Evaluation of forages for smallholder milk production in Zimbabwe

FINAL TECHNICAL REPORT[1]

APRIL 1994 - MARCH 1996

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[1] *"This research was funded by the by the Overseas Development Administration of the United Kingdom. However, the Overseas Development Administration can accept no responsibility for any information provided or views expressed"*

BACKGROUND

Milk and dairy products are in short supply in the rural areas of Zimbabwe. Intake of animal protein is low Small holder milk production, which is strongly developing in these areas, is generally regarded as one of the best means of providing resource-poor farmers with regular cash incomes. Milk contributes to improved livelihoods and is a more attractive incentive for investment of scarce financial resources than beef, which is a long term investment and brings infrequent returns. In these areas livestock production is usually the preferred activity. Whilst the percentage off-take for beef from small-holder cattle systems is low , the reasons farmers give for owning cattle emphasise the importance of draught power, milk production and social security, with beef production being regarded as a terminal function. Within the indigenous cattle of Zimbabwe there has been no sustained selection for either milk production or ease of milk let-down. The major constraints to milk production in the low rainfall areas include a discontinuous supply of good quality feed (fresh and/or conserved forage) and low milk yields among indigenous cattle.

PROJECT PURPOSE

1. To assess promising new pearl millet and elephant grass hybrids for their agronomic characteristics and capacity to sustain milk production in smallholder dairy systems under semi-arid conditions.
2. To evaluate the potential for milk production of Jersey cross-bred cows fed improved forages in smallholder systems

RESEARCH ACTIVITIES

Description of Project Site

The site chosen was on an almost flat pediment. Soils are derived from ultramafic rocks and are mainly deep and heavy textured. The soils supported shrubs of Acacia trees. Subsoil permeability and drainage was restricted. This became the basis of use of strategic irrigation especially at planting water-logging is the usual end result. They had exchangeable magnesium in excess of exchangeable calcium (table 1). This is associated with chromium and nickel toxicity but planted forages were not affected. Before being incorporated into the research station in 1978, the area was used as a horticultural garden. Long term average annual rainfall of 550mm (fig 1) and was relatively frost free.

The soils at the site range from moderate to very deep (50 -130cm), reddish to dark brown clays

derived from ultramafic rocks. Permeability of the subsoil ranges from good on the lower slope to relatively impermeable and very poorly drained on the upper slope. The site is on a slope of about 2% and slope aspect of 180^{0}.

LAND PREPARATION

This involved clearing and stumping which was carried out from July to September 1994. The site had portions with dense acacia shrubs. It had been used as a horticultural garden up to the time the station incorporated the site in 1978. The site was ploughed and disced though problems were encountered in timeliness of operations (lack of tractors) coupled with late arrival of the rains. Fencing was done immediately after land preparation in November.

PLANTING

Eight plots were marked, four in each of two replications. Planting stations were marked at spacings of 1 m inter row and 1 m inrow. Each plot measured 0.1 hectare. Four hybrids, SDPN-3, SDPN-29 SDPN-38 and Banagrass were selected and randomly allocated to the first replication. They were selected on account of their superior dry matter yields, quality and persistence over a number of seasons (1988-1994). Water was used for establishment. Cuttings for establishment of all hybrids were not available in sufficient quantities because of drought coupled with very low winter temperatures in the preceding season. Only SDPN-3 had enough cuttings for 0.1ha. and the rest were multiplied in phases. Establishment and initial growth of SDPN-3 was impressive, a phenomenon which has been observed in previous evaluation trials as well as in communal areas near the station. No fertilizer was applied at planting mainly because of high phosphorous levels, as shown in table 1, and also because of logistical constraints. After cutting nitrogen was applied in the form of 150 kg. of ammonium nitrate, equivalent to about 50kg N/ha. All four hybrids were fully established in both replications as of 31 December 1995.

MEASUREMENTS

About six weeks after establishment of SDPN-3, a preliminary feeding trial was started (table 2). To complement the animal feeding and milk production data, a number of agronomic variables were measured on SDPN-3. These included plant height, tiller and leaf numbers, leaf and stem dry matter

yields, dry matter content of fed fodder and leaf : stem ratio. This was done over a period of 21 days. Samples were taken two times a week at 'cutting point' and the a mean values for each particular variables compiled. Samples were taken from 3 plots each measuring 1m * 1m.

LIVESTOCK AND CONSTRUCTION OF STRUCTURES

Although the project was funded from April 1994, delays in transferring the initial funds delayed establishment of the forage garden and dairy infrastructure (milking parlour; feeding shed etc.). The building of the parlour started in October 1994 and the first animals were milked in it eight weeks later. The parlour meets the Zimbabwean standards for smallholder parlours (solid floors and roof; running water). It also contains a ramp to hold three cows to reduce the labour involved in milking. Electricity was installed in the second year, as was a tank to collect and measure rainwater from the dairy parlour roof. An open-sided shed to permit individual feeding of 16 animals was also constructed. Following the recent rains it has been necessary to put solid floors into this building. In November 1994 an area of 1.5 ha was fenced, ploughed and the establishment of Bana grass and three related hybrids (SDPN 3, 29 and 38), chosen from on-going screening trials of forage material begun. The plan was that using station root-stocks equal areas of each would be rapidly established. A water system was extended into the garden so that strategic watering, especially during the establishment phase, could be applied. Cross-breeding of indigenous (Nkone, Tuli) cows to a Jersey bull started in 1991 and groups of three and two year old heifers calved in October and November 1994.

The plan was to evaluate the four forages for early and mid lactation milk production as well as comparing the two ages of calving (heifers were reared on range using a minimum of supplementary feed). In the event extremely erratic rainfall, higher than expected temperatures and drought delayed establishment of the forage garden. Two hybrids, Bana grass and SDPN-3, produced sufficient material for the feeding requirements. In the event long or chopped SDPN-3 was fed to the three year old animals, who received 3.0kg hay and 5.0kg concentrate per day. The two year old heifers received 2.0kg hay per day plus:

1) 25.0kg Bana grass; 2) 12.5kg Bana grass; 3) 5.0kg concentrate; 4) 2.5kg concentrate.

By the beginning of the wet season of 1995-96 the total area of Bana grass, SDPN-3 and 38 had been established. By early 1996 the area of SDPN-29 was also complete. However, only the first three forages were expected to yield sufficient for evaluation in a milking trial.

OUTPUTS

Forage

A number of variables were measured on the forages during the first and second years to complement milk production data (table 2). Forage production of these was very seasonal and tended to be concentrated to the very wet part of the rainy season (January - February). It was shown that up to 10 tonnes forage dry matter can be grown with relatively low rainfall (< 600mm) using *Pennisetum hybrids*.. Persistence was good in all hybrids during the first two seasons.

Livestock

Between 1991 and December 1995 a total of 109 F_1 calves have been born (57 males; 52 females). Birth weights averaged 27 (±5.0)kg and 90 day weights 98 (±11.2)kg for calves born in 1991, 1992 and 1993. Survival rate to weaning was 86%. Of the F1 females, bred for the first time, 26 have been bulled and 23 calves produced . Of the 13 F1 females bred to produce a second calf 12 have calved, with a calving interval of 373 (±39.0) days. The seven 3 year old calvers gave 1255 (±347.0)l of milk in 282 (±41.6) days and reared their calves. In mid-lactation four of them received 3kg hay and 5kg dairy meal and a supplement of SDPN3, either chopped or long. Intake of chopped forage was higher (fixed at 30kg/head/day) than long (28kg/head/day). Milk yield (5.5±0.77 l/head/day) was not improved by chopping the forage. The six 2 year old calvers gave 821 (±172.3)l of milk in 252 (±19.8) days reared their calves. In mid-lactation four of them received supplements, to natural grazing, of Bana grass (12.5 or 25.0kg/day) or dairy meal (2.5 or 5.0kg/day) but yield levels were such (3.1±1.06 l/head/day) that no differences were noted. In late 1995 nine steers (three 1992 born; six 1993 born) were finished for slaughter, by group feeding of a high energy diet *ad libitum* for 90 days. Intake averaged 1020kg/head as fed. Carcass weights

were 227 (±9.5) and 187kg (±9.4) for the 1992 and 1993 born respectively.

In the first feeding trials chopped forage was eaten to a greater extent than long (refusals consisted of stems). When refusals were subsequently chopped they were eaten by dry stock. Where hand chopping is necessary feeding long, so that the cows eat the leaf material, should reduce labour requirements (the cows also eat the most nutritious part of the plant). This aspect requires further study. The trial was stopped at the end of the third period of a 4x4 Latin square design trial because lack of rain stopped forage growth earlier than expected. Average milk yields (after feeding of calves) were 5.5 ±0.77kg per head per day.
For the two-year-old heifers milk yields were: 3.1; 3.1; 3.0; and 3.3kg per day for treatments 1 to 4 respectively (after feeding of calves). Over the lactation six two-year-olds gave 821 ±172.3kg milk in 252 ±19.8 days. In the 1994-95 wet season three-year-old heifers produced 1255± 347.0kg disposable milk in 282 ±41.6 days. Thirteen heifers were bred to give a second calf with 12 calving in 373 ±39.0 days (one heifer was subsequently transferred to an off-station project; the remainder are on standard management to see if the differences ascribed to age in the first lactation persist). In general the cross-bred heifer is hardy, fertile and easy to handle. Early puberty has been noted, suggesting, coupled with high fertility, early calving as a practical management strategy. Male calves have been used for ploughing (ODA project: 'Improving the productivity of draught animals in sub Saharan Africa') and carting. Steers have been slaughtered after intensive feeding for 90 days (carcass weights: two-year-old 187 ±9.4kg; three-year-old 227 ±9.5kg). Meat sold to Matopos staff has been judged of good quality and taste but overfat (feeding of high energy diets prior to slaughter should be less than the generally accepted 90 days).

Meeting of objectives

The first objective of assessing the four forage lines has been met in that agronomic data is now available. There was a problem in the first season because of the late start and the rainfall pattern. The study will be continued during the 1996-97 season and is supported by work on both sandy and clay soils (both within the station). The forage garden is now fully established. The evaluation of F1 Jersey crosses is now expanding as Jersey and indigenous bulls are being used to establish the limits of exotic dairy genes necessary for acceptable levels of milk production. Evaluation of male progeny is unusual in this type of study and is yielding useful information (a cross in which the male has no draught power or carcass value

would not attract farmer interest). The dairy unit is now fully operational. Management is aiming at a system to which smallholder farmers can identify (minimum inputs; once-a-day hand milking; cows suckling calves after milking etc.).

CONTRIBUTION OF OUTPUTS

When this project started farmer interest in milk production was under estimated. This project is now co-operating and seconding animals to three on-farm sites (One a training centre which is setting up four satellite dairies); a further five sites are producing forage from pennisetums. A Field Day was held at Umhlonyane (project site) on 26/03/1996. It was attended by 230 smallholder farmers, either involved with or interested in dairying. The concept of growing forage was accepted, the major concern being the unavailability of suitable animals. At present over supply of liquid milk is not seen as a problem (Processing to increase shelf-life and mobility are options if this situation arises). At present smallholder milk production is based on fresh forage during the wet season, thus making seasonal production inevitable. Preliminary work has started on ensiling pennisetums. their acceptability to cattle will be tested. During the next season pennisetums (cut and carry; supplements to natural gazing) will be compared with natural grazing as the sole source of forage. These studies need linking to detailed studies of conservation suitable for relatively resource poor smallholder farmers in semi-arid areas

PUBLICATIONS AND DISSEMINATION OF PROJECT RESULTS

This project has been reported in the Annual Reports of the Division of Livestock and Pastures (1993-94 published; 1994-95 in the press). It was also the subject of a short paper and poster presentation (appendices 1 and 2) at the All Africa Animal Conference (Pretoria, April 1996).

Training

A number of small scale dairy groups (3); Training centres: (University of Zimbabwe (2); National University of Science and Technology (1); Bulawayo Polytechnic (1); Church organisations (1) and non governmental organisations (2), sent their representatives for training in animal husbandry (dairy) and forage production at the small scale dairy site for periods ranging from one and three weeks.

Table 1

Basic characteristics and nutrient status of soil at the site prior to planting in October 1994.

Code	Col.	Tex.	PH	Nitrogen (ppm)	Available P_2O_5 (ppm)	*Exchangeable Cations (me./100g)*			
						K	Ca	Mg	Total
1	S/B	Mg/Sc	6.2	39	136	0.3	14.38	9.98	24.66
2.	B	Mg/Sc	6.5	75	130	1.56	13.86	12.66	28.08
3.	B	Mg/Sc	6.3	25	65	0.26	1.94	10.00	22.20

Table 2.

Agronomic characteristics of SDPN-3, SDPN-38 and Bana grass fodder cut and fed to cross-bred cows during 1995/96 season.

Phase[1]	Plant height (cm)	Tillers /plant	% DM as fed	DMY (t/ha)	CP %		NDF %		ADF %	
					Leaf	Stem	Leaf	Stem	Leaf	Stem
	SDPN-3									
1	87	47	20	5.7	21.6	17.6	65.4	63.0	36.5	38.4
2	120	71	22	7.1	18.7	15.1	71.5	67.5	39.8	43.7
3	140	75	24	11.9	14.4	11.4	76.5	73.9	44.9	48.3
Mean	116	64	22	8.1	18.2	14.7	71.1	68.1	40.4	43.5
S.E ±	15.4	8.7	1.1	2.0	2.1	1.8	3.2	3.1	2.4	2.9
	BANA GRASS									
1	90	45	19	5.9	18.0	16.6	67.4	65.2	36.7	40.1
2	120	55	22	6.5	16.9	15.1	72.3	69.0	42.8	45.3
3	140	65	24	9.9	13.3	7.3	78.6	73.9	46.5	50.2
Mean	117	55	22	7.4	16.1	13.0	72.8	69.4	42.0	45.2
S.E ±	14.5	5.8	1.4	1.2	1.4	2.9	3.2	2.5	2.9	2.9
	SDPN-38									
1	102	53	18	6.0	17.3	13.0	69.3	65.2	40.9	43.0
2	132	74	21	6.1	16.5	12.3	72.0	68.9	43.5	45.7
3	140	86	26	11.0	12.4	9.3	81.2	77.1	49.3	55.0
Mean	125	71	22	7.7	15.4	11.5	74.2	70.4	44.6	47.9
S.E ±	11.6	9.6	2.3	1.7	1.5	1.1	3.6	3.5	2.5	3.6

[1]. Phase 1. February 1996
2. March 1996
3. April 1996

Table 3
Performance of first calf heifers

Age at 1st Calving (years)	Two	
Number in 1st lactation	6	6
Yield (kg)[1]	821	
Lactation length (days)	252	
No (2nd lactation) (in progress)	6	5
Calving interval (days)	361	

[1] Not including milk consumed by calf
F1 steers (2 and 3 years old) were pen-finished before slaughter

Table 4

Performance of steers for beef production

Age at slaughter (years)	Two	Three
Induction wt (kg)	240	323
Final wt (kg)	361	451
Carcass wt (kg)	187	227
Fleshing index[1]	5.5	3.7

Relationship between carcass weight and length : Cold Storage Company Score; A+=1—E-=10