R5194: Tethering of small ruminants in Tanzania: purpose & implications

A Final Technical Report on a Research Project Funded by the Department for International Development's Livestock Production Research Programme

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EXECUTIVE SUMMARY

The use of goats for producing milk is being encouraged on resource-poor smallholdings in densely populated areas of Tanzania and elsewhere. In addition, for economic and environmental sustainability, greater integration of crop and animal agriculture is being promoted. Integration requires being able to control the movement of animals during grazing. Tethering of animals is commonly used on smallholdings, particularly during the crop-growing, rainy season. Although tethering is widely practised in the tropics, little is published on tethering and its implications for animal productivity and farming system.

Project R5194 was therefore designed to investigate tethering and contribute to LPP's Purpose 1. (*Performance of livestock in high potential and peri-urban intensive farming systems (crop/livestock) improved*), Outputs 4 (*Improved strategies for animal husbandry and nutrition in the intensive livestock production system and in crop/livestock systems in high potential and peri-urban areas developed and promoted*) and 5 (*Livestock management strategies for improving the integration of crops and livestock in mixed farming systems developed and promoted*).

The project was designed to produce six outputs ((a) to (e)) using 15 research activities:
(a) Practice of tethering small ruminants defined and problems identified (Activities 1-3)
(b) Effect of tethering *per se* on the productivity of goats quantified (b) and explained (d) (Activities 4-5).
(c) Production responses to modifying tethering methods quantified (c) and explained (d) (Activities 6-14).
(d) Outputs (b) and (c) explained through measuring intake and behaviour (Activities 4-14).
(e) Effects of tethering methods on pasture regrowth and sustainability demonstrated (Activity 15).
(f) Improved methods of tethering suggested.

Output (a)
Activity 1 (review of literature) confirmed the widespread use of tethering and the dearth of literature on the technology. A survey (Activity 2) and PRA (Activity 3) indicated tethering to be widely practised in Mgeta and Mlali divisions of Morogoro region. Tethering was used to control the movement of grazing goats, particularly during the growing season. The practice was increasing due to children going to school and being less available for herding. There was

much diurnal variation in the duration of tethering, ranging from 4 to 8 h. There was also a wide range in the length of tethers (1.5-7.5 m), which were made of sisal and attached either to the neck (Mgeta) or leg (Mlali).

Outputs (b) and (d)

Activities 4 (dry season) and 5 (wet season) involving Local, non-lactating goats tethered (2.5 m) or not tethered to graze *Brachiaria*-dominated pasture for 8 h daily, showed no effect of tethering on grazing behaviour and herbage dry matter (DM) intake. Intake was estimated by the Short-term Weight Change (SWC) and Alkane techniques, which gave similar DM intakes. Both techniques had not been used previously under tropical, developing-country situations.

Outputs (c) and (d)

Activities 4 and 5, with dry goats, and 6 (wet season) and 7 (dry season), with lactating Norwegian cross Local goats, showed that tethering for 4 h instead of 8 h daily, reduced DM intake and reduced milk yield by 20%. In Activity 10, goats in the wet season tethered to graze for 8 h daily with tether lengths of 2.5 m (one location), 1.77 m (two locations) or 1.44 m (three locations) showed no differences in milk yield or DM intake.

Output (e)

Tethering (2.5 m) goats for 8 h daily at the same location for one versus four days did not affect wet-season, herbage mass at the end of grazing, nor at 15 or 30 days following grazing. However, tethering at the same location for seven days, instead of one, reduced herbage mass and the difference was evident 15 and 30 days after grazing.

Output (f)

Outputs (a) to (e) suggest that farmers should tether goats to graze for as long as possible (8 h) each day, in order to maximise intake and hence production. Tethering by the neck is preferable to the leg as the latter may restrict blood flow and increase the risk of limb loss. On *Brachiaria* pasture in the wet season and using tethers of 2.5 m, goats should be tethered at the same location for no more than four days and preferably allocated a fresh location daily.

Project R5194 has generated one paper in a refereed international journal and seven papers presented to national and international conferences (four in Tanzania, one in Ethiopia, one in Canada and one in UK). The paper published in the refereed journal represents the first report in the scientific literature on comparing and using the Short term Weight Change and Alkane

techniques for estimating intake of goats grazing tropical pasture in a developing-country situation.

An extension leaflet has been prepared in draft form and further scientific papers are planned.

The outputs have been communicated to members of the Tanzania Goat Network (TAGONET) which comprises farmers, NGOs (Farm Africa, Heifer Project International) and scientists working at universities and NARS.

The project trained one Tanzanian (D S C Sendalo) to PhD level. Dr Sendalo is now working in NARS, Central Tanzania, at Mpwapwa. The project has also stimulated other postgraduate studies at Sokoine.

The emphasis on goats and tethering means that the outputs are poverty focused, being particularly relevant to resource-poor smallholders.

BACKGROUND

Greater integration of crop and animal agriculture is being advocated in the intensively farmed and densely populated areas of Tanzania and other tropical countries. The use of small ruminants for producing milk and meat is being encouraged in these smallholder situations. Tethering is commonly used for controlling the movement of grazing and browsing goats and sheep, particularly during the crop-growing, rainy season. Although tethering is widely practised throughout the developing tropics, little is published on the farmer-rationale, methodology or implications of tethering for animal productivity and farming systems.

The demand for Project R5194 evolved from a dairy goat project concerned with introducing crossbred milk goats into smallholder farms in the Uluguru mountains in Central Tanzania (Madsen *et al*., 1990). The dairy goat project, commencing in 1986 and still running, is based at the Department of Animal Science and Production of Sokoine University of Agriculture, Morogoro, and is sponsored by the Norwegian Agency for Development Cooperation (NORAD). From the outset, the dairy goat project showed that tethering was widely applied, but there appeared to be little documented information available on the practice.

PROJECT PURPOSE

Project R5194 commenced (October 1991) before the current use of Logical Frameworks. However, in regard to the Updated Logframes of the Livestock Production Research Programme (Annual Report 1997-1998), the Project contributed to Purpose 1 (*Performance of livestock in high potential and peri-urban intensive farming systems (crop/livestock) improved*), Outputs 4 (*Improved strategies for animal husbandry and nutrition in the intensive livestock production system and in crop/livestock systems in high potential and peri-urban areas developed and promoted*) and 5 (*Livestock management strategies for improving the integration of crops and livestock in mixed farming systems developed and promoted*).

Based on the background (above) and discussion among the collaborators, the project aimed to have the following specific outputs within the overall purpose of improving the

performance of dairy goats on smallholder farms in high potential farming systems (crop/livestock).

Output a) To define the practice and identify the problems incurred when tethering small ruminants in the tropics.

Output b) To quantify the effect of tethering *per se* on the productivity of goats.

Output c) To define production responses of small ruminants, especially goats, to modifying tethering methods.

Output d) To explain production responses observed in Outputs b) and c) by measuring responses in behaviour, intake and health.

Output e) To demonstrate the effects of tethering method(s) as in (c) on pasture regrowth and sustainability.

Output f) From the findings of a) to e) suggest improved methods of tethering.

RESEARCH ACTIVITIES

Activity 1 (Output a))

A review of world literature was undertaken.

Activity 2 (Output a))

A formal survey of tethering practice in two divisions (Mgeta and Mlali) of Morogoro Region was undertaken in the dry (1992) and wet seasons (1992) by Dr I Minde of the Department of Rural Economy of Sokoine University of Agriculture. The survey involved a sample of 30

farmers from each division. Details of methodology are given in Minde (1992). Mgeta is 70 km south of Morogoro, in the Uluguru mountains, at 1400 to 1800 m, and has an annual rainfall of 1100 mm. Mlali is 30 km south of Morogoro, at the base of the Uluguru mountains, at 600 m, and has a semi-arid climate with 600 mm annual rainfall. Morogoro Urban area is also at the base of the Uluguru mountains, at 600 m, and has 600 mm annual rainfall.

Activity 3 (Output a))

An informal survey of tethering practice was also undertaken by Dr Sendalo. The informal survey took the form of a Participatory Rural Appraisal (PRA) and was undertaken in May 1992 (wet season) and August 1992 (dry season) in the same divisions as those used in Activity 2. In each of the seasons, a random sample of five villages (three in Mgeta, two in Mlali) were used and group discussions involved six farmers/group with farmers being chosen because they owned small ruminants. Not the same farmers were used in the dry and wet seasons. Details of methodology and findings are given in Sendalo (1995a). Informal discussions were also held with goat owners in the Morogoro Urban area.

Activity 4 (Outputs b & c)

A 28-day experiment was conducted in the dry season (October 1992) which involved comparing the intake and behaviour of 24 Local, non-lactating goats. As the animals were raised on-station, they had no previous experience of being tethered. The goats were allowed to graze for 8 h daily either untethered (8 animals) or tethered (8 animals); a further group (8 animals) was allowed to graze for 4 h daily whilst tethered. The goats were grazed on a *Brachiaria*-dominated pasture, but there was extensive invasion of other plants, including species of *Bothriochloa*, *Hyperrhania*, *Sporobolas*, *Panicum* and legumes. It was originally intended to use lactating crossbred animals in this experiment, but this was not possible because a sufficient number of lactating crossbreds was not available due to high mortality (from pneumonia and helminthiasis) of goatlings which had occurred during late 1991 and early 1992 (a tandem study on goat health was initially proposed;Taylor, 1992). Prior to commencing Activity 4, expert advice on how to measure intake of grazing animals was provided by a visit to Sokoine in April 1992 of Mr Penning and Dr Mayes. As well as visiting the survey divisions and holding detailed discussions, seminars were presented by Mr Penning on the short-term weight-change technique (SWC) (Penning and Hooper, 1985) and by Dr Mayes on the n-alkane technique (Mayes *et al*., 1986). Further technical advice was provided by Dr Romney spending six weeks at Sokoine during the commencement of

Activity 4 in October 1992. Application of the SWC technique was made possible by the NRI providing a battery operated electronic balance with a built-in animal weighing programme accurate to ± 20 g (DT150J Mettler, Switzerland). Alkane impegnated paper and a dosing gun were provided by Dr Mayes. Alkane analyses of pasture and faeces were undertaken by Dr Mayes of MLURI. A detailed description of the experiment and techniques used is given in Sendalo (1995b) and Romney *et al*. (1996).

The choice of treatments was based on the findings of Output a), Activities 2 and 3, which showed a range of 4 to 8 hours daily in the duration of grazing practised by farmers keeping small ruminants. Farmers argued that animals tethered for 4 h grazed more intensively than those tethered for 8 h, with a result that there was no difference in performance. Farmers preferred 4 h grazing, in the afternoons, as this allowed them to devote the mornings to cultivate their plots which were generally distant from the homestead and grazing sites. A detailed description of the experiment and techniques used is given in Sendalo (1995b) and Romney *et al*. (1996).

Activity 5 (Outputs b & c)

Activity 5 was an experiment identical to that of Activity 4 but undertaken during the wet season (May - June 1993). The animals used, non-lactating, Local goats, were similar to those used in Activity 4, but were not the same animals and had not previously been tethered. A detailed description of the experiment is given in Sendalo (1995b).

Activity 6 (Outputs c & d)

Activity 6 involved a 28-day experiment in the wet season (April - May 1993) undertaken with 24 Norwegian cross Local, lactating goats to compare the effect of tethering during grazing for 4 or 8 h daily. The rationale of the experiment was to use lactating animals and measure the effects on milk yield as well as on grazing behaviour and intake. The goats were not supplemented and therefore relied entirely on grazed herbage. The pasture used was the same as that in Activities 4 and 5. The conduct of the experiment was as in Activity 5. A detailed description of the experiment is given in Sendalo (1995c).

Activity 7 (Outputs c & d)

Activity 7 involved an identical experiment to that of Activity 6 except that it was undertaken in the dry season (October - November 1993) with tethered, Norwegian cross Local, lactating goats, but did not use the same animals. A detailed description of the experiment is given in Sendalo (1995c).

Activity 8 (Outputs c & d)

Activity 8 involved a 28-day experiment in the wet season (April - May 1994) undertaken to compare the intake and grazing behaviour during 8 h tethering daily of 8 Local, non-lactating goats, 8 Norwegian cross Local, non-lactating goats and 8 Norwegian cross Local, lactating goats. The rationale for the experiment was to confirm the results of Activities 4 and 5 which showed higher intakes for non-lactating, Local goats than those shown by lactating, Norwegian cross Local goats in Activities 6 and 7. The pasture used was the same as that in previous experiments. A detailed description of the experiment is given in Sendalo (1995d).

Activity 9 (Outputs c & d)

Activity 9 involved a similar experiment to that of Activity 8 except that it was undertaken in the dry season (September - October 1994) and compared the intake and grazing behaviour of 12 Local, non-lactating goats and 12 Norwegian cross Local, non-lactating goats. A detailed description of the experiment is given in Sendalo (1995d).

Activity 10 (Outputs c & d)

Activity 10 involved a 28-day experiment in the wet season (January 1995) undertaken with 24 Norwegian cross Local, lactating goats tethered for 8 h daily. Eight goats were confined in one location daily with a 2.50 m length tether as in all previous experiments. Eight goats were confined in two locations daily (4 h/location) with a 1.77 m length tether. Eight goats were confined in three locations daily (2.67 h/location) with a 1.44 m length tether. Thus goats on all treatments were allowed the same total area (19.6 m^2/goat) of grazing daily. The hypothesis of the treatments was that intakes would be increased by increasing the number of tethered locations on account of goats being offered increasing opportunities to graze fresh, untrampled herbage. The pasture used was the same as that in previous experiments. A detailed description of the experiment is given in Sendalo (1995e).

Activity 11 (Outputs c & d)

Activity 11 involved an experiment with 12 non-lactating, Local goats and 12 non-lactating Norwegian cross Local goats tethered for 8 h daily, in the dry season (September 1994), to measure the diurnal variation in rate of intake in the SWC technique. Rate of intake was measured at 0800-0900 h, 1130-1230 h and 1500-1600 h. The rationale for the experiment was to test the validity of assuming in the earlier experiments that diurnal variation in rate of intake was negligible. The pasture used was the same as that used in previous experiments. A detailed description of the experiment is given in Sendalo (1995f).

Activity 12 (Outputs c & d)

Activity 12, in the wet season (June 1994), involved an experiment with 8 non-lactating Local goats and 8 non-lactating Norwegian cross Local goats tethered during days 1-7 for 8 h daily. The effect upon rate of intake in the SWC technique, of reducing the duration of tethering to 4 h was measured in 8 goats during days 8 to 12. The rationale of the experiment was to test how goats adapt their rate of intake following a reduction in the duration of grazing allowed. It was hypothesised that reducing the duration of grazing would increase the rate of eating. The pasture used was the same as that used in previous experiments. A detailed description of the experiment is given in Sendalo (1995f).

Activity 13 (Outputs c & d)

This experiment was identical to that of Activity 12 (Outputs c & d) save that it was undertaken during the dry season (October 1994) and the number of goats was 12 non-lactating Local and 12 non-lactating Norwegian cross Local goats. A detailed description of the experiment is given in Sendalo (1995f).

Activity 14 (Outputs c & d)

This experiment involved 20 non-lactating Galla goats which were housed individually and fed *Brachiaria* hay *ad libitum* for 28 days. The intake of each goat was measured and intake was also estimated using the Alkane (Mayes *et al*., 1986) and SWC (Penning and Hooper, 1985) techniques. The purpose of the experiment was to validate techniques used to estimate intake of tethered grazing goats in the previous experiments. A detailed description of the experiment is given in Sendalo (1995g).

Activity 15 (Output e)

This experiment involved 12 non-lactating, Local goats and 12 non-lactating, Norwegian cross Local goats tethered for 8 h daily during the wet season (June 1994). The experiment measured the effect of tethering goats at the same location for one, four or 7 days on pasture DM regrowth following a recovery period of 15 or 30 days. It was hypothesised that pasture recovery would decrease as the length of the tethering period increased. The pasture used was the same as that used in previous experiments. A detailed description of the experiment is given in Sendalo (1995h).

OUTPUTS

Output (a) Practice of tethering small ruminants defined and problems identified

Activity 1

Activity 1, the review of literature (Sendalo, 1995a), confirmed the widespread use, throughout the tropics, of tethering to control grazing in small ruminants. Furthermore, the review confirmed the lack of documented information on problems, methodology and implications of tethering.

Activity 2

Activity 2 provided a description of the farms and tethering practice in Mgeta and Mlali divisions. The results of the survey are given in Minde (1992) and also in Sendalo *et al*. (1994).

Activity 3

A summary of the findings of Activity3, the PRA in Mgeta and Mlali divisions of Morogoro region, is shown in Table 1. Notable was the prevalence of tethering, especially in the crop-growing, wet season, and the wide range in the daily duration of tethering. Also evident was the range in tether lengths. Tethers were invariably made of sisal twine, with long tethers

being made up of short lengths of old tethers knotted together. There was a tendency for use of longer tethers in the Morogoro Urban area, possibly reflecting the scarcity of pasture due to overgrazing. The greater tendency to tether by the leg rather than the neck in Mlali, compared to Mgeta, was attributed to Mlali being a predominantly Muslim community and Mgeta being Christian. Mlali farmers feared goats necking themselves if tethered by the neck, and consequently if death occurred, animals could not be eaten. The PRA indicated that tethering generally was increasingly used on account of children attending school, thus being less available to assist with herding the animals.

Outputs (b) & (d) Effect of tethering *per se* on the productivity of goats quantified and explained

Activities 4 & 5

The results of Activities 4 and 5 are shown in Table 2. As the experiments were undertaken with non-lactating goats, effects on milk production were not measured. However, in both the dry and wet seasons, tethering for 8 h daily did not significantly affect dry matter (DM) intakes estimated by either the SWC or Alkane techniques. However, in both seasons, grazing duration was reduced significantly by tethering, whereas intake rate (g DM/minute) was increased. The digestibility of the ingested herbage was not affected significantly by tethering. Detailed results and discussion of Activities 4 and 5 are presented in Sendalo (1995b).

Outputs (c) and (d) Production responses of goats to modifying tethering methods quantified and explained

Activities 4 & 5

The results are shown in Table 2. In both seasons, tethering the Local goats for 4 h per day instead of 8 h reduced intake, although differences were not significant for all assessments. As expected, reducing the tethering time reduced grazing duration. The digestibility of ingested herbage was not affected significantly by halving the duration of tethering. Detailed results and discussion of Activities 4 and 5 are presented in Sendalo (1995b).

Activities 6 & 7

The results are shown in Table 3. In both seasons, tethering the Norwegian cross Local goats for 4 h per day instead of 8 h, reduced milk yield significantly, by approximately 20%. In both seasons, yields even when tethered for 8 h were low (dry season: 570 g/day dry season; wet season: 360 g/day). As in Activities 4 and 5, halving the tethering duration reduced DM intake significantly, but did not significantly affect the digestibility of ingested herbage. Detailed results and discussion of Activities 6 and 7 are presented in Sendalo (1995c).

Activities 8 & 9

The results are shown in Table 4. The results confirmed those of Activities 4 to 7 showing that intake of Local goats were higher than Norwegian cross goats. The results of Activity 8 with Norwegian cross Local goats, also showed that the intake of lactating animals was higher than that of non-lactating ones. Detailed results and discussion of Activities 8 and 9 are presented in Sendalo (1995d).

Activity 10

The results are shown in Table 5. Contrary to expectation, reducing tether length with concomitant increases in number of tethering locations to achieve the same total grazing area did not significantly improve milk yield nor intake. Detailed results and discussion of Activity 10 are presented in Sendalo (1995e).

Activity 11

The results are shown in Table 6. There were differences in insensible weight loss and intake rate, depending on the time of day when measurements were made. The results indicate that such differences need to be taken into consideration when estimating intake using the SWC (short term weight change) technique. Of interest, however, is the fact that the SWC and Alkane techniques used in estimating intake in Activities 4 to 10 gave generally similar values. Detailed results and discussion of Activity 10 are presented in Sendalo (1995f).

Activities 12 & 13

The results are shown in Table 7. In both the wet (Activity 12) and dry (Activity 13) seasons, there was a tendency for intake rate to increase when goats were transferred from being tethered from 8 h per day to 4 h. However, despite using a high degree of replication (especially in Activity 13), differences in intake rate were seldom significant. Detailed results and discussion of Activities 12 and 13 are presented in Sendalo (1995f).

Activity 14

The results are shown in Table 8. The experiment indicated no significant differences between measured intake and intakes estimated using the SWC and Alkane techniques. Surprisingly, the hay used in this experiment was estimated from the Alkane technique to have a DM digestibility of only 318 g/kg. This value would appear to be particularly low bearing in mind that the intake achieved was 27.7 g/kg body mass, M, daily. Unfortunately it was not possible to collect faeces in this experiment and thus measure digestibility directly. Detailed results and discussion of Activity 14 are presented in Sendalo (1995g).

Output (e) The effects of tethering methods, as in (c), on pasture regrowth and sustainability demonstrated

Activity 15

The results are shown in Table 9. Tethering goats for 8 h daily at the same location for one versus four days did not significantly affect herbage mass at the end of grazing nor at 15 or 30 days following grazing. However, tethering goats at the same location for seven days instead of one day significantly reduced herbage mass at the end of grazing and this difference was evident 15 and 30 days following the end of grazing. Although this was a preliminary experiment, the results clearly demonstrate that tethering goats at a given spot for seven days will have implications for pasture regrowth during the subsequent 30 days. Further research is needed on this aspect. Detailed results and discussion of Activity 15 are presented in Sendalo (1995h).

Output (f) Suggestions for improved methods of tethering

Outputs (a) to (e) suggest that farmers should tether goats to graze for as long as possible (8 h) each day, in order to maximise intake and hence production. Tethering by the neck is preferable to the leg as the latter may restrict blood flow and increase the risk of limb loss. On *Brachiaria* pasture in the wet season and using tethers of 2.5 m, goats should be tethered at the same location for no more than four days and preferably allocated a fresh location daily.

CONTRIBUTION OF OUTPUTS

Publications

Romney, D.L., Sendalo, D.S.C., Owen, E., Mtenga, L.A. and Gill, M. The measurement of intake of grazing goats in Tanzania. In: *Proceedings V11 World Conference on Animal Production, Edmonton, Canada*, Volume 3, 1993. Abstract 278, 104-105.

Romney, D.L., Gill, M., Sendalo, D.S.C., Mtenga, L.A. and Owen, E. The measurement of intake of grazing goats. *Tanzania Society of Animal Production Conference Series,* **20** (1993), 1994, 123-129.

Romney, D.L., Sendalo, D.S.C., Owen, E., Mtenga, L.A., Penning, P.D., Mayes, R.W. and Hendy, C.R.C. Effects of tethering management on feed intake and behaviour of Tanzanian goats. *Small Ruminant Research* **19**, 1996, 113-120.

Sendalo, D.S.C., Mtenga**, L.A., Ngapongora, J.M.N., Minde, I., Owen, E., Romney, D.A. and Gill, M.** Tethering of small ruminants in Tanzania. The case of Morogoro district. *Tanzania Society of Animal Production Conference Series,* **20** (1993), 1994, 154-161.

Sendalo, D.S.C., Owen, E., Mtenga, L.A., Romney, D.L. and Gill, M. The effect of grazing time on behaviour and herbage intake of tethered Local goats. *Proceedings of 21st Scientific Conference Tanzania Society of Animal Production* 21 (1994), 1995, 270-280.

Sendalo, D.S.C., Owen, E., Mtenga, L.A., Romney, D.L., Penning, P.D. and Mayes, R.W. Tethering of grazing goats in Tanzania: effect of tethering for four or eight hours daily on intake and milk yield of Norwegian cross Local goats grazing Brachiaria in the wet season. *Animal Science,* **60**, (3), 1995, 538.

Sendalo, D.S.C., Owen, E., Mtenga, L.A., Romney, D.L., Penning, P.D. and Mayes, R.W. Tethering of grazing goats in Tanzania: effect of tethering for four or eight hours daily on intake and milk yield of Norwegian cross Local goats grazing Brachiaria in the wet season. *Proceedings of 22nd Scientific Conference Tanzania Society of Animal Production* 22 (1995), 1996, 295.

Sendalo, D.S.C. Tethering of goats in Tanzania: purpose and implications with special reference to effects on grazing behaviour and intake. *PhD Thesis*, The University of Reading. Submitted December 1995. Final version submitted to NR International Ltd, March 1996.

Sendalo, D.S.C., Owen, E., Mtenga, L.A., Romney, D.L., Penning, P.D. and Mayes, R.W. Tethering of grazing goats in Tanzania: effect of tethering for four or eight hours daily on intake and milk yield of Norwegian cross Local goats grazing *Brachiaria* in the wet and dry seasons. *4th Biennial Conference of the African Small Ruminant Research Network Conference,* International Livestock Research Institute, Addis Ababa, December 1996.

Publications in preparation

Tethering management of small ruminants. Leaflet for *Livestock Research Extension Notes.* Draft submitted to Natural Resources International Ltd.

Further scientific papers are planned on Activities 6-9, 11 and 14.

Contribution to DFID's development goals

As well as contributing to Purpose 1 of LPP's High Potential and Peri-Urban Production Systems, the outputs have relevance to the grazing management of goats (and sheep) in Semi-Arid, Forest/Agriculture Interface and Hillside Systems.

The emphasis on goats and tethering means that the outputs are poverty focused, being particularly relevant to resource-poor smallholders such as those targeted by FarmAfrica and Heifer Project International.

Scientific implications of the outputs

The publication by Romney *et al*. (1996) on Activities 4 and 5 represents the first report in the scientific literature on comparing and using the Short term Weight Change (Penning and Hooper, 1985) and Alkane (Mayes *et al*., 1986) techniques for estimating intake of goats

grazing tropical pasture in a developing-country situation. The results obtained suggest that the techniques have potential for application in the developing tropics. The Short-term Weight Change technique is particularly relevant as it involves a battery-operated weighing scale and requires no sophisticated chemical analysis.

Training

The project provided a research platform for the successful training of a Tanzanian (D S C Sendalo) to PhD level (Sendalo, 1995). Dr Sendalo was registered at the University of Reading as a `split-site' research student under the joint supervision of E Owen (Reading) and L A Mtenga (Sokoine). The project has also stimulated other studies at Sokoine, involving several MSc projects and one PhD.

Dissemination

The publications have involved several communications to the Tanzanian Society of Animal Production which meets annually. This society is attended by delegates from various organisations (universities, government, para-statals, NGOs, commercial companies and farmers) from Tanzania and neighbouring countries. One communication (Sendalo *et al.,* 1996) was to the *4th Biennial Conference of the African Small Ruminant Research Network* which has a wide attendance of African delegates concerned with improving the productivity of small ruminants. The outputs have been communicated to members of the Tanzania Goat Network (TAGONET) by Professor Mtenga, who is chairman of the Network. Members of TAGONET comprise farmers, NGOs (Farm Africa, Heifer Project International) and scientists working at universities and NARS.

Further research

More research is required, with supplemented and non-supplemented lactating goats, to examine further the importance of diurnal duration of tethering during grazing, on production. Further research is also required on the implications for pasture regrowth and pasture degradation, of tethering duration.

Research is also required on tethering for managing ruminants in crop/livestock systems when a) grazing crop residues and b) fertilising crop land (e.g. Powell *et al*., 1995).

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Table 1. *Output a) (Activity 3): Participatory Rural Appraisal (PRA) in Mgeta and Mlali*

	Mgeta	Mlali
Number of farming plots	4	2
Plot sizes (ha)	0.6	1.4
Flock sizes	6	9
% of goats	96	97
% of sheep	4	3
% of farmers tethering in wet season	88	81
% of farmers tethering in dry season	70	0
Tether length (range) (m)	4 (1.5-6.9)	4 (1.5-7.5)
% of goats tethered by neck	62	7
% of goats tethered by leg	38	93
Time animals taken out for tethering		
% of response, wet season		
0800-1000 h	67	55
1000-1200 h	21	27
1200-1400 h	12	12
> 1400 h	0	6
% of response, dry season		
0800-0900 h	40	32
1000-1200 h	47	58
1200-1400 h	13	0
> 1400 h	0	10
Source of labour	Family and hired labour during peak crop growing period	Family, hired labour during peak crop growing period
Reasons for tethering	Land scarcity, shortage of land, shortage of labour, small flock sizes	Land scarcity, shortage of land, shortage of labour, small flock sizes
Reasons for		
early morning tethering	Family going to attend crops	Family going to attend crops
late afternoon tethering	Family & children coming back from farming and school, starved animals concentrate on grazing	Family & children coming from farming and school, security against theft, large flocks need herding, starved animals concentrate on grazing
Sites of tethering	Road sides, fallow land, near homesteads	Fallow land, road sides, playing grounds, grave yards & near homesteads
Frequency of changing tethering sites	Normally left on same site whole day	Normally left on same site whole day
Supplementation	Some during dry season using locally available feeds	Some during dry season using locally available feeds

Table 2. *Outputs b), c) and d) (Activities 4 and 5): Grazing behaviour and herbage intake of non-lactating, Local goats untethered 8 h (UT), tethered 8 h (T8) or tethered 4 h (T4) daily, for 28 d, during the dry and wet seasons*

	Activity 4 (Dry season)				Activity 5 (Wet season)			
Herbage allowance (g DM/kg M_1 per d)	477.0 ±24.6				300.4 ± 19.9			
	UT 8 h	T8 h	T4 h	s.e.d.	UT 8 h	T8 h	T4 h	s.e.d.
Live weight (kg)								
Day 1 (M_1)	30.3[a]	29.4[a]	30.3[a]	1.63	27.7[a]	26.1	27.0[a]	1.33
Day 28 (M_2)	29.0[a]	28.7[a]	29.0[a]	1.82	27.5[a]	25.7	26.7[a]	1.38
Grazing duration								
Min per day	364[a]	327[b]	226[c]	6.6	364[a]	295[b]	204[c]	8.9
Proportion of `day'	0.81[a]	0.73[b]	0.94[a]	0.016	0.81[a]	0.69[b]	0.85[a]	0.022
Intake parameters								
Intake rate (g DM per minute)	3.7[b]	4.0[b]	4.7[a]	0.20	2.68[b]	3.38[a]	3.7[a]	0.166
Intake (kg DM per day)								
SWC [1]	1.34[a]	1.32[a]	1.07[b]	0.070	0.99[a]	0.98[a]	0.76[b]	0.055
Alkane [2]	1.26[a]	1.19[a]	1.05[a]	0.080	0.87[a]	0.78[a]	0.68[b]	0.050
Intake (g DM/kg M_3[3] per day								
SWC	48.1[a]	49.0[a]	37.9[b]	2.88	36.2[a]	36.5[a]	27.1[b]	2.25
Alkane	45.6[a]	42.5[a]	37.7[b]	2.77	32.0[a]	28.5[ab]	25.5[b]	1.90
DM digestibility (g per kg)	510[a]	540[a]	490[a]	20.0	602[a]	576[a]	562[a]	9.6

Row means with same superscript not significantly different ($p>0.05$)

SWC [1] estimated using the short-term weight change method (Penning and Hooper, 1985)
Alkane[2] estimated using the n-alkane method (Mayes *et al.,* 1986)
M_3[3] = mean of M_1 and M_2

Table 3. *Outputs c) and d) (Activities 6 and 7): Grazing duration, intake and digestibility of Brachiaria pasture by lactating, Norwegian x Local goats tethered for 4 or 8 h daily, for 28 d, during the dry and wet seasons*

	Activity 7 (Dry season)			Activity 6 (Wet season)		
Herbage allowance (g DM/kg M_1 per d)	168 ± 15.7			293 ± 18.5		
	Tethered 4 h	Tethered 8 h	s.e.d.	Tethered 4 h	Tethered 8 h	s.e.d.
Live weight (kg)						
Day 1 (M_1)	29.5[a]	31.5[a]	2.06	33.2[a]	33.8[a]	2.73
Day 28 (M_2)	26.2[a]	29.3[a]	1.64	29.8[a]	30.8[a]	2.23
Milk yield (g per day)						
Pre-experiment (- 6 to 0 d)	650[a]	720[a]	70.0	630[a]	650[a]	110.0
Day 22 - 28	450[b]	570[a]	50.0	290[b]	360[a]	20.0
Grazing duration						
Min. per day	206[b]	296[a]	8.13	226[a]	366[b]	3.9
Proportion of `day'	0.87[a]	0.67[b]	0.026	0.94[a]	0.77[b]	1.740
Intake parameters						
Intake rate (g DM/min.)	3.4[a]	3.1[a]	0.20	3.2[a]	2.6[b]	0.08
Intake (kg DM per day)						
SWC [1]	0.65[b]	0.88[a]	0.023	0.71[a]	0.93[a]	0.019
Alkane [2]	0.67[b]	1.02[a]	0.070	0.71[a]	0.77[a]	0.050
Intake (g DM/kg M_3[3] per day)						
SWC	23.5[b]	29.6[a]	1.00	22.8[b]	29.2[a]	1.04
Alkane	23.5	34.3[a]	2.77	22.0[a]	23.1[a]	1.53
DM digestibility (g/kg)	494[a]	520[a]	19.4	470[a]	500[a]	14.0

Row means with same superscript not significantly different ($p>0.05$)

SWC [1] Intake estimated using the short-term weight-change method (Penning and Hooper, 1985)
Alkane[2] Intake estimated using the n-alkane method (Mayes *et al.,* 1986)
M_3[3] = mean of M_1 amd M_2

Table 4. *Outputs c) & d) (Activities 8 and 9): Grazing duration, intake and digestibility of Brachiaria pasture by Local, non-lactating goats and Norwegian x Local, non-lactating and Norwegian x Local, lactating goats tethered 8 h daily for 28 d during the dry and wet seasons*

	Activity 9 (Dry season)			Activity 8 (Wet season)			
Herbage allowance (g DM/kg M_1 per d)		179 ± 17.8			254 ± 21.3		
	Local, non-lactating	Crosses, non-lactating	s.e.d.	Local, non-lactating	Crosses, non-lactating	Crosses, lactating	s.e.d.
Live weight (kg)							
Day 1 (M_1)	28.2[a]	23.9[a]	0.81	33.3[a]	26.8[c]	29.5[b]	0.75
Day 28 (M_2)				33.2[a]	26.3[c]	29.1[b]	0.72
Grazing duration							
Min. per `day'	337[a]	351[b]	8.3	282[a]	257[b]	275[ab]	8.2
Proportion of `day'	0.70[a]	0.73[b]	1.740	0.67[a]	0.60[b]	0.65[ab]	0.019
Intake parameters							
Intake rate (g DM/min.)	2.7[a]	2.0[b]	0.10	3.4[a]	2.6[b]	3.4[a]	0.16
Intake (kg DM per day)							
SWC [1]	0.89[a]	0.64[b]	0.034	0.94[a]	0.67[b]	0.91[a]	0.050
Alkane [2]	0.85[a]	0.72[a]	0.061	0.80[a]	0.74[a]	0.73[a]	0.062
Intake (g DM/kg M_3[3] per day)							
SWC	32.0[a]	27.5[b]	1.35	32.5[a]	25.0[b]	28.1[b]	1.62
Alkane	30.7[a]	31.6[b]	2.80	28.2[a]	22.7[a]	25.3[a]	2.67
DM digestibility (g/kg)	523[a]	563[a]	22.0	543[a]	560[a]	571[a]	23.1

Row means with same superscript not significantly different ($p>0.05$)

SWC[1] Intake estimated using the short-term weight-change method (Penning and Hooper, 1985)
Alkane[2] Intake estimated using the n-alkane method (Mayes *et al*., 1986)
M_3[3] = mean of M_1 and M_2

Table 5. *Outputs c) and d) (Activity 10): Grazing duration, intake and digestibility of Brachiaria pasture by lactating, Norwegian cross Local goats tethered for 8 h daily, using 1.44, 1.77 and 2.50 m tether lengths for 28 d, during the wet season.*

Herbage allowance (g DM/g M_1 per d)		125 ± 17.2		
Tether length (m)	1.44	1.77	2.50	
No. of tether locations per day	3	2	1	
Total grazing area per day (m^2)	19.6	19.6	19.6	
				s.e.d.
Live weight (kg)				
Day 1 (M_1)	29.0[a]	34.5[a]	31.1[a]	1.73
Day 28 (M_2)	28.8[a]	34.2[a]	31.3[a]	1.73
Milk yield (g per day)				
Pre-experiment (-6 to 0 d)	253[a]	350[a]	278[a]	35.0
Day 22 - 28	190[a]	212[a]	203[a]	26.9
Grazing duration				
Min per day	218[b]	231[b]	282[a]	6.64
Proportion of `day'	0.55[b]	0.58[b]	0.69[a]	0.017
Intake parameters				
Intake rate (g DM/min)	3.7[a]	4.1[a]	3.5[a]	0.22
Intake (kg DM per day)				
SWC[1]	0.81[b]	0.92[ab]	1.01[a]	0.057
Alkane[2]	0.77[a]	0.89[a]	0.94[a]	0.053
Intake (g DM/g M_3[3] per day)				
SWC	28.1[ab]	27.1[b]	33.0[a]	1.99
Alkane	26.9[a]	26.5[a]	30.6[a]	2.12
DM digestibility (g/kg)	492[a]	485[a]	443[a]	30.0

Row means with same superscript not significantly different ($p>0.05$)

SWC[1] Intake estimated using the short-term weight-change method (Penning and Hooper, 1985)
Alkane[2] Intake estimated using the n-alkane method (Mayes *et al*., 1986)
M_3[3] = mean of M_1 and M_2

Table 6. *Outputs c) and d) (Activity 11): Insensible weight loss (IWL) and intake rate of 12 non-lactating Local and 12 non-lactating Norwegian cross Local goats tethered for 8 h daily on Brachiaria pasture in the dry season. Estimates made on 3 occasions in a 3 x 3 Latin square.*

Time of the day	0800-0900 h	1130-1230 h	1500-1600 h	s.e.d.
Insensible weight loss (g/min)	1.3[b]	2.6[a]	1.7[b]	0.18
Intake rate (g DM/min)	4.7[a]	3.3[b]	1.7[c]	0.39

Row means with same superscript not significantly different (p>0.05)

Table 7. *Outputs c) and d) (Activities 12 and 13): Intake rate (IR) (g DM/min) of non-lactating Local and Norwegian cross Local goats grazing Brachiaria pasture in the wet and dry seasons, as affected by change of tether duration from 8 h per day to 4 h per day.*

	Activity 13 (Dry season)[1]			Activity 12 (Wet season)[2]		
Days 1-7	Tethered 8 h	Tethered 8 h		Tethered 8 h	Tethered 8 h	
Days 8-13	Tethered 4 h	Tethered 8 h				
Days 8-11				Tethered 4 h	Tethered 8 h	
IR estimation			s.e.d.			s.e.d.
Day 8	1.96[a]	2.02[a]	0.133	2.71[a]	1.77[b]	0.335
Day 9	3.39[a]	2.48[a]	0.228	3.22[a]	2.69[a]	0.375
Day 10	4.08[a]	2.80[a]	0.253	3.61[a]	3.03[a]	0.550
Day 11	4.37[a]	2.51[b]	0.234	4.34[a]	3.65[a]	0.324
Day 12	4.31[a]	3.25[a]	0.386			
Day 13	4.36[a]	3.69[a]	0.211			

Row means with same superscript not significantly different (p>0.05)

[1] Mean of 12 Local and Norwegian cross Local goats per treatment
[2] Mean of 8 Local and Norwegian cross Local goats per treatment

Table 8. *Outputs c) and d) (Activity 14): Feeding duration and intake (± s.e.) of Galla goats offered Brachiaria hay indoors for 8 h/day, for 28 days; intake measured (offer less refusal) and estimated using the SWC and Alkane methods.*

	Measured (offer less refusal)[1]	SWC[2]	Alkane[3]
Feeding duration			
Min per day		324 ± 6.3	
Proportion of `day'		0.77 ± 0.015	
Intake rate (g DM/min)		2.78 ±.0.011	
Intake (kg DM/day)	0.88[a] ± 0.023	0.90[a] ± 0.055	0.94[a] ± 0.047
Intake (g DM/kg M[4] per day)	27.7[a] ± 0.77	28.3[a] ± 1.68	29.58[a] ± 1.52
DM digestibility (g/kg)			318 ± 10.3

Row means with same superscript not significantly different (p>0.05)

[1] Mean of 6 observations from 19 goats
[2] Mean of 19 goats over 6 day. Technique of Penning and Hooper (1985)
[3] Estimated from 19 goats; samples of hay and faeces collected for 6 days. Technique of Mayes *et al*. (1986)
[4] Mean of live weight on days 1 and 28

Table 9. *Output e) (Activity 15):* Brachiaria *pasture regrowth (t DM/ha) over 15 or 30 days following tethered grazing by goats at one location for one, four or seven days.*

Grazing days	Herbage mass (t DM/ha)					
	At end of grazing		15 days after end of grazing		30 days after end of grazing	
	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed	Grazed
1	5.5[a] [1]	4.9[a] [1]	6.8[a] [16]	6.2[a] [16]	8.3[a] [31]	6.7[a] [31]
4	5.7[a] [4]	4.4[ab] [4]	7.4[a] [19]	5.2[ab] [19]	8.5[a] [34]	6.0[a] [34]
7	6.6[a] [7]	3.9[b] [7]	6.9[a] [22]	4.6[b] [22]	8.7[a] [37]	4.6[b] [37]
s.e.d.	0.46	0.29	0.50	0.45	0.68	0.38

Column means with the same superscripts are not significantly different ($p>0.05$)

[1] Each tethering site was 19.6 m^2 (2.5 m tether length)
[2] Mean of 16 samples (i.e. 2 samples per goat grazing site; 8 goats per treatment)
[ ] Days after end of grazing