ANNEX 1A

REPORT ON PRELIMINARY STUDIES FOR THE ZIMBABWE STOVER RESEARCH PROJECT, 1.10.97-13.10.97

Project A0730

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INTRODUCTION

1. This report describes the author's visit to Matopos Research Station, Zimbabwe, in connection with the research project on "Effects of harvest and post-harvest practices on the production and nutritive value of maize and sorghum stover". The objectives of the visit were to carry out studies on socio-economic factors influencing stover storage in the study sites identified, and to design socio-economic monitoring of sample households that could be carried out within the resources of the project, and integrated with sampling for mycotoxin surveillance and nutritive value assessment.

2. MRS staff had previously identified Golati Ward, to the northeast of the Matopos National Park, and Halale Village, Dema Ward, southwest of the Park, as study areas. Both form part of the Kumalo Communal Area, and agroecologically fall within Natural Region IV. During the study of Golati, it became clear that it was probably not a suitable site for the project, and a group meeting confirmed that Halale was probably sufficiently similar for it also to be disqualified.

3. Accordingly, short visits were made to two sites in the lowveld or Natural Region V, Sigangatsha and Bidi, both in Semukwe Communal Area, and approximately 120 and 100 km respectively south of MRS.

4. The key recommendation of this report is that MRS staff carry out further exploratory studies of a wider range of sites, including further sites adjoining the National Park, sites in the lowveld, and possibly sites further east. A checklist/questionnaire for this work is annexed.

Methodology

5. After an introductory meeting with a group of farmers in Golati on their rest day[1], we carried out a series of individual semi-structured interviews with eight farmers chosen by the Extension Worker. These were intended to give a picture of both the geographical and the economic diversity within the ward, although almost certainly, the majority of those interviewed were more than averagely wealthy. Interviews covered:

[1] Wednesday is a traditional rest day in rural Ndebele communities

- The calendar of crop production and other agricultural activities
- Varieties of maize and sorghum planted
- Acreages of different crops planted
- Calendar of animal feed sources
- Calendar of labour demand
- Harvesting and storage of stover
- Condition and management of veld grazing
- Seasonal changes in animal conditions
- Livestock production objectives
- Social differentiation

6. The calendar of animal feed sources was prepared as a matrix. Originally we asked informants to score the relative importance of feeds within each month, but this proved difficult and probably unnecessary to do in a systematic fashion. Livestock production objectives were investigated by asking informants to sort cards, bearing pictures and the Sindebele words for the major possible objectives.[2]

7. A single group interview in Halale, also on a rest day, covered most of the above topics, as did individual interviews with one farmer each in Sigangatsha and Bidi.

8. In all, six women, three men and one couple were interviewed individually, and both group interviews were mixed. It is very common to find women as de facto farm managers in the area, partly due to male labour migration.

FINDINGS

Study Areas

9. Golati ward, a grouping of seven villages with a total population of around 7000, is distinguished by relatively easy access to Bulawayo, and a very high water table, with residual soil moisture throughout the year. Despite the extremely sandy soil, these factors have allowed a certain commercialisation of agriculture, at least among wealthier households, including an interest in the potential development of dairying, and the adoption by some households of bana grass cultivation.

10. The lowveld sites are considerably more arid, more at risk from drought, and lack the market access of Golati. However, human population densities are lower, and livestock numbers per capita higher. These particular lowveld areas are greatly affected by the labour migration, principally of young men, to South Africa.

[2] Meat, milk, cash, manure, ploughing, transport and lobola (bridewealth)

Social differentiation

11. Most informants admitted that there was a substantial degree of social differentiation in their area, as witnessed by differences in livestock holding (but some informants noted that stockloaning customs made it difficult to judge a household's real wealth), possession of farm implements, nutrition, and state of housing. Most people in Golati thought that it was hard work on the farm that made the difference between rich and poor,[3] although some also mentioned the importance of *householders* having paid work in Bulawayo, or pensions. It was denied that *adult children* working in Bulawayo added to the prosperity of the rural households - if anything they were seen as a drain.

12. In the lowveld, the two informants spoke about social differentiation in rather different terms. One saw wealth as mainly a matter of luck, the other spoke of a poor person being able to collaborate with his neighbours and therefore benefit from customs like *amasiso* (traditional stockloans) and eventually become wealthy.

Livestock species, numbers and production objectives

13. In both Golati and the lowveld areas, cattle, goats and donkeys are kept. Livestock numbers are generally thought to be higher in the lowveld, but the risk of stock losses due to drought is also clearly higher. Livestock numbers of our informants are given in Appendix Table 1.

14. We were told by the Golati EW that the average household ownership of cattle (from dip records) is 12, which clearly puts all but one or two of our informants above the average. Both lowveld informants kept large goat flocks, but while one had substantial cattle holdings, the other had lost all her cattle in the drought of 1991/92 and was clearly unwilling to reinvest in cattle.

15. Some informants were keeping chickens, other poultry and rabbits, on various scales, and one of the lowveld informants kept pigs.

16. Livestock production objectives for each species in Golati are shown below. The figures refer to the frequency with which each specific combination of first and second objective was recorded. There were no readily comprehensible differences between female and male informants. The diversity of views is striking, as is the importance accorded to manure, relative to the published literature for elsewhere in Zimbabwe (Scoones and Wilson 1988, Barrett 1992). One household was engaged in pen-fattening of old oxen for sale; it was also reported that many households owned cattle with a certain admixture of exotic dairy breeds.

[3] The sub-chief explained the different prosperity levels of the seven Golati villages primarily by their proximity to beer halls, but also by their access to grazing.

Cattle	Goats	Donkeys
draught-manure (2) draught-milk (2) manure-draught (1) manure-cash (1) manure-milk (1)	manure-meat (3) meat-manure (1) cash-manure (1) money-meat (1) milk-manure (1)	transport only (4) transport-draught (1) draught-transport (1) transport-manure (1)

17. In the lowveld, different views prevailed. Lobola (bridewealth or dowry) was clearly of great importance to one couple, who also valued the cash obtained from donkey sales, while the other informants[4], lacking cattle, stressed the cash obtained from goat sales. Manure was much less highly valued:

Cattle	Goats	Donkeys
draught-milk lobola-milk	lobola-meat lobola-milk cash-milk	cash-transport draught-cash draught-transport

Grazing

18. The general impression from interviews held in Golati was that farmers did not perceive the availability of grazing and browsing on the range to be a constraint except for a relatively short period of the year. The land use pattern in Golati appears generally to be a mosaic of fields, homesites and small areas of grazing (as well as rocky areas), but there is also a relatively large area of separate rangeland inside the southern boundary of the Communal Area. There are also arrangements by which Golati people can graze for free on adjoining commercial farms. These resources can be used during various times of year - the grazing within the CA was mentioned as being used during the most difficult months of August-November, one of the commercial farms at the beginning of the wet season November-December, and another commercial farm September-April.

19. Halale presented a similar picture, as here people have benefited from formal relief grazing through the government buy-out of an adjoining commercial farm ("Model D Resettlement"). There are obviously tensions in the community as to whether the rotational grazing system imposed should be respected, but grazing does not appear to be a major constraint, even in the dry season.

20. Various months between December and May were cited as having the best grazing, with several informants describing December as the month when veld condition begins to improve, but others putting the upturn as early as the first rains in October-November. Similarly various months, but most often September and October, were cited as having the worst grazing. The veld was seen as starting to deteriorate at various times, according to some informants as early as June. The Halale group saw December as the best month, and also the month when the veld deterioration started.

[4] The brother and son of Informant 10

21. Probably more light could have been cast on these variations with more careful questioning, and consistent use of scoring months for veld conditions, but this would have added to the length of interviews. What is important for the current project is the overall satisfaction with grazing conditions, but also the uncertainty about how good November grazing is (which obviously varies from year to year) and whether animals will eat stover once there is any green flush on the veld (discussed below).

22. The lowveld informants presented a similar picture, with two significant differences. One mentioned that some Decembers there was no useful grazing in the open veld, while the other noted that the green flush that normally arrives after November rains actually supplies very little nutrition for animals.

23. Informants rarely made much distinction between grazing and browse. The common tree species in Golati give very poor browse (S Ncube pers. comm.) Browse may be important in the early rainy season, or even shortly before the rains, but this would need further research - one informant downplayed its importance.

24. In all areas, informants talked about veld areas, whether interspersed between fields or separate and more distant, as open to all comers; with the exception of the Golati sub-chief, who talked of informal methods for limiting grazing to inhabitants of the nearest few villages. The true picture of how communal grazing is managed, however, is likely to be considerably more complicated.

25. With a few exceptions, all informants spoke of kraaling their animals every night throughout the year.

Crops and Varieties

26. Cultivated areas among our informants in Golati varied between 4 and 12 acres, but the Extension Worker estimated that average land cultivated per household was between 4 and 6 acres.

27. Cropping patterns in Golati are dominated by maize, with smaller acreages of sorghum planted, and small amounts of a number of other crops: sweet potatoes, groundnuts, bambara nuts, cowpeas, beans, peas, vegetables, wheat, “sweet reed” (forage sorghum) and bana grass. Ratios of maize to sorghum by area planted vary between 1.5:1 and 16:1, with one informant planting no sorghum at all, and ratios of maize to all other crops between 5.5:1 and 3:7.

28. Sorghum became unpopular in the area because of the likelihood of bird attack, and seems to have virtually passed out of cultivation by 1989. However, because of the severe drought of 1991/92, and the efforts of the

extension worker over the last two years, there has been some return to sorghum cultivation.

29. Sweet potatoes are cultivated for sale on the lucrative Bulawayo market. The very high watertable, and some rudimentary irrigation systems, also allow cultivation of a variety of garden vegetables for sale.

30. The same range of crops, except for garden vegetables, were recorded in the lowveld, with the addition of pearl millet and finger millet. Ratios of maize to sorghum were 1:1 and 2:1, and of maize to all other crops 1:4 and 1:1.5.

31. A large number of varieties of maize and sorghum were recorded, as seen in Appendix Table 2. Informants typically planted four or five varieties of maize and two of sorghum, aiming to balance a variety of factors such as taste preference (for food and for beer in the case of sorghum), yield, drought tolerance, resistance to weevil damage. When probed informants claimed to distinguish varieties on the basis of stover yield and stover palatability, but these were never raised spontaneously, and it is unlikely if storage practices allow them to compare stover palatability across varieties

Agricultural Calendars

32. Information on the timing of agricultural operations varied considerably between informants. The Golati sub-chief explained this with reference to different people planting at different times owing to variations in soil type (while Golati is distinguished by very sandy soils there are more clayey areas scattered throughout), and differential access to draught power.

33. One farmer had planted maize after isolated early rains in September, as a trial, but most would not plant until October, either in anticipation of rains (dry planting) or immediately after rain. Planting of sorghum generally follows maize in November, but can take place at the same time as maize in October. Planting of legumes generally also follows maize, but maize planting can be continued after all these crops into December.

34. January and February are the months of weeding all crops (sometimes starting in December), and applying top-dressing among some households. Some households harvest maize green at this stage, and some plant late maize in its place or in other plots, or fill the blanks left by poor germination.

35. March is dominated by the necessity of scaring birds from the sorghum crops, but cowpea leaves (used as a relish) are harvested. Groundnuts are ridged, and in some cases harvested.

36. One household reported harvesting some sorghum in March, most gave April as the month of sorghum harvesting, and one said it continued into July. The heads of sorghum are cut off, and may be dried on racks in the fields or taken to the threshing floor for threshing later.

37. The harvesting of maize starts for some households in April. Fallen maize plants are collected, and the main crop is cut and stooked. Stooking was practised by all but one household. It allows the maize to dry, even with isolated winter showers, to a level it is easily storable and saleable, while avoiding the loosening of grain which would occur if the maize continued growing. It also allows winter ploughing around the stooks, winter ploughing being an officially recommended practice as draught animals are in better condition, and one informant said that chemical control of termites was easier and more cost-effective than if maize continued growing. Dehusking of maize is likely to start immediately all the plants are stooked, although ideally each stook should stand for one month. Some households reported dehusking into July. August and September are dominated by threshing of sorghum and shelling of maize.

38. There was a great diversity of views about what months constituted labour bottlenecks and periods of relative leisure. Information is presented in Appendix Table 3. Basically, the planting season (October-December) the weeding season (January) and the bird-scaring/early harvest season (April-May) are all seen by different informants as the busiest time of year. July-September are seen as the least busy, with mentions of April (by a non-grower of sorghum) and October (by a wealthy but late-planting household). No clear pattern related this to gender: while some male informants seemed to downplay the importance of female threshing and shelling labour, so did many of the female informants.

Use of residues for livestock feed

39. The following Table summarizes information on the use of sorghum and maize stover as livestock feed. For each informant, one row relates to stover grazed in-field, and one to stover fed from a store.

40. Store types vary greatly. In Golati we saw stover stored on rocks, in some cases partially shaded by trees (3) in others not (2,5,7), in enclosures with a soil floor (4), or a floor of part-rock and part soil (6). The amounts of stover stored seemed to include up to 150m^3 per household. Informant 1, and one other man interviewed in passing, made no attempt to store stover at all, as they believed it was better used as kraal bedding and then incorporated in the soil. Informant 8 made a heap of harvested stover in the field, to which the animals had no direct access. In Halale we saw high wooden platforms, directly above the kraal. In the lowveld the pattern appears to be a low wooden platform in a large enclosure that also contains granaries and the threshing floor. The wooden structures were built for far smaller amounts of stover than the Golati enclosures.

ANNEX 1A

Area	Infor-mant	May	June	July	Aug	Sept	Oct	Nov	Comments
G O L A T I	1 Field Store	✔	✔	✔	✔				Animals graze in her own fields strictly supervised, mainly on groundnut hay, sweet potato vine. They also graze on others' fields
	2 Field Store			✔	✔	✔	✔		
	3 Field Store	✔	✔	✔	✔	✔	✔		Stover in short supply this year because of poor (waterlogged) crop last year
	4 Field Store		✔	✔	✔	✔	✔	✔	There is likely to be stover available in November, which is exceptional
	5 Field Store		✔	✔	(✔) ✔	✔	✔	✔	Maize stover grazed in field, sorghum stover stored. Might use standing maize stover in August if available
	6 Field Store				✔	✔ ✔	✔		In-field grazing is mainly of contour grasses, plus gleanings of stover
	7 Field Store				✔	✔ ✔	✔ ✔		In-field grazing is mainly of contour grasses, plus gleanings of stover
	8 Field Store	✔	✔	✔	✔	✔	✔	(✔)	Stover is stored in a heap in the field, to which animals have no access. Use of stover in November depends on availability
HALALE	- Field Store	(✔)	(✔)	✔	✔	✔	✔	(✔)	Not clear about stover use in May-June. Use in November depends on availability
LOW-VELD	9 Field Store			✔	✔	✔	✔	(✔)	Stover in field mainly gleanings. Use of stover in November depends on absence of rain damage
	10 Field Store		✔	✔	✔	✔ ✔	(✔)		Use ends when rains come

41. If farmers wish to store stover, their main priority is clearly to make it inaccessible to animals. Most have some concern to keep the area drained, which can be more or less accomplished by using a rocky area, or better still by a wooden platform, but this involves more labour. A few are concerned with shading against sun. None seemed to have supplied even a vaguely rainproof roof.

42. There was a surprising lack of agreement over the relative merits of sorghum and maize stover. Several farmers said that animals preferred maize stover, or that it was better for them. One said that sorghum stover was less good for cattle, and preferred to reserve it for his donkeys. Others took a different view, and saw sorghum stover as more nutritious, more palatable (as animals eat it all, leaves and stem) and more important to store. One informant who took this view also saw it as more vulnerable to termite damage, so used it before maize stover. She believed maize stover caused diarrhoea, unless alternated with grass hay.

43. Use of other crop residues and stored cut grass (mainly from field contours) is shown in Appendix Table 4. Weeds, thinnings and the residues of maize harvested green are not fed to animals, mainly because farmers believe that animals who get a taste for green fodder during the growing season may trespass on fields, but also because this material is thought to be dangerous to animals. Four farmers in Golati used various purchased feeds during the dry season.

44. Farmers quantified the importance of stover for their animals in different ways. Stover, sometimes in conjunction with cut grass, other crop residues, and grazing on contours was typically seen as equally important to, or more important than, open grazing, over a period which some farmers said started as early as May, and one farmer put as continuing into November. Two informants (one in Golati, one in the lowveld) referred to animals getting virtually no nutrition at all from open grazing during September and October, and depending entirely on stover.

45. Farmers are conscious of poor animal condition over the dry season, particularly overall thinness and poor skin condition. They see this as a dangerous state that can lead in bad years to death, and not as a natural condition from which animals will recover during the rains. Some farmers noted that stover on its own stopped animals deteriorating beyond a certain point, but did not keep them healthy. Cattle are not milked over the dry season, from as early as April.

46. Of the eight farmers interviewed in Golati, it could be said that five saw little or no problem with stover storage.[5] One informant did not store stover, preferring to use it as bedding and incorporate into the soil once trampled, one had made little or no use of stover that year because of veld availability, three others saw little problem in keeping stover until the first rains, at which point it

[5] As a brief interview was held with another farmer who used no stover storage whatsoever, the total could be put at six out of nine.

is likely to spoil, but at which point also animals lose interest in stover and/or there is unlikely to be much left. One of these mentioned that unseasonal rains are more likely in June or July, during which stover is still stooked in the field, and relatively resistant to rain damage. The Halale group presented a similar view of stover storage.

47. The three farmers who were more worried about stover storage were worried by the possibility of early rains, which would cause mould in stover, by termite damage (these factors were both mentioned by an informant who kept stover in a soil-floored enclosure) and by the effect of the sun in "scorching" or "hardening" the stover (mentioned by the same informant, and two others who kept stover on rocks).

48. In the lowveld, our informants were clearly concerned by the risk of early rain (in June or July) which could spoil any crop residues, although groundnut hay is most rapidly affected, and by spoiling caused by the regular first rains in October or November. One informant wished to continue feeding into November and even December. He noted that the veld flush from the first rains, if they arrived, was small and not very nutritious. The other lowveld informant claimed to be interested in feeding stover (to goats and donkeys - she was cattleless) all year round. However in both cases it was unclear what the absolute availability of stover, even under ideal storage, would be.

DISCUSSION

49. While it might still be possible to carry out the research project as planned in Golati, it is very likely that better sites could be found, still within a reasonable distance of MRS. The main reason for rejecting Golati would be lack of perceived interest in better storage of stover. This in turn relates to:

- relatively low pressure on grazing because of de facto use of nearby commercial farms[6]
- soil and water table conditions that give high returns to soil fertility management, so that stover is valued as much for incorporation (in a trampled but uneaten state) as for feed.

50. It may also relate to a commercialised economy, that allows some farmers to purchase concentrates and commercial feeds during the dry season.

[6] It was pointed out by participants in the LPP workshop at MRS immediately following the study, that low grazing pressure could be a product of herd numbers still recovering from the 1991/92 drought. Even if this is the case, and grazing pressure can be expected to increase in the next few years, it does not alter the argument that there is presently a lack of interst in stover, which would be needed for a programme of on-fram trials.

51. The following criteria for selecting a site or sites are proposed:

- reasonable availability of maize and sorghum stover
- average or worse than average grazing pressure
- perceived farmer interest in better/longer storage of stover
- relative ease of access to MRS.

52. Subject to agreement by MRS, it is recommended that rapid appraisals are carried out as soon as possible in several further sites, probably including Bidi, at least one other lowveld location, Silozwe CA, and areas east of the Old Gwanda Road. Appraisals should consist of a semi-structured group interview and a minimum of eight individual farmer interviews. Wherever possible, farmers should be chosen so that each of the following classes are represented by two farmers (local averages can be obtained from the extension worker or from a group interview):

Livestock numbers higher than local average Planted area larger than local average	Livestock numbers lower than local average Planted area larger than local average
Livestock numbers higher than local average Planted area smaller than local average	Livestock numbers lower than local average Planted area smaller than local average

53. A checklist and a questionnaire are included in the Annex. The questionnaire has been designed in a fairly structured manner to allow for rapid collection and easy collation of responses at MRS, but the MRS team should feel free to experiment with visual methods to collect the data needed, alter the order of questions if necessary, and to add relevant comments to the questionnaire. A preliminary choice of site or sites made at MRS on the basis of the RRAs, in particular a simple analysis of questions 11-15 of the questionnaire, can be reviewed by the NRI-based members of the team.

54. Following the choice of one or at most two sites, I will communicate with MRS on the design of a broader baseline survey, perhaps of 40 farmers, which will collect somewhat more detailed socio-economic and farming systems knowledge (e.g. household labour availability, purchase of feeds, areas and varieties planted, planting dates) from study households. Hopefully this can be launched prior to my next visit, which I recommend be scheduled for early April 1998[7], otherwise it will be launched at that point. In either case, the same farmers should be used for a simple monitoring exercise on harvest and storage behaviour over the dry season, primarily from a socio-economic point of view. This can also be launched during my April visit.

55. The monitoring exercise can run concurrently with the pilot introduction of improved storage structures and the systematic sampling of stover on a more restricted group (of 8-10 farms) as proposed in Dr Coker's report.

[7] As soon as possible in the new UK finanacial year, and before harvest.

ANNEX 1 - CHECKLIST FOR SEMI-STRUCTURED GROUP DISCUSSION

Relative importance of maize and sorghum
- Is cultivation of either increasing?
- Most common maize varieties
- Most common sorghum varieties

Availability of veld grazing around the year *(score each month 1-10, perhaps using stones, trying to arrive at consensus)*
Are there any large areas of good grazing people use?
- Within CA?
- Outside CA? - expand

What systems do people use to store stover?
What are advantages and disadvantages of each system?
Are there people who take a decision not to store stover? Why?

Over what months is stover important?
Can people compare its importance to that of other feed sources?
In what month does stover cease to be an important feed? Why?
(e.g. availability of grazing, stover runs out, stover spoiled)
Would people welcome improvements in stover storage?
What prevents them currently from improving stover storage?

What are people's main objectives in keeping different species of livestock?
(use cards, but try and get a consensus among the group for each species)

To Discuss with Extension Worker

Average cattle holding per household, trends in livestock holding
Average planted area per household
Trends in sorghum/maize cultivation
Trends in stover storage
Trends in availability of veld grazing

ANNEX 2 - QUESTIONNAIRE FOR INDIVIDUAL FARMER INTERVIEWS

Village Date

1. Name of informant

2. Number of adults available for work on farm *(exclude those present only at weekends)*

3. Areas planted this year (acres):

	maize	_____
	sorghum	_____
	pearl millet	_____
	finger millet	_____
	groundnut	_____
	sweet pot.	_____
others	_____	_____
(specify)	_____	_____
	_____	_____
	_____	_____

4. Number of livestock

cattle	_____
goats	_____
donkeys	_____
sheep	_____

5. Wealth of this household compared to local average *(tick one box)*

Livestock numbers higher than local average Planted area larger than local average ❒	Livestock numbers lower than local average Planted area larger than local average ❒
Livestock numbers higher than local average Planted area smaller than local average ❒	Livestock numbers lower than local average Planted area smaller than local average ❒

6. Major agricultural operations by month:

	Maize	Sorghum
Sep	_____	_____
Oct	_____	_____
Nov	_____	_____
Dec	_____	_____
Jan	_____	_____
Feb	_____	_____
Mar	_____	_____
Apr	_____	_____
May	_____	_____
Jun	_____	_____
Jul	_____	_____

7. Describe the stover storage structures or places

(If little or no storage takes place, why? Does informant use stover for bedding or plough it in?)

8. Estimate maximum amount of stover (in m^3) that is stored.

9. Use table to describe use of feed sources May-December *(tick if a resource is normally used, add comments if necessary)*

Feed source	M	J	J	A	S	O	N	D	Comments
CA veld									
Other veld									
Stover in field									
Maize stover from store									
Sorghum stover from store									
Groundnut hay									
Cut grass									

10. Score the availability of grazing and browse from the veld (local or other) 1-10 for each month.

Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug

11. In which months are crop residues *(consider all residues together, but not specialist fodder crops or cut natural grass)*:

	M	J	J	A	S	O	N	D	Comments
more important than veld grazing?									
equally important to veld grazing?									

12. Which of maize and sorghum stover: is preferred by animals?
is better for animals?

13. *(Mark each statement "No", "Yes" or "Strongly")* Is the informant:

concerned with rain damage to stover during the dry season?

concerned with rain damage to stover at the beginning of normal rains?

concerned with damage to stover from the sun?

concerned with damage to stover from termites?

concerned with any other form of damage to stover?

Comments:

14a. Does the informant think it would be useful to extend the storage of stover further into the rainy season?

b. Up to which month would s/he wish to have stover in store?

c. Would s/he normally have stover to store by this time?

15. What prevents the informant from improving stover storage *(tick more than one if necessary?)*

Not necessary (other feed sources adequate) _____
Not necessary (not enough stover) _____
Lack of cash _____
Too busy _____
Lack of know-how _____

16. Does the informant ever buy or sell stover *(note amounts, prices, frequency, whether a normal or exceptional practice)*

APPENDIX TABLE 1 - Livestock Numbers by Household

Area	Informant	Cattle	Goats	Donkeys
G	1	37	c.20	1
O	2	16	2[a]	1
L	4	18	13	5
A	5	36	7	8
T	6	18	>20	4
I	7	5	10	1
	8	13	18	6
Low-	9	30	>100	(b)
veld	10	0	c.50	3

a) He recently had twelve donkeys stolen
b) Informant did not give a figure for donkeys but clearly owned one or more
This information was not collected from informant 3

APPENDIX TABLE 2 - Maize and Sorghum Varieties Planted

	Maize	Sorghum
Golati/ Halale	R201 R215 R401 SC206 SC401 SC501 SC601 SC611 SR52 CG4141 CG48?? Pannar 473 Gutsha	DC 75 Red Tswetha Red Swazi? Luntente SV1&2 Sikhothama NC330 Stitch Makareyaka Other indig-enous varieties
Lowveld	R200 R201 SC401 Pannar 473 Pannar 6363	Red Tswetha SV1&2 G15 Impala

APPENDIX TABLE 3 - LABOUR CALENDARS

Area	Infor-mant	S	O	N	D	J	F	M	A	M	J	J	A
GOLATI	2 (M)	*6*	**7**	**10**	**10**	**10**	9	8	7	9	7	7	7
	3 (M)	8	**10**	9	7	6	6	9	9	**10**	8	*5*	7
	4 (F)	8	9	9	9	8	7	9	**10**	7	6	*4*	5
	6 (F)		**busiest**										*least busy*
	7 (F)			**busiest**					*least busy*				
	8 (F)	4	*3*	8	8	**10**	9	7	9	8	5	5	5
LOW-VELD	9 (C)	5	**10**	6.5	8	**10**	8	9	**10**	6	9	8	*3.5*
	10 (F)	4	6	**10**	**10**	9	8	7	8	8	9	7	*3*

M=male informant, F=female, C=couple. Months were scored with 10 as busiest. Busiest months are highlighted in bold, least busy in italics. Informant 5 (C) stated that all months were equally busy, as any spare time was spent on irrigated vegetables

APPENDIX TABLE 4 - Use of Other Crop Residues, Cut Grass and Tree Pods

Area	Infor-mant	May	June	July	Aug	Sept	Oct	Nov	Dec	Comments
GOLATI	1				G,S	U	U	U		
	2		C	C	C	C,F	C,F	(F)		Sweet potato vines and cowpea tops mixed with grass in some months
	3	G								
	4					(F)	C,G	C	C	
	5					F,G,S	F,G,S	F,G,S		
	6			G,S	G,S	(F)				Use in August depends on availability
	7					C,G,S	C,G,S			
	8						G,S			
HALALE	-	Pearl millet stover, cowpea tops, groundnut hay and dicrostachis pods all fed at various times May-Nov								
LOW-VELD	9					P	G,P	P		Groundnut hay fed mainly to donkeys
	10	Groundnut hay possibly fed with other stover June-October								

C=stored cut grass, F=purchased feed including All-in-Feed, urea blocks, molasses, also crushed maize grain, G=groundnut hay, P=tree pods, S=sweet potato vines, U=urea treated cut grass.

Overview of surveys conducted in Bidi, Irisvale and Silozwi Districts

By C D Wood and J Morton, Feb 1998

Background

1. Surveys were conducted of nine to ten farms in each of three districts to identify a site suitable for the trial introduction and evaluation of improved stores for stovers. Districts should have an identified need for improved stover storage and appear to be likely to adopt such improvements. Gulati district, the site first considered, is favoured by a high water table which facilitates production of crops and grazing even during the dry season and so was not considered suitable.

Cultivation

2. The area under major crops and adult labour available averaged over the farms surveyed are given in Table 1.

Table 1 Average adult labour availability and area of major crops

		Bidi	Irisvale	Silozwi
No adults		3.8	3.5	4.6
area (acres)	maize	3.1	5.3	5.0
	sorghum	1.7	0.3	0.6
	pearl millet	1.8	0.2	0.2
	finger millet	0.4	0.0	0.0
	groundnut	0.6	0.5	0.7
	sweet pot	0.1	0.6	0.3
	Cowpeas	0.5	0.2	0.2
	bambara nuts	0.6	0.9	0.6

All three districts had about 6 acres under cereals, although at Bidi there was a more diverse range of cereals produced, possibly reflecting a dryer nature which favours production of sorghum and millet which are more drought resistant than maize. Other crops were produced in all three districts which can produce nutritionally valuable residues for ruminant feeds. Based on these data, labour availability and crop residue production appear to be similar in the three districts, although farm to farm differences within districts could be large.

Livestock

3. Again farm to farm differences could be large, but there tended to be more goats in Bidi, more cattle in Irisvale while livestock appeared to be generally less important in Silozwi as indicated in Table 2. These conclusions were also supported by the regional livestock data and general overviews of the three districts. Again the preference for goats in Bidi may be indicative of its more marginal nature, goats generally being preferred when there are problems in feeding cattle.

Table 2 Average number of livestock per farm

	Bidi	Irisvale	Silozwi
cattle	7.3	26.4	8.5
goats	32.7	13.0	3.0
donkeys	5.9	3.4	2.2
sheep	5.4	2.5	0.0

Feed availability

4. There was good agreement between all the farmers that the August to November period was when grazing was most restricted, and hence when stored stovers may be particularly useful. Stovers may be grazed in fields in August and September and taken from storage from September to November. Since the 1992 drought led to the deaths of much livestock, particularly cattle, farmers also appear to be interested in storing feed as a hedge against future droughts. Parallels can be drawn with drought-prone North West India where excess straws and stovers are kept in haystacks until required as cattle feed during droughts (or spoiled by rain). Such material has been retained for seven or eight years, and presumably longer if required.

Stover storage

5. Eight of nine farmers at Bidi stored stover, nine of ten at Irrisvale (one of these as "silage") and nine of ten at Silwozwi (although it was said that stover storage was not so common here). Hence the storage of some stover is widely practiced in all three districts. "Sheds/ingalani" and raised platforms in kraals are used for storage in Bidi, in Irrisvale storage methods include storage in bags, as silage and in a "tank" (but details are sketchy), while in Silwozwi rocks are widely used as bases for storage. Practices between farms are quite variable.

6. Without exception, all the farmers interviewed express an interest in improved and extended stover storage. Increased storage periods ranged from 1 month to 1 year. At all three sites at least one farmer expressed interest in storing stover for as long as one year as a hedge against drought. Early/dry season rains and the effects of the sun were seen as the major storage problems by nearly all farmers. Late rains also caused some spoilage. Termites were seen as a problem by several farmers, particularly for stooked maize, although several described various countermesures which were said to control the problem. Other storage problems were caused by rats, stalk borers and baboons, but these appeared to be localised rather than general problems.

7. Lack of labour was a commonly given reason for not improving stores, lack of money, know-how and not thinking about it were other reasons given. Lack of salt to give with the stover was said by one farmer to be a constraint to stover storage (salt increases the palatabilty of stover).

It is not clear from the surveys if there is stover available for extended storage.

Site(s) for future work

8. This study wants to focus on sites where improved and possibly extended storage of stovers is most likey to be of use to farmers, and hence is most likely to be adopted. Such sites will be where:
- livestock, particularly cattle, are important;
- cereals are grown on a sufficient scale to generate enough stovers for storage;
- alternative dry season feeds are in limited supply;
- where droughts could lead to losses of livestock.

9. All three of the sites surveyed have the desired characteristics to some extent. Bidi appears to be the most marginal of the three sites, and appears to be the most suitable of the three for introducing improved stores for stovers. Although cattle numbers are currently fairly low due to losses in the 1992 drought, they are said to be increasing due increasing calving rates and purchases. Irrisvale also appears suitable, and the varied storage practices warrant further investigation (e.g. description of methods and further interview with farmers). There are complicating factors in Irrisvale as many of the cattle do not belong to the farmers but to the Cold Storage Company, Zimbabwe Farmers Union and NGOs. Silowozwi is perhaps the least suitable as livestock appears to be a less important element of the mixed farming here, although it is said that cattle numbers are set to increase as more grazing land is being made available. Although most crop residues are said to be currently used for manure/compost this situation could change in the future, and indeed this survey indicates considerable interest in the storage of at least some of the stover.

ANNEX 1C

FILE NOTE

REPORT ON QUESTIONNAIRE SURVEYS OF BIDI WARD AND IRISVALE RESETTLEMENT AREA, MATEBELELAND SOUTH, ZIMBABWE

Project A0730

Dr J Morton

1. INTRODUCTION

This report presents the major findings of questionnaire surveys conducted in Bidi Ward of Semukwe Communal Area, Matobo District, and Irisvale Resettlement Area, Umzingwane District, in November 1999 for the research project on "Effects of Harvest and Post-Harvest Practices on the Production and Nutritive Value of Maize and Sorghum Residues in Zimbabwe", funded by DFID's Livestock Production Programme and implemented by NRI and Matopos Research Station.[1]

After rapid initial surveys in four sites in Matebeleland South in late 1997/early 1998, research work to measure the effects of storage on stover began in Bidi with the 1998 harvest. This involved researcher-managed trials of on-farm stores of a model unlikely to be affordable by farmers (Mk1 stores) in the 1998 storage season, and more participatory trials of farmer-designed low-cost stores (Mk2 stores) in the 1999 storage season.

While the project was able to carry out semi-structured interviews with Mk1 and Mk2 farmers and gain important insights into their attitudes to stover storage, both groups were mainly self-selected. To assess better the extent of stover storage problems and the likely uptake of solutions in the population as a whole, it was decided to carry out a small structured survey. 32 more or less randomly-selected households were surveyed in mid-1998.[2] Due to extreme drought conditions and very poor harvests, only very limited information on stover storage was obtained.

The project decided to encourage farmers in Irisvale Resettlement Area (another of the sites appraised in early 1998) to build Mk2 stores during the 2000 storage season, and so far has met an enthusiastic response. Again it was decided to carry out a structured survey of the area. A new simplified questionnaire was administered in November 1999 to 41 farmers in Irisvale, and 31 in Bidi.[3]

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[1] Questionnaires were administered by Ndabazinhle Nyoni of Matopos Research Station. Data entry was made by Diana Jacques.

[2] The list originally provided by the agricultural extension service had been drawn up in connection with relief distribution, and 8 households of the 40 originally selected had to be excluded as absentees or destitute old people who did not constitute agricultural households in any normal sense.

[3] Irisvale households, being a resettled population, are relatively well documented, and could be randomly sampled. Three households could not be interviewed due to funerals and

2. The Study Areas

Bidi Ward, lying around 130km south of Bulawayo in Natural Region V, is made up of five administrative villages. From official figures the total population is 8118 people in 1763 households, but the number of farms or agricultural homesteads, as documented in drought relief records, was 619, and our experience shows that even this figure is an overestimate. As Bidi is part of a Communal Area, arable land is assigned by chiefs on a basis of need and also in practice inherited, but cannot be traded. This explains the large variation in arable land area per household. Access to grazing land has not been fully investigated, but is likely to combine common-property and open-access elements.

Irisvale[4] is a Resettlement Area, established in 1985. It lies 80km southeast of Bulawayo just off the tarmac Bulawayo-Beitbridge road, on the borders of Natural Regions IV and V. The part the project is dealing with is composed of eight villages, established on five former commercial farms, all west of the Mzwingane River and in Umzwingane District. To the east of the river in Insiza District is another Resettlement Area, also referred to as Irisvale, which will not be further discussed here. The total area is 16305 ha, and the population 2032 people in 254 households.

People came from overpopulated Communal Areas, commercial farms and towns all over Matebeleland. There used to be problems between people from different areas, but people have necessarily adapted. People from the adjoining Nswazi Communal area refused resettlement, demanding instead an extension to their own grazing area. There are only limited contacts with neighbouring Communal Areas, except through Irisvale children attending secondary school outside the area. Priority in resettlement was originally given to the unemployed, but it was later realised that this would not work and priority was given to wage earners, who could afford the necessary inputs. At no time was priority given to Master Farmers, and farming skills are unevenly distributed.

Each household has 12 acres of arable land. Either the husband or the wife can be the registered holder; for many of the earliest settlers, the wife took title as she could be registered as unemployed even if the husband was working. Land cannot be bought or sold, but unlike Communal Areas, women automatically inherit on the husband's death. All grazing land belongs to a specific village. The villages inherited paddocking infrastructure from the commercial farms, but except in Village 8, which has three-month rotational grazing in five paddocks, fences have been vandalised by Nswazi people or other outsiders, and paddocking is not practised. The grazing area west of the tarmac road should be used by Irisvale people but is instead only used by

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absences and were dropped from the sample. The 1998 sample was use for bidi, with a further two farmers being uncontactable, and one of those earlier judged too destitute for inclusion being reinstated. Clearly small sample sizes and less than random sampling (especially in Bidi) demand caution in interpreting these results.

[4] More information on Irisvale is given in Morton 1999.

Nswazi people. There are very few cases of Irisvale cattle being grazed outside the RA under any arrangement.

3. SUMMARY OF KEY FINDINGS

Key findings in each site are summarised and compared below:

Table 1: Summary and Comparison of Key Findings, Bidi and Irisvale

	Bidi (n=31)	**Irisvale** (n=41)
Average number of adults available for work on farm	4.1	3.4
Households keeping cattle	26%	100%
Average cattle holding	12.50 (cattle-owning hhs) 3.23 (all hhs)	18.06(cattle-owning hhs) 15.85 (all hhs)
Average goat holding	10.74	5.34
Average donkey holding	3.29	1.85
Households purchasing livestock feed	0%	34%
Households purchasing livestock salt	19%	7%
Planting choices - cereals	97% planting maize, sorghum, pearl millet. 16% households planting finger millet.	100% planting maize. 13% planting sorghum, 5% planting pearl millet
Planting choices- other	94% bambara nut, 84% groundnut. Cowpea, sunflower	82% bambara nut, 72% groundnut. Cowpea, sweet potato, sunflower, sugar peas, coffee
Average area - maize	1.66 acre	5.85 acres
Average area - sorghum	1.85 acres	n/a*
Average area - groundnut	0.72 acres	0.6 acres
Average area - bambara nut	0.73 acres	0.80 acres
Average total planted area	6.97 acres	7.59 acres
Major cultivation problems - maize	1. drought/poor rainfall 2. too much rain/waterlogging 2. poor fertility/lack of fertiliser/manure	1. drought/poor rainfall 2. stalkborer 2. poor fertility/lack of fertiliser/manure

ANNEX 1C

	Bidi	**Irisvale**
Households using traditional ingalanis - maize	26%	21%
Households using traditional ingalanis - sorghum	19%	0%
Households using traditional ingalanis - groundnut	29%	1%
Households who had heard of roofed stores	84%	49%
Households who had seen roofed stores	71%	39%
Households building or planning to build roofed stores	23%	15%
Reasons for not having built roofed stores	1. shortage of time/labour 1. shortage of grass 3. no animals	1. Shortage of time/labour 2. Shortage of grass 3. Lack of info./confidence
Households storing green stover/stover from green maize	1%	0%
Households reporting spending time or money building/repairing stores	13%	24%
Households salting, chopping or mixing stover	19%	27%
Households recording losses of stored stover	26%	1%
Months stover most likely to be fed from store	1. September 2. October 3. August	1. September 1. October 3. August
Months stover most likely to be named as most important feed	1. September 1. October 3. August	1. September 2. October 3. August
Households who would like to feed stover into November	16%	7%

NB: all Bidi data expressed as percentages uses n=31. Irisvale data expressed as percentages uses n=39 for questions relating to 1998 crop planting and 1999 residue storage specifically, and n=41 for other questions.

* Only 5 farmers in Irisvale, cultivated sorghum with a total area of 3.5 acres, a negligible amount when averaged across 39 farmers.

4. BIDI

The average number of adults available for work on farm (excluding those present only at weekends) was 4.10, with a range of 1-10.

4.1 Livestock

The most notable feature of livestock holdings in Bidi was that only around one-quarter of households owned cattle at all. The picture was broadly similar to that in the 1998 questionnaire survey, which reported nine of 32 households as owning cattle, and an average holding of 3.1 per household. Comments received in both years attributed the low cattle numbers to the 1991/92 drought. It is worth speculating, following information obtained elsewhere in Zimbabwe, that some households have taken a conscious decision not to re-invest in cattle following the drought.

Two households had no livestock of any species. Given that certain households had been excluded form the sample as being too destitute to constitute agricultural households, both this and the proportion of the cattle-less could be viewed as underestimates.

Table 2: Livestock Holdings by Species, Bidi

Livestock Species	Households Owning (n=31)	Average holding (all hhs)	Average holding (hhs reporting)	Maximum holding
Cattle	8	3.23	12.5	46
Goats	29	10.74	11.4	60
Sheep	12	2.74	7.1	14
Donkeys	25	3.29	3.9	10

The biggest change since 1998 was in goat numbers. No households had been goat-less in 1998, and the average holding was down from 17.9 in 1998 to 10.7 in 1999. Informants mentioned major deaths of goats (and to a lesser extent sheep) from starvation, disease, external and internal parasites, as well as goat thefts.

Distribution of goats and cattle (even within the category of those keeping cattle) was very unequal, with a few households maintaining large herds/flocks.

Sheep numbers were slightly decreased from 1998, and donkey numbers slightly increased. 15 households had kept sheep in 1998, with an average household holding of 3.5. 22 households had kept donkeys in 1998, with an average holding of 2.9.

Table 3: Distribution of Households by Holding of Livestock Species, Bidi

Species	0	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60
Cattle	23	3	2	-	2	-	-	1	-
Goats	2	11	6	6	2	3	-	-	1
Sheep	19	5	4	3	-	-	-	-	-
Donkey	6	19	6	-	-	-	-	-	-

No households reported keeping livestock anywhere other than close to the homestead. Donkeys recorded for one household were actually the property of a brother.

Of 29 households responding on grazing of stover on fields after harvest, 23 households reported grazing their animals in their fields *and* in others' fields *and* having others' animal graze in their fields. Three households only reported having others' animals graze stover in their fields, one reported its own and others animals grazing its own fields, one reported harvesting all its own stover and sending its animals elsewhere, and one reported only its own animals in its own fields. Comments were fairly evenly balanced between those who saw this situation positively in terms of agreements within villages and agreed dates for access, and those who saw it as a problem of straying.

6 households had purchased salt for livestock during the season, between 2 and 20 kg per household. None had purchased stockfeed. One was mixing salt with bran and bambara nut shells to feed to donkeys.

4.2 Cultivation

At the time of the survey, only 3 households had planted for the 1999-2000 growing season. All data here relates to crops grown during the 1998-99 season. Area measurements are in acres. Averages are of all households, unless specified otherwise.

Table 4: Cultivation, Bidi

Crop	Households planting (n=31)	Average area	Minimum area	Maximum area
Maize	30	1.66	0.1	5
Sorghum	30	1.85	0.15	4
Pearl Millet	30	1.69	0.25	4
Finger Millet	5	-	0.25	2
Bambara Nut	29	0.73	0.25	3
Groundnut	26	0.72	0.25	3
Cowpea	11	-	0.25	1
Sunflower	1	-	0.5	0.5
Other unspecified	2	-	0.25	0.5
Total Planted Area	-	6.97	1.25	15.25

Note: Cultivated areas for finger millet cowpea, sunflower and "other", averaged, across the full sample are negligible.

From the above figures, maize, sorghum and pearl millet are of almost equal importance as cereal crops, and take up over two-thirds of the planted area, with bambara nut and groundnut taking up most of the rest. Planted area varies sharply between households.

Table 5: Distribution of Households by Planted Area, Bidi

Area	0-1.75	2-3.75	4-5.75	6-7.75	8-9.75	10-11.75	12-13.75	14-15.75
HHs	1	3	10	6	3	4	3	1

4.3 Cultivation Problems

The most important problems affecting growing maize was clearly drought or poor rainfall, followed by episodes of excessive rainfall or waterlogging, and by fertility problems (or manure or fertiliser shortage). For sorghum the most important problem was bird attack, followed by *striga* infestation. Responses in the table below are non-exclusive.

Table 6: Problems Affecting Growing Crops, Bidi

Problem	**Maize**	**Sorghum**	**Ground-nut**
households responding	26	26	16
drought/shortage of rain	19	3	3
sun	2	-	-
too much rain/waterlogging	5	-	-
poor fertility, lack of fertiliser/manure	5	2	3
poor germination - unspecified	-	-	2
porcupines	-	-	1
rats	-	-	1
birds - presumably quelea	-	11	-
termites	4	-	1
aphids	-	3	-
stalkborer	1	-	-
crickets/hoppers	1	1	-
weevils	1	1	1
cutworm	-	1	-
striga	2	6	-
problems with weeding - unspecified	1	-	-
ingumane smut	-	2	-
"rotting"	-	-	1
family illness	1	1	-
shortage of Draught Animal Power	2	1	1
late planting - unspecified	1	1	1
poor crop/harvest - unspecified	1	-	2

4.4 Storage Practices

Responses on crop residue storage practices were unsatisfactory, and in particular underestimate the extent, virtually universal, to which crop residues are grazed in the field. However, they do give better information than the 1998 survey, when the harvest of both major cereal crops was so disastrous that only five farmers reported any sort of storage of maize or sorghum stover.

Assuming no-responses indicate no storage structures, these figures show that traditional ingalanis (open platforms) and other storage structures are only maintained by about one-quarter of households. These included one farmer who was part of the Mk2 trial: this household also had a traditional ingalani. The table allows for a small number of multiple responses. "Other" refers either to storing residues in a goatshed, or in feeding to goats immediately after picking (of groundnuts).

Table 7: Crop Residue Storage Practices, Bidi

Practice	Maize	Sorghum	Ground-nut
hh responding	25	27	25
Grazed in field	13	21	9
Stored in tree	5	1	6
Traditional Ingalani	8	6	9
Roofed Ingalani	1	1	0
Other/unclear	1	0	2

26 of the households had heard of roofed stover stores and 22 had seen a roofed store. This is not surprising given project activity over two storage seasons, and the high visibility of the Mk1 stores in particular. Two households claimed to be building stores, and five were planning or wishing to build stores. 26 of the households had heard of roofed stover stores and 22 had seen a roofed store. Of all those building, wishing or planning to build, plus the Mk2 household in the sample, only 3 were cattle-keepers: put another way of the 9 cattle-keeping households, six had no plans to build. 16 households (including one building and one planning to build) gave clear answers as to why they had not built stores: most important were lack of time or labour power, and difficulty in obtaining thatching grass. However, such reasons are likely to work in combination, and it is probable that lack of animals was an unspoken reason for many households.

Table 8: Reasons for Not Building Roofed Store, Bidi

Reason	Households Reporting
Shortage of time/labour	4
Shortage of grass	4*
Shortage of poles	1
Lack of information	2
No animals	3
Waiting for MRS to build	2

* included households building or planning to build.

Only two households reported bringing a significant amount of stover into store while green. In one case this was stover from a failed late-planted crop, in the other the stover later dried in the sun. Both stored it in traditional ingalanis.

Three households sprayed salty water on stover before feeding it: one of these dipped groundnut hay in salty water before storing it. One household reported spraying salty water on maize grain before feeding, and two spraying it on sorghum/maize bran.

Besides the Mk 2 farmer, 3 households had spent time or money building or repairing traditional ingalanis this season. The maximum outlay had been 24 hours of household labour plus Z$150. The Mk2 farmer had spent 1 week and $70 materials on a traditional ingalani, $600 hired labour and $130 materials on the Mk2 store, plus her husband's labour on both.

4.5 Storage Problems and Objectives

4 households had suffered unintended losses of stored stover to livestock (one when a groundnut hay store fell down in the wind). Four households reported other forms of storage loss: to sun (two households - to sorghum and to groundnut), termites and "weevils" (all three crops), and aphids (sorghum). Spoilt stover was put in the kraal in one case.

16 households gave useful responses on the months during which they fed stover from the store, and the months during which stored stover was the most important feed for livestock.

Table 9: Storage Calendars, Bidi

Months	J	A	S	O	N
Households reporting stover fed from store	4	6	9	8	4
Households reporting stover most important feed	1	4	11	11	3

This can be compared to data on when farmers practice in-field grazing of stover (taken from the non-random rapid appraisals of 9 farmers in early 1999).

Table 9a: Use of In-field Grazing, Bidi, 1998

Months	J	A	S	O	N
Households reporting use of in-field grazing	1	5	7	5	-

In the questionnaire survey, a number of households named months in which they had not used stored stover as months during which stover from store was the most important feed. The most likely explanation of this was that these were months during which stover is generally very important, but these households had stored insufficient quantities to feed into these months.

Five households would have liked to continue feeding stover into November; the implication is that they had been unable to do so because of storage losses. If the data is reliable, this finding puts into context previous findings from informal surveys that feeding stover at the end of the dry season and at the very beginning of the rains is important to farmers: in practice only a small proportion of a random sample of farmers have enough stover to make this a concern.

5. IRISVALE

The average number of adults available for work on farm (excluding those present only at weekends) was 3.44, with a range of 2-6.

5.1 Livestock

Table 10: Livestock Holdings by Species, Irisvale

Livestock Species	Households Owning (n=41)	Average holding (all hhs)	Average holding (hhs reporting)	Maximum holding
Cattle	36	15.85	18.06	62
Goats	29	5.34	7.55	31
Sheep	2	0.20	4.00	6
Donkeys	19	1.85	4.00	10

One household had no livestock at all. Only two households were keeping cattle offsite, 16 head or 2.5% of the total cattle holdings. No households reported keeping other livestock species offsite.

Table 11: Distribution of Households by Holding of Livestock Species, Irisvale

Species	0	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61-70
Cattle	5	4	10	6	5	5	3	1	1	1
Goats	12	15	8	3	1	1	1	-	-	-
Sheep	39	1	1	-	-	-	-	-	-	-
Donkey	22	14	5	-	-	-	-	-	-	-

Of 36 households responding on grazing of fields after harvest, 33 households reported grazing their animals in their fields **and** in others' fields **and** having others' animal graze in their fields. One household only reported having others' animals graze in its fields, and two (both in village 1A) only reported their own animals grazing in their own fields. Comments generally showed that grazing on in-field stover is regarded as something farmers would like to stop, with varying success, by fencing or harvesting of stover. Two households saw in-field grazing as more rule-bound, restricted to neighbours or those from the same village.

14 households (34%) had purchased some form of livestock feed over the dry season. In 11 cases this was All-in-Feed, between 1 and 17 bags per household. One of these was also buying molasses, and one salt. One household was buying brewers' grain and salt, and one pen-fattening meal. One household was buying salt only, and no feed.

5.2 Cultivation

At the time of the survey, no households had planted for the 1999-2000 growing season, so all data here relates to crops grown during the 1998-99 season. Two households were new arrivals and did not give information on 1998 plantings. Averages are of 39 households, unless specified otherwise. Area measurements are in acres.

Table 12: Cultivation, Irisvale

Crop	Households planting (n=39)	Average area	Minimum area	Maximum area
Maize	39	5.85	1	10
Sorghum	5	-	0.5	1
Pearl Millet	2	-	0.25	0.5
Finger Millet	0	-	-	-
Bambara Nut	32	0.79	0.1	2
Groundnut	28	0.59	0.15	1.5
Cowpea	6	-	0.5	1
Sunflower	2	-	0.5	1
Sweet potato	2	-	0.25	0.25
Coffee	1	-	2	2
Sugar peas	1	-	0.25	0.25
Total Planted Area	-	7.59	1.5	12.25

Note: Cultivated areas for sorghum, millets, and other minor crops averaged across the full sample are negligible.

From the above figures, maize is by far the most important crop, followed by bambara nut and groundnut, with sorghum and millet grown by a small minority of households. Despite Irisvale plots being limited to 12 acres, planted area varies considerably within that, with mean planted area (in any one year) being less than eight acres. Whether this indicates that systematic fallowing is practiced is not clear. One household appears to have circumvented the 12 acre limit to cultivate over 13 acres.

Table 13: Distribution of Households by Planted Area, Bidi

Area	0-1.75	2-3.75	4-5.75	6-7.75	8-9.75	10-11.75	12-13.75
HHs	1	3	6	9	8	11	1

5.3 Cultivation Problems

The most important problem affecting growing maize was clearly drought or poor rainfall, followed by fertility problems/manure or fertiliser shortage, and stalkborer. Responses in the table below are non-exclusive.

Table 14: Problems Affecting Growing Crops, Irisvale

Problem	Maize	Sorghum	Ground-nut
households responding	36	3	15
drought/dry spells/poor rainfall	27	-	4
waterlogging	3	-	-
manure shortage/poor fertility	5	-	-
poor germination -unspecified	-	-	2
cattle eating crop	1	1	-
wildlife	1	-	-
rats	-	-	2
partridge	1	-	-
birds -unspecified (probably quelea)	-	2	-
stalkborer	5	-	-
termites/ants	1	-	3
aphids	-	-	1
cutworm	-	-	1
insects - unspecified	-	-	1
weeds	1	-	-
illness delaying planting	1	-	-
delayed planting - unspecified	-	-	1

5.4 Storage Practices

As with Bidi, responses on crop residue storage practices were unsatisfactory, and in particular underestimate the extent, virtually universal, to which crop residues are grazed in the field. They do show that only around 20% of households used traditional ingalanis, with a further 20% improvising storage in huts, kraals or gardens around the homestead. An additional three households are listed below as "grazing" but said they stored stover in better years. In all, around half the households were investing some effort in storing stover.

Table 15: Crop Residue Storage Practices, Irisvale

Practice	Maize	Sorghum	Ground-nut
hh responding	37	3	27
Grazed in field	21	3	15
Stored in tree	1	0	0
Traditional Ingalani	8	0	2
Roofed Ingalani	0	0	1
Other/unclear	8	0	9

20 of the households had heard of roofed stover stores and 16 had seen a roofed store. Again this is not surprising as the project has discussed stover storage with Irisvale farmers on several occasions, and facilitated a visit by then to a field day in Bidi. Two households were building stores, and four were planning or wishing to build stores. 14 households (including one building and one planning to build) gave clear answers as to why they had not built stores: most important were lack of time or labour power, and difficulty in obtaining thatching grass. However, such reasons are likely to work in combination.

Table 16: Reasons for Not Building Roofed Store, Irisvale

Reasons	Households Reporting
Shortage of time/labour	6*
Shortage of grass	3
Lack of information/confidence in idea	2
Shortage of money	1
No scotchcart	1

*included households building or planning to build.

No household reported bringing a significant amount of stover into store while green.

Eight households reported spraying salty water on stover and/or groundnut hay before feeding it to animals. Three households grind or chop stover, one to mix with molasses, and one to mix with brewers' grain, bran and groundnut hay.

Nine households reported spending time repairing or building traditional ingalani this season. Estimated time spent was between four and seven hours, with an average of 10 hours for those responding. One household reported spending 56 hours labour and Z$150 on a fenced kraal specifically for stover.

Four households reported losses of stored maize stover (two from rain, one from sun, one from termites). None reported losses of stored sorghum stover or groundnut hay. Spoilt stover was used as manure in three cases, put in the kraal in one case.

16 households gave useful responses on the months during which they fed stover from the store, and the months during which stover was the most important feed for livestock.

Table 17: Storage Calendars, Irisvale

Months	J	A	S	O	N
Households reporting stover fed from store	1	9	12	12	6
Households reporting stover most important feed		3	12	11	2

This can be compared with information on the months in which farmers practice in-field grazing of stover, taken from the non-random rapid appraisal of 10 farmers in early 1998.

Table 17a: Use of in-field grazing, Irisvale 1998

Months	J	J	A	S	O	N
Households reporting in-field grazing	2	6	7	7	3	1

In the questionnaire survey, three households would have liked to continue feeding stover into November, but were currently unable to do so.

6. COMPARISON, DISCUSSION AND CONCLUSIONS

As could be expected from Irisvale's relatively privileged status as a resettlement area, there are major differences between the two sites. Bidi farmers, still apparently not recovered from cattle losses in 1991-92, have now suffered heavy losses of goats to disease and parasites. Average livestock holdings in Irisvale are far higher, and much more concentrated on cattle (11 households own cattle but not goats, which is virtually unheard of in communal areas). Over a third of Irisvale households, and no households in Bidi purchase livestock feed (excluding salt). This supports what we already know about the more commercial orientation of at least some livestock producers in Irisvale. In both sites, there appears to be free grazing, at least within villages or neighbourhoods, of harvested fields. Although a number of farmers regard this state of affairs as a problem, it seems unlikely to change (e.g. through fencing). In the long run this favours the adoption of stover harvesting and storage.

Perhaps surprisingly, total cultivated area was not on average very different in the two sites, although it was more unequally distributed in Bidi. The Bidi farming system gives equal importance to maize, sorghum and pearl millet, while the Irisvale farming system is very heavily centred on maize to the exclusion of other cereals. Bambara nut and groundnut are important minor crops in both. In Irisvale, there is a greater range of minor crops cultivated by one or two farmers in the sample.

Both areas have been afflicted by drought in the 1998-99 growing season, though not it would seem as badly as in 1997-98 or 1991-92. In both areas some farmers also reported soil fertility problems, and/or shortages of manure and fertiliser. A great range of crop weeds, pests and diseases were reported, most notably *striga* in Irisvale. Some Bidi farmers reported waterlogging problems when rain did come.

As regards storage practices, the surveys demonstrated that only a minority, although a significant minority, in either area, currently invest effort in building and maintaining crop residue storage structures. In Bidi, around one-quarter of farmers have traditional ingalanis. In Irisvale, farmers are less likely to have traditional ingalanis, but more likely to store stover ad hoc in huts, kraals or around the courtyard. However, Irisvale farmers are more likely to experiment with salting stover or mixing it with more nutritious feed (27% compared with 19%), and in spending time or money building or maintaining residue storage structures (24% compared with 13%). Expressed concern about storage losses, and expressed desire to extend residue storage time, were very low in both sites. The area of maize and sorghum planted per livestock unit[5] is 0.46 acre in Bidi and 0.32 acre in Irisvale, but it is possible that higher yields in Irisvale would more than compensate for such a difference, and it would be hard to know how to interpret a difference anyway (more stover per livestock unit could make stover storage less or more likely).

[5] Using a rule of thumb for current purposes of bovine=1, shoat =0.2, donkey =0.5

Within each community, it is hard to identify at this stage, easy indicators for readiness to adopt improved storage. Average cattle holding was not significantly higher than average for those reporting spending time or money on storage structures in either community, and in Bidi a number of those maintaining storage structures were cattle-less. Households investing in storage tended to have more adults available than the average (5.4 against 4.1 in Bidi, and 4.7 against 3.4 in Irisvale), though with small sub-samples these figures are of dubious significance.

But other answers do suggest the importance of labour shortage and difficulties in obtaining thatching grass in deterring improved storage. The project and dissemination efforts based on it must bear this in mind, and continue to seek for low labour input storage methods, and methods which use alternatives to hard-to-obtain thatching grass.

In both areas, enthusiasm for stover storage has probably been diminished by drought and poor harvest, but these are facts of life in Southern Zimbabwe. In the longer term, population and grazing pressure, allied to the social difficulties of preventing others' cattle from grazing in harvested fields, is likely to favour adoption of improved storage. In the medium-term, even in better years, we need to accept that improved stover storage is likely to remain the concern of a minority in both sites.

Construction of Mark 2 stores (May 1999) - J Morton

Farm 21 Mr B Ndebele, Matshina

The farmer was building two Mark 2 stores and one traditional open store. One of the Mark 2s will be used for maize stover only, the other for sorghum and GNH. The store for maize stover will be roofed using the roofing grass provided by MRS, pearl millet stover will be used to roof the other mark 2 store. The Mark 2 stores have three central support poles and will have a ridge pole like the Mark 1 stores. The stores are about 2 m wide and 5 m long. Most of the poles going into the ground have been debarked (all the poles supporting the roofs of mark 2 stores have been debarked), and the bases of the poles were treated with used engine oil to help protect them from termites.

Farm 22 Mrs J Ncube, Bidi

The farmer was ill and so was not visited. It was considered very unlikely that a Mark 2 would be constructed here this year without help from the project.

Farm 23 Mr and Mrs A Moyo, Bidi

A very large mark 2 store was under construction (approx 6m x 6m), traditional platform (approx 3.5 m x 6 m) adjoining in large enclosure. Big poles of Acacia sp (A *galpin*?) have been used as roof supports, but were not debarked or charred. It was said that the bark falls off anyway in a year and that they should last about 10 years. They were cut locally, not provided by MRS. The roof will be designed like the Mark 1 stores, with a central ridge pole, but the roof will be fairly flat.

Farm 24 Mrs D Ngwenya, Matshina

19. Mrs Ngwenya had a traditional platform, approx 3 x 4 m. The ground holes had been dug and posts collected for the Mark 2 store, but it is at an early stage of construction. It will be about 3 x 5 m. There was a lot of stover in the fields. The Mark 2 store should be finished by the end of May. The farmer expected to use the stover from October. The farmer's family was doing all the construction, but expected to hire someone to do the roof thatching. The main support posts will be debarked and charred.

Farm 25 Mr J Dube and Mrs S Dube

20. The Mark 2 store was nearly completed. The roof was designed like traditional huts with no central ridge pole as used in the Mark 1 stores. The store was about 6 m long and 3 m wide, the roof about 1.7m high at the edges. The support poles cost about Z$300, construction of the support frame Z$250, thatch support and thatching labour Z$250, string/twine Z$120, food supplied to other farmers who helped Z$100, platform Z$200, so the farmer spent about Z$1,500 on the store. MRS provided thatching grass and 3 long mopane poles, so the total unsubsidised cost was probably about Z$3,000 (about £50; £1 = Z$60 at this time). Plastic sheeting and old woven plastic sheeting was used to cover grains (for chicken feed) on platforms at this farm.

Farm 26 Mrs Gabriel Ndebele, Machina

Harvesting was now more or less finished, there was a traditional store full of stover (raised platform about 1.5 m high which doubled as a goat shelter underneath). There are support posts for a traditional store in an adjoining enclosure, and this will be used as the platform for the mark 2 store. 9 support poles will be used, with a ridge pole, like the mark 1 roof.

Farm 27 Mr J Ncube, Tshipisani

Have traditional store approx 3 x 4 m and 2m high with maize stover. The mark 2 store will be built alongside it, there is a good sized enclosure for storage.

Farm 28 Mrs Aelitha Moyo, Matshina

The farmer has a traditional store approx 3 m wide x 9 m long with maize and sorghum stover. There is also a lower platform (about 0.6 m off the ground compared to 1 m for the traditional platform) which will be roofed, approx 3 x 5 m. The farmer has the 3 poles and thatching grass from MRS. There is no man at the farm and the farmer is unclear what to do, and is busy with the harvest. The roof supports and roof frame need to be constructed. MRS will arrange for some help to be given.

Farm 29 Mr E M Ndebele, Matshina

An enclosure to build the stores is being built, but not the stores themselves as yet (neither traditional nor mark 2). The stores should be ready in June. The farmer is also a builder, and is planning to build 4 brick pillars to support the roof at each corner. He plans to do all the construction and thatching himself, unless he is busy on other jobs. He has thatching grass from MRS.

Farm 30 Mr and Mrs J Ndlovu, Bidi

The support frame and framework to support the thatch roof for the mark 2 store has been completed. Store still to be thatched and platform to be constructed. The store is about 4m x 4 m with the roof about 1.6m high at the edge. The farmer wanted a bigger store but thought there would not be enough grass for the roof. The store has 8 support posts, all obtained locally. The 3 mopane poles supplied by MRS will be used to support the platform. The thatcher will come on 14 May to do the roof. A traditional store will be constructed alongside. The farmer may want to extend the structure for next year to increase capacity. Estimated cost: main poles Z$300, construction of frame Z$600, roof frame and thatching Z$600, nails Z$40, string Z$30, total cost Z$1,600; probable total cost about Z$3,000 without subsidies. Stover was tied into bundles for carrying.

BACK TO OFFICE REPORT

VISIT TO ZIMBABWE TO INITIATE THE SAMPLING OF MAIZE STOVER FOR EVALUATION OF NUTRITIVE VALUE AND MYCOTOXIN CONTAMINATION

14 - 23 April 1998

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Circulation: D Thomas, B Blake, J Perfect, B Wright
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Summary of key points

1. The initial samples of stover were collected from the 10 participating farms. These will be further dried, heat treated, ground and sent to NRI for dividing and analysis. The sub-samples for chemical analysis will be returned to Matopos. Dr Coker to visit Zimbabwe in late May for second sampling.

2. Current storage structures at the 10 participating farms were described. Plans for improved storage structures were prepared and arrangements for their construction initiated by Mr Ncube.

3. Leaf loss from maize stovers was acknowledged by farmers to be a problem, especially this year which was particularly dry. It appeared that there was only limited (if any) scope to make practical improvements to the usual practices which would reduce such losses without compromising other aspects of the harvest.

4. The proposed monthly survey of 40 farms in the Bidi district has been considered by Mr Ncube, but will involve a greater level of resources than are available. It is therefore proposed that the survey is conducted at approximately 3 monthly intervals, i.e. the initial survey and two follow-up surveys. The survey should be initiated when time permits after the construction of the improved stores, and possibly after the second sampling period depending on progress (i.e. possible early/mid June).

5. Receipts for expenditure by Matopos were received to cover the period to the end of the visit. It is understood that steps are being taken to obtain administrative support and suitable bank accounts for the DFID projects; such developments will be welcomed by project staff.

Background

6. Project A0730, effects of harvest and post harvest practices on the production and nutritive value of maize and sorghum residues in Zimbabwe, started on 1 October 1997. This project is funded for three years by the Livestock Production Programme (LPP) and is being conducted in collaboration with Matopos Research Station near Bulawayo. Areas where stovers are of particular importance as feeds are the preferred target areas as farmers will be more likely to be interested in improved storage and harvesting techniques. Initial survey work indicated that the drier lowveld site at Bidi (approx 150 km south of Bulawayo) fell into this category, and therefore this region was chosen as the site for storage trials.

Objectives/terms of reference

7. The primary objectives of this visit were:
a) Initiate sampling of stovers at the time of harvesting, the first sampling period.
b) Review facilities for sample preparation, packaging and dispatching.
c) To review the design of the improved storage structure.
d) Review plans to construct 10 such structures at collaborating farms.
e) Familiarisation with harvesting methods with a view to identifying possible improved procedures which retain stover quality.
f) Review administrative matters of the project.

Activities

Farms visited

8. The ten farms collaborating with the on-farm storage trial were visited to take the initial stover sample and review existing storage facilities. There was one change to the list of farms prepared by Dr Morton (visit report 30 March - 7 April 1998), Mrs M Ndhlovu (farm 7) replacing Mr P T Ndhlovu at Tshipisani on the advice of Mr Ncube and Mrs Maithanda (the local extension worker). It is understood that Dr Morton already has baseline data on this farmer. The revised list of farms is given in Table 1. In all cases the harvest was much further advanced than is usual at this time of year. This is because the rains stopped early, effectively ending in January instead of March or April. This may have been due to the "El Nino" climatic phenomenon which was particularly strong this year. As a result the late sown maize had largely dried early in the fields, making the harvest early and poor. This has several implications. The harvest was earlier than usual limiting the time available for the planning and construction of improved stores. The stovers were going into storage much drier than usual making the leaf material much more likely to fragment and be lost. Risk of mould attack and mycotoxin accumulation were conversely probably greatly reduced for this initial period. Stover (as well as grain) production was appreciably reduced compared to more average conditions. Green grazing was already starting to dry out, earlier than usual, indicating that stovers will have to be used earlier than usual. Therefore there will be particular pressure on feed resources such as stovers during the coming dry season.

Table 1 Farmers included in on-farm trial

Farm No	Place	Farmer
1	Bidi	Mrs Ndiweni
2	Bidi	Mrs S Ndiweni
3	Bidi	Mr R Dube
4	Matshina	Mrs P Phuthi
5	Matshina	Mrs P Moyo
6	Matshina	Mr M Ndhlovu
7	Tshipisani	Mrs M Ndhlovu
8	Tshipisani	Mrs Maphosa
9	Lingwe	Mr R Nyati
10	Lingwe	Mr M Ndebele

Stover sampling

9. The ten farms were visited from 16 to 20 April for stover sampling. Sampling was intended to give a sample representative of the maize stovers which will be stored. Fifty stovers from each farm were taken for the sample. If the stovers were in stooks or stacks, which was mainly the case, an approximately uniform number of stovers was taken from each stook/stack. Stovers were taken from different parts of the stook/stack at random. Standing stover was sampled by taking stovers at regular intervals from different parts of the field. Where some stovers were in stacks and others still standing, a by-eye judgement was made on the proportion of stover in each category and the sampling adjusted to reflect this proportion. Cobs were removed from the stovers leaving the leaf sheath as is usual here. Failed plants which contained small poorly developed cobs were sampled with these cobs as it is usual practice to leave these with the stover. Some details are given below in order of farm number (which was not the chronological order of sampling). Some light rain fell on the morning of 17 April but this appeared to have little or no effect on the stovers collected.

Farm 1: About a third of the maize crop still standing in field, most of it looking dry already. This will be harvested in 1 to 2 weeks time to stooks, and the cobs removed and stovers stored shortly afterwards. Children usually help with the harvest and they return to school on 2 May, so harvest likely to be completed by then. 36 stovers were taken from 12 stacks of stovers (stovers stacked in heeps when stooks dimantled during cob removal), 3 at random from different parts of each stack. 7 stovers were taken at random from each of the two fields with standing maize.

Farm 2: About a third of the total maize planted was still standing in two fields and was still quite green. It was said to need about a further month before harvesting, and the stover should be stored from the end of May. The farmer said that this stover would be stored separately from the rest of the stover which was well dried and in 6 stacks.

Therefore only the 6 stacks were sampled.

Farm 3: Nearly all the stover was in 6 large stooks on support frames. Very little (<5%) of the crop was still in the fields awaiting stooking. The 6 stooks only were sampled, the stovers being mainly dry although a few were still quite green.

Farm 4: Stover in 18 stacks, all very dry, randomly sampled (2 stovers/stack + 1 additional stover from 14 of the stacks). Some standing stover which was to be left for grazing in the field was not sampled.

Farm 5: For early sow maize, the stovers had been spoiled by rain and will be used for compost or for feeding in small quantities to animals. It will not be put in the stores and therefore was not sampled. Late sown maize was all still standing in the field. This was sampled by taking 50 stovers from different parts of the field.

Farm 6: All maize stover in three stacks, but not much of it.

Farm 7: About a third of maize standing the rest in stacks. 12 stacks sampled (3 stovers per stack) plus 14 stovers from standing crop. Several stovers had bind weed wrapped around them which was left on as this was normal practice.

Farm 8: Very diverse forms of maize stover here. A very small amount of green stover from a failed crop was being dried on one platform (usually used to store maize cobs). This was not sampled as the quantities were small. A large batch of very dry stover with cobs had been stacked on another platform to stop pilfering by grazing donkeys. There was an appreciably quantity of standing stover and a stack of harvested stover in the field. 20 stovers were selected from the platform, 20 from the standing crop plus 10 from the stack in the field.

Farm 9: Nearly all maize well dried in stooks or stacks.

Farm 10: All maize in stooks and were just starting to harvest cobs. Stovers well dried.

10. On returning to Matopos, the samples were sorted and well dried material replaced in plastic sacks, moist material was laid out to sun dry surrounded by netting intended to trap leaf material which may fragment and be lost. Clearly the maize stover was somewhat heterogeneous in terms of its state when sampled. Time of sowing was clearly an important factor as well as timing and management of the harvest and stovers.

Weights of stovers sampled

11. During sampling the weights of the stovers collected were checked occassionally to estimate the likely weight of sample obtained. These spot checks indicated a range of weights of 81 to 127 g/stover and an average of 104 g/stover. The weights of the samples collected were also checked as shown in Table 2. As some of the samples were moist to some extent it is difficult to give a reliable final sample weight, but the range appeared to

be about 4.1 to 6.7 kg for the 50 stovers, with an average in the order of 5.5 kg (110 g/stover).

Table 2 Weights of stover samples collected

Farm No	Total weight of stover sample (kg)	Comments
1	5.69	1.46 kg being dried further
2	4.17	1 stem damp
3	6.66	1.33 kg being dried further
4	6.26	0.2 kg being dried further
5	est 4 kg when dried	all damp
6	6.31	all dry
7	4.15	all dry
8	3.35 (dry only)	1 sack of 3 being dried further
9	5.26	2 stovers being dried further
10	5.87	all dry

Subsequent to the visit it was discovered that the samples must be heat treated at not less than 56^{o}C for not less than 30 minutes to reduce the risk of the samples carrying viable foot and mouth disease. This treatment will also help further reduce the moisture content of the samples to reduce the risk of deterioration in storage and shipment. Samples will be chopped manually and ground to 1 mm (using the laboratory mill purchased by the project) and dispatched in sealed plastic sacks within a suitable outer container and sent by air freight.

Existing storage facilities

12. Existing storage facilities are summarised in Table 3, with further notes below where appropriate.

Farm 1: Have enclosed compound which will house the store, farmer planting orange and mango trees in part of the compound. Adequate room but space will need clearing.

Farm 2: Will build platform outside kraal in open area which will be fenced in with a wire fence to stop animals getting in.

Farm 3: Loads of space in home compound for storage. Also has separate storage kraal for groundnut, groundnut hay and pearl millet grain storage. Cut dried grass used to cover pearl millet. Uses "A" frame to dry and store groundnut hay on outside and nuts on inside.

Table 3 Existing storage facilities at farms included in on-farm trials

Farm number	Size of store enclosure	Size of storage platform	Height of platform above ground

1	large enclosed field	platform to be built	
2	will put wire fence around store	planned 6 x 4m	planned 1m
3	store in large home compound	platform to be built	
4	small 7 x 7m	3 x 3 m	0.3m
5	18 x 18 m	6 x 2.5m	1m
6	very large	4 x 4 m	0.6m
7	30 x 30m	platform to be built	
8	round, 16 m diameter	3 x 2m	1m
9	10 x 10m	7 x 3m	1m
10	small, 7 x 7m	2 x 2m	0.3m

Farm 4: Small storage kraal, existing platform will have to be moved to get improved store in. Has two roofed structures, with thatched roofs for shading goats. Plastic sheeting and corrugated iron sheeting used to cover corn cobs in wooden cradle ("sirara").

Farm 5: Very large storage kraal with lots of spare space. Following earlier discussions with project staff, farmer decided to construct own roofed store using pearl millet stover and cut dried grass for roofing. This will be used for groundnut hay and sorghum stover only so that they can participate in the project trial. Have "A" frame dryer/store for groundnut hay.

Farm 6: Following earlier discussions with project staff, farmer planned and started to construct own roofed store. Wooden supports had already been constructed and thatched roof was planned, but this will be postponed so that the structure can be used as an uncovered platform for the on-farm trial.

Farm 7: Very large kraal with plenty of space.

Farm 8: Very large kraal with plenty of space. Has some maize stover on platform from last year, looked mouldy underneath top layer and spoiled. It will be used for compost.

Farm 9: Space to build alongside existing platform.

Farm 10: Has thatched roofed structure to shade goats. Was constructed by craftsmen from the village for about Z$75 (£3).

Farms 4 and 10 had only restricted space to build an improved store, the other eight farms appeared to have adequate space. Two of the ten farmers were already taking action to build their own roofed stores, stimulated by earlier contacts with the project. Also roof-like structures are quite commonly used to shade animals. This is very encouraging as if the roofed stores are found to be a worthwhile improvement on open platforms, farmers appear to be able to have suitable structures constructed using locally available resources.

Improved stores

13. Different farmers had different areas available for stover storage and different quantities of stovers to store. It became clear at an early stage that a single standard design would not be universally appropriate as different sizes would be required. Also different farmers had different capabilities to construct, or employ craftsmen to construct, roofed stores to their own design and requirements. It was decided that the stores initially constructed by the project would be intended for experimental trial purposes primarily rather than a suggested design which farmers were likely to adopt. Should the trial be successful there would be scope for developing types of designs in consultation with the farmers collaborating on the trial. These designs would be intended to stimulate interest during extension activities as individual farmers would be able to modify the designs as they saw fit.

14. Outline designs were prepared for 5 x 4 m stores (for eight of the collaborating farms where space was not restricted) and for 3 x 3 m stores (for farms 4 and 10). The designs consist of a corrugated asbestos roof supported by treated gum poles, materials which can be puchased locally but which are probably too expensive for farmers to use themselves for this purpose (although are used for house construction). The larger design of store costs about Z$7,000 in materials (about £256). It is planned to start construction on or about 27 April. Discussions with Tim Donaldson indicated that the roof should be designed to have sufficient overhang to protect the stovers; insufficient overhang is a common fault with traditional grain storage structures.

Loss of stover leaves

15. Stover leaves are generally the most nutritious part of the stovers. However, this material can be lost during handling and storage reducing the nutritive value of the stover as a whole. All 10 participating farmers were asked whether leaf loss from stovers was seen as a problem and what steps they took to reduce it. Leaf loss was widely seen as a problem. Fragmented leaves were very much in evidence in the fields and farmers were aware of its value as a feed. This material is grazed in the fields, so it is not necessarily all lost if it does fragment from the stover. Farmers will also pick up the material if possible and feed it to cattle. Leaf loss was a particular problem this year due to the exceptionally dry conditions. Normally the stover leaves are still a little moist when they are stored which reduces leaf loss. Stovers can also be handled after rain or early in the morning when there is a dew as the leaves are moistened to minimise losses. Fencing can be used to trap leaves, but collecting the material is labourious. None of the farmers could suggest a practical way of reducing leaf loss under such dry conditions. Indeed, it is difficult to see what can be done as the leaves dry out very much faster than the stover stems. As the stems must be dried sufficiently to prevent mould damage the leaves must inevitably be very well dried and liable to fragment. There was certainly awareness amongst the farmers that moist leaves were less likely to be lost by fragmentation.

Survey

16. The proposed monthly survey of 40 farms in the Bidi district (proposed by Dr Morton during his April 1998 visit) has been considered by Mr Ncube, but will involve a greater level of resources than are available. It is therefore proposed that the survey is conducted at approximately 3 monthly intervals, i.e. the initial survey and two follow-up surveys. The survey should be initiated when time permits after the construction of the improved stores, and possibly after the second sampling period depending on progress (i.e. possible early/mid June).

Administrative matters

17. The laboratory mill, purchased in the UK and dispatched via the British High Commission and Tim Donaldson to Matopos, arrived in full working order during Dr Wood's time at Matopos.

18. It is understood that the proposed DFID project administrator will be appointed shortly and that Matopos will be opening a bank account to service these projects. Both developments would be extremely welcome. The current situation is unsatisfactory. Project funds in Zimbabwe are held at the University of Zimbabwe through the very kind collaboration of Dr Titterton, in the absense of a ready alternative account to hold the funds. Neither Mr Ncube or Dr Wood has direct control or access to information on these funds. This causes uncertainties about the true financial position of the project and delays when Mr Ncube needs to access these funds, as well as being an imposition on Dr Titterton.

Action points

Dr Morton to prepare baseline data sheet on farm No 7.

Dr Coker to visit Zimbabwe in late May for second sampling. References on mycotoxins and sampling will be provided to Ndabezinhle Nyoni.

Mr Ncube to arrange and supervise the construction of the ten improved (roofed) stores.

Mr Ncube to arrange and supervise the drying, heat treatment, grinding and dispatch of the first batch of stover samples.

Dr Wood to seek confirmation of balances of project funds held in Zimbabwe.

Invoicing implications

No special implications - invoiced by usual DFID research project procedures.

SAMPLING PROBLEM - R Coker

1. General sampling problem

The design using 1 sample per store on each farm, gives no information about the sampling procedure and inaccurate estimates for the mean response values. A further disadvantage is that the only statistical analysis that can be performed is a meta-analysis of all the experiments. There are two alternatives forms of this, using farms as blocks or analysing the three-way table of means for farm, rep and store. Using farms as blocks assumes that there is no farm/treatment interaction, which may not be true. Analysing the table of means, does not take into account the accuracy of the mean values, which from only 1 sample, would be very poor.

The experiment can be improved by having sampling replication within farm. This will yield information about the variability of the samples and yield more accurate confidence intervals for the mean values. The sampling variation would be accounted for by fitting the sample term as a random effect. In order to get good estimates for the sampling and the unit variance it is necessary to take at least **10 samples** of stover, with two analytical replications of each.

2. Sample size

It is now necessary to try and determine how many stover there should be in each sample. A representative sample should give an accurate estimate for the variability in the stores. Some idea of the variability can be obtained by looking at the data for the variable cg48 from a previous experiment. To allow for the variability in the samples a random effects model was fitted, taking the form

cg48 = constant + rep + sample + error.

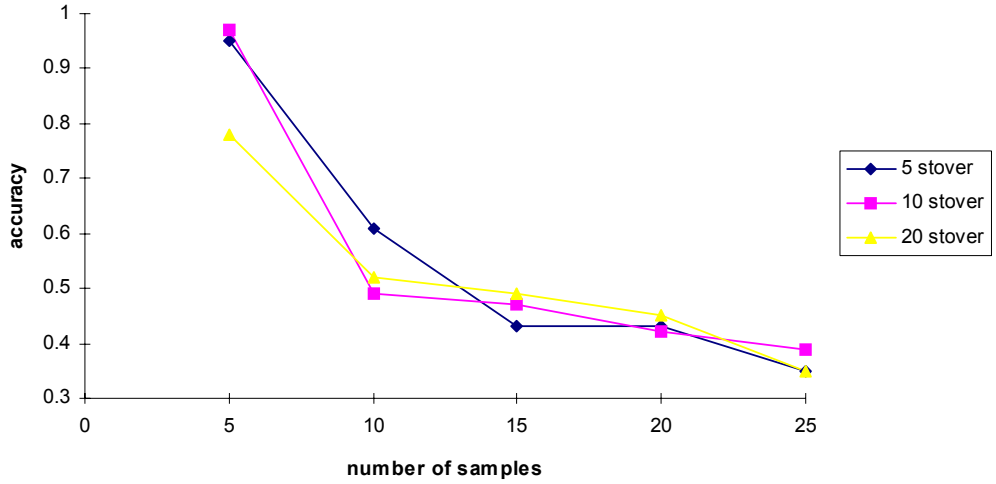
Where sample was assumed distributed $N(0,s^2)$ and error $N(0,e^2)$ and estimates for these variances were obtained using residual maximum likelihood. Table 1 gives the mean value and variance estimate for the data from each farm.

Farm	**Mean estimate**	**Variance estimate**
1	251	56
2	233	86
3	220	71
4	238	52
5	259	18
6	226	70
7	245	112
8	247	108
9	245	112
10	238	41

Table 1 Estimates of mean and variance (rounded to nearest integer)

Although the estimates for the mean and the variance are inaccurate they do give some idea of the large variability between farms. The sample size should be chosen to give estimates as accurately as possible within the practical limitations of the

experiment. Using the information from Table 1 a store of 2000 stover were simulated with a distribution of N(250,80) and for each sample a smaller error from the analytical replication was added. The accuracy of the estimate of the sampling variation was quantified as (standard error of estimate)/estimate. Figure 2 shows this value for 5 to 25 samples with 5 to 20 stover per sample.



Although time precludes running the simulation for longer there is evidence that the most effective method for improving the accuracy of the estimate is to increase the number of samples, rather than the number of stover per sample. The recommendation from this simulation would be to use ten samples with 10 stover per sample.

3 Sampling for aflatoxins

There is the added complication that the aflatoxins are highly heterogeneous with not all stover containing toxins. It is assumed that the probability of toxins is not too small (i.e. approx less than 0.1), because in this case there is no suitable sampling scheme. The probabilities of obtaining at least one infected stover in a sample size of 1 to 50 are shown in Figure 3 for three probabilities of stover infection.

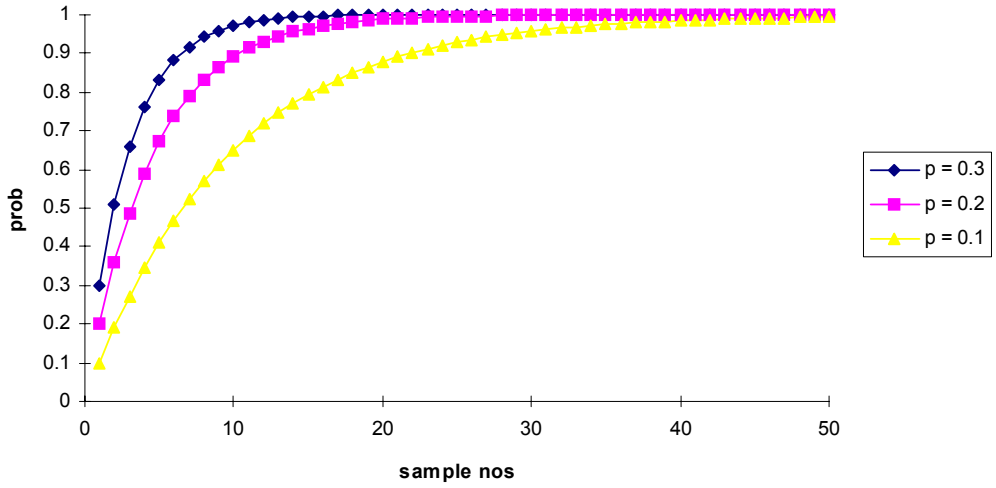


Figure 3 prob (of at least one infected stover in sample)

For probabilities higher than 0.1 this shows that 10 stover is a reasonable sample size. The same graph for the probability of having at least two stover in a sample is shown in Figure 4.

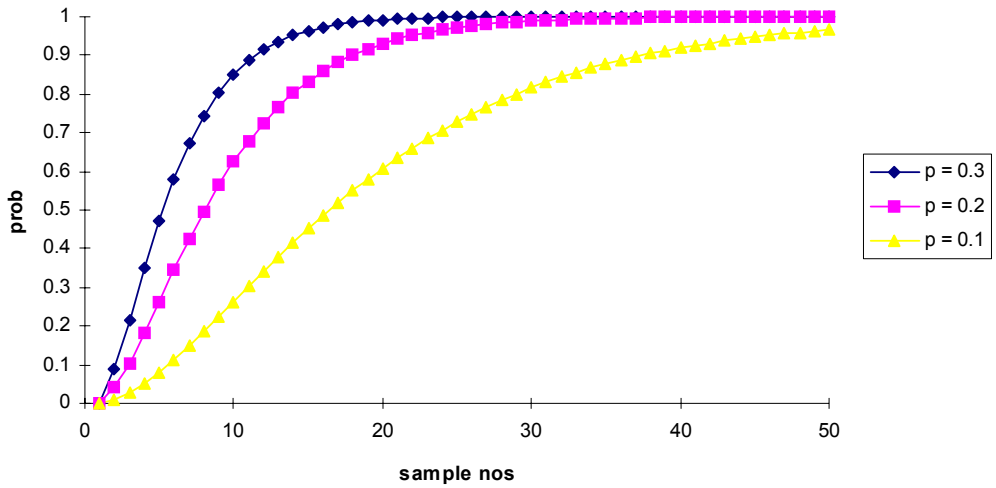


Figure 4 prob (at least two stover in a sample)

It appears that the existing store is not likely to have any toxins and the test between the stores can be thought of as testing whether the mean for the new store is significantly different from zero. If the samples contain too many zero concentrations then it will be difficult to analyse, because the data will be severely non-normal. Figure 4 shows that increasing the probability of getting infected stover, requires a prohibitive number of samples.

If 10 samples of 10 stover are taken Figure 5 shows the probability of getting at least one infected in all possible number of samples.

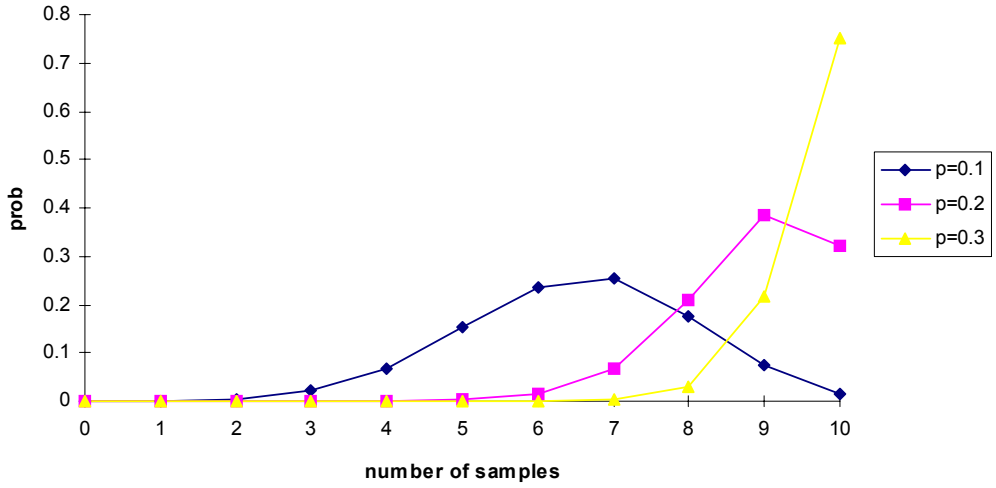


Figure 5 Prob(of getting at least one infected stover in x samples), x = 1,...,10

For larger probabilities of infection, most of the samples will contain at least one infected stover, which will allow a random effects model to be fitted to the concentrations. Testing the mean against a zero concentration gives a significant result at the 5% level if the coefficient of variation is less than sqrt(n)/2. For n = 10 this is equivalent to the coefficient of variation being less than 150%, which with 10 samples should be attained. If both stores give toxin concentrations then the next section considers the analysis.

4. Within farm analysis

Although both stores are on a single farm, they are unreplicated and should be considered as separate experiments. For any response variable each experiment can be analysed using a random effects model and from this confidence intervals for the mean response level can be calculated. These can then be compared and any intervals that do not overlap indicate important differences between the stores.

5. Combined analysis

The mean responses from each experiment on each farm can be expressed in a table of the form.

Farm		*existing store*	*new store*
1	*rep 1* *rep 2*		
2....			

This can then be analysed using a random effects model taking treatment (existing,new) as a fixed effect and all other effects and their interactions as random effects. Since there is an estimate of the variability of the data within each farm, it would be interesting to consider using this as a covariate.

6. Summary

The sample needs to be representative enough to identify any differences between the new and the existing stores. This report has shown that a suitable sampling scheme is 10 samples of 10 stover from each store on each farm. Each store should be divided up into an imaginary grid of 10 squares, and 1 sample randomly taken from each square of the grid.

If this is unacceptable then the minimum for a scheme that allows within farm analysis would be 8 samples of 5 stover from each store on each farm. If there are not enough resources for this reduced scheme, then a possibility is 2 samples from each store on each farm with as many stover as possible per sample. This method will not allow any within farm analysis.

Another approach would be to only do the within farm analysis for selected farms.

In vitro gas production protocol used for Zimbabwe stover samples - C Wood

Wednesday

Grind substrate to pass through a 1 mm dry sieve (if not already ground). Weigh out substrate. Generally use 1g of substrate, weigh to a tolerance of $\pm$0.010g (except if glucose is used as a standard in which case use 0.5 g glucose). Note actual weight used.

Thursday

Make up suitable amounts of medium as described overleaf, but excluding the reducing agent. Bring medium to the boil, without allowing to boil for more than a few minutes, and allow to cool under CO_2 overnight.

Friday

Add reducing agent, keep flushed with CO_2. Medium should turn pink or go clear. Dispense 90 mls of medium into 125 ml serum bottles using automatic pump and gassing with CO_2. Always fill a few spare bottles with medium, also include extra bottles if a diluted inoculum is to be used. Seal with butyl rubber stoppers, but do not crimp. Store at 4^{o}C.

Monday

Transfer the substrate into the serum bottles containing the medium using a small wide bore funnel. Gas the bottles with CO_2. Reseal with butyl rubber stoppers and crimp with aluminum caps. Replace in the incubator at 4^{o}C and programme it to switch to 39^{o}C at about 2am to prewarm the bottles.

Tuesday

A minimum of 2 people are required to inoculate the bottles

Donor animals

species - sheep
diet - hay:concentrate 70:30 DM basis. Approx composition of concentrate: oil 5.5%, protein 18%, fibre 8%, ash 8%, vit A 9000iu/kg, vit D3 2000iu/kg, vit E 10iu/kg.

Prepare Inoculum

Restrain donor animals using collars. Remove fistulae bung and remove rumen fluid using a pump. Collect rumen fluid starting at 8.15 am before the sheep are fed and keep warm in a thermos flask. Pour about 500ml of rumen fluid and solids into a blender and blend for 20 seconds at a high rating. Filter fluid through 4 layers of muslin in a large funnel and collect in a beaker under an atmosphere of CO_2.
Inoculum is used diluted as follows:
one part rumen fluid to three parts medium (x4 dilution).

Keep the inoculum stirred and under CO_2.

Inoculation of the bottles

While the inoculum is being prepared, the serum bottles are adjusted to atmospheric pressure and the bottles are then returned to the incubator at 39^{o}C.

Using a 20 ml syringe and 21 gauge 1.5 in (0.8 x 40 mm) needles (colour code green), 10ml of inoculum is injected into each bottle. Shake bottles and return to the incubator.

Starting at 10 am, the bottles are readjusted to atmospheric pressure, shaken and returned to the incubator. This is taken as the starting point (Time = 0). Readings are then taken at the following times.

		Time	Hours After Inoculation
Day 1	Tuesday	1000	0
		1300	3
		1600	6
		1900	9
		2200	12
Day 2	Wednesday	0100	15
		0700	21
		1300	27
		1900	33
Day 3	Thursday	0100	39
		1000	48
		2200	60
Day 4	Friday	1000	72
Day 5	Saturday	1000	96

SAFETY NOTE Readings should be taken in a fume cupboard and gasses evolved disposed of inside the fume cupboard.

A pressure transducer (we use Bailey and Mackey Ltd, Birmingham B42 1DE, UK) is used to measure headspace pressure in the bottles. The transducer had a range of 0 - 25 psi, accuracy of 0.1 $\pm$ 2%, readings calibrated to read in units of psi (although such calibration is not essential). It was connected to a disposable luer lock 3-way tap allowing a needle (23 gauge 1 in, 0.6 x 25 mm; colour coded blue) and syringe to be fitted to the other outlets.

Gas pressure is read by removing bottles tray by tray from the incubator, inserting the needle through the butyl rubber stopper into the headspace above the medium. Note pressure. Adjust the pressure to atmospheric by removing gas into the syringe and

note volume of gas removed (read the syringe). Take readings from all the bottles in the tray, shake the bottles, and return them to the incubator.

Determination of Dry Matter Disappearance (DMD)

On Saturday at the end of the gas production run, vacuum filter through pre-weighed filter crucibles (Sintaglass, porosity 1 - regraded P160). Wash bottle with water to removed residues and wash residues on the filter. Oven dry overnight at 105^{o}C then allow to cool in desiccator and weigh. Express DMD as a proportion of the initial dry matter in the substrate.

MEDIA

SAFETY NOTE, calcium chloride, resazurin are classed as irritants. Sodium hydroxide, sodium sulphide, ferric chloride are corrosive. Ferric chloride can cause serious damage to eyes. Avoid skin contact, wear gloves and laboratory coat. Wear eye protection to make up stock solutions.

Dihydrogen sulphide gas is very toxic and may be generated from sodium sulphide. Vent waste gas in fume cupboard when readings are taken.

Carbon dioxide can cause suffocation. Use only in a well ventilated laboratory, avoid breathing the gas.

Inoculum could contain harmful microbes. Animals used must be healthy. Wear gloves and laboratory coat when handling. Handle in fume cupboard as far as possible. Clean spillage, dispose of solid wastes by incineration.

NITROGEN (N) RICH (THEODOROU) MEDIUM

Component Solutions

1. Micromineral solution (g per 100 ml)
Make up stock solution and keep in fridge.

Calcium chloride ($CaCl_2.2H_20$)	13.2
Manganese chloride ($MnCl_2.4H_20$)	10.0
Cobalt chloride ($CoCl_2.6H_20$)	1.0
Iron chloride ($FeCl_3.6H_20$)	8.0

2. Buffer solution (g per 1itre)
This is made up in variable quantities for each fermentation run and can be stored in a fridge for a limited period. Calculate how much is required for each run.

Ammonium hydrogen carbonate (NH_4HCO_3)	4.0
Sodium hydrogen carbonate ($NaHCO_3$)	35.0

3. Macromineral solution (g per litre)
This is made up in variable quantities for each fermentation run and can be stored in a fridge for a limited period. Calculate how much is required for each run.

di Sodium hydrogen orthophosphate 12-hydrate

($Na_2HPO_4.12H_2O$)	9.45
Potassium di-hydrogen orthophosphate (KH_2PO_4)	6.20
Magnesium sulphate 7-hydrate (Mg $SO_4.7H_20$)	0.60

4. Reducing Solution (g per 100ml)
Make up freshly

Distilled Water	96ml
Sodium Hydroxide 1M Na OH	4ml
Cysteine HCL.$1H_2O$	0.625
Sodium sulphide	0.625

5. Anaerobic indicator (g per 100 ml)
Make up stock solution and keep in fridge

Resazurin	0.1

To make medium mix the component solution in the following amounts to make about 1 litre of medium.

1. Micromineral	0.1 ml
2. Buffer	200 ml
3. Macrominerals	200 ml
4. Reducing Solution	40 ml
5. Indicator	1 ml
6. Deionised water	559 ml

Equation fitting - France model

France, J., Dhanoa, M.S., Theodorou, M.K Lister, S.J Davies, D.R. and Isac, D. (1993) A model to interpret gas accumulation profiles associated with *in vitro* degradation of ruminant feeds. *Journal of Theoretical Biology* **163**: 99-111.

1. Using a spreadsheet, calculate gas production data per g DM and subtract values for the no substrate control. It is usual to fit the equation to data averaged over treatment replicates.

2. Equation for fitting:

$G = A - BQ^tZ^{\sqrt{t}}$ eqn 1

where G = cummulative gas production per g DM corrected for no substrate control
t = incubation time (h)

Initial estimates A = 200, B = 200, Q = 1, Z = 1.
A - B*(Q**t)*(Z**SQRT(t)) for SPSS

This directly yields values for A = gas pool size (ml per g DM)

From the parameters estimated using equation 1, two rate constants and the lag time can be calculated as follows:

rate constant (h^{-1}) b = -lnQ eqn 2

rate constant ($h^{-0.5}$) c = -lnZ eqn 3

lag time (h) $\sqrt{T} = \frac{-lnZ/2 \pm \sqrt{(lnZ)^2/4 - ln(B/A) \times lnQ}}{lnQ}$

For SPSS, the equation to fit (equation 1)has the form:

A - B*(Q**time)*Z**SQRT(time)), whence A, B, Q and Z

3. The other values can be calculated using a spreadsheet (e.g. excel). Set up as follows:

Parameter	**row**	**formula to type in**
A	2	(derived from equation 1)
B	3	(derived from equation 1)
Q	4	(derived from equation 1)
Z	5	(derived from equation 1)
b	6	-LN(Q)
c	7	-LN(Z)
lnZ	8	LN(Z)
lnB/A	9	LN(B/A)
lnQ	10	LN(Q)
square root function	11	(row8*row8/4)-(row9*row10)
square root T+	12	(-row8/2 + SQRT(row11))/row10
square root T-	13	(-row8/2 - SQRT(row11))/row10
T+	14	row12*row12
T-	15	row13*row13
function -c/2b	16	-row7/(2*row6)
alternative √T	17	-row8/(2*row10)
alternative T	18	row17*row17

Better Stover Stores Make Sense

The rains come and the stover gets ruined. It is terrible if rains, even short showers, come in winter. There is never enough stover for the cattle and goats at the end of the dry season. BUT things can be done better. Adding a roof to a traditional store will stop the rain from ruining the stover. Winter rains are not a problem with a roofed store. Keeping stover in good condition at the start of the rains, until the grass is good for grazing, can be done with no problems. Farmers in Bidi have been using roofed stores for several years to test them out. Word is spreading that they are really useful to farmers who depend on storing stover to feed cattle.

What is more, a roofed store can be used for many things, for keeping other crops and farm equipment. Some farmers have found them very useful for sheltering goats during the rains, when the stover has all been used.

The stores can be different shapes and sizes, different styles and in different materials. Wooden stores with grass thatched roofs and open sides are typical (see photograph). It all depends on what is best for you. Low platforms are used to put the stover on. The roof should overhang the platform so that rain does not blow in at the sides. It helps if the roof is not too high. With careful building you can avoid the need to use very long poles.

Why not try one for yourself? Your local extension worker or the staff of Matopos Research Station will be pleased to give you more advice.

Produced by Matopos Research Station, Zimbabwe, and the Natural Resources Institute, University of Greenwich, United Kingdom.

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Kunganjani wakhe eyakho. Umlimisi wakho loba abe Matopos Research Station bazakuncedisa.

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Better Stover Stores Make Sense

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