemented by training at village locations, where a camping site is identified by the field extension staff. Farmers often indicate that the village and farm field location creates a good environment for practical training. Of course, participation is easiest for farmers in the immediate vicinity, and as a result their numbers tend to be highest. Below are presented some general guidelines on how farmer training courses in village situations can be organized. Row planting courses are used as an example, since, to date, this theme has dominated farm level Farmer Training Courses that have been offered.

3.1.2.2 Approach

Training needs for courses are identified by the local extension staff. In most cases such

training needs are presented to other interested agencies by the DAO. A committee is in turn formed, to draft a training program to address those specific needs. For example, extension staff in the Mahalapye East District had observed that:

(a). Many farmers who had bought row planting equipment, had never used it.
(b). Many farmers who used row planters, didn't do so effectively.

Therefore, the DAO proposed that farm level Farmer Training Courses on the topic of row planting and inter-row cultivation could help solve these problems.

3.1.2.3 Organizing Farmer Training

Without careful planning it is not reasonable to expect the farm level Farmer Training Courses to be successful. These can involve a great deal of time, resources and collaboration. Some of the major points that need to be considered, are the following:

(a). ***Farmer Selection.*** The responsibility of selecting the target group should be that of the local ADs. In order to try and be fair, one possibility is to have each extension AD bring with him/her two farmers to the course. It is important that farming household representatives attending the courses have ready access to row planters and also preferably inter-row cultivators. Also they should be responsible for supervising and doing the activities on which they receive instruction. For example, men usually do row planting when animal draft is used. However, women are usually responsible for doing any hand weeding. In order to interest farming households in both row planting and mechanical weeding, it has been found advantageous to invite both husbands and wives from the same households, to attend the courses. In order to be cost effective, farmer training should be held for a minimum of 20 farmers, but no more than 50. When the group of farmers is very large, trainers will not be able to communicate effectively and many participating farmers will hesitate to ask questions or be actively involved in the activities of the course.

(b). ***Accommodation.*** It is important that accommodation arrangements be made well in advance. Two options that have been used during training courses to date, have been tents and local schools. What ever accommodation is selected, water and toilet facilities need to be available. Enough food for participants must be purchased. Where present, Rural Training Centers can be very helpful in providing food and cooking it for the participants. However, if a center is to provide such support, it is very important that they are approached well in advance so that funds can be set aside and it can be placed on their schedule of activities. Usually the best time to schedule farm level training courses involving row planting and mechanical weeding operations is just before the rains start.

(c). ***Plot Preparations.*** If a row planting course is to be held the plot may need plowing well in advance so that it is ready when training starts. This may require that plowing be done immediately harvesting is completed, provided the ground is soft enough to permit plowing.

(d). ***Necessary Inputs Made Available.*** In the case of row planting courses, draft animals, yokes/harnesses, planters, cultivators and seed must be available for use by farmers. In the past, Sebele planters and the Mahon inter-row cultivators have been used. Donkeys have been the source of traction with a wide pole used to span the

team for both row planting and mechanical weeding. The wide spacing of the draft animals for planting is most preferred because the animal on the outside of the row is always used as a marker. While wide spacing has been used for cultivation, farmers have also been taught to harness donkeys in a single file. This allows a donkey team to easily walk within a row, hence minimizing damage to the crop. This system is mostly preferred when plants are tall as they may easily be damaged by the pole when it is being dragged by donkeys.

(e). ***Trainers.*** Trainers should include all ADs from the villages of participating farmers. The AD's participation in the training program will enable them to provide more effective extension follow-up and support during the following cropping season. Other trainers should be added as needed. Trainers need to be recruited, who are experienced in the activities to be taught. Such individuals have, in the past, been selected from ALDEP, the DAO's office, Development Trusts, FMIDU and ATIP in the Department of Agricultural Research (DAR), the Rural Sociology Unit (RSU) in the Department of Planning and Statistics (DPS), Rural Training Centers (RTC), and sometimes knowledgeable farmers. It has been observed that experienced farmers are often effective communicators and that other farmers tend to listen to them. Usually one trainer in addition to the ADs from participating villages, for every ten to twelve farmers, will be enough to provide adequate instruction to farmers.

3.1.2.4 Length And Content Of Training Course

A timetable for the course needs to be drawn up, and the contents decided on. For example, the optimal length of a row planting and mechanical weeding course is about three days. In such courses, the following topics have been taught:

(a). A small amount of theory is taught on topics such as: seedbed preparation, optimal planting conditions, row planting versus broadcasting, different types of planters inter-row cultivators, harnesses and yokes, winter feeding of draft animals, etc.

(b). Practical training has included:

i. Instruction on the maintenance and operation of the different planters and inter-row cultivators, especially the types they own.
ii. Practice in selecting the correct seed plate and testing to see if the seed drops and the seed rate is satisfactory.
iii. Practice in hitching up row planters and inter-row cultivators.
iv. Operating the row planters and inter-row cultivators.

Finally training and assessment should not stop with the course itself. As a result, efforts have been made in the row planting and mechanical weeding courses to ensure that:

(a). Extension staff try and keep in contact with the participant farmers after the course, and help the farmers solve problems that arise in applying what they have learned.

(b). DAR research and RSU staff undertake studies to assess the impact of the courses, for example, assessment of how well farmers have applied the information they have learned, in their farming enterprise. Such impact assessments can be important in determining if, and how, future courses should be modified to make them more effective.

3.1.3 CONDUCTING FARMER FIELD DAYS

3.1.3.1 Introduction

Farmer field days can be valuable in a number of ways. For example:

(a). Inviting farmers and other agriculturalists to the field days is a good way of letting people know what is currently being done in the village, with respect to new technologies. At the same time, field days can generate a good deal of interest in the new technologies within the farming community.

(b). Field days are useful for demonstrating how production can be increased through the use of improved technologies, and for encouraging farmers to think about how they can improve their own production systems.

(c). Field visits also provide participating farmers with a chance to show off their efforts, and to explain to the community what they are doing. These visits allow farmers outside the research program to participate in technology evaluation, and to add their comments and ideas.

(d). Field days provide an opportunity for on-station researchers to see how technologies they have developed are performing in the field, to listen to farmers' comments about the technologies, and to get ideas for improvements. At the same time, it gives members of the farming community an advanced look at some of the new technologies being developed, so that these technologies are not totally unfamiliar when they appear in the extension program.

(e). Field days can be a forum for getting on-station researchers, extension personnel and farmers together in the field to discuss specific problems and issues.

(f). Finally field days can help in stimulating competitiveness among farming communities in terms of trying to out-produce each other.

3.1.3.2 Approach

To organize a successful farmers' field day, it is important that the proper preparations are made. Some of the factors that are necessary to consider are as follows:

(a). ***Involving All Interested Parties In Planning And Presentations.*** Participating farmers, local extension and FSR personnel in the area all have a role to play in the planning of, and presentations at, farmer field days. When people are involved in the planning of an activity, they become more interested in ensuring its success.

Farmers participating in the research program and local extension personnel can be involved in the planning in many ways, and can often contribute greatly. For example, they can help select the most interesting fields to visit. Local people in the village can welcome the visitors, and if food is to be prepared, they can help to organize a good location for eating, can help in organizing cooking and eating utensils, cooking and serving the food and cleaning up afterwards. In addition, farmers learn best from fellow farmers, so it is always an advantage, wherever possible, to have individual farmers present the trials on their land to the visitors. Extension personnel and researchers can always add to what the farmer/presenter has said, if they feel important points have been left out.

Extension personnel may actually have items they wish to present during the field day, and may also help by assisting with trucks or vehicles for transporting farmers. Participation by extension personnel in field day activities generally adds to the overall program, and their participation will be more enthusiastic if they are included in the planning and implementation of the field day.

(b). ***Deciding On The Audience.*** The nature of the audience can affect the types of presentations made at field days. For example, if a field day is held only for on-station researchers, the discussions would probably be conducted in a highly technical fashion, possibly by the on-farm researchers themselves. However, if the majority of the audience is made up of farmers, the discussion would probably not be quite as technical, that is, more applied in nature, and presentations of field trials might be done by the host farmers.

(c). ***Arranging Transportation.*** Field days generally involve farmers in a district or districts coming to a particular village lands area to visit the fields, and to observe the trials being carried out.

Transport to the village in question, and around the fields, is generally not a problem for government officials, since they have access to government vehicles. However, it can be a major problem for limited-resource farmers. For this reason, generally the people responsible for the field day should organize transport for the farmers as well -- both to the village and around the fields. Large trucks, busses or four wheel drive vehicles can usually be obtained from the central transport office (CTO), or the Ministry of Agriculture (MOA) pool for this purpose.

(d). ***Logistics.*** The success or failure of a field day depends on careful planning, good organization and constant checking of arrangements. Points to take action on, are as follows:

i. Early in the planning stage, the village headman needs to be contacted about plans to hold a farmers' field day.

ii. In order to have good attendance, the date of the field day must be decided upon well in advance. The same applies for the selection of an audience (see (b) above).

iii. As soon as the audience is selected and the date set, the prospective audience must be informed of the date and invited to attend. The more time allowed for people to fix their schedules and organize their affairs, the more people will be able to attend. For example, it is not useful to invite people to a field day two days beforehand, because they will have planned other activities for that date.

iv. The organizers must work with farmers to choose which fields to visit. This needs to be done early, to allow time to select the most appropriate fields. For example, one way is to choose fields which:

-- Represent the type of work being done,
-- Show off promising results from improved technologies, or
-- Provide examples of certain specific problems which can then become a focus for discussion.

v. If food is to be provided for the visitors, this also requires careful attention.[7] First it is necessary to estimate how many people will attend. Then it is important to decide on a menu. This is usually done together with farmers in the host community. After that the amount of food required can be roughly calculated. It is better to have too much than too little. The organizers have to purchase the food, find people to do the cooking, organize pots, plates, cups, knives and forks (usually possible through the local primary school), identify a place for the meeting, and know what to do if it rains. All of this needs to be done in advance.

vi. In any case, whether food is provided or not, the organizers need to ensure that water is available for people to drink in the field during the field tour. People will find it difficult to concentrate, and will be quite uncomfortable and want to leave the field, if they are allowed to become thirsty.

vii. When planning a field day, it is necessary to develop a program or schedule for the day. This informs the participants about what is happening, and also allows the organizers to make sure there is sufficient time allotted to cover all the important items. Before finalizing the schedule, shortly before the field day, the organizers should drive around to all the fields they expect to visit during the field day. This will allow the organizers to estimate the travel time required between the fields, and also ensures that there are no surprises on the day of the visits. Once this is done, the organizers can determine exactly how many field visits can reasonably be included.

viii. Field days should start with an introduction of important visitors and an overview of the work involved in the program. A discussion of the day's schedule needs also to be included. Time should be allowed at the end of the day for some final discussion of what the visitors have observed, some concluding remarks, and thanks to the visitors for attending.[8]

3.1.4 COMPETITIONS AT AGRICULTURAL SHOWS

3.1.4.1 Introduction

Organizing competitions on agricultural techniques for arable farmers at Agricultural Shows can help to stimulate interest in adopting improved technologies. One convenient focus is on the techniques of row planting and mechanical weeding. Such competitions can be

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7. There are a number of ways in which meals can be paid for. For example, it might be possible for the farmers themselves to make contributions, for the meals to be financed and provided by the local Rural Training Center, or for the meals to be financed by ALDEP.

8. In terms of the length of time to be spent on different activities, the following times have been found to be satisfactory: opening session not starting too early and lasting for 30 minutes; allow about 45 minutes to an hour for each field visited, plus whatever travel time is required between fields; allow about one hour for lunch, if lunch is planned; allow about 30 minutes to one hour for a final discussion of the day's observations and closing remarks, and; allow enough time at the end of the program for visitors to be off the roads before dark.

entertaining, yet at the same time convey the message that adopting relatively complex improved technologies is not only possible, but is also rewarding for the adopter.

Participation in the contest may also act as a reward for farmers in extension areas who are practicing row planting. District Agricultural Show contests can hopefully determine who is the best row planting farmer in each district. When enough districts hold their own contests, district champions could then perhaps compete with each other for the title of the National Row Planting Champion.

3.1.4.2 Organizing A Competition

To organize a successful competition there is a great deal of preparatory work required to ensure smooth implementation on the day of the Agricultural Show. Some of the steps that are necessary, are the following:

(a). An Organization or Working Committee needs to be formed well in advance, to assign responsibilities and coordinate preparation and activities. All agencies that contribute in some way to the competition should be represented, with the chairmanship being held by the ALDEP representative. Possible examples of representatives, in addition to ALDEP, are the DAO, and staff from the RTC, Agricultural Information Services, and the Department of Agricultural Research.

(b). In order to be able to have a successful competition and ensure preparation and implementation does not become a burden to too few agencies/individuals, it is important for the Organizing Committee to allocate responsibilities. These should be assigned according to the expertise and skills of the different individuals/agencies.

(c). The responsibilities that will need to be assigned include, but are not necessarily confined to, the following:

i. Contestants, usually about six per Agricultural Show, need to selected by ADs, as the best row planters in their extension areas. The contestants are expected to provide their own donkeys for the contest. As indicated, ADs should have primary responsibility for selecting suitable contestants. However, the DAO's office could play a supportive role and possibly APRU in DAR could provide transport for the animals -- usually donkeys.

ii. The Agricultural Show Committee needs to be approached for permission to stage the contest and to allocate a time slot and land for the purpose. ALDEP or the DAO could possibly be assigned this responsibility.

iii. The evaluation and judging criteria are agreed to by all parties, and are adequately explained to the contestants. All the Organizing Committee members would be involved in these activities.

An example of the type of criteria and the points to be awarded which has been used in recent row planting and mechanical weeding contests is given in Table 3.1.

TABLE 3.1: SUGGESTED SCORING SYSTEM FOR ROW PLANTING CONTESTS

TASK	POINTS POSSIBLE	POINTS OBTAINED
Seed plate setting	0-10	_____
Correct hitching	0-10	_____
Speed of row planting	10	_____
Quality of row spacing	0-10	_____
Straightness of rows	0-10	_____
Seed placement	0-10	_____
Mechanical weeding speed	10	_____
Quality of mechanical weeding	0-10	_____
Handling of donkeys	0-10	_____
General knowledge on row planting	0-10	_____
TOTAL POINTS		_____

iv. Accommodation and food needs to be arranged for the contestants. Also, due to the novelty of the event, it is probably desirable to rehearse with the potential contestants the various steps they will need to perform during the contest. The RTC can often help with these arrangements and the rehearsal.

v. The land at the Agricultural Show needs to be properly prepared and demarcated; the necessary equipment assembled; kraals constructed and food and water made available for the animals; and the appropriate fencing, posters and banners put up. Also flags -- 50 centimeter lengths with pieces of plastic stapled at one end -- need to available to demarcate plants for the mechanical weeding operation. The site also provides a convenient place to put on show other technologies linked with row planting, such as forages for preparing animals for plowing and planting activities, different types of planters, etc.

In terms of preparing the site, experience has shown that a barrier needs to be built around the contest area to prevent the audience from coming too close to the contestants. When constructing the barrier it is important that enough room is left at the headlands for easy turning of animals. In terms of size, a sub-plot of 10 meters by 30 meters appears to be satisfactory for each contesting team. The plot needs to be plowed in advance while the ground is still moist. Late plowing results in having to wet the ground before plowing, which involves a great deal of additional work. Sometimes the plot may need to be leveled a day before the contest, to remove all the traffic that may have occurred. Sub-plots need to be marked with lime indicating the boundaries. The distance between the sub-plots should be at least two meters.

Primary responsibility for undertaking these time consuming tasks can probably best be assigned to ALDEP and the DAO's office with a possible supportive role being provided by research staff.

vi. Appropriate judges need to selected. Any Organizing Committee members plus other knowledgeable individuals -- including farmers -- could be nominated for this task.

vii. A commentator needs to be chosen and provided with an appropriate sound system and introductory commentary notes on the contest and contestants.

Some ideas on points to include in this background material are:

-- Criteria for farmer selection.
-- Resources farmers are expected to bring with them.
-- How the judges will adjudicate.
-- What the theme of the contest is.
-- Other items that are on demonstration but are linked to the theme.

Any member of the Organizing Committee can be assigned the responsibility for providing this information, while the Agricultural Information Service in the Ministry of Agriculture has, in the past, proved to be very helpful in providing the commentator and sound system.

viii. Appropriate prizes need to obtained and arrangements made for presenting them to the contestants. ALDEP is currently in the best position to arrange for the prizes.

3.1.4.3 Concluding Point

Although ATIP played an important catalytic role in getting the row planting contests started at Agricultural Shows, it is not considered appropriate that it should continue to play a leadership role. Consequently it was recently proposed that ALDEP would take-over this role. This has also recently been supported by those attending a meeting of research and extension staff in the Central Agricultural Region, which was chaired by the Regional Agricultural Officer (RAO)."

Therefore it is reasonable to expect that this suggested guideline for organizing competitions at Agricultural Shows might be modified as a result of ALDEP taking over the leadership role.

3.2 ENCOURAGING COOPERATION

3.2.1 COOPERATION BETWEEN FARMING SYSTEMS RESEARCH AND STATION-BASED RESEARCH

3.2.1.1 Justification

Both on-station (i.e., experiment station-based) and FSR are needed in order to develop improved technologies suitable for limited resource farmers. This is because they perform different activities and therefore are complementary to each other, rather than substitutes for each other. One major difference between them is that while station-based research primarily concentrates on creating new technologies (i.e., applied research), FSR focusses on helping to adjust technologies to specific environmental conditions (i.e., adaptive research). In this connection, FSR can also help feedback information about future priorities for applied research to station-based researchers.

Table 3.2 illustrates some of the major differences between on-station and FSR, and in doing

". Held in Mahalapye on May 2nd, 1990.

so, shows why both types of research are necessary.

TABLE 3.2: SOME DIFFERENCES BETWEEN STATION-BASED AND FARMING SYSTEMS RESEARCH

CHARACTERISTIC		STATION-BASED RESEARCH	FSR
Location of trial		Usually experiment station	Usually on-farm
Disciplines involved		Often single Mostly technical	Usually several Technical and social
Priority setting for trial:	Researcher	More involved	Less involved
	Farmer	Less involved	More involved
Experimental design:	Complexity	Usually more	Usually less
	Management	Researcher	Researcher or farmer
	Implementation	Researcher	Researcher or farmer
Degree of experimental control		More	Usually less
Evaluation of trial results -- Factors taken into account:			
Systems perspective		Less likely	More likely
Technical feasibility		Yes	Yes
Economic viability/reliability		Less likely	More likely
Social acceptability		Less likely	More likely
Farmer opinion		Not likely	More likely
Expense of experimental program:			
Fixed (overhead) costs		Likely to be higher	Likely to be lower
Variable (recurrent) costs		Likely to be lower	Likely to be higher

3.2.1.2 Types Of Cooperation

Given the potential importance of interaction between on-station and FSR there are a number of strategies that are currently pursued to try to ensure that constructive interaction takes place. Some of the strategies are listed in Table 3.3. As can be seen, there are varying degrees of collaboration. Also there is some potential overlap between the various activities. For example, participation in the research program team meetings can result in visits by station-based research scientists to the field to visit plots, address farmer groups about specific technologies, and cooperate in joint trials.

Obviously collaborative work represents the most intensive form of interaction between station-based and FSR. The highest level of collaboration is where there is joint responsibility for specific trials, studies or surveys. This is the most desirable form as it eliminates the division between station-based and FSR. As a result of this collaboration, there is less chance of miscommunication, and a greater chance that the results will be accepted by all concerned.

In recent years there has been increasing emphasis on collaborative work in addition to improvements in communication and joint visitation. Collaborative work should continue to develop further as the Program Research Teams in DAR become more effective.

3.2.1.3 Role Of Research-Oriented Farmer Groups

The Research-Oriented Farmer Group (ROFG) approach can be a useful tool for facilitating collaboration between FSR and station-based research. The ROFGs can encourage on-station research programs to participate in FS-type research in several ways. These include:

(a). ROFGs have a flexible format which makes it easy for the on-farm research program to respond to the needs of on-station commodity research teams, in terms of their needs for the on-farm evaluation of technologies they are developing.

TABLE 3.3: TYPES OF COOPERATION BETWEEN STATION-BASED AND FARMING SYSTEMS RESEARCH

NATURE OF COOPERATION	---- DEGREE OF COMMITMENT ------ STATION-BASED RESEARCHER	FSR RESEARCHER
A. Mainly Communication:		
Circulating papers on work programs and results to interested parties	Low	Low
Research program team meetings	Some	Some
B. Visits:		
By station-based researchers to farmers' fields, to address farmer groups (ROFGs), to give advice in identifying and solving problems, etc. -- usually at the invitation of farming systems researchers	Some	Low
By farming systems researchers to experiment station-based researchers	Low	Some
C. Collaborative work:		
Surveys undertaken by farming systems researchers to address specific issues raised by station-based researchers -- sometimes latter help in design, implementation, etc.	Some	Much
Farmer evaluation of technologies station-based researchers are interested in, e.g., crop varieties, implements, etc.	Some	Much
RMRI trials undertaken on experiment station to address issues raised by farming systems researchers	Much	Low
Joint responsibility for designing, implementing and evaluating on-farm trials by FS and station-based researchers	Much	Much

(b). The format allows for a rapid appraisal of how new technologies will perform under farmer management -- over many farms, not just one or two -- and can provide quantitative data on yield levels and farmers' perceptions of the technologies.

(c). The system also allows on-station researchers to discuss new technologies with large numbers of farmers at one time -- through the group meetings. This can provide a source of new ideas for important technological developments.

The FSR team can also benefit from this interaction with station-based researchers in that:

(a). The station-based commodity research teams act as a source of new technology options for the FSR program.

(b). The interaction will help ensure that the FSR activities are better understood on-station. This can help to generate more support for the on-farm work among station-based researchers.

The potential improved collaboration between FS and station-based research, that can be created by the ROFGs, will only be realized if:

(a). The ROFGs are used to fully support the needs of station-based research teams.

(b). Station-based researchers visit the FSR programs to observe the farmers' trials, and discuss results with farmers and FSR teams.

(c). The FSR teams return useful data and suggestions to the station-based research teams in a timely and professional manner.

3.2.2 COOPERATION BETWEEN RESEARCH AND EXTENSION

3.2.2.1 Justification

Since research and extension staff are located in different departments, special efforts have to be made if collaboration is to develop. The most pressing need is for collaboration at the highest levels, but collaboration between farming systems researchers and extension staff at the regional level can also be very useful. Such collaboration is desirable because:

(a). Extension staff possess substantial knowledge about the area where they are posted, and know many of the farmers personally. This local knowledge is invaluable to farming system researchers in their diagnostic, design and testing work.

(b). Farming system researchers interact with small numbers of farmers -- though representative of a much larger number of farmers -- while extension staff have a mandate to work with all farmers. In a sense, the extension service provides a conduit for FSR teams to reach farmers as a whole. Therefore interaction between FSR teams and extension staff can help provide a multiplier effect for FSR work, can assist in providing extension staff with relevant messages to disseminate, and can help extension staff in developing appropriate methods and systems for disseminating technologies to farmers.

In reviewing the types of activities that can relate to (a) and (b) above, it is apparent that those relating to (b) are much more compatible with the job descriptions of most extension staff, and are therefore easier to collaborate on. In contrast, those activities that relate more to (a) above, are harder to cooperate on, since they are less compatible with the job descriptions of field level extension staff. Availability of free time and enthusiasm on the part of individual extension staff are important criteria in determining whether collaboration will take place with reference to activities relating to (a) above.

There are, currently, two positive strategies being used to encourage coordination between research and extension in Botswana. These are:

(a). At the national level, a Research Extension Liaison Office (RELO) has an important potential role to play not only in improving interaction between DAR and the Department of Crop Production and Forestry, at the national level, but also between research and extension in the various regions.

(b). Within the regions, mutual recognition on the part of extension and research (i.e., FSR) personnel of the benefits of interaction has led to the development of informal linkages which have received the support of the leadership in senior research and extension staff at the headquarter level. Hopefully, over time these linkages will become more formalized thereby moving away from the more informal linkages which have been based on personal relationships.

3.2.2.2 Types Of Cooperation

Some of the cooperative activities that can be established between on-farm research teams and extension staff, are described in Table 3.4. The number and range of collaborative activities have increased over the years. These activities have involved varying levels of commitment, and have often resulted in promoting further collaborative efforts. Once again

there is considerable potential for the overlapping of activities. For example, consultation activities have lead to collaborative activities, while farming systems researcher participation on a supportive basis, in dissemination-type activities, may lead to new items for the research agenda. In recent years, emphasis has been given to pursuing activities requiring higher levels of commitment from both research and extension (i.e., collaborative and dissemination-type activities). This trend needs to continue.

When allocating responsibilities in cooperative activities, it is important for the cooperating groups to recognize and take into account the mandates and skills of each group. For example, farmer training courses should be run by extension staff, while researchers play supportive roles. On the other hand trials designed to test technologies are often best done under the direct control of research staff with extension staff playing supportive roles.

TABLE 3.4 TYPES OF COOPERATION BETWEEN EXTENSION STAFF AND FARMING SYSTEMS TEAMS[a]

NATURE OF COOPERATION	DEGREE OF COMMITMENT	
	EXTENSION	RESEARCH
A. Consultation		
Discussion of work program – proposals and results – with regional extension staff and other interested parties in the region, e.g., ADEP, NGOs,[b] etc	Low	Some
Attendance, when desirable, by farming systems research staff at regional extension meetings and district monthly management meetings	Much	Some
B. Visits:		
Local extension staff help in organizing village kgotla meetings to present proposals and results of on-farm research work programs	Some	Some
By senior extension staff to trials undertaken by on-farm research teams	Low	Some
Attendance by extension staff at farmer field days – sometimes help in organization	Low	Some
C. Work Program Collaboration:		
Secondment of locally stationed extension staff to the farming systems research teams to help in implementing all the activities of the farming systems research team.	Much	Some
Joint planning, implementation and evaluation of trials, e.g., National Tillage Trials	Much	Much
D. Dissemination		
Participation by farming systems research staff in in-service training courses for extension staff	Much	Some
Supportive role by farming systems research staff in organizing competitions at agricultural shows to encourage adoption of improved technologies	Much	Some
Supportive role by farming systems staff in extension oriented farmer groups	Much	Some
Supportive role by farming systems research staff in helping extension staff in "hands on" training of farmers to adopt improved technologies	Much	Some

a Some of the activities listed in the table are the subject of other Guidelines, for example, organizing competitions at Agricultural Shows (Section 3.1.4), organizing Farmer Field Days (Section 3.1.3), organizing Farmer Training Courses (Section 3.1.2), and running Extension Oriented Farmer Groups (Section 3.1.1)

b Non-Governmental Organizations, e.g., Development Trusts, Brigades, etc.

3.2.2.3 Role Of Research-Oriented Farmer Groups

It is important for extension personnel to participate in research activities because, as indicated earlier, they can help researchers to be aware of and understand farmers' problems, and also because they are expected to pass research findings onto the farming community. They will do a better job of this if they have participated in developing the recommendations.

The Research-Oriented Farmer Groups (ROFG) provide one useful option for integrating research and extension at the field level.[10] They are useful because:

(a). They allow extension agents in research villages to participate in regular meetings with farmers and researchers. Through these meetings, the extension agents can participate in the development of new ideas and new technologies, and can observe the effectiveness of new technologies over years.

(b). The joint organization of field days -- to exhibit ROFG activities -- allows extension personnel, based in the region, to become familiar with new technology options, as they develop. The field days also allow regionally-based extension personnel to discuss the new technologies with farmers, and to evaluate their effectiveness, before taking those technologies into the general extension program.

Thus the ROFG approach allows for extension input into research programs and helps to ensure that extension personnel are familiar with, and confident of the new technology options they decide to extend to farmers.

3.3 TECHNIQUES

3.3.1 ESTIMATING TSWANA GOAT WEIGHT WITH A TAPE MEASURE

3.3.1.1 Purpose

Scales for weighing animals for selling, dosing or recording growth and development are expensive and not readily available in rural areas. As farmers become more involved with smallstock production and markets for meat and milk develop, a need for some system to estimate body weight becomes more important. The use of a common sewing tape measure, readily available for approximately P1.50, can help to solve this problem.

3.3.1.2 Procedure

In order to estimate Tswana goat weight, the tape is used in combination with the table of estimated weights as given in Table 3.5. The table is divided into four categories:

(a). Birth to three months old.
(b). Females over three months old.
(c). Males over three months old.
(d). Male castrates over three months old.

After measuring the heart girth circumference, go to the table, select the proper category of animal and look up the estimated weight opposite the measurement. This will give an excellent approximation of the weight of that animal.

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[10]. Extension-Oriented Farmer Groups (EOFGs) where extension staff play more of a leadership role, are discussed in another Guideline -- see Section 3.1.1.

TABLE 3.5: ESTIMATED WEIGHTS FOR TSWANA GOATS BASED ON HEART-GIRTH MEASUREMENTS, TUTUME AGRICULTURAL DISTRICT, 1989

HEART GIRTH	0 TO 3 MONTHS	GOATS OVER 3 MONTHS		
	WEIGHT	FEMALE WEIGHT	MALE WEIGHT	MALE/CAST WEIGHT
CM	KG	KG	KG	KG
25	1.8			
26	1.9			
27	2.1			
28	2.2			
29	2.4			
30	2.6			
31	2.9			
32	3.2			
33	3.6			
34	3.9			
35	4.2			
36	4.5			
37	4.8			
38	5.1			
39	5.4			
40	5.7			
41	6.0			
42	6.3	6.7	9.7	8.8
43	6.6	7.3	10.0	9.1
44	7.4	7.9	10.3	9.4
45	7.9	8.5	10.7	9.7
46	8.3	9.2	11.0	10.0
47	8.7	9.8	11.4	10.3
48	9.1	10.5	11.8	10.7
49	9.5	11.2	12.3	11.1
50	10.0	11.9	12.7	11.6
51	10.4	12.6	13.2	12.0
52		13.3	13.7	12.5
53		14.0	14.3	13.1
54		14.8	14.9	13.6
55		15.5	15.5	14.2
56		16.3	16.1	14.8
57		17.1	16.7	15.4
57		17.1	16.7	15.4
58		17.9	17.4	16.1
59		18.7	18.1	16.8
60		19.6	18.8	17.5
61		20.4	19.6	18.2
62		21.3	21.4	19.0
63		22.3	21.2	19.8
64		23.0	22.0	20.7
65		23.9	22.8	21.5
66		24.9	23.7	22.4
67		25.8	24.6	23.3
68		26.7	25.6	24.3
69		27.7	26.5	25.2
70		28.7	27.5	26.2
71		29.7	28.5	27.5
72		30.7	29.6	28.3
73		31.7	30.6	29.4
74		32.7	31.7	30.5
75		33.7	32.8	31.6
76		34.8	34.0	32.8
77		35.9	35.1	34.0
78		37.0	36.3	35.2
79		38.1	37.6	36.5
80		39.2	38.8	37.8
81		40.3	40.1	39.1
82		41.4	41.4	40.4
83		42.6	42.7	41.8
84		43.8	44.0	43.2
85		44.9	45.4	44.6
86		46.1	46.8	46.0
87		47.4	48.3	47.5
88		48.6	49.7	49.0

Source: ATIP WP 30.

The technique of measuring is as follows:

(a). The tape measure used to estimate heart girth should be placed around the rib cage just behind the elbow of the front legs.

(b). The tape should be snug, but not loose or pulled tight.

(c). If the animal is not relaxed, allow it to do so and take several measurements using the most consistent one for the estimation.

It is important to understand that there are several limitations in using this approach to estimating weight. Some of these are as follows:

(a). Animals in advanced pregnancy may be heavier than the estimated weight in the table.

(b). Animals in very poor condition or very heavy condition may not be accurately estimated by this technique.

(c). If animals are over filled with feed and/or water, estimates will be low. It is best to

use this technique after they have been kept away from feed and water for several hours.

(d). The extremes for each range of estimated heart girth measurements and the corresponding weight estimates -- smallest and largest heart girths -- will not be as accurate as those near the middle.

(e). One-half centimeter measurements were ignored in the processing of the data. If half centimeter measurements are to be used in estimating weight, it can be done by splitting the difference between the two weights indicated on the table.

In conclusion, it would be desirable to make additional observations on the relationship between heart girth measurements and weight estimates before finalizing this as a technique. In any case, it is thought that the technique is potentially adequate for farm or village use, but it may not be suitable for station research where accurate weight measurements are often critically important.

3.3.2 USE AND CARE OF THE BLOODLESS CASTRATOR (BURDIZZO)

3.3.2.1 Description

The bloodless castrator should only be used for the specific purpose of obtaining a bloodless castration. This tool may be purchased in four different sizes, from a 23 centimeter (9 inch) size for very young smallstock up to the 48 centimeter (19 inch) model designed to be used on large mature animals, both cattle and smallstock.

There is a crutch attachment that may be fitted to the three larger sizes. This enables the operator to use one hand and his knee in order to free the other hand to properly feel the tissues to be crushed. This reduces the possibility of mistakes and unnecessary injury. In Figure 3.1 depicts how to use the bloodless castrator.

3.3.2.2 Use Of The Instrument

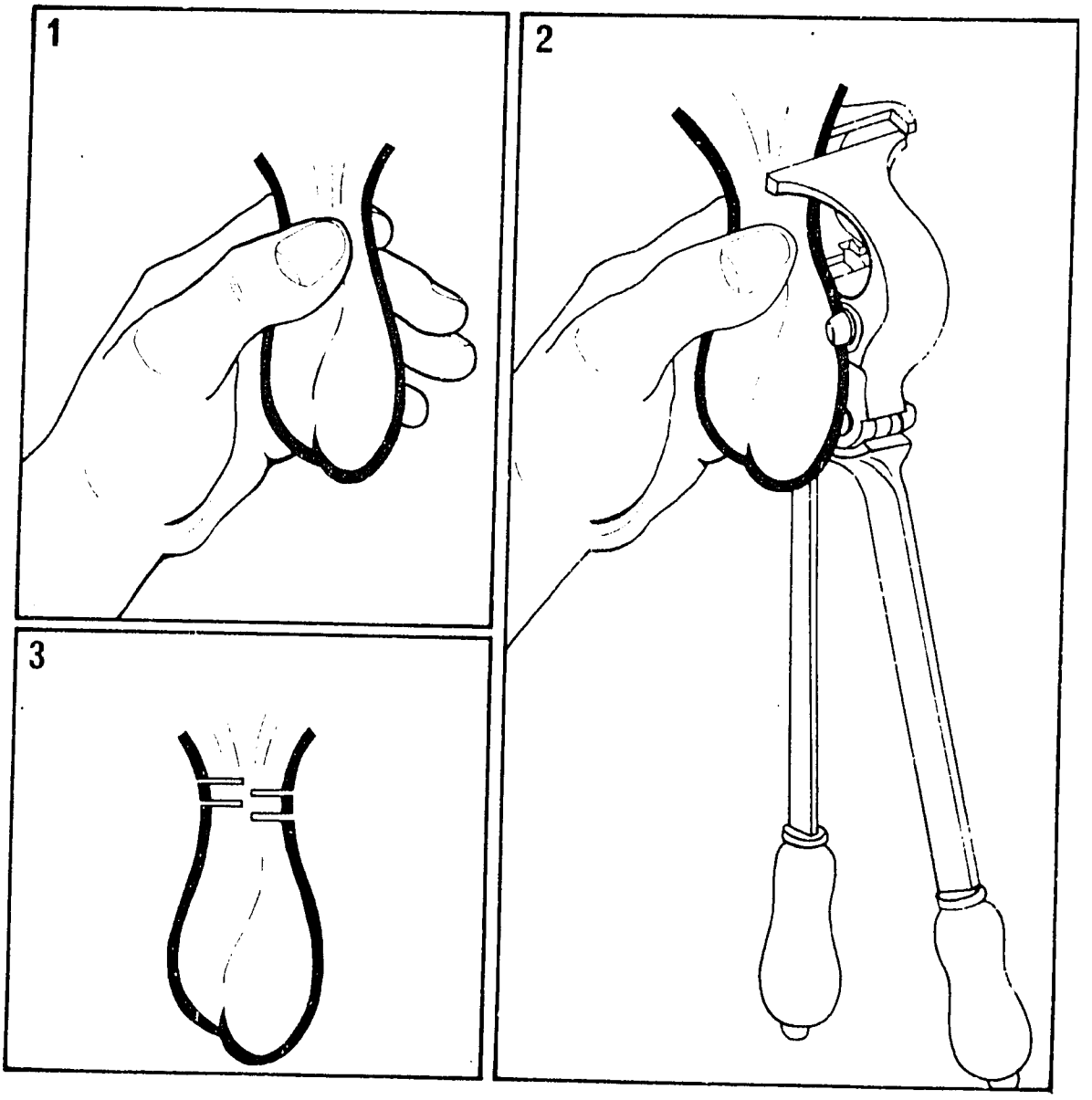
The correct procedure for using this instrument is as follows:

(a). Each cord should be crushed separately and at a different level. This procedure will destroy the blood and nerve supply to the testicles and not interfere with the blood vessels or nerve supply to the lower scrotum or bag. This will prevent the massive swelling and loss of tissue commonly seen when this instrument is not used correctly. Diagram 1 in Figure 3.1 shows the testicle being pushed into the base of the scrotum and the spermatic cord being pushed to one side.

(b). The instrument should be placed on the scrotum as shown in Diagram 2. The cord should be pushed toward the inside of the leg and the instrument placed so it crushes only one cord and so that only one-half of the face of the instrument is in contact with the scrotum.

(c). The cord stop prevents the cord from escaping the jaws of the instrument and holds it in the proper place.

FIGURE 3.1: OPERATING THE BLOODLESS CASTRATOR (BURDIZZO)



Source: *Agrinews*, 1975.

(d). Bring the handles together tightly until there is a "click", which indicates complete closure of the instrument. Squeeze as little of the bag as is possible -- approximately one-quarter of the width of the scrotum. Leave the instrument closed for a few seconds.

(e). By feeling with the fore finger and thumb it is possible to check if the cord is broken.

(f). Repeat the procedure on the other side of the bag, that is, crushing and breaking the other cord. Diagram 3 shows how the Burdizzo marks should appear after the operation is completed.

(g). Remember, this instrument is designed for bloodless castration. It is not a rapid procedure and is only as efficient as the operator of the instrument.

(h). Precautions to take are as follows:

i. Crush only one cord at the time.

ii. Do not clamp completely across the scrotum -- bag or sack.

iii. Make sure the penis is not in the jaws of the instrument. If this organ is crushed the animal will usually die.

iv. Do not include more than one-quarter of the sack with each cord.

v. Leave the instrument in place in the closed position for a few seconds. check with your thumb and fore finger to see if the cord is crushed and broken.

vi. Take time and be careful.

3.3.2.3 Care Of The Instrument

The instrument requires very little in the way of care. The most important thing to remember is never to use it on anything except flesh. If it becomes sprung, or the jaws do not come together correctly it will not work correctly. If the spermatic cords are not both crushed, the animal will still be intact and capable of showing breeding behavior even though it may not be capable of producing offspring.

The instrument should be cleaned carefully with soap and water after being used, and dried carefully before being stored after use. It is also a good idea to place a drop or two of fine machine oil, like that used on sewing machines, at each of the four joints of the instrument. With this kind of care and providing it is not misused, this instrument will last for 30 years or longer.

APPENDIX A: REFERENCES

ATIP WP 27. Thedford, T., K. Kelemogile, F. Worman, and J. Baathgodi. "Techniques and Considerations for Kraal and Shelter Construction for Smallstock". June 1990.

ATIP WP 30. Worman, F., T. Thedford, K. Kelemogile, and J. Baathodi. "Heart Girth Measurement as an Estimate of Weight for Tswana Goats". June 1990.

Anon, 1975. "The How, Why and When of Castration". *Agrinews.* Gaborone: Agricultural Information Services, MOA.

APPENDIX B: ACRONYMS

AD	Agricultural Demonstrator
ALDEP	Arable Lands Development Program
APRU	Animal Production Research Unit
ATIP	Agricultural Technology Improvement Project
CTO	Central Transport Office
DAO	District Agricultural Office(r)
DAR	Department of Agricultural Research
DAS	District Agricultural Supervisor
DDF	District Demonstration Farm
DPS	Division of Planning and Statistics
EOFG	Extension-Oriented Farmer Group
FMDU	Farm Machinery Development Unit
FS	Farming Systems
FSR	Farming Systems Research
kg	Kilogram
IITA	International Institute for Tropical Agriculture
MDP	Malapo Development Project
mm	Millimeter
MOA	Ministry of Agriculture
RAO	Regional Agricultural Office(r)
RELO	Research Extension Liaison Office(r)
RIP	Rotary Injection Planter
ROFG	Research-Oriented Farmer Group
RSU	Rural Sociology Unit
RTC	Rural Training Center
ST	Secondary Tillage
TA	Technical Assistant
USA	United States of America