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EDITORIAL

ARNAB'S FUTURE IS BRIGHTER NOW THAN EVER BEFORE

Most of our readers missed the ARNAB Newsletter in 1982. Like most growing organizations, ILCA had to take stock of its past performance (through the Quinquennial Review of 1982) and realign its future priorities. This exercise caused a temporary break in the publication of the ARNAB Newsletter.

Early this year (1983), the activities of ARNAB resumed in earnest and the scientific secretary was able to visit eight institutions in East and West Africa to discuss with them their ongoing research, their past achievements, adoption rate of their research findings and their plans for the future. During this mission, material was collected *en route* to sustain future lively issues of the Newsletter. It became apparent that the field adoption of technological advances was lagging behind research efforts. The editor would therefore welcome readers' views on which way we should go to make crop residue research applicable to the majority of African smallholder livestock producers.

Following the earlier successes of Backmann, Lampilla, Wilson and Pigden and the McGill group on the use of alkalis etc. to ameliorate the feeding value of coarse roughages, many countries including some in Africa have intensified their research into the use of alkalis to increase the feeding value of the available local crop residues. Excellent research results have been obtained in this quest but the application rate in all sectors of the livestock industry in Africa is negligible.

There are also orthodox research workers who are looking into ingredient complimentarity in crop residues and agro-industrial by-products as means of compounding whole rations for livestock nutrition.

Considering the African situation where livestock are largely grazed (nomadic system), stall-fed with available crop residues (mixed farmers) or released to scavenge on abandoned fields, should we not look into the potential of leguminous plants (haulms,

browse, hedge rows or fodder banks) as components of the feeding regimes?

At the subhumid station in Kaduna, Nigeria, ILCA scientists, in collaboration with the National Animal Production Institute and the Federal Livestock Division have devised an ingenious way of establishing and maintaining legume-grass fodder banks for dry season feeding. Initially, the banks were surface sown with two varieties of *Stylosanthes* (*S. hamata* cv Verano and *S. guianensis* var. Cook) which gave good yields of 4-6 tonnes of dry matter per ha with crude protein content of over 13%. Controlled grazing, using the high quality forage legumes as a supplement rather than a substitute for national pastures, improved the utilization of coarser feeds and resulted in higher yields and liveweight gains comparable to feeding regimes when expensive concentrates are employed.

Adoption of this technique in the Kaduna area was spontaneous and individual farmers have reserved portions of their 4-6 ha plots for fodder bank establishment. Subsequent cropping of the banks produces higher yields than usual since nitrogen fixed by the legumes contributes to the crop nutrition. Re-seeding the banks is accomplished by the grazing animals themselves through scattering of viable seeds in the dung as the animals graze.

ILCA scientists have adopted a slightly different approach in Niono (Mali) and Ibadan (Nigeria). Cereal crops are undersown or alley cropped with suitable leguminous fodder or browse plants. The after-harvest standing stalks are grazed with the legumes with excellent improvements in animal productivity.

At Addis Ababa in Ethiopia, ILCA scientists have collected and screened a large variety of *Trifolium* species indigenous to the highlands of Ethiopia. Active research is under way to establish the synergistic nutritional effects when these legumes are fed in graded quantities in combination with cereal crop residues to ruminant livestock. Preliminary results indicate that total dry matter intake and organic matter digestibility of the combined (basal poor quality hay) and supplemental *Trifolium* hay increase linearly when the legume is fed at graded levels.

NETWORK NEWS

Highlights of Scientific Secretary's visits

Nairobi, Kenya: - Prof. J.A. Kategile (formerly at the University of Dar-es-Salaam) has taken up appointment with the IDRC as scientific officer responsible for eastern and southern Africa. He will still be very much concerned with crop residues research albeit in an advisory role.

At the University of Nairobi, Kabete, Dr. A.N. Said became interested in crop residues research as far back as 1969. His earlier work looked into the potential of sisal waste as ruminant livestock feeds. Later, Dr. Said studied the uses of cottonseed cake, cereal by-products and molasses as protein and energy sources for coarse roughage-based diets. On the alkali treatment scene, various members of the department have carried out research on the use of sodium

hydroxide, hydrous and anhydrous ammonia, soda ash, carbide sludge, magadi salt (sodium sesuioxide) and urea as treatment alkalis for corn cobs, maize stover, wheat, barley and rice straws.

Future research will look into simpler ways of using urea as treatment alkali and a non-protein-nitrogen source. Straight-forward-supplementation of roughage based diets with agro-industrial cakes will continue to be studied.

TANZANIA

University of Dar-es-Salaam, Morogoro Campus

Past work at this centre modified the alkaline treatment procedures to on-farm application (assuming the reagents and equipment can be procured). These included the "dip and drain sodium hydroxide treatment procedure", simultaneous harvesting and treatment procedure with a rear-mounted flail harvester and ammoniation of large heaps of straw with ammonia gas or urea. Most of the commonly available cereal residues were tested and the product assayed *in vivo* and *in vitro* with varying degrees of success. Future plans are to supplement crop residue based dairy cattle rations with copra, simsim, sunflower, kapoc and cottonseed cakes in the Moshi and Kilimanjaro cereal producing areas in Tanzania.

CAMEROONS

Institut de Recherches Zootechniques, Nkolbisson

Earlier work at this centre evaluated the substitution levels of maize and rice by-products into complete beef fattening rations (Nkolbisson) and sheep and goat rations (Mankon). Among the on-going research are projects on:

Value of cereal by-products and different protein sources in milk production rations (Bambui);

Utilization of different legume plants, cassava and other high quality forage protein sources in sheep and goat feeding (Nkolbisson);

Utilization of coffee/cocoa by-products in sheep and goat rations (Nkolbisson); and

Supplementation with cottonseed cake for maintenance of sheep and goats on pastures.

Leucaena leucocephala is being evaluated as a protein source for dairy cattle and incorporation rates of bran and molasses are being assessed for swine rations. These studies are to be expanded to include potential uses of coffee wastes and banana by-products in cattle rations.

SENEGAL

Ecole Inter-Etats des Sciences et Médecine Vétérinaire (EISMV), Dakar

EISMV, in collaboration with the Laboratoire national de l'élevage et de recherches vétérinaire (LNERV) and the Institut sénégalais de recherches agricoles (ISRA) have carried out extensive research into the use of peanut husks, bran and molasses as components of beef fattening rations. As a result of these studies, the Société de développement de l'élevage dans la zone Sylvopastorale (SODESP) has been finishing steers at the Keur Massar feedlot on crop-residue based rations for the Dakar abattoirs. Even though a number of feedmills are either planned or are already in operation, the current prices of oil cakes and haulage costs for bulky cereal residues do not augur well for the future unless raw material prices are reduced.

GHANA AND NIGERIA

University of Ghana, Legon; University of Ife, Ile Ife

These forest-belt based Universities have geared their research to the potential of cash crop (cocoa, cassava, palm and copra) processing by-products in both ruminant and monogastric animal nutrition. At Ife a recent grant by the government will enable researchers to intensify their investigations on dried cocoa husk incorporation rates in ruminant rations. A variety of cereal crop residus and grasses will be fed to provide bulk and minimize the slimy nature of the husk meal. Earlier results indicate that the husks can replace over 30% of the grain component in beef fattening rations without any reduction in weight gain.

Similar evaluation trials of the husks have been carried out at the University using sheep and goats. Cocoa-husk based rations are currently being tested with swine.

IDRC ORGANIZES A RESEARCH WORKSHOP ON "FEASIBILITY OF BY-PRODUCT AND NON-CONVENTIONAL FEED UTILIZATION FOR ANIMAL PRODUCTION" (Nairobi, Kenya; September 26-30, 1982)

The workshop focussed on the practical application of by-product and non-conventional feed research achievements in productive animal feeding systems. There have been many breakthroughs in terms of improving the nutritive value of by-products and non-conventional feeds. These include physical treatments (drying, soaking, grinding, chopping, pelleting, high steam treatments etc.); chemical treatments, microbiological procedures (ensilage of straw, wet or fresh crop wastes such as citrus pulp, coffee pulp and sugar cane tops) and supplementation of by-product based rations with energy (molasses), protein and non-protein nitrogen sources. Appreciable increases in voluntary intake, digestibility and improved nutrient use reflected by increases in animal performance (weight gain, milk production) have been reported as a result of employing these techniques.

The workshop reviewed and recommended research methodologies appropriate to a specific by-product or non-conventional feed for different animals and users (small-scale farmers, large-scale farmers

and feed mill operators). The basis of these recommendations were economic feasibility and the ease of adapting the procedure to the prevailing animal feeding system. On-farm research (OFR) was pinpointed as the surest way of monitoring the success of any given feeding regime. OFR was emphasized for the identification of previously unrecognized constraints faced by farmers in the use of by-products, e.g. absence of straw-chopping equipment, tools for ensilage etc.

Several participants commented on the difficulties faced in OFR. These included problems in blocking treatments to remove differences due to flock size, family and village influences. Farmers were found to interfere with the management of untreated animals where treatment differences were substantial.

The need for more precise national inventories of by-product availability and demand was raised. It was stressed that, while these inventories could be prepared from existing statistics, care should be taken to include seasonality, alternate uses and costs.

STUDIES ON THE NUTRITIVE VALUE OF MAIZE BY-PRODUCTS IN AFRICA

1. Experiments conducted in Kenya.

Maize (*Zea mays* L.) is perhaps the commonest cereal crop cultivated throughout Africa. Maize stover production in Kenya alone is estimated to be five hundred thousand metric tonnes annually (Said *et al*, 1982). The principal by-products of the maize plant, namely the stover, cobs and bran, are used at different intensities as livestock feeds. Maize bran is used to feed household poultry, pigs, sheep and goats. If fed, maize stover and cobs are offered in the un-processed form. Current research has focussed on pretreating maize by-products (among other coarse roughages) to improve their nutritive value for ruminant livestock nutrition.

The following summaries (and others to follow in later editions) will present results of experiments conducted in various parts of Africa, basically in tabular form with the hope that readers will form their own conclusions.

In Kenya, Kevelenge (1978) compared the nutritive value of green maize stover, maize cobs, whole sugar cane and sugar cane tops using Romney marsh wethers (1-2 yrs) as assay animals. The cobs and stover were mixed with *Chloris gayana* hay in the ratio of 60:40 but the sugar cane tops and whole cane were fed as the sole feed. Mean nutrient composition, digestibility and animal performance data are presented in Table 1.

At the Kitale Agricultural Station in Kenya, Nang'ole (1979) compared the nutritive value of maize cobs (ground to pass through a 6 mm screen), NaOH or Magadi (sodium sesquioxide salt) treated maize cobs in a 2 x 3 factorial using Romney wethers. Levels of NaOH and Magadi salt applied were 4.5 g/100 g cobs and 9.0 g/100 g ground cobs

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(The Scientific Secretary acknowledges the kind permission of the IDRC to abstract the above article from the conference notes).

TABLE 1

CHEMICAL COMPOSITION, DIGESTIBILITY AND INTAKE OF GREEN MAIZE STOVER, MAIZE COBS, WHOLE SUGAR CANE AND SUGAR CANE TOPS FED TO SHEEP

	Chemical composition				Digestibility coefficient				Intake (digestible)			
	Stover	Cobs	W. cane	Tops	Stover	Cobs	W. cane	Tops	Stover	Cobs	W.cane	Tops
Dry matter	94.4	94.6	94.0	97.4	63.8	60.0	60.8	54.3	41.8	19.9	13.7	28.8
Organic matter	91.9	98.7	97.8	90.4	63.8	60.6	62.9	56.2	-	-	-	-
C. protein	8.5	2.0	2.4	4.7	52.4	37.7	-25.1	37.7	2.6	0.9	-0.2	1.1
ADF	36.3	47.6	27.5	43.1	-	-	-	-	-	-	-	-
NDF	60.9	86.7	40.6	63.3	-	-	-	-	-	-	-	-
H. Cell.	24.6	39.1	13.1	20.2	-	-	-	-	-	-	-	-
Lignin	4.4	5.8	4.9	5.0	-	-	-	-	-	-	-	-
Ash	8.1	1.3	2.2	9.6	-	-	-	-	-	-	-	-
Energy (Kcal/g)	4.3	4.4	3.9	3.5	63.9	54.8	58.7	52.4	183.3	70.5	51.3	105.3

TABLE 2

ANIMAL PERFORMANCE DATA

	Stover	Cobs	W.Cane	Tops
Mean initial weight (kg)	38.2	43.9	31.5	42.6
Daily wt. change (kg)	35.0	-11.0	-51.0	- 1.0
Intake/gain/loss	346.9	679.5	50.2	659.3

respectively. Treatment time was 24 hrs using one litre of solution per kg dry matter. Chemical composition and *in vivo* digestibility coefficients of the test feeds are as shown in Table 3.

TABLE 3
CHEMICAL COMPOSITION AND DIGESTIBILITY OF GROUND MAIZE COBS TREATED WITH NaOH OR MAGADI SALT

	Chemical composition (%)			
	Ground cobs	Ground cobs + 1 l H O	NaOH-treated	Magadi-treated
Crude protein	1.72	1.52	1.83	1.78
Organic matter	98.67	98.45	93.36	91.20
NDF	70.55	71.02	60.52	63.34
Cell contents	29.45	28.98	39.48	34.66
ADF	57.01	56.61	53.85	54.14
Hemicellulose	13.54	14.41	6.67	11.20
Cellulose	45.34	44.45	44.22	42.54
Lignin	11.67	12.16	9.63	11.20
Silica	0.51	0.67	1.10	0.64
	Digestibility coefficients (%)			
Dry matter	-	44.68	54.16	61.57
Crude protein	-	28.02	16.98	18.17
NDF	-	57.01	55.06	64.98
ADF	-	53.04	47.97	63.09
Cellulose	-	57.21	53.37	66.67

In another experiment, Nang'ole (1979) studied the interaction between particle size, chemical treatment and *in vivo* digestibility of the corn cobs. The cobs were ground to pass through either a 6 or 10 mm screen before the treatments were applied. His results are shown in Table 4.

TABLE 4
DIGESTIBILITY COEFFICIENTS OF MAIZE COBS GROUND TO PASS THROUGH EITHER A 6 OR 10 mm SCREEN, TREATED WITH EITHER SODIUM HYDROXIDE OR MAGADI SALT AND FED TO SHEEP

Screen size :	10 mm			6 mm		
Treatment :	Water	NaOH	Magadi	Water	NaOH	Magadi
Dry matter	46.04	53.14	56.09	43.32	53.18	67.04
Crude protein	23.37	23.82	24.54	32.70	9.43	14.21
NDF	51.99	53.20	54.90	50.02	56.94	70.05
ADF	56.65	46.90	59.41	52.43	49.04	66.78
Cellulose	57.70	53.33	63.46	56.73	53.41	69.85

In a separate experiment Friesian steers and heifers (av. age 9 months and av. wt. 110 kg) grazing a mixed pasture of *Setaria, Desmodium* and Silver leaf were offered either NaOH or Magadi treated ground (10 mm screen) maize cobs *ad lib*. Three heifers and three steers were put on each diet and records were kept for 91 days.

Animals on the control, NaOH and Magadi treated cobs gained 380, 480 and 500 g per day, respectively. The respective maize cob intakes and feed conversion efficiencies were 3.35, 5.11 and 2.56 kg/day and 8.85, 10.94 and 5.12 kg/kg gain. Tubei (1982) fed Dorper sheep (6-8 months, av. wt. 28.5 $\pm$ 5.3 kg) 400 g commercial dairy cubes plus urea molasses mixture (MUM) as a basal ration. In addition, he fed either 4% ammonia treated maize cobs or maize stover *ad lib*. Ten animals were put on each treatment and the experiment lasted 91 days. The pertinent results are summarized in Table 5.

Daily dry matter intake and body weight gains on the U-MC, NH-MC, U-MS and NH_3-MS were 25.3, 41.5, 23.6, 28.4 g/$W^{0.75}$ per day and 78.6, 128.5, 61.2 and 87.8 g/day.

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TABLE 5

CHEMICAL COMPOSITION OF UN-TREATED MAIZE COBS (U-MC), AMMONIA TREATED MAIZE COBS (NH_3-MC), UN-TREATED MAIZE STOVER (U-MS) AND AMMONIA TREATED MAIZE STOVER (NH_3-MS)

	U-MC	NH_3-MC	U-MS	NH_3-MS
Organic matter	96.6	97.0	93.6	93.7
Crude protein	2.2	7.5	6.3	8.1
Crude fibre	37.5	36.1	37.1	34.9
Ether extracts	1.4	3.1	2.3	3.7
NFE	55.6	50.3	48.0	47.1
Ash	3.4	3.0	6.4	6.3
	Chemical composition of the complete diet (above plus dairy cubes)			
Organic matter	98.4	97.0	93.6	92.5
Crude protein	9.9	12.4	8.7	13.3
Crude fiber	29.3	29.5	34.3	32.3
Ether extract	3.1	3.0	4.0	4.0
NFE	52.6	50.6	45.1	43.1
Ash	5.2	4.6	7.8	7.5
GE (Kcal/g)	4.2	4.2	4.3	4.3
	Digestibility coefficients			
Dry matter	55.0	61.2	56.1	58.9
Organic matter	65.7	62.5	56.1	61.0
Crude fiber	65.7	62.9	68.5	70.1
Crude protein	49.5	46.7	36.6	39.8
Ether extract	57.9	67.2	44.7	67.4
NFE	58.8	68.3	48.4	57.2
NDF	60.2	63.0	62.2	68.2
N-Balance	4.6	5.4	6.7	6.4

3. Said, A.N., Sundstol, F., Tubei, S.K., and Musimba, W.K. 1982. The most promising results for the use of by-products for ruminant feeding in Kenya. Paper presented at the IDRC workshop on *Feasibility of by-product and non-conventional feed utilization for animal production* held in Nairobi, Kenya on Sept. 26-30, 1982.

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TECHNIQUE TALK

In vitro techniques using either rumen fluid or cellulase enzyme to estimate digestibility of forages.

In many research programmes, there is the need to determine the digestibility of large numbers of samples of pasture, hay or straw. It is difficult to analyse many samples in feeding trials which involve large numbers of animals, amounts of equipment and inputs of labour. Such trials are slow and they require large quantities of feed. *In vitro* assays have been developed for estimating the digestibility of forages.

Numerous studies have been made in which *in vivo* digestibility has been correlated with the results of various chemical and microbiological determinations. The highest correlation with *in vivo* digestibility has been the two-stage *in vitro* technique developed by Tilley and Terry (1963). This technique, although developed for temperate pastures, has also proved satisfactory for tropical species (McLeod and Minson, 1969a) and grass-legume mixtures (McLeod and Minson, 1969b). The method involves successive incubation of the sample with rumen fluid for 48 hrs followed by acid pepsin for another 48 hrs.

More recently, an *in vitro* technique involving the incubation of the forage sample with acid pepsin for 48 hrs followed by incubation with a cellulase enzyme for another 48 hrs has been used. The accuracy of this pepsin-cellulase method for estimating dry matter digestibility of grasses and legumes *in vivo* has been assessed by McLeod and Minson (1978). The standard error involved in predicting *in vivo* digestibility was found to be comparable with that using the Tilley and Terry rumen fluid method. Dr J. Lambourne, who is a colleague of Minson and McLeod at the Cunningham Laboratories in Brisbane and is currently seconded to ILCA as Director of Research, has stoichiometrically reduced the volumes of forage sample (150 mg), pepsin and cellulase solutions (10 ml) with very little loss in the accuracy of the assay procedure. This reduction in volumes saves on reagents and increases throughput.

The *in vitro* techniques are also useful in screening changes in potential digestibility of forage that has been subjected to physical, chemical or biological treatment. However, there are limitations in the estimates once such treatments have been imposed. Numerous studies have illustrated that *in vitro* organic matter

digestibility estimates of sodium hydroxide treated forage overestimate actual *in vivo* digestibility. The discrepancy occurs due to the fractional digestion rate (fraction of the organic matter in the rumen digested per day) of treated material in the recticulo-rumen and in the fractional passage rate (fraction of the organic matter that flows to the omasum per day) of undigested cell walls from the recticulo-rumen. The increase in fractional passage rate may result from increased intake and/or effects of the alkali treatment on the rate of fluid flow. These effects indicate that extreme care should be taken in interpreting *in vitro* estimates of the digestibility of treated forages. Where possible, appropriate *in vivo* estimates should be made. A comparison of the two *in vitro* techniques reveals that each has some advantages and disadvantages. It is necessary with both methods to include standard samples (usually three of different digestibility) of known *in vivo* digestibility or that have had their *in vitro* digestibility determined several times. These provide estimates of digestibility that deviate from values obtained *in vivo*. These results can also vary slightly from run to run. This is especially true of the rumen fluid method. The standards can be used to correct these effects if it is desired. Their major use is to indicate whether the procedure was carried out correctly.

With the Tilley and Terry rumen fluid method, it is necessary to keep and maintain rumen fistulated animals 1/, normally fed a uniform, standard medium or high quality diet. The diet needs to be uniform to ensure a reasonable level of enzyme activity in the rumen fluid, and it needs to be uniform to ensure that the fluid collected for different runs has similar characteristics. Rumen fluid for this method should only be taken from animals that have been fed the uniform diet for at least three to four weeks. There is no need to maintain fistulated animals for the pepsin-cellulase technique, but it is necessary to purchase a reasonable stock of the cellulase enzyme to avoid any variability in activity that might occur between different batches or suppliers. While the initial cost of the enzyme may be high, the cost per sample analysed is reasonable.

The pepsin-cellulase technique yields less variable results than the rumen fluid procedure, so it is possible to analyse samples in duplicate whereas triplicate determinations are required for the rumen fluid method. This has obvious advantages in the number of samples that can be assessed.

1/ To obviate the need for rumen fistulated animals, scientists at the ILCA HQ in Addis Ababa have routinely obtained rumen fluid using a stomach tube connected to a cylindrical seiving device. The stomach tube is hooked to a vacuum pump via a series of conical filtration flask traps. When the pump is started, rumen fluid is drawn into the first receiving flask. If a stiff polyester tubing is used, rumen fluid can be obtained from various locations of the rumen by re-directing the connecting tubing.

The Tilley and Terry method can be varied to measure changes in the rate of digestion which might occur when supplements, such as nitrogen and minerals are added to forage. For example, the digestibility measure could be made using several different times of incubation with the rumen fluid (e.g. 6, 12, 24 hrs). This may indicate changes in the rate of digestion as well as potential digestion. The pepsin-cellulase method is unlikely to measure responses in the same way. Another disadvantage of the pepsin-cellulase procedure is that it underestimates the digestibility of feeds rich in starch and lipids since neither pepsin nor cellulase will attack these components.

For most purposes where forages are to be used as feeds for ruminants, the measurement of nitrogen content and an *in vitro* digestibility provides a meaningful description of the quality of the forage. Other commonly used chemical descriptions of forages such as the proximate analysis or van Soest detergent analysis (Goering and van Soest, 1970) may be of less value than *in vitro* digestibility measurements. Although *in vitro* assays are very useful in screening forages, it must be remembered that for final information about a particular sample, an animal feeding trial must be carried out.

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EDITORIAL

TOWARDS RESOLVING SMALL SCALE FARMERS' LIVESTOCK FEEDING PROBLEMS

Traditionally, ruminant livestock feed resources in Africa are based on rangeland grazing and on communal grazing within sedentary arable farming systems supported by crop residue feeding and scavenging. Intensive cultivated pasture development has been almost entirely restricted to parastatal ranches, research institutions and a few private livestock farms, especially in dairy enterprises where the price of milk justifies the additional costs involved.

One of the reasons for this restricted development is that over the last 20 years there has been an increase in the use of marginal lands for grain production especially in the derived savannah zones. This has tended to restrict summer grazing facilities for pastoralists. The emerging trend is for pastoralists to depend symbiotically on crop residues produced by the arable farmers in the transitional cereal growing areas of Africa for their livestock nutrition during the dry season.

Mixed farmers in the cereal producing areas, who keep livestock for draught power, milk manure and petty cash (and occasional slaughters), are facing dwindling communal grazing privileges as a result of the expansion of the area devoted to cereal production. These farmers conserve cereal crop residues and legume haulms to augment their year-round feed budget.

In the humid forest belt, small trypanotolerant ruminants supplement their browse and tall grass diets with household discards of tuber peels (yams, cocoyams and sweet potato) and fruit and tree crop residues (plantains, bananas, citrus, coffee and cocoa).

The current demand for meat, milk and other livestock products suggests that there is a need to improve further the productivity and quality of the existing livestock population at a time when traditional feed resources tend to be dwindling. Research efforts should therefore be focussed on non-conventional feed resources and especially on the use of crop residues to close the feed gap.

A number of new techniques have been developed that increase the efficiency of utilization of crop residues (Jackson, 1978). Except in some developed countries (e.g. Norway, Sweden and Denmark), these techniques do not appear to have been tested outside research institutions. However, such testing must be done to find out whether or not the techniques maintain their effectiveness on farmers' animals under village conditions in Africa. The work should be continued until all constraints for easy adoption have been identified and removed. The first stage is to identify the type of farm and animal production system that will form the target group. Inputs for the experiment should preferably originate from the farm or should be procurable with minimum costs and labour requirements. On these farms, crop residue use is most likely to make an impact by a procedure that initially raises the feeding value of the crop residue. This could be a chemical, physical or biological modification of the residue coupled with corrections for protein and mineral nutrition.

The chance of breakthrough will depend on the successful raising of animal productivity from low to intermediate levels rather than on trying to provide the complete nutritional requirements for high animal productivity all at once. Thus rations that contain over 30% of expensive concentrates (fish meal, imported additives etc.) to furnish additional protein and energy are unlikely to be used at village level unless livestock products such as milk command good prices to provide cash for the purchase of concentrates. A good start may be for the farmer to grow or conserve good quality legume crops or their residues for strategic feeding to furnish the requirements for rumen microbial growth which in turn influences the extent and rate of crop residue digestion.

If chemical treatments are to play a role in this endeavour, it would be advantageous to explore the proven benefits from the use

of fertilizer grade urea whose technology may be understood by farmers. Research findings from Bangladesh (Saadullah et al, 1981) and southeast Asia (Ambar and Djajanegara, 1982; Wanapat et al, 1982; Jayasurija, 1982) indicate that the nutritive value of rice straw is improved by more than 50% when ensiled, sprayed or stacked with urea. It has also been demonstrated at ILCA that nitrogen intake increased from 1.1 $g/d/wkg^{0.75}$ to 9.0 $g/d/wkg^{0.75}$ and its digestibility was raised from 33.0% to 70.0% when teff straw and oat straw were either ensiled for 3 weeks or sprayed with fertilizer grade urea and fed to sheep. Limitations to urea treatment may be the acceptability of the treated straw and continuous subsidy of urea prices.

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NETWORK NEWS

FAO/ILCA PLAN TO CONVENE AN EXPERT PANEL TO DISCUSS RESEARCH METHODOLOGY IN CROP RESIDUE STUDIES

Research methodology appears to differ among the various institutions in Africa. This is particularly so with the analytical procedures routinely employed to evaluate the nutritive components of livestock feeds. Some institutions have adopted the fibre fractionation procedures developed in Beltsville by Van Soest and Goering. Others still retain the classical Weende Proximate Analysis scheme with or without special assays for crude cellulose. This diversity makes it difficult to compare inter-institutional research data. There is therefore a need to develop a unified procedural approach.

There appear to be four basic approaches to the use of crop residues as ruminant livestock feeds. These are: chemical treatments to improve the potential rate and extent of digestion; substitution of cereal crop residues in balanced livestock rations; the use of non-conventional feed resources (cocoa by-products, banana pseudostems, etc.) as replacements for some dietary ingredients compound livestock rations based on farm produced crop residues. Different *in vitro* and *in vivo* digestibility techniques are used but the approach to the use of procedures to solve specific problems differs among institutions.

At the Dakar conference organised by FAO and ILCA in 1981, network members requested FAO and ILCA to convene an expert panel to draw up guidelines for crop residue research methodology. If current plans mature, FAO will provide a consultant to visit African research institutions later this year whose report will serve as the basis for a workshop tentatively scheduled for March 1984.

ILCA TRAINS STAFF OF AFRICAN RESEARCH INSTITUTIONS

Since the inauguration of ILCA's headquarter facilities in October 1980, the HQ research laboratory has conducted several group and individual training sessions for young scientists and support staff drawn from all parts of Africa. From April 5 to 29 this year, Mr Abou Bacayoko, an animal scientist from Mali, visited the laboratory to familiarise himself with indirect techniques in assessing forage nutritive value. These included the Tilley and Terry *in vitro* procedure, the pepsin-cellulase procedure, the nylon bag technique and the use of Van Soest summative equations based on the detergent system of analysis.

Dr G S Madata, a principal livestock research officer from the Uyole Agricultural Training School in Tanzania, also visited ILCA to compare notes on indoor and range livestock experimentation techniques (May 7 - 29, 1983). Other research groups that have benefited from our laboratory technician training scheme include ILCA's Small Ruminant Programme in Ibadan, Nigeria and the Institute of Agricultural Research, Holetta, Ethiopia.

From September 19 to October 8, 1983, the HQ laboratory will offer a bilingual course in "Animal nutrition and forage evaluation". Twelve scientists drawn from African research centres are expected to attend.

RESEARCH BRIEFS

The greatest threat to continuous livestock weight gains in Africa is the inability to find suitable feeds during periods of drought. To bridge this feeding gap, scientists have focused attention not only on crop residues, but also on non-conventional feed resources such as cocoa by-products and banana pseudostems. The following summaries on cocoa by-products were provided by authors or drawn from departmental reports. The names of the authors and their institutions are provided for interested readers to establish the necessary contacts.

1. UTILIZATION OF COCOABEAN SHELLS AS LIVESTOCK FEED

D E Pessey and R E Larson.
University of Ghana,
Legon, Ghana

(Abstract from the Department of Animal Science)

Six 2-year-old Nungua blackhead wethers were used in three trials to determine intake and digestibility of unprocessed cocoabean shells, hot water extracted cocoabean shells and cocoa husk meal. Hot water extraction of cocoabean shells resulted in a significant increase in total nutrient intake but drastically reduced digestibility of all the proximate principles except ether extract.

Chemical composition of the experimental diets

	Chemical composition		
	Untreated cocoabean shells	Hot-water extracted cocoabean shells	Cocoa husks
Dry matter (%)	87.3	88.5	84.4
Crude protein (%)	18.8	17.2	8.6
Crude fibre (%)	15.1	23.9	44.2
Ether extract (%)	14.2	7.3	1.5
Nitrogen-free extract (%)	45.0	46.5	36.7
Ash	6.9	4.5	9.0
Theobromine (%)	3.1	2.7	0.2
Energy (Kcal/g)	5.0	5.0	4.6

	Mean apparent coefficients of digestibility (%)		
Dry matter	58.8[a]	28.7[c]	36.4[b]
Crude protein	37.4[a]	-	12.2[b]
Ether extract	73.1[ab]	77.8[a]	65.6[b]
Crude fibre	46.7[a]	7.3[b]	17.9[b]
Nitrogen-free extract	69.0[a]	45.5[c]	58.8[b]
Energy	62.0[a]	33.8[b]	37.0[b]

Digestibility of the cocoa husk meal was intermediate between those of the treated and untreated cocoabean shell meal. Intake of the cocoa husk meal was adequate to meet maintenance requirements and was significantly higher than the other treatments. The high level of theobromine in the cocoa shells even after extraction make their use as a livestock feed unfeasible.

2. PERFORMANCE OF SHEEP FED RATIONS OF COCOA HUSK

S K Doamekpor and E O Otchere (1977)

(Source: Departmental report to the technical Director of the Ministry of Industries, Science and Technology, Ghana from the Department of Animal Science, University of Ghana, Legon).

The effects of three levels of cocoa husk (45%, 60% and 75%) in balanced sheep diets were studied. Four growing wethers were put on each of the sheep diets. The results of the intake and digestibility trials indicated that acceptable maintenance rations can be formulated using dried cocoa husk meal (DCHM) at 45% and 60% substitution levels without significant losses in daily weight gain. Average daily weight gains in the 80-day feeding trial were 7.9 g, 8.4 g and 300 g respectively on the 75%, 60% and 45% DCHM substituted diets. Animals on the 75% DCHM substitution level showed depressed feed intake. The best gains were made during the first 40 days of the experiment when fresh cocoa husks were fed. Nutrient digestibility was highest at the 45% substitution level following which there was a drastic depression in voluntary intake and nutrient digestibility.

3. STUDIES ON THE DIGESTIBILITY OF DRY COCOA HUSK BASED RATIONS BY SHEEP

Issah Al-Hassan Musa and E O Otchere,
University of Ghana,
Legon (1978)

(Source: as for 2 above)

Digestibility studies with wethers were conducted on four rations in which maize was substituted for dry cocoa husk meal (DCHM). The diets were: 60% DCHM + 40% other ingredients; 40% DCHM + 20% maize + 40% other ingredients and 60% maize + 40% other ingredients. Each of the rations was tested with four sheep maintained in metabolism crates. Results from the studies indicated that inclusion of maize in DCHM diets almost linearly increased the TDN value of the ration. There were also significant improvements in the digestibility of the proximate components. Wethers on combinations of DCHM and maize consumed lower amounts of feed but made higher weight gains.

The performance of sheep on the 60% maize diet was similar to those on 40% DCHM + 20% maize. The highest daily gain (202.4 g/d) was recorded for sheep on the 20% DCHM + 40% maize diet followed by those on 40% DCHM and 20% maize (143.0 g/d) diets. These values were respectively 3.4 and 2.4 times higher than the gains recorded for animals on the 60% DCHM diet. These results show that satisfactory use of DCHM can be made to replace maize in complete sheep rations.

4. PERFORMANCE OF PIGS FED RATIONS CONTAINING COCOA HUSK MEAL

O B Smith,
University of Ife,
Ile Ife, Nigeria

(Source: submitted to ARNAB by the author)

Dried, milled cocoa husk (MCH) was substituted for maize in a growing-finishing pig ration containing 56.5% maize at the levels of 0%, 15%, 20% and 25%. The rations were evaluated on the basis of liveweight gain and carcass characteristics. The results of the experiment

showed that feed conversion efficiency was highest on the 15% MCM diet followed in descending order by 0% MCM, 20% MCM and 25% MCM. Pigs on the 25% MCM diet showed the lowest average back fat thickness (2.4 cm) and the highest loin-eye area (26.4 cm).

PROFILE

It is intended to continue publishing the profiles of ARNAB members. One or two profiles will appear in subsequent issues of the newsletter giving a short history of the member, his field of research and his achievements. Members are therefore requested to send their personal profiles to the scientific secretary including a passport size black and white photograph or negative. Profiles will be published on a first come, first served basis. In this issue, we publish the profile of Prof. M H Butterworth who is currently the Deputy Director of Research at ILCA and Head of the ILCA nutrition programmes.

After completing his PhD at the Rowett Institute in Scotland, Dr Butterworth was appointed as animal nutrition chemist at the Imperial College of Tropical Agriculture (now the Faculty of Agriculture, University of the West Indies) where he established a small nutrition research unit. After five years in Trinidad, he became Professor of Nutrition at the Faculty of Veterinary Science of the Central University of Venezuela. He joined FAO in 1965 and for 16 years was manager of projects in Mexico, Swaziland and Malawi until he joined ILCA in October of last year. With the exception of a short break, during which he was visiting Professor at the University of Gottingen, he has spent all his professional career in the developing world. He has published more than 70 research and similar publications and his book "Beef cattle nutrition and tropical pastures" will be published in 1984. Agricultural by-products and crop residues that he has worked on include waste bananas, sugar-cane bagasse molasses, poultry manure, maize bran, cereal straws and legume haulms.

ARNAB

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Vol. 3, No. 3 September 1983

EDITORIAL

The problems of technology transfer to target groups

In our effort to encourage small scale farmers improve the feeding value of their crop residues and agro-industrial byproducts, we should ensure that:

1. inputs needed for any technology are affordable;
2. the farmer observes demonstrable improvements in his livestock production when he uses the technology; and
3. labour requirements do not unduly upset his yearly operations calander.

Most African subsistence farmers have insufficient cash reserves to enable them acquire the inputs for costly but proven interventions that would produce large improvements in their operations. For example, in the advanced nations, the use of tractors has not only reduced the drudgery in arable farming but has also improved individual farmer productivity. The economics of scale however do not favour tractor ownership by subsistence farmers in Africa, and animal traction is therefore to be preferred. Similarly, we would not recommend the use of gamma irradiation as a means of improving the feeding value of coarse roughages to African subsistence farmers. Instead we might recommend simple chopping, the feeding of legume haulms with cereal crop residues or farm produced leguminous feeds.

These interim measures may produce immediate results in which case the technology is most likely to be adopted. If more time is required then consistent demonstration and supervision of farmer operations is needed.

Labour for land preparation, sowing, weeding and harvesting are fixed priorities for mixed subsistence farmers. Any introduced technology should preferably be incorporated readily into these farm operations rather than compete with them.

Another way of financing technological inputs would be for farmers to cooperatively purchase and share equipment, if this can be arranged. Government intervention in the form of loans, establishment of factories and the subsidy of farm imputs will always be a blessing to subsistence farmers.

NETWORK NEWS

Courses

A refresher course in Animal Nutrition and Forage Evaluation techniques was given by the ILCA Nutrition Unit from 19 September to 7 October 1983. Fourteen young scientists from Burundi (1), Cote d'Ivoire (1), the Gambia (1), Ghana (1), Upper Volta (1), Kenya (1), Madagascar (1), Malawi (1), Nigeria (1), Sudan (2), Jordan (1) and Uganda (1) attended the course. Items covered included current developments in the conduct of *in vivo*, *in vitro* and analytical methodology. Dr J P Van Soest, of Cornell University, USA and Drs. D Little and J Tothill of CSIRO, Queensland, Australia gave special seminars in their fields of specialization, in addition to formal lectures. Depending on the availability of funds this course will be run annually.

Dr T R Preston consults for ARNAB

Dr T R Preston, a senior lecturer at the James Cook University, Townsville, Australia was engaged by FAO in September 1983 as an ARNAB consultant to:-

1. determine research priorities in crop residues and agro-industrial byproducts use in some African countries;

2. review and examine in detail the methodology and procedures adopted in such research;

3. discuss the design of experiments for evaluating the nutritive value of available feeds and using them in appropriate production systems, and provide such advice as may be required;

4. compile a list of names of individuals, institutions and sites involved in active crop residues research;

5. assess adoption rates of research findings within small scale and commercial farms and individual plants;

6. estimate national inventories of crop residues and byproducts and the extent of use particularly of cereal crop residues; and

7. prepare a report to FAO based on the above, for presentation at the FAO/ILCA Expert Consultation on 'Guidelines for research on the better use of byproducts and crop residues' in March 1984. This consultation will be held at ILCA headquarters.

Dr Preston has already visited some institutions in Africa but it is unlikely that he can visit all. Readers who might wish to contribute to the terms of reference of Dr Preston's study may do so through the ARNAB secretariat in Addis Ababa.

Conferences

The Animal Production and Health Centre in Sri Lanka in association with FAO is organizing a training course on 'Byproduct Utilization in Buffalo Feeding'. The course will be held in Sri Lanka from 7 to 27 November 1983. The course is basically for junior scientists from 10 Asian countries but two ARNAB members will be accepted if funding can be arranged by the nominating institution. Unfortunately, ARNAB cannot fund participants; but those who can find funding from other sources may contact the course organiser Dr B K Soni, Regional Animal Production and Health Officer and Secretary, FAO Regional Office, Maliwan Mansion, Phra Atit Road, Bangkok, Thailand.

Feed-back from our readers

Dr Noble Jayasuriya of the Department of Animal Science, University of Peradeniya, Peradeniya, Sri Lanka writes:

'You are doing a great job with the newsletter and I wish you all the best in future.'

From a farming systems research team in Lesotho

Dr Earle W Klosterman shares his experiences in Africa:

'My African experience is strictly limited to Lesotho but, in my opinion, Lesotho farmers are a long way from using alkalis etc. to improve the feeding value of crop residues. First of all they must harvest significant amounts. A discussion of *in vitro* techniques may be of interest to those in the laboratory but has little relevance to Lesotho at the present time. Detailed laboratory procedures may be of interest to those hoping to fund and establish research facilities; however, in my opinion, I believe such facilities would presently be a waste of money in this country.'

'When I first came to Lesotho, I was frustrated with the lack of any laboratory or livestock research facilities with which to conduct on station research. However, I now view this lack as a blessing in disguise, if we did anything, it had to be with farmers and their animals ..... I believe the present research need is to determine what Lesotho farmers are able and willing to do with what they have. I am now wondering if there may not be other African countries in a similar position.'

Editor's comment: Dr Klosterman's message is clear. Must we wait for first class research facilities before we are able to break our inertia to assist subsistence farmers? Your comments are welcome !

RESEARCH BRIEF

Dr J A Ayoade, Lecturer in Animal Nutrition, Department of Livestock Production, Bunda College of Agriculture, University of Malawi, Box 219, Lilongwe, Malawi has sent the following abstract from his work:

Dr Ayoade's research interests are:

1. use of agricultural residues (groundnut haulms, bean haulms, groundnut shells, maize stover, maize cobs) by livestock;
2. evaluation of leaves of trees and shrubs as feed for goats; and
3. studies on the nutrition of Malawian goats.

Voluntary intakes, digestibility and nitrogen utilization of groundnut and bean haulms by goats. (From J A Ayoade and P E Makhambera, 1983. *S. Afri. J. Anim. Sci. 13 : 12-13)*

Four castrated Malawian goats, weighing 16.0 - 20.5 kg were used in a two period cross-over design (2 x 20 days) to measure voluntary intake, nutrient deigstibility and nitrogen utilization of groundnut and bean haulms. The dry matter contents of both feeds (Table 1) are relatively high and provided there are adequate amounts of both feeds available, Malawian local goats can meet their requirements for dry matter (3% of body wt.) and their maintenance requirement for digestible crude protein (1.4 - 2.0g/kg$^{0.75}$) from these feeds alone.

Table 1. Chemical composition of groundnut and bean haulms

Component	Composition (g/100g DM)	
	Groundnut haulms	Bean haulms
Dry matter	94.5	92.3
Crude protein	8.8	10.0
Crude fibre	31.4	41.1
Ether extract	0.3	1.4
Nitrogen free extract	45.2	39.5
Ash	14.3	8.1

Table 2. Voluntary intake, digestibility and nitrogen utilization of groundnut haulms and bean haulms by goats.

	Groundnut haulms	Bean haulms
Voluntary intake (daily)		
Dry matter (g)	601.6	534.3*
Free matter (g/g DM)	1.8	2.0 NS
Digestible crude protein ($g/kg^{0.75}$)	2.8	3.7***
Apparent digestibility (%)		
Dry matter	50.8	51.9 NS
Crude protein	45.4	57.0***
Ether extract	37.6	47.6**
Nitrogen utilization (daily)		
Nitrogen intake (g)	8.5	8.5 NS
Faecal nitrogen output (g)	4.6	3.6**
Urinary nitrogen output (g)	2.4	1.5***
Nitrogen retention (g)	1.5	3.4***

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; NS = not significant

RECENT REFERENCES IN CROP RESIDUE UTILIZATION

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Tomes J G, Payne R W, Fairnie I J, Burton K N and Timmel D. 1982. Effects of feeding grain alcohol fermentation byproducts of merino Sheep. *Proc. Aust. Soc. Anim. Prod.* 14: 543-546

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Vol. 3 No. 4 February, 1984

EDITORIAL

ARNAB IN 1983

Nineteen eighty-three has been a good year for ARNAB. The activities of the network were revived in earnest following a visit by the scientific secretary to eight institutions in February. This was followed in September by an FAO consultancy (Dr T R Preston) as well as a second visit to institutions by the scientific secretary and the Animal Sciences Programmes Officer of IDRC in October.

The year has seen a shift in research direction in that attention is now being focused on the use of farm-produced crop residues in combinations that provide adequate rations for livestock during periods of feed shortage. This line of research appears appropriate to small-scale farmers since the inputs are farm-produced.

Readership of the Newsletter has expanded to around 1000 and more requests pour in daily for inclusion on the mailing list. The publicity received by ARNAB during the year has begun to yield dividends. It is likely that IDRC will support research in some ARNAB participating institutions as well as the operations at the ARNAB secretariat over a three-year period commencing in 1984. FAO continues its interests in ARNAB activities and as a result of Dr Preston's consultancy in September, it will convene in collaboration with ILCA an expert consultation panel to draw up guidelines, protocols and research priorities for ARNAB (see Network News). In wishing all our readers the best 1984, ARNAB would welcome news items for inclusion into the Newsletter as well as useful suggestions and support that would promote research on the better use of crop residues and agro-industrial by-products for animal feeding. The following section 'Network News' concentrates on the forthcoming meeting of experts at ILCA scheduled 5-9 March, 1984.

NETWORK NEWS

FAO/ILCA Expert consultation on guidelines for research on the better use of by-products and crop residues for animal feeding.

ILCA, Addis Ababa. March 5-9, 1984

A proposal was tabled at the Dakar ILCA/FAO workshop in 1981 on the "use of crop residues and agro-industrial by-products for animal feeding" and that ILCA and FAO convene a team of experts to discuss research priorities and methodologies appropriate to crop residue research in Africa. In September 1983, FAO sponsored Dr Preston to visit some core ARNAB institutions, and as a result of his report the above workshop has been scheduled for March 5-9, 1984.

FAO will provide funding for six high-level experts from developed countries and six from developing countries whilst ARNAB (with pre-project funding by IDRC) will sponsor one participant each from the core ARNAB institutions. The proposed list of speakers and topics are as follows (subject to acceptance and availability of the speakers):-

1. Dr J Reed (ILCA)
   Selection of appropriate methods for estimation of nutritive value by chemical analysis of crop residues and agro-industrial by-products in developing countries.

2. Ørskov , E R (Rowett Institute)
   Methods of studying the fermentation of crop residues and agro-industrial by-products in the rumen **in situ** with special reference to developing countries.

3. Minson, D J (Cunningham Laboratory)
   Selection of appropriate methods for **in vitro** analysis of the nutritive value of crop residues and agro-industrial by-products in developing countries.

4. Sundstøl, F (Agricultural University, Norway)
Establishment of procedures for research into the treatment of crop residues and agro-industrial by-products in developing countries.

5. Picard, M (Incra, Nouzilly, France)
Methods of estimating digestibility and metabolism of crop residues and agro-industrial by-products in monogastric species in developing countries.

6. Butterworth, M H and Mosi, A K (ILCA)
Practical evaluation of crop residues and agro-industrial by-products for ruminants in developing countries with special emphasis on East Africa.

7. Preston, T R (James Cook University, Australia)
   a) Mission report on the use of by-products in Africa
   b) Validity of feeding standards and development of feeding systems based on crop residues and agro-industrial by-products for ruminants and monogastric species in developing countries.

8. (Speaker to be named)
Utilization of agro-industrial by-products and crop residues by monogastric species in Europe.

9. Cuca, M (Presiden, ALPA, Chipiango, Mexico)
Potential for the better utilization of crop residues and agro-industrial by-products by monogastric animals in Central America with special emphasis on methodology, equipment, facilities and personnel involved as well as the research priorities of the region.

10. Parra, R (Facultad de Agronomia, Venezuela)
Potential for the better utilization of crop residues and agro-industrial by-products in ruminant feeding in Latin America with special reference to methodology, equipment, facilities and personnel involved as well as research priorities of the country.

11. Prof. Szebistko (Academia Rolnicza, Poland)
Potential for the better utilization of crop residues and agro-industrial by-products in animal feeding in China with special reference to methodology, equipment, facilities and personnel involved as well as an outline of research priorities for this country.

12. Kajarern, Sarota (Khon Koen University, Thailand)
Potential for the better utilization of crop residues and agro-industrial by-products in animal feeding in South East Asia with special reference to methodology, equipment, personnel involved as well as research priorities of the region.

13. Hadjipanayotou, M (Agricultural Research Institute, Nicosia, Cyprus)
Potential for the better utilization of crop residues and agro-industrial by-products in animal feeding in the Middle East with special reference to methodology, equipment, facilites and personnel involved as well as research priorities of the region.

14. El Naga, M A (University of Alexandria)
Potential for the better utilization of crop residues and agro-industrial by-products in animal feeding in North Africa with special reference to equipment, facilities and personnel involved as well as an outline of research priorities of the region.

15. Dr Noble Jayasuriya (FAO/ILCA)
Potential for the better utilization of crop residues and agro-industrial by-products in animal feeding in North Africa and Sri Lanka.

In addition to the above presentations, participants from core ARNAB institutions will present poster sessions on inventories of crop residues in their countries and highlight the current strategies for optimizing their utilization. Participants from ARNAB core institutions will stay for an additional two days to discuss ARNAB affairs.

RESEARCH BRIEFS

Effect of concentrate supplements on voluntary intake and digestibility of chopped groundnut haulms by goats.

by

J A Ayoade and P J Tambala, Dept. of Agric., University of Malawi, P O Box 219, Lilongwe, Malawi.

A digestibility trial was conducted with goats for a period of 50 days using chopped grundnut haulms (dried leaves plus stems) with or without a concentrate mixture (maize bran, 83%; groundnut cake, 5% poultry manure, 10%; and salt, 2%). Voluntary dry-matter intake of the haulms was significantly ($P<0.05$) increased when supplementary concentrate equalled 15% of the body weight of the goats. However, a significant ($P<0.05$) decrease in haulm intake was observed when supplementary concentrate intake was elevated to 2 and 5% of the body weight of the goats. This indicates complementary and substitution effects at the lowest and highest levels of concentrate supplementation respectively. Concentrate supplementation significantly ($P<0.01$) increased dry matter and organic matter digestibility but had no effect on crude protein digestibility.

2. Performance of growing/fattening pigs fed rations containing different levels of bean-pod meal.

by

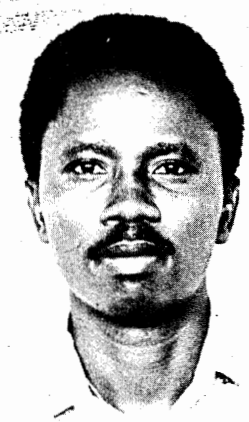
J A Ayoade and T P E Makhambera, Department of Livestock Production University of Malawi, P O Box 219, Lilongwe, Malawi.

Four groups of four male pigs (Landrace x Large white crosses) weighing approximately 13 kg were given a maize-based ration (50% maize) with or without 5, 10, or 15% dried and milled bean pod (bean-pod meal) to replace maize. Daily weight gain of pigs on the 0, 5, 10 and 15% bean-pod meal substituted rations were, respectively, 0.57, 0.48, 0.50 and 0.44 kg/day. The respective feed requirements per kg weight gain were 3.50, 3.39, 3.82 and 3.84 kg. The dressing percentages were,

respectively, 66.35, 67.86, 67.89 and 68.08 and the dressed out values (chilled weight/liveweight) 0.64, 0.66, 0.66 and 0.66. Inclusion of bean-pod meal into the diet significantly ($P<0.05$) lowered the mean daily gain but had no significant effect on the other parameters measured.

ARNAB MEMBER PROFILE

In this edition we publish the profile of Dr J A Ayoade, a staunch member or ARNAB whose contributions to the newsletter are greatly appreciated.



Full Name: Dr John Adisa Ayoade

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Malawi

Degrees: BSc. (Hons) (Agricultural Biochemistry and Nutrition) University of Ibadan, Nigeria (19749
PhD (Agricultural Biochemistry, Ruminant Nutrition), University of Nottingham (1981).

Research Interests: During his PhD studies Dr Ayoade investigated the potential of a series of substituted methionine derivatives in withstanding ruminal microbial degradation and their ability to meet the methionine requirements of sheep when fed orally. Dr Ayoade joined the Livestock Production Department of the University of Malawi as a lecturer in Animal Nutrition in 1981. His present research interest include: 1. The use of some agricultural residues (groundnut haulms, bean haulms, bean-pods, groundnut shells, maize cobs and maize stover) by livestock; 2. Evaluation of leaves of trees and shrubs as feeds for goats; and 3. Studies on the nutrition of Malawian sheep and goats.

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EDITORIAL

SUBSISTENCE FARMING ECONOMICS: HOW TO SHIFT THE ESTABLISHED EQUILIBRIUM OF PRODUCTION

"In the subsistence farming economics which dominate the continent of Africa, livestock are frequently the catalyst that enables increases in cash income to be initiated and thereby enable fertilizer, better seed and pest control to be purchased, resulting in improved crop yields and much greater productivity of land and labour". This statement was made by the Director General of ILCA, Dr Peter Brumby, at the opening session of the joint ILCA/FAO Expert Consultation on Guidelines for Research on Better Utilization of Crop Residues and Agro-industrial Byproducts in Animal Feeding in Developing Countries held at ILCA HQ on March 5-9, 1984. The statement summarizes the delicate interdependence that exists between livestock and crop production at the subsistence farmers' level in Africa. This interdependence has been developed over decades of trial and error to an equilibrium level of production. Any change in this equilibrium must be demonstrably better and less risk-prone to the farmer than the existing practice since he can ill-afford failure for even a year.

It is therefore suggested that our ideas for research on the better utilization of crop residues for livestock feeding emanate from the livestock feeding practices as used by subsistence farmers. A period of observation will be required. Thereafter, controlled experiments that remove the bottlenecks in the feeding regime and improve the nutritive value of the residues should be undertaken using inputs that are likely to be affordable by the farmer. The next stage would be to test the new package on farms following discussions and acceptance by some pilot farmers. Introduction of the package should be a gradual process, allowing the farmer to master the various steps involved. If the package produces demonstrable economic returns to the pilot farmers' operations, it is most likely to be copied by nearby farmers with similar resources and infrastructure.

NETWORK NEWS

Conferences

The FAO and ILCA jointly organized an Expert Consultation on "Guidelines for Research on the Better Utilization of Crop Residues and Agro-industrial Byproducts in Animal Feeding in Developing Countries at ILCA's Headquarters in Addis Ababa on March 5-9, 1984. Mr. Hans A H Dall, the FAO Regional Representative in Addis Ababa performed the opening ceremony. In his speech, he stressed past activities of the FAO in this field and wished the workshop fruitful discussions. In his welcoming address, Dr Peter Brumby, the Director General of ILCA, emphasized the often disguised but important role that livestock play in subsistence farming economics. Livestock, he stressed, have a much more important role in human welfare in Africa than simply providing meat and milk.

Papers given at the workshop represented an up-to-date "state of knowledge" on crop residue usage for livestock feeding and will be published jointly by ILCA and FAO in the "Animal Production and Health Series" of the FAO. A ready reference manual "Use of crop residues as feeds: Guidelines for Research", will also be published for scientists working in this field.

Funding by IDRC enabled eight ARNAB members, one each from Egypt, Sudan, Kenya, Tanzania, Malawi, Nigeria, Cameroon and Senegal, to attend the above workshop. Contributions from the ARNAB members, apart from their active participation in the working groups, included presentation of either papers or posters on the past, present and future use of crop residues as well as inventories and alternate uses of existing crop residues and agro-industrial byproducts in their countries. The group also reviewed the past, present and future activities of ARNAB and presented outlines of their current research projects for discussion. Major decisions on the protocol of experiments and subsequent analyses of the results were taken. The ARNAB members proposed to convene in Alexandria, Egypt during 1985 to discuss progress on the agreed plan of action.

Research briefs

GLOBAL/REGIONAL/SUB-REGIONAL/COUNTRY REVIEWS ON THE POTENTIAL FOR BETTER UTILIZATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS IN DEVELOPING COUNTRIES.

Below are summaries of papers presented in the above session during the recent ILCA/FAO workshop (March 5-9, 1984). Summaries of papers on methodology will appear in the next issue of the ARNAB Newsletter. The summaries were prepared by Dr T R Preston, Dr V L Kossila and Mr J Goodwin of the FAO.

GLOBAL REVIEW OF THE POTENTIAL USE OF CROP RESIDUES AS ANIMAL FEED

by

Vappu Kossila

The global situation on the production of fibrous crop residues was described for 1981. The study was based on FAO statistics which were modified for this particular purpose. Results were given on a regional and on an individual country basis. The quantity of fibrous crop residues in each country and region was observed in the light of the population of grass eaters (cattle, buffaloes, camels, sheep, goats, horses, mules, asses) since these animals have greater potential for the use of fibrous crop residues than grain eaters (pigs and poultry). Forages constitute some .86% of the metabolizable energy intake of grass eaters, 17.7% of that of pigs and 8.6% of that of poultry in the world. The review indicated that about two thirds of crop residues were derived from cereal crops. In developed as well as developing countries crop residues account for about 24% of the total feed energy suitable for ruminant livestock while agro-industrial byproducts account for only about one percent.

Asia is the leading region in the production of crop residues from wheat, rice, paddy, millet, buckwheat, sugarcane, nuts, oilplants and vegetables as well as fruit and berries. North and Central America constitute the leading region in the production of fibrous crop residues from maize, sorghum and pulses. Europe is the leading region in residue yields from barley, rye, mixed grain and roots and tubers. USSR leads in residue yields from oats.

In 1981, global production of fibrous crop residues from different crops in trillion tonnes was: maize 1.0, wheat, rice and paddy, pulses each 0.5, sorghum and oilplants each 0.3, barley and sugarcane each 0.2, roots and tubers 0.17, millet and nuts each 0.13, fruits and berries 0.11, vegetables 0.08, oats 0.06 and rye 0.05. If all crop residues are counted, the world average would be 6166 Mcal ME and 3.4 tonnes of DM per LU of grass eater per year (1 LU = 500 kg liveweight at maintenance level).

The amount of crop residues in tonnes DM per LU of grass eaters per year was: 6.66 in North and Central America, 3.56 in Asia, 3.54 in Europe, 2.94 in USSR, 2.20 in Africa, 1.87 in South America and 1.06 in Oceania.

Large differences were observed between individual countries. Much of these differences could be explained by climatic factors, level of technology in agricultural production systems, availability of natural pastures and forest lands for grazing, availability of drinking water, extent of livestock diseases, religious and cultural factors and political and economic regulation systems.

Yields of crop residues have risen proportionally more than livestock numbers from 1970 to 1981. The grain eater population in percent of total livestock population is the highest in Europe (33.7%) and the lowest in Oceania (3.3%). Countries which have high crop residues per LU of grass eaters tend to have also high grain eater numbers.

It is evident that at present there are more fibrous crop residues available per LU of grass eaters than a decade ago. From an economic and security point of view, research should be strongly directed towards improving the rate of utilization of fibrous crop residues as livestock feed.

PRACTICAL EVALUATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS FOR RUMINANTS IN DEVELOPING COUNTRIES WITH EMPHASIS ON EAST AFRICA

by

M H Butterworth and A K Mosi

A brief history of the evaluation of crop residues as animal feeds in developing countries, including those of East Africa, was presented. It was pointed out that in some cases data had been collected over a period of more than 60 years. A large quantity of crop residues is produced annually in East Africa which amounts to about 700-800 kg per livestock unit. However, there are considerable difficulties in making precise estimates because of uncertainties both in crop production figures and extraction indices.

Recent work in East Africa was reviewed, emphasis being placed on the chemical treatment of crop residues that has been intensively investigated in various countries of the region.

Work carried out at ILCA in Addis Ababa has stressed the use of legume forages as supplements to fibrous crop residues. Different levels of Trifolium tembense, a clover native to the Ethiopian Highlands, have been fed with oat, wheat, teff and maize straws. In all cases both intake and digestibility were increased. The average digestibility of the crop residue when fed alone was 48.3% and the intake was 49.8 g/kg LW 0.75. The provision of 45% legume hay improved digestibility to 65% and intake to 58 g/kg LW 0.75, equivalent to improvements of 35% and 15% in digestibility and intake respectively.

POTENTIAL FOR THE BETTER UTILIZATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS IN ANIMAL FEEDING IN NORTH AFRICA

by

M A El Naga

The northern countries of Africa are deficient in animal feeds, estimated to be some 27% of calculated requirements. The available feed

amounts are not consumed at a regular rate over the whole year. The more nutritious 65% of available feeds are consumed during the winter (rainy) season. The animals suffer during the summer (dry) season from severe shortages of feed reflected in many imbalances due to deficiencies in nitrogen, soluble carbohydrates, vitamin A precursors and minerals. At the same time, these countries have considerable amounts of crop residues and agro-industrial byproducts which are under-utilized. The amounts of unused byproducts need to be surveyed. The fractions which could be directed to animal nutrition should be identified.

Improving the nutritive value of low quality roughages (conventional and non-conventional) can be achieved by arranging for the consumption of nutritious and low quality ingredients to be regular over the whole year. Some of the winter materials (preserved as hay or silage) could be shifted to the summer season and vice versa. This will provide the animals with a more balanced diet over the year. Moreover, the non-traditional byproducts should be used after proper processing (chopping and mixing) and supplementation with the deficient nutrients in the form of urea, molasses, vitamin A and minerals.

Simple machinery to conduct this work could be fixed on mobile trailors and driven by tactors to the farmers' sites to treat their local ingredients. Chopping and supplementation can result in doubling the daily body weight gain of animals. In milk production a diet based on chopped and supplemented byproducts resulted in a similar level of milk yield as that obtained on 1:1 concentrate to green roughage diet (on DM basis). The mechanization of processes involved in the improvement of the nutritive value of such ingredients needs to be evaluated economically.

Animal species should be compared in terms of their ability to utilize byproducts more efficiently. Buffaloes have proved to be very efficient in this respect, although camels may even exceed buffaloes.

POTENTIAL FOR BETTER UTILIZATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS IN ANIMAL FEEDING IN THE MIDDLE EAST

by

M Hadjipanayiotou

Crop residues and agro-industrial byproducts can and should play a more significant role in the nutrition of ruminants in Middle Eastern countries.

Supplementary feeding with nitrogen, energy and minerals as well as chemical and physical methods of treatment have been used in order to improve feeding value. The chemicals used are: NaOH, $Ca(OH)_2$, urea, O_3 and SO_2. Based on existing knowledge, it is concluded that treatment with NaOH is currently too expensive, and more emphasis should be put on ammonification; and that urea might be preferable to NH_3 especially in developing countries. Treatment with a mixture of $Ca(OH)_2$ and urea deserves further attention.

Byproducts such as citrus pulp, grape marc, and others with a high moisture content, should be processed to improve their storage quality. Processing of animal wastes is also important as a means of destroying pathogens. Dehydration of byproducts results in a stable product which is flexible to use, but it should not be recommended because of costs and loss of nitrogen. Ensiling is less flexible but is preferred to dehydration because it requires less energy.

In many countries there are no data on byproducts. If we are interested in making better use of them as animal feeds, it is important to know the quantities, seasonal availability, alternative uses, nutritive value and their location versus that of livestock industries.

Processes for improving byproducts must be practical and economical and, if possible, should use existing farm machinery and not require new and expensive equipment. Countries in the region must make use of the prevailing high ambient temperatures for drying byproducts and for enhancing chemical treatment of crop residues.

Finally, it is recommended that before setting research priorities, possible beneficiaries should be identified, and that governments, through various means, should promote the use of byproducts and their associated technology for which there is sufficient knowledge.

POTENTIAL FOR THE BETTER UTILIZATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS IN ANIMAL FEEDING IN THE INDIAN SUB-CONTINENT

by

M C N Jayasuriya

Ruminants in the Indian subcontinent are generally reared on poor quality herbage such as native grass, weeds and crop residues, because the available arable land is given high priority for cultivating cash crops to produce food for the ever increasing human population. The prevailing economic conditions limit the importation of animal feedstuffs and ruminants in particular have to depend more and more on the vast quantities of crop residues and agro-industrial residues and agro-industrial byproducts available in this region.

Cereal straws are the predominant feed resource in the region, but their inherent nutrient deficiencies make them poor quality feeds. Despite the theoretical simplicity of supplementing straw with nitrogen, energy and minerals to alleviate the nutrient deficiencies, feeding systems based on supplementation alone have not proved successful. Trials in Sri Lanka, India and Bangladesh have clearly demonstrated that ammonification through the use of urea solution offers an excellent opportunity to increase animal production through the better utilization of crop residues. Apart from providing supplemental nitrogen, urea treatment increases the digestible energy intake by the animal.

Supplementation by way of small quantities of both soluble and rumen undegradable protein, improves the feeding value of the treated material. Simple methods acceptable to the small farmer are now available for treating cereal straws with urea solution.

The economics of straw treatment should not be viewed only in relation to production; treated straw has limited value as an "acceptable emergency feed" for sustaining animal production at times of feed scarcity.

POTENTIAL FOR THE BETTER UTILIZATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS BY MONOGASTRIC ANIMALS IN CENTRAL AMERICA

by

S Khajarern and J Khajarern

Livestock production in a tropical southeast Asian farm is of secondary importance compared to crop production. Ruminants are raised for draught purposes and/or as farm assets, while pigs and poultry are raised for cash needs and for family consumption. Within this setting, the potential availability of crop-residues and agro-industrial byproducts is high compared with the livestock population. Among less fibrous agro-industrial byproducts, energy sources from rice milling and starch extraction and molasses are essentially adequate for the pig and poultry industries of the region, whereas plant protein sources are substantially deficient and must be imported. Fibrous residues and agro-industrial byproducts, such as rice-straw, sugar cane tops, leaves and stems, and maize stover are abundant but underutilized. Apart from being used as feed, these resources are used as soil conditioners, in construction and for paper manufacturing and other non-feed purposes.

Rice straw is the only residue which has been used for animal feeding in small farms. Much research has been done to use other residues as feed but practical adoption of the results has been negligible. Rice straw is a poor source of roughage of low dry matter intake and nutrient digestibility. Physical treatments, such as chopping and/or soaking the rice straw prior to feeding, gave positive responses in terms of increasing intake and digestibility. Supplementation of chopped straw with sweet potato chips, urea and/or molasses, or with small amounts (200 g DM/d) of protein sources, such as leucaena, gliricidia and cassava leaf meals or with water hyacinth, bring about a significant improvement in terms of increasing intake, nutrient digestibility, nitrogen retention and animal weight changes.

Literature reviews show that chemical treatment with alkalis, ammonia and other oxidants also increase intake and nutrient digestibility of rice straw, but these technologies seem unlikely to be practicable in SE Asian small farms. Straw treatment by ammonia released from urea/urine or by cheap alkalis as calcium oxide or hydroxide, seems to have potential applicability in the region. However, before these treatments can be put into practice at the small farm level, more work is needed to devise a cheap and effective process to minimize ammonia escape during the treatment period; to establish effective procedures in calcium oxide/hydroxide treatment; and to formulate guidelines for supplementing the treated and/or untreated straw with economic and practical feeds. These are considered as the research priorities of the region.

Another high priority is to assess completely, in quantitative and qualitative terms, the residues that are actually available for feeding purposes on a year-round basis. Assessment should give information on what, where, when, how much and what quality of each residue is available. This will help the development of year-round feeding strategies. The appropriate treatments for improving the feeding value of each residue also need to be investigated.

Finally, socio-economic backed extension work for applying the residue feeding in the real small farmer's feeding systems deserves the immediate attention of all researchers.

POTENTIAL FOR THE BETTER UTILIZATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS BY MONOGASTRIC ANIMALS IN CENTRAL AMERICA

by

M Cuca

Most of the tropical and sub-tropical countries have shortages of protein and energy sources such as soybean meal and maize. Therefore, it is very important to use other locally grown materials of lower cost. Ingriedients that can be used in poultry and swine diets in Mexico and Central America are sorghum, rice polishings, cassava leaf meals, bananas and molasses.

Alternative systems include the encouragement of "back yard" swine and poultry keeping.

An inventory should be made of all the resources available in each area. Research is needed in order to determine the biological value of some unconventional ingredients. The results must be organized and the information made available to the producers who are in a position to use these ingredients. It is recommended that each country should establish an office that can make decisions and co-ordinate all the research on crop residues and byproducts.

POTENTIAL FOR THE BETTER UTILIZATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS IN RUMINANT FEEDING IN LATIN AMERICA

by

R Parra

Crop and animal production generates a range of fibrous materials which have traditionally been called residues. These have been classified as crop residues, fibrous agro-industrial residues, urban fibrous residues and animal wastes. They all have aroused considerable interest as sources of feed, energy and/or fertilizers. Tropical America cannot develop intensive ruminant production systems like those of developed temperate countries due to the low availability of cereal grains, oilseed meals and high quality roughages.

Fibrous residues will become more important in tropical countries and improved ways to use them as feed sources have to be developed. They are produced in large quantities, but there are important limitations to their use, such as their low nutritive value, low density and high moisture content, which impose severe technological and economic constraints.

Estimations are given of the gross production of fibrous residues in Latin America compared with the estimated energy requirements of the ruminant population in that region.

Ways of utilizing agricultural residues are discussed along with their advantages and limitations. Brief consideration is given to different ways of improving their feeding value. Special attention is given to alkaline treatment (NaOH and NH4OH) and to some aspects related to its efficiency, which have arisen in work carried out by the authors.

It appears that from a biological standpoint, the limitations of many agricultural residues in animal feeding could be overcome. The main problems which remain are related to the technological and economic viability of their use. At present, crop, animal and agro-industrial operations are poorly integrated in many tropical countries, making difficult the incorporation of these feed resources into animal production on a large scale.

UTILIZATION OF AGRO-INDUSTRIAL BYPRODUCTS AND CROP RESIDUES IN ANIMAL NUTRITION IN EUROPE

by

K Szebiotko

Methods should be elaborated and introduced in agricultural practice for preparation and preservation of byproducts produced on farm, e.g. ensiling of feed components (straw, green plants and others). This very effective method is not in use in many African and other countries. Silage is always better utilized by animals than straw or hay.

In slaughter-house or fish processing plants where only small amounts of byproducts are obtained, chemical acidification methods (1 to 1.5 kg sulphuric acid/100 kg byproducts or 0.2 kg hydrochloric acid and 2 kg formic acid/100 kg) can be used. Such a product can be added to swine feed in amounts of 1 kg per head daily.

Utilization of protein and vitamins from greem biomass of plants in monogastric animal nutrition will play a very important role in improving the economic utilization of agricultural products. The proposed method is very simple and effective and can be introduced even in very small farms. This method is based on the separation of leaves from stems. In the leaf

fraction there are high concentrations of protein and vitamins (about 200% higher than in the whole plant). The stem fraction has a lower content of protein but very high amounts of fibre. In an alfalfa leaf fraction the content of protein varies from 27 to 32% and of fibre from 12 to 13%; from carotene 120 to 150 mg%. This method is very effective for plants such as alfalfa, clover, lupins, faba beans etc. Sun-dried material after crushing can be separated using sieves or forced air. This technique, due to the easy application and energy conservation, may be used on large scale farms.

In ruminant and monogastric animal feeding, appropriate mineral or mineral-vitamin concentrates should be added to the feed produced on the farm. In this case, extensive research on composition and nutritional value of grasses and other feedstuffs in various regions of Ethiopia and other countries should be carried out to establish the composition of such concentrates.

Ammonia, either in aqueous or anhydrous form, can be used for removal and inactivation of toxic substances produced by different fungi. Ammonia detoxifies aflatoxins. Ammonia is also very useful in preserving wet grain and other plant seeds used as feed. The amount of ammonia added to grain or other products to prevent spoilage depends on the moisture content and ranges from 1 to 3.5% for an H20 content of 17-32%. This method can be applied for long or short term grain storage.

SELECTIONS FROM THE ILCA LIBRARY HOLDINGS.-

The ILCA Library holds a large number of both conventional and non-conventional literature on animal agriculture. In addition to the SDI (selective dissemination of information) service which is open to all ARNAB members on request, the newsletter will publish some titles relevant to crop residue research both within and outside Africa. Network members may request either hard or microfiche copies from the ILCA library.

1. Kendall, J.D. (1977). Likely future for crop residue feeding detailed. FEEDSTUFFS, U.S.A. v. 48(7) p 21-22. The article outlines future developments regarding crop residue feeding for beef cattle. Trials on the stocking of bluestem range and three methods of treating protein to reduce its degradability in the rumen are discussed.

2. Addy, B.L. and D. Thomas. (1977). Intensive fattening of beef cattle by stall feeding on the Lilongwe Plain, Malawi. II. Utilization of crop residues, crop byproducts and leucaena. TROPICAL ANIMAL HEALTH AND PRODUCTION (UK) 9(4) P. 191-136 Trial results showing average weight gain, feed intake and feed conversion efficiency of steers fed various rations, specifically residues of maize and groundnut haulms, maize bran with varying levels of dried leucaena leaf or cottonseed cake for dry season fattening are discussed.

3. Addy, B.L. and D. Thomas (1977). Intensive fattening of beef cattle by stall feeding on the Lilongwe Plain, Malawi. In: TROPICAL ANIMAL PRODUCTION (UK) 9(4) p. 197-202. Trial results showing comparative productivity of Malawi Zebu and Fresian x Malawi Zebu steers fed on either green forage crops or crop residues supplemented with local concentrates are discussd. The article also discusses feed intake, weight gain, feed conversion efficiency, carcass yield and slaughter performances.

4. Miller, T.B.; A.B. Blair Rains and R.J. Thorpes. (1964). The nutritive value and agronomic aspects of some fodders from northern Nigeria. III. Hays and dried crop residues. JOURNAL OF BRITISH GRASSLAND SOCIETY (U.K.) 19 p. 77-80. Trial results showing digestibility of dried forage and forage crops, specifically Andropogon gayanus bush forage, groundnut haulms, velvet bean, cowpea and Sorghum vulgare and stilozobium spp. mixture are presented with a discussion of their agronomic aspects.

5. Musangi, R.S. (1975). The role of ruminant livestock in mixed farming in tropical Africa. JOURNAL OF THE ASSOCIATION FOR THE ADVANCEMENT OF AGRICULTURAL SCIENCES IN AFRICA. vol. 2 (supplement 2) p. 281-283. The article discusses the role of ruminant livestock in mixed farming systems in Africa, especially through the utilization of farm pasture forages and crop byproducts, provision of farm manure, animal proteins and work.

6. Anderson, D.C. (1978) Use of crop residues in beef fattening systems. JOURNAL OF ANIMAL SCIENCE (USA) 46(3) 849-861. This article reviews yields, nutrient composition, utilization as feed, handling and the use of cereal crop residues in feeding systems for beef cattle production in the United States.

7. Ward, J.K. (1978). Utilization of corn and grain sorghum residues for beef cow forage systems. JOURNAL OF ANIMAL SCIENCE (USA) 46(3) 831-840. The article reports on studies on weight gain of cows grazing corn and grain sorghum residues under two basic forage systems, viz. conventional spring-summer-fall grass grazing with winter crop resiue grazing and partial drylot husbandry using harvested crop residue during spring-summer-fall with winter crop residue grazing emphahsizing the effects of weather and supplemental nitrogen sources.

8. Sak Nuru, P.N. de Leeuw and G.O. Aabalu. (1978). The potential for livestock production in the river basin irrigation schemes in Nigeria. FIRST LIVESTOCK CONFERENCE, ZARIA, NIGERIA. 31 Aug - 1 Sep. 1971. (Available on microfiche only). This paper discusses the importance of legumes in livestock production in Nigeria and mentions the establishment of Stylozanthes spp. with data on the beneficial effects of including legumes in pastures. Also discussed are the nutritive value of silages and dried forages and how these affect liveweight gains of Fulani cattle fed basal rations of crop residues and cottonseed.

9. Jahal, M.M.; V.K. Jain, K. Sambaswarao and N.N. Pathak. (1981) Effect of feeding dried and ground citrus fruit residue on the intake and digestibility of nutrients in lambs. INDIAN JOURNAL OF ANIMAL SCIENCES. 51(2) 189-193. Studies on the effect of feeding lambs with dried and

ground citrus fruit residue, instead of crushed maize and wheat bran, on dry matter intake, digestibility of proximate nutrients, nutritive value of rations, plane of nutrition and daily body weight gains are discussed.

10. Tropical Agricultural Research and Training Centre, Turrialba (Costa Rica) (1978) Milk and beef production systems for the small farmer using crop derivatives. 1978 PROGRESS REPORT, IDRC, OTTAWA (Canada) 48 pp; 2 figs, 14 tables. This project report covers the period 1977-1978 and describes the development of integrated crop-livestock systems appropriate to small and medium size farm in Costa Rica. It offers a static and a dynamic diagnosis of farms in four different regions and an analysis of biological, and economic constraints of farming systems. It also presents results of experiments on the use of crop residues, particularly common bean straw and starch-rich tropical resources in the feeding of cattle and uses a model farm to study the effects of introducing a dual purpose milk and beef production system for small farmers.

11. Kaufmann, von R.; R.O. Magaji and P.N. de Leeuw. (1983) The importance of crop residues in the diet of Fulani cattle in the sub-humid zone of Nigeria. ILCA SUB-HUMID ZONE INTERNAL COMMUNICATION. No. 3. 7 pp; 3 tables. This report presents results of a preliminary investigation carried out in Nigeria to evaluate the contribution of crop residues to the diet of cattle owned by settled Fulani on Katchia grazing reserve. It assesses the yield of millet and sorghum residues and examines the relationship between farmers and livestock owners with regard to permits to use the residues.

12. Ruiz, M.E. (1979) The use of green bananas and tropical crop residues for intensive beef production BSAP OCCASIONAL PUBLICATION (UK). SYMPOSIUM ON ANIMAL PRODUCTION IN DEVELOPING COUNTRIES. Harrogate, 1981, No. 4 p. 371-383. The report investigates the possibility of using tropical agricultural residues and byproducts in intensive beef production systems of Latin America. It describes the utilization of green bananas for penned and grazing cattle and of bean and sweet potato residues as basal cattle feeds, analysing changes in body weight of cattle given these feeds on a supplementary or basal level.

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EDITORIAL

INPUTS FOR FARM-BASED CROP RESIDUE RATIONS: SOME ALTERNATIVES

Among the field experiments being conducted by ILCA is the introduction of legumes either in the form of alley cropping using Glyricidia or Leucaena spp into cereal crop farms. Intercropping using Stylozanthes or fast growing bean spp is also being tested. The intention is to provide a balanced diet to ruminants that graze the fallows after the cereals have been harvested. This approach would cut down the labour in harvesting the crop residues for pen feeding and would enable the spread of animal manure during the time that the animals are grazing the legume-crop residue stands.

Simultaneously, there has been exploration for both indigenous and imported fodder crops that would fit into existing farming systems. In Ethiopia alone, about thirty species of clovers of the genus Trifolium have been collected (see Kahurananga, 1982). The performance of these clovers as compared to imported varieties of the same genus has been assessed (Akundabweni, 1984) and their response to minimal applications of phosphatic

fertilizers indicate that Trifolium tembense can produce up to five tons dry matter per hectare. (Jutsi,1984).

In terms of the nutritive value of the native clovers, Mosi and Butterworth (in press) have established that, when Trifolium tembense comprises 20% of a tef straw-based diet, significantly more total dry matter is consumed than when tef straw is fed alone. Inclusion of 25% trifolium in the diet further significantly increased total dry matter intake but no more benefit was realized when trifolium comprised 35% of the diet. There was a substitution effect between trifolium and tef straw but in spite of that, nitrogen retention, its digestibility and the utilization of dietary phosphorus were all improved.

The above approach demonstrates how cereal crop residue-based diets may be improved to provide above maintenance rations using as inputs, cropped legumes or indigenous legumes, conserved from fallow lands.

There are cases where prolonged draught causes severe livestock losses. The current hypothesis proposed by Preston (consultant to ILCA) is that, loss of condition in draught situations is not so much due to lack of energy, but to inadequate levels of protein in the coarse roughages that are the only feed resources available during that period. The suggestion is to use molasses as a carrier for urea. Molasses acts as a readily fermentable carbohydrate and urea provides the non-protein nitrogen (NPN) necessary for rumen microbial growth. The enhanced rumen ecosystem would then promote the utilization of the fibrous residues. ILCA, in collaboration with the Ministry of State Farms and the Ministry of Agriculture, is currently testing the strategy in Ethiopia with promising results.

These approaches may be some of the areas where national research efforts may have rapid pay-offs.

References:

Akundabweni, L. 1984. Native clovers of the Ethiopian Highlands: The backwoods champions. ILCA Newsletter Vol.3,No.1. January, 1984.

Jutsi,S. 1984.Some effects of P and N/P fertilization on three African clovers (Trifolium tembense T. rueppellianum and T. steudneri) on a P deficient vertisol. ILCA Newsletter Vol.3 No.2. April, 1984.

Kahurananga, J. 1982. ILCA'S forage legume work in the Ethiopian Highlands. ILCA Newsletter Vol.1 No.4. October, 1982

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PLEASE DIRECT ALL ENQUIRIES, SUGGESTIONS AND SHORT COMMUNICATIONS TO DR. A.K. MOSI, CO-ORDINATOR AND SCIENTIFIC SECRETARY OF ARNAB, ILCA, ADDIS ABABA.

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NETWORK NEWS

Courses

In mid-August, 1984, the Nutrition Department at ILCA in conjuction with the Training Department will convene the annual course on "Priciples of Livestock Nutrition and Forage Evaluation". Announcements for the course have been sent to the National Institutions throughout Africa. For details of the course, please contact the Training Department at ILCA. Next year, the course will concentrate on the mineral nutrition of farm animals.

Nylon bags for research (see Orskov below)

The nylon bag technique is a rapid way of ranking forages according to their rates of degradation in the rumen. Inter-laboratory results are sometimes difficult to compare especially when the mesh size of the nylon cloth differs. The ILCA Headquarters Laboratories has recently acquired the type of material

BEST AVAILABLE

that is recommended for use in U.K. and would be happy to donate pieces to interested ARNAB members who would want to test the procedure in their laboratories. Without prejudice to other suppliers, the material was procured from Henry Simon Ltd.; P.O. Box 31, Stockport, Cheshire, England, SK3, ORT. The brand name is Simfil Nylon Filter Cloth HSO3 and the mesh size is between 20-40 microns.

New Reference Books.

The Elsevier Science Publishers have released two new books "Straw and other by-products as feed." edited by F. Sundstol and E. Owen and "Impact of diseases on livestock production in the Tropics" edited by H.P. Riemann and M.J. Burridge. These books are deemed up-to-date in subject matter and would be invaluable assets to all ARNAB members.

News from Botswana

Mr B.M. Mosimanyana, head of the nutrition section of the Animal Production and Research Unit in Botswana has sent to ARNAB Botswana'a major research objectives in crop residue usage. These are:-

a) to examine the yield and nutritive value of locally grown cereal crop residues, namely, maize, sorghum, millet and small quantities of wheat and rice. Leguminous residues include groundnuts, mungbeans and cowpeas.

b) to determine whether the available crop residues can be improved in nutritive value by chemical and physical treatments. (Reserach in this area in Botwsana has so far been on a laboratory scale)

c) to determine the effect of early harvesting and mode of storage on the nutritive value and to evaluate the effect of early harvesting on grain quality and yield.

d) to carry out supplementary feeding trials on selected communual cattle under field conditions.

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Mr. Mosimanyana emphasised that crop residue research is on the priority list in Botswana since there is the need to recondition draught oxen on crop residue-based diets for early ploughing. Dairy cows are also maintained on crop residue-based diets during the long winter dry season. Farmers are aware of the benefits in conserving crop residues and national inventories are being compiled as per the objectives of ARNAB.

RESEARCH NEWS

Tanzania

Wheat feed as the sole feed for growing-fattening pigs.

A.V. Goodchild, Head of Animal Nutition Dept.
Tanzania Livestock Research Organization. Mpwapwa, Tanzania.

Wheat feed in Tanzania consists of the whole mixed by-product of milling wheat in white flour production. It is equivalent to a mixture of 1.4 parts wheat bran with 1 part of wheat pollard. An experiment at Mpwapwa, Tanzania compared wheat feed (16.1% crude protein, 9.0% crude fibre) with maize feed (8.9% crude protein, 1.4% crude fibre) as an energy source for growing-finishing pigs. In three of the four feeding treatments, a constant level of protein supplement was fed with maize meal, wheat feed or a mixture of the two. In the fourth treatment, wheat feed was fed with minimal levels of added protein (Table 1). Three pigs (one gilt and two barrows) were allocated to each treatment by a split litter method. The pigs received the treatment ration when the average weight was 34 kg until they were slaughtered at 92 kg liveweight on a strict scale based on the mean liveweight of all pigs in the trial. Performance of the pigs (including the amount of subcutaneous fat trimmed from the carcass at slaughter) is shown in Table 2.

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Table 1. Percent composition of fattening diets fed from 45-92 kg liveweight.

Ingredient	Treatment Description			
	Maize meal + protein supplement	1:1 Maize meal Wheat feed protein suppl.	Wheat feed + Protein supplement	Wheat feed no protein supplement
Maize bran	73.8 (64.0)	36.9 (32.0)	0.0	0.0
Wheat feed	0.0	36.8 (32.0)	73.8 (64.0)	97.3 (95.3)
Cottonseed cake	12.0 (10.0)	12.0 (10.0)	12.0 (10.0)	0.0
Sunflower cake	10.0 (19.3)	10.0 (19.3)	10.0 (19.3)	0.0
Fish meal	1.5 (3.0)	1.5 (3.0)	1.5 (3.0)	0.0 (1.0)
Limestone	1.0	1.0	1.0	1.0
Salt	.50	.50	.50	.50
Premix	.25	.25	.25	.25
Total	100.0	100.0	100.0	100.0
% C.P.	14.2 (16.06)	16.6 (18.3)	19.5 (21.0)	15.9 (16.2)
Crude fibre	4.0 (4.1)	6.8 (7.9)	9.7 (9.9)	8.8 (8.6)

Figures in parenthesis indicate the composition of the grower diets where it differed from the fattening diets.

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Table 2. Performance of pigs fed wheat feed -based diets
(Means of three pigs)

Phase	Treatment Description				
	Maize meal + protein supplement	1:1 Maize meal Wheat feed + supplement	Wheat feed + protein supplement	Wheat feed no protein supplement	SEx
Growth					
Intake kg/pig/d	1.62	1.65	1.67	1.68	.04
Gain kg/pig/d	.42	.44	.48	.37	.06
Kg feed/kg Gain	3.88	3.70	3.51	4.51	.94
Fattening					
Intake kg/pig/d	2.43	2.45	2.40	2.45	.01
Gain kg/pig/d	.69	.71	.67	.67	.09
Kg feed/kg gain	3.52	3.48	3.67	3.65	.15
Carcass weight	67.12	65.62	65.42	64.47	1.96
Fat trim, kg	21.75	20.11	19.69	17.45	.49
Backfat (mm)	34.39	29.52	32.37	28.22	1.21

From the above results, it can be concluded that this particular wheat feed can be used successfuly for growing and finishing pigs if supplemented only with vitamins and minerals, and that performance is as good as animals fed more conventional rations during the fattening period. The product is cheaper than the ingredients in the other diets where protein concentrates need to be added. Carcass fat and backfat thickness was reduced on the wheat feed diet but whether this is beneficial will depend on the consumer requirements in the country concerned.

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Sudan

Evaluation of acid insoluble ash (AIA) as a marker for predicting the dry matter digestibility of high roughage and high concentrate diets for Desert sheep in Sudan.

M.G. El Hag and G.A. El Hag

University of Khartoum, Faculty of Agriculture, Shambat. Sudan

Six mature animals made up of three Sudan Desert goats and three Sudan desert rams per treatment were used to evaluate the *in vivo* digestibility of the rations shown in table 1. Samples of feeds offered and the faeces collected from each diet were analysed for acid insoluble ash (AIA) by the 2-N HCl procedure of Van Keulen and Young (1977) and total recovery of AIA was determined for each ration. Paired t-tests were used to determine whether the ration digestibility calculated by total AIA recovery was different from the *in vivo* values. Secondly, digestibility values determined by total collection were regressed on the digestibility values obtained with AIA as a marker, and correlation coefficients were calculated.

Table 1. Composition of test rations in percent dry matter

	High Roughage Rations 1	2	Sorghum grain ration
Wheat bran	-	50	-
Sorghum bran	50	-	15
Berseem hay	10	13	19
Cottonseed cake	25	5	15
Sorghum grains	-	-	50
Salt	1	1	1
Groundnut hulls	14	31	-
Total	100	100	100

$$\text{Recovery \%} = \frac{(\text{Faecal DM\%}) \times (\text{DM excreted}) \times 100}{\text{Feed DM AIA\%}) \times (\text{DM consumed})}$$

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Results

Table 2. Mean dry matter digestibility values, using acid insoluble ash versus total collection method (all species combined)

Ration	Total collection % digestibility	AIA Marker % Digestibility
Wheat bran	56.70b	50.70c
Sorghum bran	66.74	58.00
Sorghum grains	79.05d	93.30e
All rations (goats)	68.74	66.90
All rations (sheep)	66.26	68.00

Means in the same row with different letters differ significantly (P<0.05)

Table 3. Prediction equations for total collection (Y) on digestibility determined with AIA as a marker (X).

Rations	Prediction Equation	Correlation coefficient
Sorghum bran	Y = 0.39X + 44.12	0.61
Wheat bran	Y = 0.053X + 54.04	0.13
Sorghum grains	Y = -1.18X + 189.05	-0.43
All rations (G)	Y = 0.49X + 35.97	0.97***
All rations (S)	Y = 0.42X + 37.92	0.84**

S = Sheep, G=Goats

For details of this paper, see World Review of Animal Production Vol. XIX, No.2, April-June, 1983. pp 7-12

BEST AVAILABLE

More abstracts from papers presented at the ILCA/FAO conference on the better utilization of crop residues for animal nutrition.

SELECTION OF APPROPRIATE METHODS FOR IN VITRO ANALYSIS OF THE NUTRITIVE VALUE OF CROP RESIDUES AND AGRO-INDUSTRIAL BYPRODUCTS IN DEVELOPING COUNTRIES.

By P.M Vanbelle.

The *in vitro* digestibility technique of Tilley and Terry is the best available at present for predicting the nutritive value of forages and by-products in spite of some obvious disadvantages:

* The repeatability is not always satisfactory from one run to another or from one laboratory to the other, even after rigourously standardizing the diets of the animals, the sampling conditions, and of inoculum preparation.
* The necessity of supporting fistulated animals (costly).

Enzyme techniques, despite slightly lower precision, offer several advantages:

* Good repeatability and easy to manipulate - indispensable for analyses in series.
* Avoids the use of fistulated animals.
* Applicable to products of low digestibility after certain pretreatments (pepsin-HCl, NDF).
* The regression established in certain cases seem to be applicable to several species or groups of feeds.

Its major disadvantage consists in the difficulty of obtaining enzyme brands of large spectrum of action with constant activity from one batch to another. To obtain less variable results among several laboratories, it would be necessary to:

* Standardise very rigourously the methods of investigation in different laboratories of different countries.
* Have standards of known *in vivo* digestibility.

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Chemical and in vitro methods are complementary. The adaptation of the fractional separation technique of van Soest to non-conventional crop residues and agro-industrial by-products costitutes a priority for discerning the problems relative to the understanding of the cell wall indigestible fraction.

The information about the environmental conditions (eg: temperature, rainfall) the species, the state of development, can be more reliable than a simple chemical criterion.

In vitro determinations destined to predict the digestibility of feeds are not absolute measurements, and are more appropriately used for screening purposes.

METHODS OF STUDYING THE FERMENTATION OF CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS IN THE RUMEN WITH SPECIAL REFERENCE TO DEVELOPING COUNTRIES

by

E. R. Orskov

The nylon bag technique is simple, robust and powerful tool essential in most applied nutrition studies in ruminants. Among its uses are the following:

* To screen the potential usefulness of unknown wastes and by-products
* To assess rapidly the potential effectiveness of chemical and biological treatment of low quality roughages
* To examine the positive and negative effects of supplements on rate of degradation of fibrous roughages
* To provide information and understanding of feeds in a manner often more useful than in vivo digestibility and chemical analysis
* To provide information both rate and potential extent of digestion and thus information relating to voluntary intake
* To examine the most useful combination of feeds and by-products in order to create an optimum rumen environment
* To describe protein degradability for most protein supplements, especially when combined with information on outflow rate
* As a teaching tool, to give students a rapid understanding and appreciation of the dynamics of digestion in ruminants.

METHODS OF ESTIMATING DIGESTIBILITY AND METABOLISM OF CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS IN MONOGASTRIC SPECIES IN DEVELOPING COUNTRIES

by

M. Piccard, D. Bouron and J. Le Dividitch

Digestibility tests provide useful information for the more appropriate utilization of by-products by monogastric animals, provided that they are done:

* At the right moment when chemical composition and the acceptability level of the raw material is known and befor comparative feeding trials are carried out.

* Using an adequate procedure, i.e.:

- Metabolizable energy should be measured on adult cockerels using either a rapid test technique with or without force feeding or a classical method.
- Digestible energy on growing pigs (30-80kg) using cages, total collection for at least 7 days, and either addition or dilution techniques.
- Digestible amino acids may be measured on cockerels and extrapolated to pigs. A simple nitrogen digestibility test after uric acid elimination) can be used and amino acid values derived from the results using standard composition of the ileal juice.

* With constant attention to precision, during the animal test and any laboratory assay: especially for dry matter variation, feed spillage and refusals, faeces collection, and gross energy measurement.

* Aiming at debating the results, of an experiment rather than giving a "dry number." Such an attitude will lead to a self control on the unit system and experimental procedure to be selected.

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The methods described with some detail in the paper have been chosen as the simplest reliable technique taking into consideration the goal of the seminar. These general guidelines should be improved by experience for a given type of by-product. But any selected technique must not alter the predictability of the results when the data are compared to table values for other ingredients. The aim of this type of work is to introduce the ingredient into monogastric feeding systems which are based upon linear programmed economical optimization.

DEFINITION OF PROCEDURES FOR RESEARCH INTO THE TREATMENT OF CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS IN DEVELOPING COUNTRIES.

by

F. Sundstol

It is not possible to describe procedures for research into treatment of agro-industrial byproducts and crop residues that will fit under all circumstances. Some view-points of general character are outlined.

Before starting a research project on this topic, a feasibility study should be carried out to identify some of the relevant problems and to establish the right approach. Information that could be of interest in such a study include:

* Amounts, quantity and distribution of materials
* Alternative uses of materials
* Alternate feeds and feed supplements
* Level of technology in the agricultural sector
* Potential improvement due to treatment
* Availability and cost of chemicals and equipment
* Adverse effects of chemicals
* Possibility of government support

A research programme on crop residues and agro-industrial byproducts may be carried out at three levels: (i) basic research, (ii) applied research and (iii) field reserach. These are equally important and should roun more or less parallel.

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Basic research should be carried out on university or experimental farms where fundamental problems are studied. Field research should be carried out at well-run private farms, goverment farms or like. Here practical aspects of by-product utilization should be studied and the "bottlenecks" of the technology uncovered.

Sound training of the personnel should be taken to ensure a rapid flow of information between the various groups working in the field of by-products.

It is difficult to recommend one particular method of treatment because this will depend on the local conditions. For many tropical countries, it might be logical to think of ammoniation by urea treatment as the first alternative.

VALIDITY OF FEEDING STANDARDS AND DEVELOPMENT OF FEEDING SYSTEMS BASED ON CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS.

by

T. R. Preston

Feeding standards and computer formulated least cost rations have markedly improved the efficiency and profitability of pig and poutry production throughout the world. In ruminants, feeding standards are useful as a general guide for planning purposes. But for energy and protein, even with high quality feeds, differences between predicted and realised animal responses may reach as high as 30%. The discrepancies are even greater when sugar containing by-products and fibrous crop residues form the basis of the diet.

The basis of the problem is the dual mode of digestion in ruminants where gastric digestion is both precede and followed by microbial fermentation. Sugar -containing by-products and fibrous crop residues contain no starch and insignificant amounts of protein, necessitating major dependence on fermentation as the digestion pathway.

It is hypothesised that the digestion and end products resulting from microbial fermentation of sugar and of fibre-rich feeds are deficient in glucogenic precursors as well as amino acids and that this is a major constraint to animal productivity.

To dvelop effective feeding systems with crop residues and by-products, the more appropriate method is by strategic supplementation (with or without chemical/physical treatment of the basic resource) in the following sequence:

* Fermentable nitrogen (urea, ammonia or poultry litter) to ensure that levels of rumen ammonia do not fall much below 10 mg/100 ml rumen fluid
* Small amount (<25% of diet DM) of high quality green forage, preferably legume, to stimulate rumen function and fermentation
* Small amount (<5% of diet DM) of good quality protein that will escape the rumen fermentation (by-pass protein)
* Improve the balance of the digestion end products by feeding "by-pass" starch or manipulate the rumen fermentation so as to increase the production of propionic acid and/or decrease the population of protozoa.
* Increase the degradability of the basal diet by alkali or acid treatment.
* Repeat the supplementation sequence.

POTENTIAL AND CONSTRAINTS IN THE UTILIZATION OF AGRO-INDUSTRIAL BY-PRODUCTS IN CAMEROON

by

Ruby T. Fomunyam

Several tonnes of agro-industrial by-products are produced each day in Cameroon. Although there is variabilty in the chemical composition, the costs of the products as well as the costs of processing them, there exists a great potential for producing good quality meat from these feed items within the operation limits of the small-scale farmer in Cameroon. This would greatly reduce competition with man for feed resources. Cottonseed meal, the major protein source in Cameroon, has promoted efficient growth when fed to non-ruminant and ruminants. Chicks fed test diets in which 0, 50, 75 and 100% soybean was replaced by cottonseed meal in corn-soybean diets had similar growth rates. In swine diets, 14, 20 and 45% rice bran fed in place of corn were found to be optimum levels for suckling, grower and finisher pigs. Carcass traits showed that more lean meat and profit were realized from market pigs as the level of rice bran increased in the diets, suggesting that grading pork prior to sales would greatly encourage the production of better quality meat in Cameroon.

USE OF CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS IN SUDAN

by

M.G. El Hag

A survey indicated that 4.5 million tonnes of agro-industrial by-products are available in Sudan. It is estimated that the energy present in these by-products could satisfy about 9% of the maintenance requirements of the animal population in the Sudan (about 55 million heads of cattle, sheep, goats and camels). The major by-products include: cereal straws, groundnut hulls and haulms, sugar cane tops, bagasse, molasses, cotton stalks and trash, sesame field residues, wheat bran and cottonseed cake, and field residues of sorghum and cotton after crop harvest.

Laboratory analysis indicates that most by-products are relatively of poor quality with very high contents of lignin and crude fibre and low content of nitrogen.

Seven different feeding trial were conducted with cattle, sheep and goats. The rations contained cottonseed cake, wheat bran, molasses and urea with roughage supplied by cereal crop residues, bagasse or groundnut hulls. Animal performance was comparable with that obtained using conventional high grain rations but the cost was 50% less.

Different methods have been studied to enhance the nutritive value of groundnut hulls, sorghum straw and bagasse. Results were not very encouraging either for ensiling or NaOH treatment applied to groundnut hulls and sorghum straw. Based on these findings, the use of NaOH is not advocated under Sudan conditions due to its high cost, lack of experience in its use and hazards encountered in its application.

The method which proved to be successful and promising was physical treatment (grinding and pelleting). Levels of pelleted bagasse of 30, 40 and 50% resulted in improved digestibility and intake of the overall diet with 40% promoting better animal performance. This method is recommended under Sudan conditions because of its simplicity and cheapness as compared to chemical treatment.

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USE OF CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS IN SENEGAL

by

N. Mbaye

Since 1967, many studies have been carried out at the Institut Senegalais de Recherches Agricoles (ISRA) on the availability and nutritive value of agro-industrial by-products and crop residues in Senegal.

Crop residues include straws of rice, millet, sorghum straw, maize cobs, groundnut haulms and bean haulms.

Agro-industrial by-products include hulls/shells from groundnuts and cotton; oilcakes of groundnut and cotton; and brewers grains.

Research methodology is based on classical proximate analysis; the detergent fibre procedure; *in vitro* digestibility by enzymes and the Tilley and Terry technique, and intake, digestibility and growth studies with sheep.

The overall objectives are to determine the nutritive value of the feed resources, the animal requirements and feeding standards for different situations, and to predict animal performance from feeding trials.

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INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA, P.O. BOX 5689, ADDIS ABABA, ETHIOPIA
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EDITORIAL

Drought feeding strategies. Molasses-urea mixtures could play a role

The devastating effects of drought are now more prevalent in Africa than ever before. These droughts cause untold misery to peasants. Their livestock numbers are seriously depleted and re-stocking takes many years because of depletion of brood stock. Therefore the need to find ways and means of minimising these losses by the use of unorthodox feed resources !

Ruminants generally meet their nutritional requirements when they graze pastures containing above 7% crude protein. However, when grasses mature and protein content falls below this level rumen microbial nutrition suffers and directly affects the ability of the microbes to digest fibrous feeds. Protein limitation therefore appears to be the first limitation to continuous productivity of ruminants maintained on African rangelands. A reduction in protein and consequently energy intake leads to the severe emaciation and deaths observed in prolonged droughts.

Ammonia (which can be produced by the hydrolysis of urea) provides the main nitrogenous molecule required by rumen bacteria for growth Excess ammonia causes urea toxicity and death in ruminants. However, if urea intake and the rumen release rate of ammonia are carefully adjusted to the requirements of the rumen bacteria, better use can be made of coarse roughage diets.

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Molasses has been found to be a good carrier for urea. It is also a source of readily fermentable carbohydrate and contains traces of the major minerals required by ruminants (see below). Current research has shown that, controlled intake of urea-molasses mixtures reduces weight loss in ruminant livestock maintained on coarse roughages. However, urea-molasses supplementation must be initiated before the onset of protein malnutrition.

Liquid molasses-urea mixtures containing 3% to 8% urea have been successfully used on Queensland beef properties (FARM: - The business Magazine of Australian Agriculture, Vol. 5, No. 8. September, 1984, pp 34-38). Also molasses urea blocks can either be made locally or obtained from commercial firms (see below).

ARNAB members are encouraged to explore the safe use of urea-molasses mixtures in land-starved mixed farming communities where crop residues constitute the bulk of ruminant feeds and for free ranging ruminants.

Mineral Composition of Wonji Molasses - Ethiopia

Sodium	0.12%
Potassium	6.05%
Calcium	1.55%
Magnesium	0.26%
Iron	956 ppm
Manganese	76 ppm
Copper	23 ppm
Zinc	68 ppm

NETWORK NEWS

Courses

This year's "Principles of livestock nutrition and techniques of forage evaluation" course was attended by 13 participants drawn from 9 African nations (Burundi, 1; Ethiopia, 2; Kenya, 2; Mauritius, 1; Nigeria 2; Senegal, 1; Tanzania, 1; and Zimbabwe, 1; and one from Syria. The course was built around an experiment

that demonstrated the proper and improper ways of administering molasses urea mixtures to ruminants. Analysis of field collections was undertaken by the participants themselves. These activities were supported by 'hands-on' demonstrations including fistulation, manufacture of fistula plugs and urea-molasses blocks, **in vitro** experimentation including the use of nylon bags, ensilage procedures with urea, a variety of coarse roughages and dung cakes. Field trips were organised to demonstrate ILCA's research approach and on-farm experimentation.

The course lasted 21 days and was rounded off with a seminar on participants' projects in their home countries.

In addition to the regular ILCA staff, Drs R A Leng and T R Preston (consultants) gave lectures to the course participants.

RESEARCH NEWS

Evaluation of leaves of trees and shrubs as feeds for goats (III) Voluntary intake and digestibility of **Lippia asperifolia rich** (Chanzi) and **Secuminega viros Bull** (Chandzelo) by goats.

J A Ayoade

University of Malawi, P O Box 219, Lilongwe, Malawi.

Bunda College of Agriculture is situated on latitude 14 11"S and longitude 33 45"E. The annual rainfall is 875 mm. Observations on the grazing behaviour of goats on the campus revealed that they preferentially browsed **Lippia asperlifolia rich** and **Secuminega virosa bull.** Therefore a 42 day experiment was carried out to compare the voluntary intake, dry matter and organic matter digestibility of freshly harvested leaves of both species of plants by goats. The experiment was a simple change-over design. The results obtained are summarized in table 1.

Table 1

Voluntary dry matter intake, dry matter and organic matter digestibility of tested leaves

	Lipia	Secumineg
DM intake/day		
Mean / animal (g)	79.9	127.6
g/100 kg body weight	648.8	887.6
g/kg met size	12.1	17.2
Digestibiliity (%)		
Dry matter	75.5	70.4
Organic matter	77.0	72.4

The results in table 1 indicate that, while **Lipia** intake was lower than that of **Secuminega,** both the dry matter and organic matter of the later were better digested by goats. Differences between treatments were however not significant ($P<0.05$). Although the digestibility coefficients of both species were high the voluntary intake was unexpectedly low. This could be due to the presence of tannins or polyphenolics although lack of laboratory facilities prevented the establishment of these compounds in the leaves.

(Editor's note: The above research brief was received with some details missing ---- are the plants leguminous browse? How many animals were put on a treatment? What were the average weights ? etc. ----- the abstract is however published as an example of how much can be done even in the absence of full research facilities).

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Home-made urea-molasses blocks

A K Mosi
International Livestock Centre for Africa, P O Box 5689, Addis Ababa

Liquid molasses transportation can be messy and costly. Urea-molasses blocks on the other hand are easier to handle and can be made by farmers' cooperatives at a central location for distribution. Although still in the experimental stage, we have been able to cast hard blocks with the following ingredients:-

Molasses	52.0%
Common salt	5.0%
Fertilizer grade urea (46% N)	7.5%
TSP or DAP fertilizer	2.5%
Unslaked lime (CaO)	10.0%
Bran as filler	23.0%*

* Bran is used as a filler but other additives such as protein cakes, anthelminthics and vitamins can be substituted into the bran fraction.

The salts are dissolved in a minimum of water not exceeding their total weight (heat is required to dissolve them) and the mixture of finely powdered CaO and filler is added with constant mixing. A thick gel is formed and this can be cast in suitable containers. A cement mixer facilitates the mixing. Before the gel completely solidifies, it can be futher pressed in a cement block making machine.

Please play with the formula and let us hear of any improvements you add to get even better blocks.

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LITERATURE REVIEW

Molasses as stockfeed

D C Nicol*, J J Daly** and P J Round***

Beef cattle Husbandry Branch, Department of Primary Industries. *Bundaberg, **Brisbane and ***Towsville.

(Note: This article was read at the proceedings of the Australian Society of Sugar Cane Technologists in 1984. An abridged version is given below for information and possible experimentation where relevant.)

1. Beef cattle feeding

i. Cattle licks

Molasses is very palatable to most stock and in the liquid form provides a suitable carrier for small quantities of minerals. In this role, molasses is eaten in such small amounts that it provides no appreciable energy to the diet. Protein, non-protein nitrogen, minerals such as phosphorus sodium or calcium and trace elements such as cobalt and copper, as well as vitamins are often additives to molasses licks.

ii. Stock blocks

Solidified molasses blocks and molasses salt blocks have been used to provide minerals in the intensive and extensive cattle systems in Australia. Other additives included in solid blocks include alcohol ethoxylate detergent for bloat control and methoprene for buffallo fly control and monensin sodium, a volatile fatty acid manipulator.

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2. Dairy cow feeding

The dairy industry has been a traditional user of molasses. Lake (1982) estimated that 30,000 tons were being fed annually on dairy farms in south east Queensland. A recent estimate for annual molasses usage in the Queensland and northern NSW dairy industries was 100,000 tons.

Considerable research has been done to determine the milk response when molasses is fed to dairy cows. The average response in long term feeding is 0.7 kg milk per kg molasses, (Chopping **et al.** 1976, 1980). These workers also showed a linear increase in milk yield per cow up to 3.6 kg molasses per day. Cowan and Davison (1978) substituted 3 kg molasses for 2.4 kg maize at high and low levels of available pasture without a significant difference in milk yield

The incorporation of molasses into feeding systems on dairy farms will continue as long as the price of molasses remains competitive and returns to milk remain in parallel to molasses prices as they have done since the early 70's.

3. Molasses for sheep, goats, and other animals

Molasses licks and solidified blocks are used to a minor extent with these animals on commercial properties. In 1982, sheep in south Queensland were fed 450 to 650 g/d of a mixture of molasses and cottonseed meal (15% w/w) as a low cost survival ration (Knight **et al.**, 1984). Proximity to grain areas and the transport of molasses to the sheep areas are factors likely to restrict the increased usage of molasses in sheep areas unless fodder subsidy schemes favour molasses .....

iii. Drum-licker system (DLS)

The development of low cost dry-season supplement fed through a dry licker (Mutch, 1966) did much to boost the usage of molasses in the beef industry in the sixties and seventies in Queensland. A mill to paddock system of cattle supplementation was popular with beef growers. The Mossman mill mixed 6%, 10% or 20% urea (w/w) with final molasses which was diluted with water on the property at the required rate (Kenny, 1970). Phosphoric acid was included as a fermentation inhibitor and as a supplement of phophorus for cattle; however, it was later shown to depress animal performance (Winks and Laing, 1972) and its use is now not recommended.

In the DLS, daily intakes of molasses range from 200 to 500 g per day but the mix can be varied to provide higher levels of molasses where paddock feed is scarce. Fed at these levels, molasses provides enough sulphur to balance the nitrogen: sulphur ratio needs of the beast and also acts as an attractant.

iv. Home-brew licks

Another dry season supplement commonly fed in Queensland is a mix of grains, molasses, urea and meat meal (Durand, 1978). Individual daily molasses intake rarely exceeds 250 g per day.

4. Future use of molasses in the beef cattle industry

Because of its cheapness and ease of feeding, molasses has a large potential usage as a feed for cattle.

In the 1950's up to 12% of the cattle population would be lost in a severe drought. In the 1960's, this declined to about 9% and during the 1970's losses were down to 6%. Before the acceptance of large scale drought feeding, at least 10% of the herd could be lost in a drought and this can be used as a benchmark to indicate the potential extent of drought feeding.

With beef cattle numbers in 1983 at 9.3 million head a total of 930,000 head mostly cows, could be lost in severe drought. This represents 20% of the breeder herd. If 930,000 drought prone animals were fed for 100 days at 2.5 kg per head daily, they would consume 232,500 tonnes of molasses equal to 35% of average production from 1978 to 1982. With drought ocurring every 3 to 5 years, this is a recurring demand varying in quantity with the severity of the drought .....

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5. Molasses as an energy source

Molasses is also used as a source of energy in complete cattle feeds. Its use as a substitute for grain depends mainly on relative prices. Including 10-15% molasses in grain concentrate ratios increases palatability and reduces dust but inclusion above that level is difficult because of the moisture content of the final feed where flow properties also detereorate above the level (van Niekerk, 1981).

Conflicting evidence is available on the nutritive value of molasses when incorporated in various levels in rations. Lofgreen and Otagaki (1960) found that molasses has a relatively high net energy value for fattenting steers when incorporated at 10% but found that as the level of molasses increased to either 25% or 40%, the net energy value was greatly reduced. From experiments summarized by van Niekerk (1981), provided molasses does not exceed 14% in beef fattening ratios, molasses has a feeding value of about 80% of that of maize, both expressed on as-feed basis.

Thurbon and Winks (1970) found that the substitution of grain by molasses when both feeds were incorporated as 0%, 10% or 25% in a high legume roughage diet for fattening cattle, did not reduce either liveweight gain or dressing percentage. In later experiments, steers were fattended successfully on sorghum forage: molasses diets with up to 33% molasses, provided that a true protein source was added. Recent work by Gulbransen suggests that molasses with urea could be included in grain diets at 25-30% in low cost or opportunity feedlots.

Other studies (Preston and Willis, 1970) have shown that molasses can be used as the major energy source (70-80% of the ME of the diet is molasses) for fattening cattle and that for liveweight gain per unit of ME, it is comparable to high-grain diets. Stewart (1976) calculated that it would be feasible to fatten 250,000 cattle in Australia with high molasses diets instead of exporting the molasses. Experiments with mixtures containing up to 80% molasses in NSW showed commercial feasibility although weight gains, depressing percentages and fat cover, were lower than with conventional grain feeding (Sundstrom and Palmer, 1977). Trials with high molasses diets were also carried out in the early 70's. While

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no commercial ventures of any size have resulted to date in Australia any new requirements of younger, leaner carcasses in the export trade could lead to commercial ventures near sugar mills in the future.

6. Supplementation of pastures with molasses

Molasses have been fed ad libitum to cattle grazing improved pastures in coastal regions of Queensland. The results show that supplementation of plentiful pastures, containing green leaf, gives poor intakes of molasses and poor conversion ratios because of high substitution rates.

7. Fortified molasses as drought feed

The high substitution rates of molasses supplemented to pastures are a boon where the survival or small production gain is required as forage diminishes in a drought. There has been a significant increase in the use of molasses as a drought feed in the 1982/83 drought (Wythes and Ernst, 1984). A successful system of feeding various mixes of molasses and urea with or without protein meal has been developed (Nicol **et al,** 1984). The molasses mixes are fed in open troughs in paddocks with spare roughage. The urea/molasses ratio can be manipulated to determine the approximate daily intake by cattle and protein meals can be added for increased performance. Gulbransen (1982) found that a diet of 2 kg a day of molasses containing 3% urea, fed without roughage gave comparable survival performance to 1.4 kg cracked sorghum grain.

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ANNOUNCEMENTS

CHANGE IN THE LEADERSHIP OF ARNAB

The Directorate of ILCA has named Dr T R Preston and Dr Mopoi Nuwanyakpa as Coordinator and Scientific Secretary of ARNAB, respectively. Dr Preston will be with ILCA for 6 months a year to coordinate ARNAB activities, to conduct on-farm research in Ethiopia and to stimulate and assist ARNAB members to do similarly. Dr Nuwanyakpa will work closely with Preston in the execution of responsibilities to ARNAB. Dr Nuwanyakpa's non-ARNAB responsibilities include nutrition experiments on crop residues and byproducts at ILCA headquarters and close associations with Dr Preston and others in the ILCA Nutrition Unit in conducting on-farm research projects.

Dr Augustine K Mosi has served ably as Senior Animal Nutritionist at ILCA headquarters and as Scientific Secretary of ARNAB. As Dr Mosi will not be with ILCA in the forseeable future, ILCA acknowledges, with deep appreciation, his many contributions to the organization and to ARNAB.

The following is the verbation text of Dr Mosi's farewell message to ARNAB members and the readership of ARNAB and at large.

> "The idea to form a Pan-African Research Network for Agricultural Byproducts was conceived when the Association for the Advancement of Agricultural Sciences in Africa (AASA) and ILCA jointly hosted a workshop on the Utilization of Agricultural, Forestry and Fishereis wastes in Douala, Cameroon on November 17-21, 1980".
>
> "The birth of the network was witnessed in Dakar, Senegal on 25 September, 1981 when the FAO agreed that leadership of ARNAB should reside with ILCA"

"My job as the first Scientific Secretary and co-ordinator, has been to nurse the rather fragile network with a newsletter and occasional visits in addition to my main responsibility as a full-time research scientist at ILCA. In course of time ARNAB has been restructured through the formation of core membership to enable specific attention and inputs to be concentrated on members' projects. The network has since then attracted the attention of the International Development and Research Council (IDRC) of Canada and some members' projects enjoy IDRC funding. I leave ILCA with the firm belief that ARNAB membership will expand to all corners of Africa in the very near future and that the effort in contributing to its establishment was worthwhile"

"I would like to thank all Network members, the Directors of Institutes involved in the Network and ARNAB sympathisers for their co-operation, assistance, hospitality and brotherliness during my tenure of office from 1980 to 1985".

"I also owe a debt of gratitude to all as the many discussions and field trips to members' projects have widened my knowledge as regards to potential and extreme diversity of crop residues and the roles they can play as alternative feed resources for livestock on the African continent. I believe that the Network has already made an impact in stimulating research on the use of crop residues and agro-industrial byproducts in Africa and that tremendous grounds will be covered in the years to come".

ARNAB WORKSHOP IN ALEXANDRIA, EGYPT

The next ARNAB workshop will be held in Alexandria, Egypt from October 14-18, 1985. Topics to be discussed include:

1. Institutional reports (research activities)
   a. Utilization of crop residues and byproducts in existing farming systems.
   b. Use of poultry litter in animal feeding

2. Research methodology
   a. Analytical techniques
   b. Farm surveys
   c. On-farm experiments
   d. Quantification and classification of crop residues and byproducts

3. Discussion of research and other activities that will ensure the attainment of ARNAB's mandate.

SUBMISSIONS SOUGHT FOR THE ARNAB NEWSLETTER

The ARNAB Scientific Secretary apologies to ARNAB member institutions and the ARNAB readership at large for the delay in preparing the December edition of the ARNAB Newsletter. The transition and assumption of the new responsibilities of the Scientific Secretary and the Coordinator have been the main reason for the delay. It is now hoped to publish the next Newsletter in mid-March. ARNAB member institutions and other readers of this Newsletter are encouraged to contribute research notes and abstracts for publication. Shortage of research data and important announcements should not be allowed to delay the timely publication of the Newsletter.

DIRECT CORRESPONDENCE AMONG CONTRIBUTORS TO THE ARANB NEWSLETTER

In the interest of space and time, research notes submitted for publication in the ARNAB Newsletter will be restricted to brief details of experimental procedures, findings, conclusions and recommendations. Readers interested in details not provided in the Newsletter are encouraged to write directly to the contributors (addresses will be provided). This is seen as a way of promoting direct professional contacts among the readers of this Newsletter. If the original papers are needed "urgently" and cannot be obtained from the contributors in time, the ARNAB Scientific Secretary can provide them.

PERIODIC LITERATURE SEARCH FOR ARNAB MEMBER INSTITUTIONS

The ARNAB Scientific Secretary will use the ILCA microfiche services to conduct, periodically, literature searches on crop residue and byproduct research topics of interest to ARNAB member institutions. Copies of the completed searches will be mailed to member institutions.

The timing of the searches will be planned in due course. However, ARNAB member institutions may, at any time, request a search specifically tailored to their research needs.

MOLASSES-UREA-MINERAL BLOCKS FOR RUMINANTS GRAZED UNDER EXTENSIVE MANAGEMENT

B Ahokpe, H Guerin and M Cisse of the "Institut Senegalais de Recherches Agricoles" have experimented with various methods of making molasses-urea-mineral blocks. Their final formulation, when given to sheep fed rice straw, resulted in a gain of 125 g/sheep/day. More detailed experimentation using their blocks is being planned. It is hoped that results obtained will be submitted for publication in this Newsletter.

AN INTERNATIONAL STRAW UTILIZATION SEMINAR IN SRI LANKA

The straw Utilization Project of Sri Lanka has considerable data and experience from using urea and ammonia treatment and supplementation to enhance the utilization of paddy straw. Extension workers and research technicians interested in participating in an international seminar on paddy straw utilization, planned for "mid 1985", should contact:

The Coordinator
Straw Utilization Project
P O Box 138
KANDY
Sri Lanka

WORKSHOP ON "MATCHING LIVESTOCK SYSTEMS TO AVAILABLE RESOURCES IN DEVELOPING COUNTRIES"

The International Livestock Centre for Africa (ILCA) will convene a workshop on this topic at its headquarters in Addis Ababa, Ethiopia between September 2-6, 1985. The objective of the workshop will be to propose strategies and recommendations for decision makers, planners and scientists from both the developed and developing countries, for optimising livestock productivity from available resources through an integrated technnology that employs multi-purpose animals and recycling of crop residues and byproducts as feeds for animals. These strategies and recommendations will arise from discussions of the following themes:

1. Feed and genetic resources available in developing countries.
2. Traditional livestock systems.
3. Socio-economic constraints to the introduction of technical innovations into smallholder farms and pastoral systems.
4. Technical innovations which might be introduced in order to "match systems to available resources."
5. Monitoring and assessing the impact of innovations at the level of the smallholder and pastoralist.
6. Improving the training of scientists involved in livestock development.

Participants to be partly or wholly sponsored by ILCA will be notified in due course. Others interested in attending under their own funding should notify the ILCA Director of Training as soon as possible.

THE ETHIOPIAN GOVERNMENT AND ILCA CONDUCT JOINT ON FARM RESEARCH PROJECTS

By

T R Preston, ILCA Consultant
ILCA Headquarters

The objectives of these on farm research projects are to:

1. Identify the basic feed resources (mainly dry pastures, crop residues and agro-industrial by-products), work out a feeding strategy and site cattle/sheep enterprises at points where feeds are produced/available.

2. Promote the use of 70,000 tonnes or more of molasses and an equal quantity of oil seed cakes and animal byproduct meals produced in Ethiopia to improve the utilization of the basic resources, and hence to promote the export of livestock products (meat, hides and skins) rather than of the original raw materials (the traditional practice).

3. Distribute molasses/urea mixtures to smallholders, pastoralists and State Farms. Emphasis is on simplicity and making maximum use of the existing resources. For example mixing is done by putting urea and water in a commercial fuel tanker at a point at least 5 km distant from the sugar factory. The agitation on the journey to the factory ensures that urea is quickly dissolved. Molasses is then added and because of its high density (1.5) compared with fuel oil, the tanker becomes fully loaded (on a weight basis), when the tanker body is only 2/3 full. The unused space, together with the baffles in the tanker body, facilitate mixing of molasses with the urea solution during the drive from the sugar factory to destinations at Peasant Associations and State Farms.

The molasses/urea mixture is stored in simple un-lined pits in the ground preferably sited on sloping land so that unloading into the pit and discharge to the users is done by gravity. In the smallholder/pastoralist schemes the storage/distribution points are sited near wells. Farmers bring their own containers (cans and earthen pots) and their donkeys when they bring their cattle to the wells for watering and take back the molasses/urea mixture to their homes.

4. On State Farms, tractors and trailers are being replaced by donkeys and horses as the means of taking the molasses/urea from the storage pits to the cattle feed troughs. Replacing tractor power with animal power frees the tractor to perform more important tasks, such as ploughing and cultivation for producing legume forages.

In the first week of the programme some 10,000 cattle and the same number of sheep have been introduced to molasses/urea feeding.

5. Replace concentrates on dairy farms and in feedlots with supplements which provide fermentable nitrogen (urea and poultry litter) for the rumen micro-organisms and bypass proteins (oil seed cakes and legume forages) for the animal. The increased capacity and efficiency to feed cattle on State Farms help pastoralists and smallholders who need buyers for their surplus sheep and cattle, a need that has become especially acute because of the continuing drought.

6. Promote active integration between different enterprises. For example, poultry litter and excreta are being used to replace the urea required by cattle and sheep. In turn, the use of molasses and crop residues in the diet of cattle and sheep has released wheat offals which can now be fed to poultry to substitute cereal grains. The planting of legume trees (**Leucaena** and **Gliricidia)** to provide wood for fuel and leaves as animal feed is also encouraged.

The role of ILCA has been:

1. To assist in planning and supervising the overall strategy.
2. To monitor progress and assess the impact on the rural communities.
3. To design, execute and supervise supporting research activities which are carried out both on State Farms and ILCA institutions and which are aimed at providing answers to problems raised during the execution of the new feeding systems.

It is hoped that this collaborative effort between the Ethiopian Government and ILCA will serve as a model that can be used by other African countries to enable them to make better use of their existing feed resources.

RESEARCH BRIEFS

INEXPENSIVE DETERGENT FIBRE ANALYSIS USING A MICRO SYSTEM

By

J D Reed

Animal Nutritionist, ILCA

Addis Ababa, Ethiopia

Introduction

Total fibre (cell wall) in forages, crop residues and byproducts is important in determining nutritive value (Van Soest 1967). In cereal crop residues, it is the most important substrate for rumen microorganisms and therefore the major source of energy for ruminants.

Lignin and hemicellulose, which may account for over 50% of total fibre in cereal crop residues, are not recovered in the crude fibre method. Estimation of fibre by the crude fibre method is therefore not recommended because it underestimates total fibre (Van Soest and Robertson 1980).

Research groups in developing countries have been slow in adopting the detergent methods of forage fibre analysis, partly because of the high costs of reagents and apparatus. The ILCA Nutrition Unit has developed a micro-fibre apparatus that gives similar results to conventional systems for fibre analysis (Goering andVan Soest 1970), costs very much less than the conventional apparatus, and uses one tenth the amount of reagent. The apparatus, glassware, Fisher catalogue number and approximate costs for both systems are shown in Table 1.

Table 1. Description and costs of the conventional and the micro-fibre systems.

Conventional Systems

Description	Fisher Cat. No.	Quantity	Price (USD)
Labconco Crude Fibre extractor	09-681B	2	
600 ml beakers	02-5456	120	330
Toal for 12 refluxing units			8,552
Description	**Fisher Cat. No.**	**Quantity**	**Price (USD)**
Large Hotplates	11-493-601T	2	383

50 ml flasks	12-09-650A	24	63
100 ml beakers	02-545A	120	213
Rubber tubing (bore 3.2 mm)	14-150-5A	1pk	4
Glass tubing (6 mm OD)	11-350D	1pk	22
Stoppers	14-140H	1pk	10
Clamps	05-766	24	187
Total for 16 refluxing units			882

Figure 1 shows how the refluxing apparatus of the micro-fibre system is assembled.

Results and Discussion

Differences between the systems were not significant for neutral-detergent fibre (NDF) and acid-detergent fibre (ADF), but were for lignin and silica (Table 2). The conventional system gave higher values for lignin and silica (mean differences: 0.6 percentage units each for lignin and silica). However, the two systems ranked similarly the samples for NDF, ADF, lignin and slica.

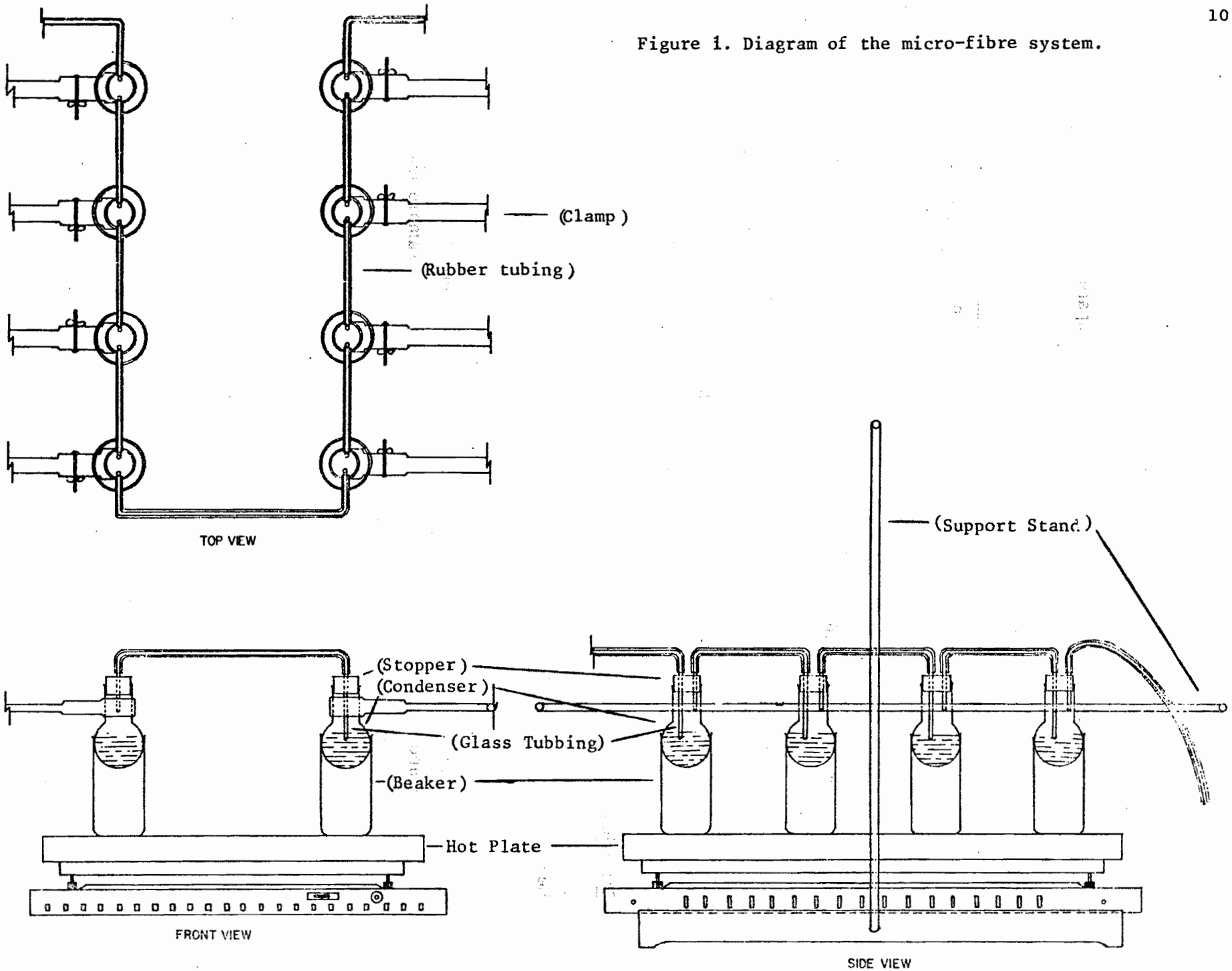
The micro-system is recommended because it gives similar results in fibre analysis as the conventional system, at substantial savings in costs of apparatus and reagents. Both systems can be built using glassware and hotplates already available in many laboratories, thereby making it unnecessary to purchase the expensive Labconco Crude Fibre Extractor.

Table 2. Neutral-detergent fibre (NDF), acid detergent fibre (ADF), lignin and silica determined (% dry matter) by the micro fibre system compared with the conventional system.

	NDF[1]		ADF		Lignin		Silica	
Feed	Micro	Normal	Micro	Normal	Micro	Normal	Micro	Normal
Maize stover	66.9	64.6	38.1	40.5	3.0	4.0	2.2	3.3
Tef straw	70.1	70.7	38.7	40.3	3.8	4.3	2.3	3.9
Wheat straw	68.9	68.0	47.3	47.1	5.5	6.1	4.2	5.8
Sorghum								
Leaves	51.1	52.6	32.0	32.8	3.9	4.4	10.9	12.0
Stems	58.8	60.4	40.0	39.5	4.4	5.2	0.8	1.0
Trifolium tembense								
Leaves	27.2	27.9	24.6	24.9	3.8	4.6	-	
Stems	43.0	42.5	39.2	39.8	5.9	6.2	-	-

[1] For the micro-system, 0.1 g of sample and 10 ml of detergent were used for ADF and NDF analyses. However, 0.5 g and 50 ml of sample and detergent, respectively, may be used with the system.

Figure 1. Diagram of the micro-fibre system.



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At an annual tropical African population growth rate of around 2.8%, land will be required increasingly for producing human food crops, and less for the development of pasture. As agricultural production technology in Africa can be expected to remain stagnant in the forseeable future, grain and tuber food production will not keep pace with the rapidly expanding human population. This will therefore rule out the possiblility of using cereal and other staple foods for feeding livestock, and necessitate greater use of crop residues and agro-industrial byproducts.

Chemical treatments used in industrialized countries to improve the feeding value of low-quality roughages are not yet transferable to tropical Africa, owing to the meagre resources and poor technical know-how of rural farmers, who comprise the bulk of Africa's livestock producers. In attending to the urgent need to investigate ways of increasing the use of crop residues and agro-industrial byproducts for ruminant animal production in tropical Africa, research workers must focus on taking inventories of the seasonal and regional availability of byproducts and residues, developing simple technologies for collection, handling, storing and treating before feeding, and finding suitable combinations of the residues and by-products with other readily available feedstuffs.

Workers in many private and public institutions in Africa are devoting the meagre material and human resources available to them to investigate one or several of these priority research fields. Some of the byproduct and residue work being done outside of the continent may also be very applicable to our livestock problems.

Limitations of funds usually impose serious restrictions on getting the results of research done in many parts of Africa printed in the international scientific journals. This leads to a large proportion of very useful information being kept in "hidden documents", i.e., papers published in only a small number of copies, usually in mimeo form. Furthermore, most African institutions lack the funds for obtaining partial or complete volumes of the popular international publications, the absence of which is an important bottleneck in planning and executing research projects, and in interpreting their results.

It is therefore hoped that our ARNAB Newsletter will be used as an effective medium of information sharing among our readership at large. The guidelines outlined on page 4 are intended to encourage everyone to submit research papers, whether or not they are intended for printing in other local or international publications. Although relatively liberal, the guidelines will seek to protect this Newsletter against an onslaught of medicore research projects, i.e., those that were planned and/or implemented poorly.

The reputation of this Newsletter will be determined primarily by the variety and diversity of origins of good research work reported. The very high standards that are envisioned for the Newsletter will be marred if research data and other information of interest to ARNAB's readership are contributed constantly by the same people, or if the Newsletter is stacked with a barrage of editorials, announcements and "space fillers".

ARNAB members are encouraged to continue their active involvement in the operation of the Network, including the printing of its Newsletter. We all know that without everyone's fullest cooperation and contribution, ARNAB will not be able to attain its ultimate objectives of: (1) Laying an emulative foundation for practical and economical crop residue and agro-industrial byproduct research in Africa; (2) Making a recognizable impact on the expanded use of residues and byproducts in livestock feeding by small-scale producers in Africa; and (3) Printing a book with summaries of residue and byproduct research done by member institutions, and with practical guidelines for the utilization of residues and byproducts for African ruminant livestock production. Such a comprehensive book would be a lasting legacy to generations of African livestock research scientists and students of animal science.

ANNOUNCEMENTS

Group Training Courses Organized by the International Livestock Centre for Africa

Titles of Courses	Dates (1985)	Language	Venue	Deadline for Application (1985)
1. Handling and dissemination of agricultural information	12-23 August	English	Addis Ababa	15 June
2. Ruminant nutrition	16 Sept. - 4 Oct.	French	Dakar	27 July
3. Ruminant nutrition	21 Oct. - 8 Nov.	English	Addis Ababa	31 July
4. Seminar: The role of micro-computers in livestock management	9-13 December	English	Addis Ababa	16 September

Course Fees and Expenses

Tuition .....US$ 500
Materials and transport .....US$ 100
Weekly accommodation/board ..... US$ 350
Air fare (According to country of origin)

Course Attendance

Only applicants from within the ILCA mandate area (Sub-Sahara Africa) will be considered. ILCA has funds for only a limited number of awards to each course. Although early requests for financial assistance may receive favourable consideration, candidates are encouraged to seek funds from their governments and other sources.

GUIDELINES FOR SUBMISSION OF RESEARCH NOTES TO BE PUBLISHED IN THE ARNAB NEWSLETTER

The paper should be based on original research on crop residues and/or agricultural byproducts. Review papers may be invited by the ARNAB Secretariat.

Research notes usually should not exceed three double-spaced, typewritten pages and should be divided into the following sequential parts: Introduction, Materials and Methods (Experimental Procedure), Results and Conclusions, and References (if any).

The primary aim of publishing research notes in the ARNAB Newsletter is to give advance information on residue/byproduct research likely to be of interest to ARNAB readers. The data presented in these notes may, at the discretion of the researchers, be prepared for publication in a recognised research journal, in which case there should be acknowledgement of prior publication, in abbreviated form, in the ARNAB Newsletter.

In preparing these notes, it is sufficient to give the briefest justification for carrying out the work and only those details of experimental procedures necessary for readers to understand how the experiment was done. Only those research findings which are relevant to the conclusions drawn from the data should be presented. However, in tables and graphs, means and coefficients must be accompanied by suitable measures of variation.

For means presented in tables, the standard errors of the means ($SE\bar{x}$) can be obtained from the analysis of variance. Standard error of the mean is defined as the square root of the error mean square divided by the number of observations on which the mean is based ($SE\bar{x} = \sqrt{\frac{S^2}{n}}$). For regression equations, the coefficients of determination (r^2) and the standard errors of the regression coefficients (Syx) should be given.

Literature citations should be limited to the most important ones that will assist readers in obtaining more information about the topic being discussed. In the reference list, titles of articles and of journals/books should be written out (not abbreviated). Punctuation should be minimised (eg: see the reference list in the note by Wanapat et al)

UTILIZATION BY NATIVE (ZEBU) CATTLE AND SWAMP BUFFALOES OF RICE STRAW UNTREATED OR AFTER ENSILING WITH UREA WITH OR WITHOUT SUPPLEMENTS OF WATER HYACINTH (Einchhornia crassipes)

By

M Wanapat, P Sriwattabasombat and S Chanthai

Department of Animal Science, Faculty of Agriculture

Khon Kaen University, Thailand

In Thailand, rice straw is the primary feed resource for cattle and swamp buffaloes during the dry season. However, rice straw, if given as the sole feed will not support maintenance. Because of this, attempts have been made to increase its nutritive value by: chemical treatments of which the most useful appears to be ammoniation through the process of wet-ensiling with urea (Wanapat 1982); and supplementation (El-Serafy et al 1980).

The present study aimed to evaluate, in both cattle and buffaloes, the effect of urea ensiling of rice straw alone or in combination with water hyacinth.

Experimental procedure:

The rice straw was chopped in lengths of approximately 15 cm and fed as such or after ensiling with urea, incorporating in the ensiling process different proportions of water hyacinth. The water hyacinth was sun-dried to 60% moisture before being mixed with straw prior to urea-ensiling.

Twelve buffaloes and 12 native (Zebu) cattle were allocated to the following treatments (in groups of 3 animals each):

US Untreated rice straw (control)

TS Treated rice straw (5% urea and 1% salt in aqueous solution were sprinkled on the rice straw which was then ensiled in airtight sacks for 21 d)

TS : WH Straw mixed with water hyacinth (3:1 DM basis) and then ensiled with urea/salt as in TS

TS : WH As above but with a mixture of 1 : 1 (DM basis) of straw and water hyacinth

Results and discussion:

The untreated rice straw contained 0.64% N (DM basis) which increased to 0.99% N after ensiling with urea. The dry matter and ADF were digested to a greater extent in urea-ensiled rice straw and the urea-ensiled straw mixtures with water hyacinth compared with the untreated straw. Dry matter intake was also higher in treated and supplemented straw diets especially in the case of the buffaloes.

These effects on digestibility and intake were manifested in better animal performance. All animals lost weight on untreated straw and either maintained or gained weight when the straw was ensiled with urea. Appreciable gains were made by buffaloes on the water hyacinth mixtures as did the cattle but to a lesser extent.

Buffaloes ate more than cattle but the differences were not significant when expressed on a metabolic bodyweight basis. Digestibility coefficients were similar for both species but the buffaloes gained liveweight faster than the cattle.

The results indicate that water hyacinth functions as a strategic supplement enhancing animal performance on a basal diet of urea-ensiled rice straw.

Table 1: Intake and digestibility of rice straw untreated or after ensiling with urea in the presence or absence of water hyacinth

	US	TS	TS:WH (3:1)	TS:WH (1:1)
DM intake (g/kgW$^{0.75}$)				
Cattle	86.6b	88.6b	86.8b	95.8a
Buffaloes	78.8c	88.2c	111b	90.4a
Liveweight change (g/d)				
Cattle	-34b	7b	133a	23b
Buffaloes	-182b	79b	232a	329a
DM digestibility (%)				
Cattle	44a	52ab	54bc	64c
Buffaloes	50b	52b	52b	65a
ADF digestibiilty (%)				
Cattle	42c	48b	49b	58a
Buffaloes	43c	47c	55b	62a

abc Means with the same letter within a row are not significantly different ($P<0.05$)

Table 2: Comparative performance of native cattle (Zebu) and swamp buffaloes fed rice straw based diets (mean values for all diets given in Table 1)

	Cattle	Buffaloes	Significance
Initial liveweight (kg)	125	220	.001
DM intake (kg/d)	3.26	5.06	.001
DM intake (g/kgW$^{0.75}$)	89.4	92.1	NS
Liveweight change (g/d)	32	114	.05
Digestibility (%)			
DM	54	55	NS
ADF	51	50	NS

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Wanapat M, Praserdsuk S, Chantai S and Sivapraphagon A 1982 Effects on rice straw utilization of treatment with ammonia released from urea and/or supplementation with cassava chips In: The Utilization of Fibrous Residues as Animal Feeds (Editor: P T Doyle) pp 95-101. University of Melbourn Printing Services

(The paper on which this abstract is based has been accepted for publication in Tropical Animal Production, 1985: Volume 5)

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TOPICAL COMMENTARY

by

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1. HOW IMPORTANT ARE RUMEN ANAEROBIC PHYCOMYCETOUS FUNGI IN FIBRE DIGESTION ?

Increasing attention is being paid by some ruminant nutritionists and rumen microbiologists to the possible role of rumen anaerobic fungi in the digestion of fibre. After fungal zoospores attach to plant fractions in the rumen, they germinate and develop into globular structures called sporangia that produce extensive networks of rhizoids throughout the plant tissue (Davidson 1984). Within 24 h, the sporangia rupture releasing more zoospores.

Bauchop (1979) suggested that the rapid colonization, growth and extent of attachment of anaerobic fungal zoospores on plant tissues (including sclerenchyma and other slowly digested vascular tissues) indicate that fungi may form a significant part of the rumen microbiota and may play a role in fibre digestion, perhaps as initial colonizers in ligno-cellulose digestion. Another work showing that plant fragments in the rumen are sites for the extensive colonization and development of these anaerobic fungi was done at CSIRO's Division of Animal Production in Prospect, New South Wales (Akin **et al** 1983). In that study, laboratory cultures of rumen fluid samples with fresh leaf blades and antibiotics (to suppress bacteria) showed complete envelopment of the leaves, and degradation of sclerenchyma (normally resistant to attack by rumen bacteria) and cell walls by fungi. Sixty-two percent of the leaf matter in rumen cultures containing sulfur and antibiotics was lost after 48 h.

Preliminary work at ILCA (Davis 1985) indicates that fungi do actively attach to and invade fibrous tropical crop residues.

Contrary to the above reports, Windham and Akin (1984) concluded that the development of large numbers of fungal sporangia on fibre may not be indicative of their role as substantial digesters of forage. Therefore, the most active fiber-digesting organisms in the rumen are the bacteria.

Their conclusion was based on an examination of the extent of fibre digestion in whole rumen fluid (WRF), WRF + cycloheximide, and WRF + streptomycin and penicillin. Cycloheximide inhibited fungal growth, while streptomycin and penicillin suppressed bacterial populations. It was found that bacteria (i.e. WRF + cycloheximide) degraded DM, ADF, NDF and cellulose to the same extent as the total population of microorganisms in the untreated WRF. Degradation of these constitutents by fungi (i.e. WRF + streptomycin and pencillin) was less than that by the total population or by bacteria alone. In addition, no substantial loss of lignin was detected as a result of fungal degradation.

When inoculum obtained from cattle and sheep fed alfalfa hay was used, the **in vitro** digestion of NDF, ADF and cellulose in bermuda grass hay were, respectively, 1.3, 2.4 and 7.9 percentage units higher than the digestibilities of these constituents when inoculum was obtained from animals given bermuda grass hay (Windham and Akin 1984). The improved digestion in alfalfa hay inoculum may indicate that some nutrients that stimulate rumen microorganisms that were present in alfalfa were missing or in inadequate amounts in the bermuda grass. Davidson (1984) reported that the population of rumen anaerobic fungi were strongly stimulated by sulfur (contained in forages or provided as a supplement in the form of methionine).

The above research findings indicate that anaerobic phycomycetous rumen fungi may have a role in fibre digestion. The direct measurement of fungal vegetative rhizoid tissues and an understanding of their enzymatic activities within plant fragments in the rumen digesta will help to clarify the role these microorganisms play in fibre digestion. However, the measurement of fungal biomass is still difficult (Bauchop 1984). The role played by anaerobic rumen fungi in the overall utilization of fibrous feeds will therefore be the topic of many extensive research projects.

2. COLLABORATION AMONG AGRONOMISTS, PLANT BREEDERS AND ANIMAL NUTRITIONISTS MAY SIMULTANEOUSLY SOLVE PART OF THE HUMAN AND RUMINANT LIVESTOCK FOOD PROBLEMS IN DEVELOPING COUNTRIES:

Increases in cereal crop production, necessitated by the ever-expanding human population in developing countries, and the concomittant increases in crop residue availability were recently underscored (Editorial---ARNAB Newsletter Vol. 5 No. 1). Since chemical (particularly strong alkali) treatment is an economically and environmentally inappropriate technology for improving the feeding value of crop residues in most developing countries (particularly in Africa), other means of improving the intake and utilization of these important feed resources must be investigated. One of these is the use of response-type trials to determine "strategic" levels of supplementation (particularly of protein) for these feeds when fed to livestock for a given productive purpose. Another is the breeding and/or selection of crops with high quality residues.

Reed **et al** (1985) examined the relationship between dry matter (grain and vegetative matter) production of 24 varieties of sorghum (**Sorghum vulgare**) and the digestibilities of their stovers (see Figures 1 and 2). They concluded that simultaneous selection of high grain - yielding sorghum varieties with stovers of high digestibility is possible.

This conclusion is in agreement with the findings of another ILCA research worker (Powell 1985) who reported a correlation coefficient of 0.89 between sorghum grain yield and total stover (leaf and stem) crude protein content. A correlation coefficient of 0.81 - 0.84 was found between nitrogen in the stover and grain yield of maize (Grove 1979).

Estimating the quantity of cereal straws present after grain harvest is often difficult. A solution to this problem was the goal of work by Powell (1984), who predicted the DM yield of residues from linear regression equations based on grain yield. The correlation coefficients reported between grain yield, and leaf and stalk DM yields were, respectively, 0.94 and 0.90 (for sorghum); 0.76 and 0.71 (for millet) and 0.99 and 0.97 (for maize). Harvest index (HI), defined as the ratio of grain to total above-ground DM, is used to determine the grain-producing efficiency of crops (Powell 1984). Given the high correlations between grain and component DM yields of the crops studied by Powell (1984), HI may be used to indirectly estimate the total stover DM available to livestock (Okaiyeto and Egharevba 1981).

NOTE: Members of ARNAB and other readers of this Newsletter are encouraged to submit short notes on current topics dealing with the utilization of crop residues and/or agro-industrial byproducts. Desiring to keep our Newsletter continuously interesting and worthwhile, we are again making another plea for contributions from ARNAB members and our readership at large. ARNAB should never be a "one-way street!" Rather, our Newsletter should be used by everyone as a popular medium of information sharing on the many important, small-scale farmer "adoptable" by-product and crop residue research projects that are under implementation or being planned in Africa and elsewhere around the world. Before being submitted, papers should be worked on as proposed by the ARNAB Secretariat (see ARNAB Newsletter Vol. 5 No. 1).

One of our best correspondents, Dr John Ayoade, has now left the Bunda College of Agriculture, University of Malawi and is in the United States for a while. Our very best wishes to you, John and let's keep in touch.

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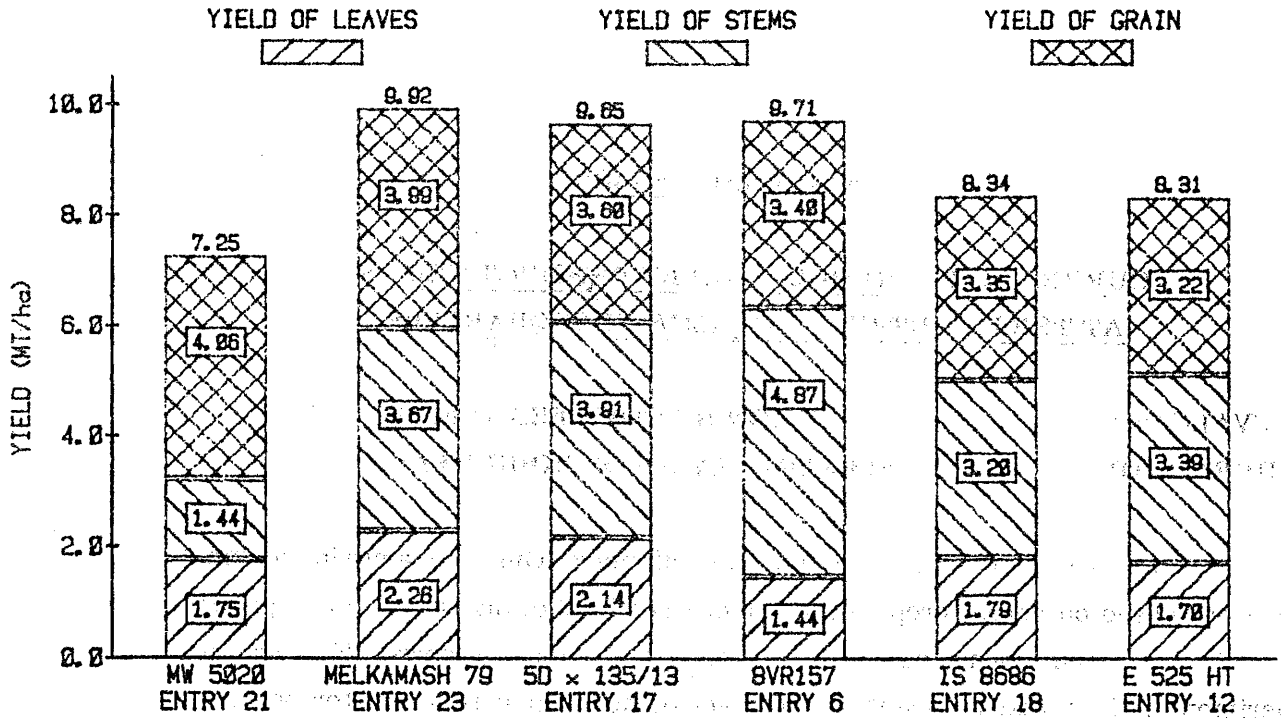

Figure 1. Yields of leaves, stems and grain of the six highest grain yielding varieties of sorghum from a group of 24 varieties.

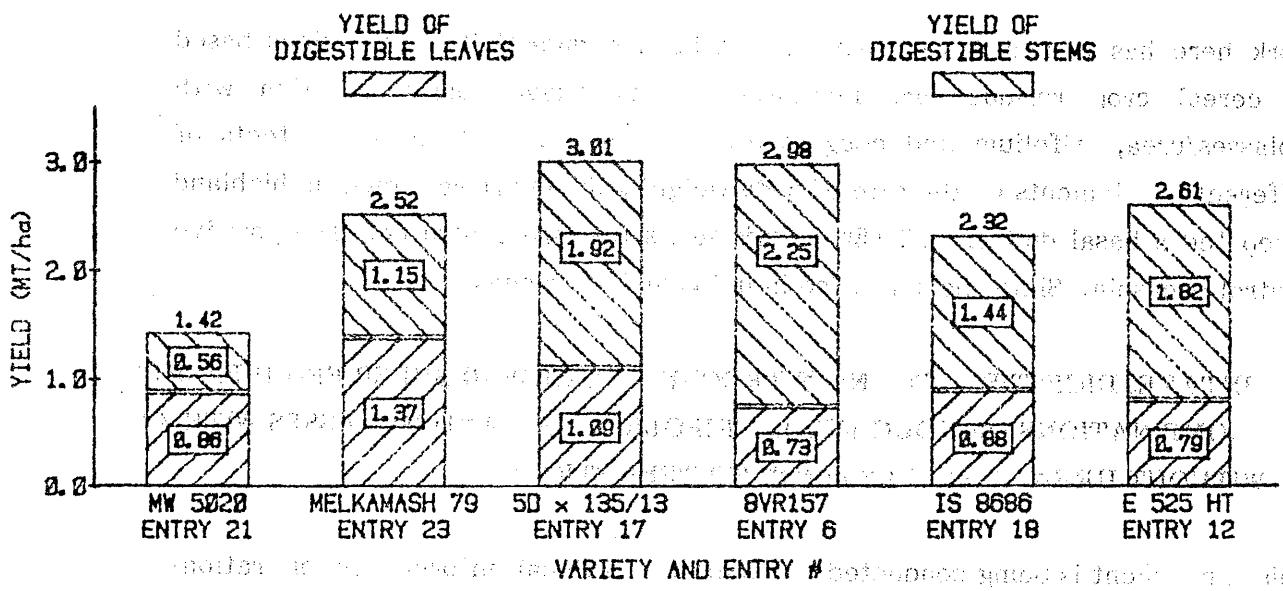

Figure 2. Yields of digestible leaves and stems of the six highest grain yielding varieties of sorghum from a group of 24 varieties.

BEST AVAILABLE

RESEARCH NEWS FLASH

CURRENT CROP RESIDUE AND BY-PRODUCT TRIALS AT THE NUTRITION BARN, ILCA HEADQUARTERS

1. EVALUATION OF MILK PRODUCTION BY COWS FED TEFF STRAW + UREA ALONE OR WITH DIFFERENT LEVELS OF NOUG MEAL

Previous work has shown that the addition of noug (**Guizotia abyssinica**) meal to rations based on cereal crop residues increases intake, digestibility and growth rate of sheep and young cattle, and milk production by cows. The present experiment is intended to quantify the level of noug meal required for optimum milk production. The trial involves 12 cows in a latin square design.

2. GROWTH RATE AND FIBRE PRODUCTION OF SHEEP FED DIFFERENT COMBINATIONS OF NOUG MEAL, TRIFOLIUM HAY AND MOLASSES WITH OR WITHOUT UREA AS SUPPLEMENTS TO TEFF STRAW

Work here has demonstrated that the intake and digestibility of rations based on cereal crop residues are increased by successive supplementation with molasses/urea, trifolium and noug meal. In the current trial, the effects of different supplements on the rate of body weight gain and fibre growth in highland sheep fed a basal diet of teff (**Eragrostis tef**) straw are evaluated. The positive control is casein. Sixty sheep are fed in individual floor pens.

3. INTAKE, DIGESTIBILITY AND NITROGEN BALANCE IN SHEEP FED DIFFERENT COMBINATIONS OF NOUG MEAL, TRIFOLIUM HAY AND MOLASSES WITH AND WITHOUT UREA AS SUPPLEMENTS TO TEFF STRAW

This experiment is being conducted to obtain additional information on rations similar to those used in the previous trial (No. 2). Thirty six intact male sheep are housed in individual metabolic crates.

4. FEED INTAKE AND UTILISATION BY DONKEYS FED DIFFERENT ROUGHAGES

The more than 3.5 million donkeys in Ethiopia are used as beasts of burden and for traction. However, little is known world-wide about feed intake and utilization by donkeys. The first phase of this trial (now in progress), is a digestibility experiment with the donkeys being held in stalls without work. The second phase will also be a digestion balance trial, but the donkeys will be worked (will carry 0, 50 or 100 kg loads) for four hours a day.

In both phases of the experiment, three forages fed **ad libitum** are cereal (teff) straw, poor quality meadow hay and medium quality forage legume (**Stylosanthes guianesis,** cv Cook). No supplements are provided. Nine donkeys are used in a latin square design.

5. EVALUATION OF PRACTICAL RATIONS FOR FINISHING YOUNG SHEEP

Previous trials here have shown the value of combinations of legume hay and molasses/urea as supplements to cereal straws. The objective of the present experiment is to investigate the feasibility of a group feeding system based on these ingredients. Thirty six sheep are used in four groups of nine each.

6. THE USEFULNESS OF INDIGOFERA VOLKENSII AS A POTENTIAL DRY SEASON DIETARY SUPPLEMENT FOR LIVESTOCK IN THE SEMIARID TROPICS

Severe reductions in forage availability and quality during the dry season decrease milk production by cattle correspondingly. Mortality rate of calves is increased and maturity is delayed by these feed limitations. Being chiefly grazers, cattle (especially calves between 0 to 9 months of age) are affected by the dry-season feed shortage more severely than sheep and goats. A way to help pastoralists maintain the weight of cattle during the growth period and, hence, to increase their production must be found.

Indigofera volkensii, a leguminous browse species that grows to a height of 15 to 30 cm, is so cherished by all species of livestock that it is usually eaten to the ground, so that by the end of the dry season it is unavailable except in areas fenced off under hedges or bushes.

The objective of this experiment, a collaborative research project between ILCA's Nutrition Unit and Southern Rangelands Program, is to determine the usefulness of **Indigofera volkensii** as a dry-season dietary supplement for young cattle. Two sets of four castrated young cattle will be used in a 4 x 4 latin square design.

Other residue and by-product research projects planned for implementation after the conclusion of the above experiments will be described in the September edition of the ARNAB Newsletter.

Anyone wishing to give ARNAB's readership an advance information about crop residue and agro-industrial by-product research work in progress or planned may do so by sending the ARNAB Scientific Secretary the titles and brief descriptions of those projects.

NOTICE: A NEW BOOK WRITTEN BY AN ILCA SCIENTIST

Dr Martyn H Butterworth, Head of the Nutrition Unit and Deputy Director of Research at ILCA, and a primary supervisor of ARNAB, has recently written a book entitled **"Beef Cattle Nutrition and Tropical Pastures".** The 500-page book was published this year by Longman, London. ARNAB congratulates Dr Butterworth for this commendable effort. Those who wish to take a "breather" from residue and by-product work may find this book useful.

RESEARCH BRIEFS

PERFORMANCE OF GROWING LANDRACE X LARGE WHITE PIGS FED RATIONS CONTAINING SUN-DRIED, CAGED POULTRY MANURE

by

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MATERIALS AND METHODS

Sun-dried, caged poultry manure (39.6% crude protein and 2590 Kcal/kg gross energy) was substituted for maize meal (in a practical type ration containing 64% maize meal) for growing pigs. The levels of manure fed were 0, 5, 10 and 15%. One of the four rations was fed to each of a group of 14 Landrace X Large White pigs (about 9 kg) for 90 days, for the purpose of evaluating growth performance and carcass characteristics.

RESULTS AND CONCLUSION

Treatments did not adversely affect the health of pigs (see the following table). Based on the results presented in this table, it was concluded that growing pigs could be raised on a maize-based ration containing up to 15% of caged poultry manure without serious depressions in growth rate and carcass characteristics.

THE PERFORMANCE AND CARCASS CHARACTERISTICS OF PIGS GIVEN FOUR EXPERIMENTAL RATIONS

	Level of caged poultry manure in the ration				
	0%	5%	10%	15%	SE$\bar{X}$
Initial liveweight (Kg)	8.50	8.63	8.50	9.50	0.36
Final liveweight (Kg)	35.33	41.50	33.13	40.00	1.09
Daily weight gain (Kg)	0.33	0.39	0.27	0.33	0.01
Feed intake Kg/Kg gain	4.82	3.97	4.86	4.63	0.23
Hot carcass weight (Kg)	17.90	19.56	19.95	24.80	1.11
Chilled carcass weight (Kg)	17.47	19.15	19.65	24.47	1.11
Dressed out value	0.49	0.46	0.59	0.46	0.02
Dressing (%)	50.67	46.67	59.53	62.07	1.82

THE VOLUNTARY INTAKE AND DIGESTIBILITY OF DIETS CONTAINING DIFFERENT PROPORTIONS OF TEFF (ERAGROSTIS TEF) STRAW AND TRIFOLIUM (TRIFOLIUM TEMBENSE) HAY WHEN FED TO SHEEP

BY

[1]A K Mosi and [2]M H Butterworth

[1]Accra, Ghana and [2]Nutrition Unit, ILCA HQ

INTRODUCTION

Procedures for improving the nutritive value of crop residues by chemical methods have not been adopted by farmers in most developing countries because of lack

of information and the necessary inputs. However, there is a wide variety of indigenous legumes which could improve soil fertility (through biological nitrogen fixation) to help boost the yields of cereal crops planted after harvesting the legumes (Haque and Jutzi 1985). The legumes could also be used as supplements to crop residues to improve the nutritional status of livestock.

There are about 30 native clover species in the Ethiopian Highlands, one of which is **Trifolium tembense.** The objective of this experiment was to assess the value of increasing levels of trifolium hay as a supplement to teff straw (an important cereal staple in the Ethiopian Highlands) fed to sheep.

MATERIALS AND METHODS

Trifolium hay was chopped and mixed with chopped teff straw so as to constitute 35, 45 and 65% of the final mixture. However, due to a large degree of selective consumption, the actual proportions of legume in the feed consumed were 20, 25 and 35%.

Twenty rams (25 ±3 kg) were tethered in individual digestion cages. Five animals were fed each of the straw/trifolium mixtures at 125% of voluntary intake. The remaining five sheep were fed teff straw alone. Water and cobalt iodized salt were available **ad libitum.** Adjustment and voluntary intake periods of 10 and 7 days, respectively, were followed by 7 days of total fecal and urinary collection. Samples of feces, feeds offered and refused were dried at 60°C for 48 h, ground and analysed chemically. Urine was collected in sulfuric acid and aliquots of it were analysed for total nitrogen.

RESULTS AND CONCLUSION

The chemical composition of the diets consumed by sheep is given in Table 1. The addition of trifolium increased the levels of protein and phosphorus and reduced that of NDF in the ration; otherwise, there was little change.

Total dry matter (DM) intake was increased by 20% and 25% trifolium hay (Table 2). Addition of 35% trifolium did not further significantly increase DM intake. There was a decrease in teff straw consumption at all levels of trifolium.

The addition of trifolium did not affect DM, OM, NDF, ADF or cellulose digestibility. However, crude protein digestibility was improved significantly by the addition of 25 and 35% trifolium. Successive increments of trifolium

significantly increased N retention, converting a ration which at best could support maintenance, into those capable of supporting modest growth.

Reference:

Haque I and Jutzi S 1985. Nitrogen contribution of four legumes to a subsequent maize crop. ILCA Newsletter 4(3):6

(The paper just abstracted will be published in "Tropical Animal Production" in 1985).

Table 1

CHEMICAL COMPOSITION OF CHOPPED TEF STRAW AND TRIFOLIUM MIXTURES CONSUMED BY SHEEP

COMPONENT	Percent trifolium			
	0	20	25	35
Dry matter (as fed)	91.06	91.72	90.95	90.99
	Based on 100% DM			
Organic matter	93.30	90.04	88.66	88.33
Crude Protein	4.24	7.71	10.75	13.20
Ash	6.60	9.96	11.34	11.67
NDF	74.40	69.34	67.50	65.11
ADF	40.96	40.81	40.76	40.70
Lignin	5.58	5.59	5.60	5.61
Cellulose	35.38	35.22	35.16	35.09
P (mg %)	201.56	212.70	216.85	222.14

Table 2

THE VOLUNTARY INTAKE AND DIGESTIBILITY OF DIETS CONTAINING DIFFERENT PROPORTIONS OF TRIFOLIUM HAY AND TEF STRAW WHEN FED TO SHEEP

COMPONENT	Percent Trifolium			
	0	20	25	35
Intake of DM (g/kgW$^{0.75}$)				
Tef straw	44.8^{a}	43.7^{a}	42.8^{a}	38.1^{b}
Trifolium hay	-	10.5	15.4^{b}	21.0^{c}
Total dry matter	44.8^{a}	54.2^{b}	58.2^{c}	59.1^{c}
Digestibility (%)				
Dry matter	46.9	45.8	49.3	49.6
Organic matter	50.4	52.3	49.4	50.4
Crude protein	18.6^{a}	19.2^{a}	25.0^{b}	27.5^{b}
Neutral detergent fibre	55.3	55.4	55.9	53.8
Acid detergent fibre	55.4	54.0	54.6	53.2
Cellulose	63.8	61.9	61.2	61.6
Nitrogen retention (g/day)	-0.15	0.18^{b}	0.55^{c}	1.03^{d}

Values within the same row with different superscripts are significantly ($P<0.05$) different

EFFECTS OF LEVELS OF NOUG (GUIZOTIA ABYSSINICA) CAKE AND DIFFERENT WATERING FREQUENCIES ON BODY WEIGHT CHANGE IN HIGHLAND SHEEP, AND ON THE INTAKE OF TEFF (ERAGROSTIS TEF) STRAW, MOLASSES/UREA AND WATER

By

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ILCA HQ

INTRODUCTION

Pastoralists in many parts of Africa (especially in light of the recurring droughts in large parts of the continent), water their livestock at certain intervals. For example, the Boronas of Southern Ethiopia water their sheep and goats, and cattle at 5- and 3-day intervals, respectively.

The objectves of this experiment were to evaluate the intake and utilization of teff straw fed with and without noug cake; growth rate and some rumen parameters in sheep given molasses/urea **ad libitum,** and subjected to three watering frequencies. These frequencies were: **ad libitum,** once a day for 30 minutes and once every three days for 30 minutes.

MATERIALS AND METHODS

The trial consisted of 3 phases: feeding and growth phase (Days 1-84, including a 10-day adaptation period), digestion balance phase (Days 86-100) and rumen fluid collection (Days 100-102). Procedures and other discussions presented below pertain only to the feeding and growth phase.

The experiment was arranged as a 2 (0 and 100 g noug cake/sheep/day) x 3 (watering frequencies) factorial. There were four sheep on each watering frequency, two with and two without noug cake. Molasses/urea (2.5% urea, W/W) was fed in a small can securely placed in a compartment within each metabolism crate. Noug cake was fed in the other compartment.

For all sheep, water was served in plastic buckets securely tied onto the crates. Water was weighed before and after being offered. Water for sheep on the **ad libitum** regime was weighed before being provided, and at least once a week (after being mostly drunk or to replace with fresh supply).

Samples of straw, noug cake and molasses-urea offered, and straw refused were dried at 60°C for 24 h, ground and analysed chemically. Sheep were weighed weekly, without prior fasting.

RESULTS AND CONCLUSIONS

Interaction between level of noug cake and watering frequency was not significant ($P \leq 0.05$) for any of the parameters measured (see the following table). Sheep given noug cake ate less straw, consumed more molasses/urea and more total feed DM, drank more water, and gained more (or lost less) weight than those without access to the meal.

Straw consumption was significantly depressed by the availability of noug cake (equivalent to about 16.5% of the diet DM intake), and of molasses/urea. The correlation between the intakes of straw and molasses/urea ($r=-0.67$) was highly significant ($P \leq 0.017$). The reduction in straw intake by molasses-urea may have been caused by the depressing effect of the sugars contained in molasses on the digestion of cellulose and to substitution (especially since molasses was available **ad libitum**).

Sheep on the **ad libitum** watering regime consumed more molasses/urea, total feed, and water, and gained faster than those on the other frequencies. However, sheep given free access to water consumed less straw than those watered once/3 days. For all parameters except water intake, sheep on the once a day watering frequency performed the poorest. Performance by sheep on the once/3-day watering interval exceeded that of those watered once a day, probably because of the sharp increase in total feed and water intake on the day that water was provided. On the average, the increase in feed consumption on the day that water was given was 60-90% more than the average feed intake during the following two days of water deprivation.

FEED AND WATER CONSUMPTION, AND SHEEP LIVEWEIGHT CHANGE

PARAMETER	EFFECTS OF NOUG CAKE			EFFECTS OF WATERING FREQUNENCY			
	+ 100 g Noug	No. Noug	$\overline{SEX}$	Once/3 days	Once/ day	Ad Libitum	$\overline{SEX}$
Straw Intake g/day)	159[b]	249[a]	36	231[a]	171[b]	207[ab]	44
Molasses/urea Intake (g/day)	702[a]	530[b]	49	575[b]	567[b]	707[a]	60
Total DM Intake (g/day)*	694[a]	569[b]	24	589[ab]	527[c]	652[a]	30
Water Intake (liters/day)	1.62[a]	1.1[illegible][b]	0.05	1.10[b]	1.17[b]	1.83[a]	0.07
Liveweight change (g/day)	23.3[a]	-5.70[b]	6.50	9.70[ab]	-11.10[b]	27.80[a]	8.00

a, b, c For each the effects of noug cake and watering frequency, means within rows with the same superscript are not significantly different ($P \leq 0.05$).

* Includes straw, molasses/urea and noug cake at DM contents of 90, 65 and 95%, respectively. All the noug cake offered was consumed.

CHEMICAL EVALUATION OF CHICKEN DROPPINGS

(An Abstract)

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An experiment was carried out to determine the chemical composition of the droppings from young cocks (raised on deep litter), pullets (on deep litter), layers (deep litter), layers (slatted floors), layers (cages) and pullets (electric tier brooders).

Droppings from layers in cages and from young cocks contained the highest and lowest crude protein (CP) contents, respectively ($P \leq 0.01$). Crude fiber (CF) content showed the reverse trend. Ash content of droppings from all layers was highest, while it was lowest for young cocks. Cage waste, although highest in CP content, was so high in ash content that its usefulness as a feed ingredient is limited. Therefore, droppings from layers on deep litter (high in CP and relatively low in CF contents) were considered the most suitable potential feed resource.

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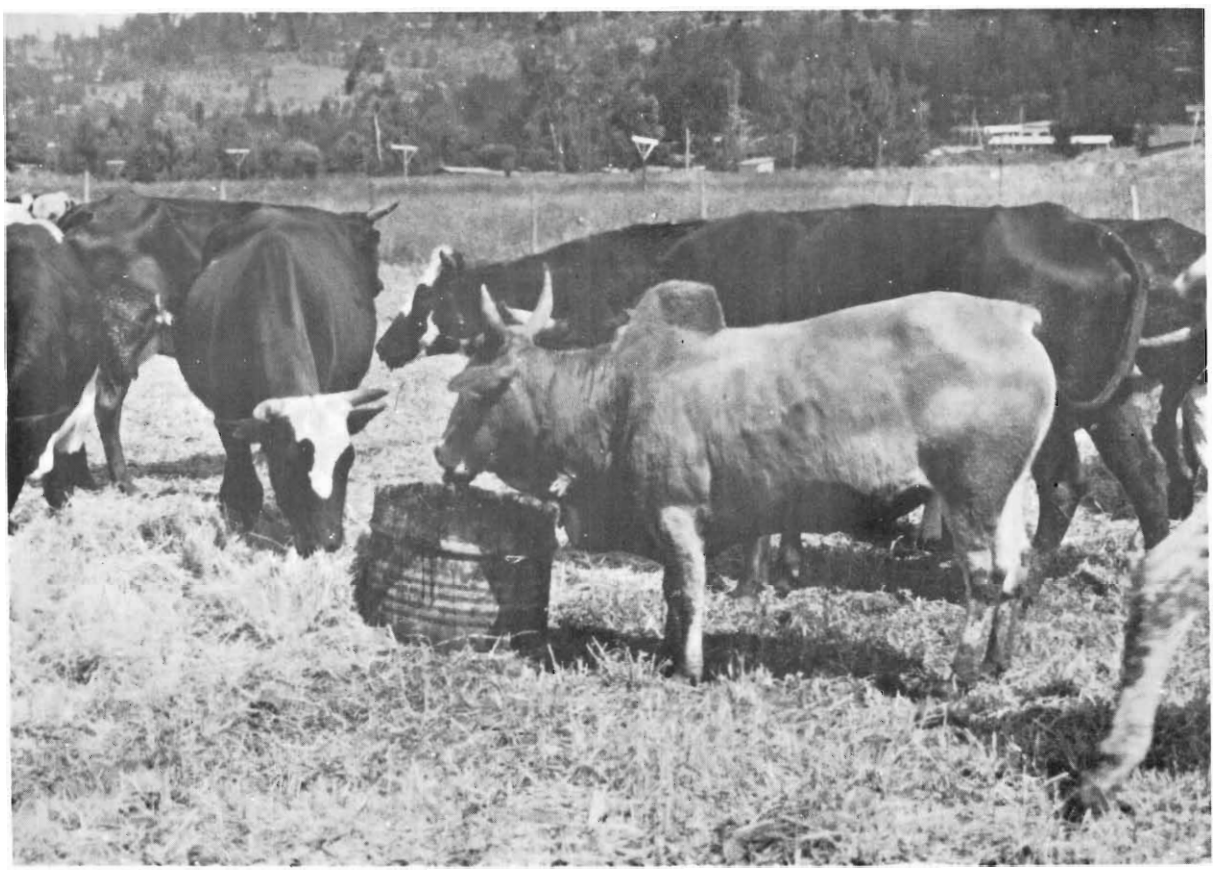
** SPECIAL EDITION **

ARNAB goes to Alexandria, Egypt



On the occasion of the 2nd Annual Workshop of ARNAB

ARNAB GOES TO ALEXANDRIA

I. INTRODUCTION:

The African Research Network for Agricultural Byproducts **(ARNAB)**, will hold its second annual workshop at Alexandria University, situated in the Mediterranean Sea port city of Alexandria. The first annual workshop of ARNAB was held in November 1984 at the Headquarters of the International Livestock Center for Africa (ILCA), in Addis Ababa. As part of our continuing efforts to keep our readership informed about ARNAB's activities, we are dedicating this edition of our Newsletter to the Alexandria workshop. We feel it appropriate to precede a discussion of the abbreviated workshop program with a quick glance at **Egypt**, a country in Northeast Africa.

II. EGYPT AT A GLANCE:

A. Population and Land Area:

Nearly all of Egypt's **46 million** people are currently living in the 35,189 sq km fertile Nile Valley and Delta, a mere 3.5% of the land area (1,002,000 sq km). The other inhabitated areas of Egypt include points along the Suez Canal, the 4,023 km of coastline on the Red and Mediterranea Seas, and the Gulf of Aqaba. The uninhabited area (96.5% of the country), consists of the Western and Eastern Deserts, and the Sinai Peninsula.

B. Cities:

Expansion outside of the currently inhibited areas is an essential goal of the current Five-Year (1982/83 - 1986/87) Development Plan. To curb rural migration to cities and thereby relieve population pressures from Cairo (the crowded capital

city with 11 and 6 million people during and at the end of each work day, respectively) and the other major cities (Alexandria Port Said, Ismailia, Suez, Luxor and Aswan), newer or **"Satellite"** cities (i.e. **10th of Ramadan, Sadat and 15th of May**), are being constructed on the fringes of the desert. The sites chosen are those where natural wealth (whether for agricultural or industrial use) exists, so that the new communities are economically and socially self-sufficient. To realize this goal of self-sufficiency universities are being built in all cities, so that students can stay home to complete their education. Banking services, movie houses, hospitals, sporting facilities, housing projects, and industrial plants contribute to make living in the smaller cities attractive.

C. Education:

On July 23, 1952, a group of "free officers," led by Gamal Abd El-Nassar, forced King Farouk to abdicate. Feudalism and foreign occupation in Egypt where finally brought to an end, and a socialist form of government was instituted.

Up to the **Egyptian Revolution** (July 23, 1952), there were only **four** universities in Egypt: the hallowed and world's oldest existing university, **Al Ahazar** (built in AD 972), **Cairo** University (built in 1908), **Alexandria** University (1942) and **Ein Shams** University (1950). At present, there are **eighteen** universities in Egypt.

One of Egypt's greatest assets today is its higly skilled and educated human resources, a development made possible by a **free education** system from the primary school stage through university and by the policy of the Egyptian Government to have a university in each of the smaller cities. Students living in each area are required to attend their "hometown" universities, unless their fields of study are not available there.

D. Tourism:

Egypt is a tourist attraction because of a mild year-round climate and a cultural heritiage uniting elements of the Pharaonic, Roman, Coptic, Islamic and modern eras. The major touristic sites and locations in Egypt include the Pharaonic

monuments (the most important ones being in Aswan, Luxor, Guizeh, Tell El Amarna, and Tourah El Gabal), Christian monuments (i.e. churches and monasteries) and islamic monuments (i.e. mosques, museums and citadels), the Pyramids, Sphinx, beaches (on the Mediterranean and Red Seas), lakes, oases and the botanic garden in Aswan.

E. Agriculture:

It was in Egypt some 6,000 years ago that man revolutionized agriculture with the development of new irrigation techniques, the use of draught animals, and the invention of the plow and the **ahaduf,** a device for lifting water from the Nile River into canals.

At present, nearly all the area under cultivation (2.6% of the nation's territory), is found in the Nile Valley and Delta. Except on the Mediterranean coastline, rainfall in Egypt is very slight. Egypt is therefore truly a gift of the Nile River, since without the vast irrigation projects that have been built on this river, Egypt would be a total desert.

That life in Egypt depends on the Nile River is also underscored by the other ways that its water is used. The quantities of water from the Nile used for agriculture. power generation, drinking and household use, and industry are (in billion cubic meters/year): 49.7, 4.0, 3.3 and 2.5, respectively.

Scientific research in Egypt has made great contributions to the socio-economic development of the country. The areas where the greatest achievements have been made (in decreasing order of importance) are: agriculture, industry, health and environment, mining, geology, oil and energy, transport and communications, and housing.

Despite the rapid growth of other sectors of the Egyptian economy, agriculture remains the country's most important wealth-generating activity. It absorbs 47.7% of the total labor, and provides 75% of the exports and 30% of the gross national product. The other areas that make major contributions to the Egyptian national income are the public sector; processing; trade, restaurants and hotels; transport, storage and communications; and construction and building, which absorb 13.3, 8.4, 4.7 and 4.1% of the total labor force, respectively.

F. References used for "Egypt at a Glance:"

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III. THE ARNAB WORKSHOP: ALEXANDRIA UNIVERSITY. 14-18 October 1985

It is for the purpose of sharing information on their recent research projects on agro-industrial byproducts, crop residues, and other poor quality feeds; and for visiting agricultural activities around Alexandria and in the Nile Delta to learn of some aspects of the role of agriculture in the socio-economic development of Egypt, that members of ARNAB and invited scientists from outside of Africa will assemble at Alexandria University for the second annual ARNAB workshop. The theme of the workshop is **"Towards increased ruminant livestock production in Africa through the maximum utilization of crop residues and agro-industrial byproducts."**

Plenary and **Regular Workshop** papers will be presented. The topic of the plenary papers is:**"Recent developments in and research priorities for feeding systems using crop residues and agro-industrial byproducts in ruminant nutrition."** The Regular Workshop papers will be on: **"Recent research on the utilization of crop residues and agro-industrial byproducts at ARNAB and invited institutions."**

The plenary papers will be presented by speakers representing the Bangladesh Network and ARNAB, and the regular workshop papers by speakers from the following countries (along with titles of their respective papers).

1. Cameroon:

"The nutritive value of ensiled maize stover and brewers' grains for sheep and goats."

2. Cyprus:

"Byproducts utilization in ruminant diets in Cyprus."

3. Egypt:

1. "Required minerals for the improvement of poor quality roughages."
2. "Byproduct utilization in feeding ruminants in Alexandria, Egypt."
3. "Inclusion of leaf extraction residues in byproduct rations."
4. "Nutritive value of vegetable fruit wastes as animal feeds."

4. England:

"Urea versus ammonia for upgrading graminaceous materials."

5. Ethiopia:

1. "Results of ILCA-Ethiopian Ministry of Agriculture collaborative on-farm research on the use of molasses-urea for ruminant livestock production."
2. "Some recent research by ILCA on the use of crop residues and agro-industrial byproducts for ruminant livestock production in Ethiopia."

6. Kenya:

1. "ARNAB: Network Expectations."
2. "Use of INFIC Nomenclature on crop residues and byproducts produced in Kenya".

7. Malawi:

1. "Leucaena leaf hay as a protein supplement for goats fed chopped maize stover".
2. "Performance of beef cattle fattened on crop byproducts in Malawi."

8. Mauritius:

1. "Utilization of sugar cane tops in combination with **Laucaena leucocephala** as feed for goats"

2. "Upgrading liguo cellulosic waste by microbiological treatment."

9. Nigeria:

1. "Effects of silage, added nitrogen and energy on utilization of grain sorghum stover by beef cattle in Zaria, Nigeria."
2. "Utilization of cassava peel in backyard sheep and goat production in Nigeria."

10. Senegal:

"Prediction equations for estimating nutritive value and intake of some residues and byproducts."

11. Sudan:

1. "Prospects for efficient utilization of crop residues and agro-industrial byproducts for ruminant feeding in Sudan, with empahsis on quantification, constraints and research results."
2. "Methodology for livestock on-farm trials using agricultural byproducts."

12. Tanzania:

1. "On-farm research utilization of crop residues in dairy cattle feeding in Hai District, Kilimanjaro Area, Tanzania."
2. "Surveys and on-farm research among small-scale holder dairy farmers in Hai District, Kilimanjaro Area, Tanzania."

13. Zimbabwe:

"The use of crop residues in livestock production systems in the communal areas of Zimbabwe."

IV. PROCEEDINGS OF THE ARNAB WORKSHOP:

The proceedings of the workshop will be published as a matter of priority for ARNAB. Each ARNAB member institution and invited participant from other institutions will be given one copy of the proceedings. Subscribers to our Newsletter may have copies of the proceedings, at a cost to be decided by the ARNAB Steering Committee.

ARNAB Newsletter
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INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA, P.O. BOX 5689, ADDIS ABABA, ETHIOPIA

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HIGHLIGHTS OF THE SECOND ANNUAL WORKSHOP OF ARNAB

(University of Alexandria; Alexandria, Egypt. 14-17 October 1985)

1. Attendance:

Twenty three papers were presented by scientists from ARNAB's sponsoring organizations (International Development Research Centre and International Livestock Centre for Africa), Cameroon, Cyprus, Egypt, England, Kenya, Malawi, Mauritius, Nigeria, Senegal, Sudan, Tanzania and Zimbabwe. The first draft of the workshop proceedings is being reviewed.

2. Major Themes Covered by Papers Presented:

a. Use of leguminous forages and agro-industrial byproducts as supplements to cereal crop residues.
b. Use of poultry litter and other livestock wastes as non-protein nitrogen and mineral supplements to poor quality feeds.
c. Use of conserved forages, under certain conditions, to feed livestock in some developing countries.
d. Use of the International Network of Feed Information Centres (INFIC) system to provide standardized nomenclature for crop residues and agro-industrial byproducts.

3. Election of the ARNAB Steering Committee:

The Steering Committee will assist the ARNAB Secretariat in expanding the membership of the Network and in strengthening ARNAB research and other activities. The members of the Steering Committee (first four elected and last three ex-officio members) are:

a. Prof. Abdullah Said (East Africa Representative). University of Nairobi, P O Box 29503, Nairobi, Kenya
b. Prof. Anthony Adegbola (West Africa Representative). University of Ife, Ile-Ife, Nigeria
c. Dr Moustafa El-Naga (Committee Chairman and North Africa Representative). University of Alexandria, Alexandria, Egypt
d. Mr Simba Sibanda (Southern Africa Representative). Department of Research and Specialist Services, Ministry of Agriculture, Harare, Zimbabwe
e. Prof. Jackson Kategile (IDRC Representative). Nairobi Regional Office, P O Box 62084, Nairobi, Kenya
f. Dr Doug Little (ARNAB Coordinator). Animal Nutrition Unit, ILCA, P O Box 5689, Addis Ababa, Ethiopia (from March 1986)
g. Dr Mopoi Nuwanyakpa (ARNAB Scientific Secretary and Committee Secretary). Animal Nutrition Unit, ILCA, P O Box 5689, Addis Ababa, Ethiopia

Our readers in Africa who are interested in becoming members of ARNAB are encouraged to contact the Network Representatives in their regions or the Secretariat.

4. Theme and Venue of ARNAB's 1986 Workshop:

The theme of ARNAB's 1986 workshop, to be held in Lilongwe, Malawi in August, is "The Utilization of Crop Residues and Agro-industrial Byproducts with emphasis on Technologies Applicable to Small-scale African Farmers." This theme was selected a year in advance of the workshop to guide some of the research activities at ARNAB member institutions. Scientists from outside of Africa will also be invited to speak on byproduct research and other current topics in ruminant nutrition.

People interested in attending the workshop are invited to inform the Secretariat and to submit titles of papers they wish to present. Funds will be available to support only a small number of ARNAB members, so early expressions of interest would be desirable.

LEUCAENA LEUCOCEPHALA: A USEFUL FEED MAY BECOME EVEN MORE USEFUL

(A Brief Look at Some Litertaure on Leucaena)

By

M Y Nuwanyakpa

ILCA HQ

Some Agronomic Characteristics of Leucaena

Leucaena leucocephala (Lam) de Wit is a deeply rooted perennial leguminous shrub or tree that grows up to 20 m high (National Academy of Sciences 1977). It is established either by direct sowing into a well-prepared seedbed or between rows of maize, sorghum or other crops. It grows at altitudes ranging from sea level to 1800m (Bogdan 1977; Skerman 1977), thrives in its native Central America in areas with dry seasons as long as 8.5 months, but performs vigorously in tropical and subtropical lowland areas with subhumid and humid climates (National Academy of Sciences 1977). Although Leucaena can tolerate annual rainfall as low as 250 mm (National Academy of Sciences 1977) and as high as 5,000 mm (Bogdan 1977), it grows best where annual rainfall is 600 - 1,700 mm (National Academy of Sciences 1977). The dry matter yield of Leucaena, 1,360 - 18,650 kg/ha/year, is affected mainly by rainfall and cultivar (Bogdan 1977).

Some of the main attributes of Leucaena are tolerance to drought, repeated defoliation and low soil fertility, and not being fastidious regarding soil and climatic requirements (Bogdan 1977; Skerman 1977). Although the plant can survive and even grow aggressively in many marginal soils and environments, its exceptional yields occur only in fertile, well-drained soils where rainfall or irrigation is adequate (National Academy of Sciences 1977). Some deficiencies include its poor tolerance to waterlogging and to very acid soils below (pH5), slow growth up to establishment and a highly specific rhizobium requirement (Skerman 1977).

Usefulness of Leucaena as a Livestock Feed

Leucaena's usefulness lies in its availability during drought, its high palatability, high crude protein content (similar to that of alfalfa), and high digestibility (Skerman 1977). Nuwanyakpa (1986) found a CP

content and **in vitro** DM digestibility of 20% and 72% respectively in leaves and petioles of 3-year old stands of Leucaena. Liveweight gains of 1 kg/day were reported in steers grazing a Leucaena-**Setaria anceps** pasture in Queensland (Le Houerou 1980), a gain roughly thrice those obtained from some improved tropical pastures (Nuwanyakpa 1982). A 4:1 mixture of maize bran and Leucaena meal produced liveweight gains of up to 1.17 kg/day in stall-fed cattle for over six months (Beale 1980).

Leucaena Toxicity

Problems of Leucaena feeding include poor liveweight gains, depressed appetite, alopecia, enlarged thyroid glands, depressed thyroxine levels, ulceration of the oesophagus, death of newborn offspring (Jones 1979), and a possible tainting of meat and milk because of the high content of pigments (Beale 1980). The severity of these problems depends on the daily intake and duration of feeding Leucaena (Holmes 1981). These problems are caused directly by the presence of the toxic non-protein amino acid, mimosine, or indirectly by 3-hydroxy-4 (1H)-pyridone (DHP), the ruminal or enzymatic metabolite of mimosine (Lowry 1982), which being a potent goitrogen (Hegarty et al 1979), causes hypothyroidism (Jones and Hegarty 1984).

The level of Leucaena feeding beyond which toxicity is usually said to occur is 30% of the diet DM (Le Houerou 1980). Jones and Hegarty (1984) studied the effects of diets containing 10, 20, 40, 67 and 100% Leucaena on steer growth rate, DM intake, urinary DHP excretion and thyroid function. They reported linear increases in urinary DHP excretion (and presumably DHP in the circulatory system) and mimosine intake, and reductions in feed intake and growth rate with increasing level of Leucaena feeding. Both circulating DHP (**per se** or through its goitrogenic action) and low serum thyroxine levels are implicated in depressing the intake of Leucaena diets (Jones and Hegarty 1984).

Detoxification of Mimosine and DHP

Mimosine can be degraded to DHP, pyruvic acid and ammonia either enzymatically or through microbial action (Lowry 1982). The enzyme

necessary to convert mimosine is contained in some Leucaena cells that also harbor mimosine, e.g. in seedlings (Smith and Fowden 1966), and leaflets and the laminae of green pods of mature plants (see Lowry 1982). Other parts of Leucaena that contain mimosine but not the enzyme include leaf petioles, rachides, rachillae, stem and mature seeds (Lowry 1982). Rapid autolysis of mimosine to DHP occurs after maceration of tissues in ingested fresh Leucaena (when the enzyme and mimosine come in contact), at temperatures between 55-70°C, which are high enough to cause plasmolysis in the cell, but not enough to denature the enzyme, and after addition of slightly alkaline saliva. For example, when fresh, intact Leucaena was fed to a goat fitted with an esophageal fistula, 30% conversion of mimosine occurred before the ingesta reached the rumen (Lowry 1982). Because rumen pH in roughage-fed animals is seldom acidic, microbial activity **per se** is not necessary to convert mimosine to DHP when fresh Leucaena is given (Lowry 1982).

The enzyme becomes inactive at low pH (<4.0), when Leucaena is heated suddenly to temperatures higher than 70°C, or when sun-dried under clear sky. These conditions leave mimosine essentially unaffected (Lowry 1982).

Special rumen bacteria are required to degrade DHP to its non-toxic metabolites (e.g. Jones et al 1985). The microbes which detoxify mimosine and DHP, probably first discovered in Hawaii (Jones 1981), are strict anaerobes. They can be transferred to unadapted animals through inoculation with the bacteria grown in pure cultures (to serve as a concentrated source of inoculum), or with rumen fluid transferred from adapted animals and infused under anaerobic conditions into the rumen through a stomach tube or a specially-designed drench gun. Spores of the bacteria excreted in the feces can survive aerobic conditions and may be transferred to unadapted animals by drinking water, wind or ingestion with grazed forage. Young animals probably receive their inoculum through maternal licking (Jones 1986, pers. comm.).

A pure culture of two (yet un-named) strains of rumen bacteria, prepared in Australia, has recently been transferred to two goats and two sheep at ILCA. A period of four weeks was required for the introduced microbes

to become established. The reasons for such a long period are still unclear, but may be due to competition with existing rumen microorganisms, level of Leucaena feeding and digesta flow rate in relation to generation time of the inoculated bacteria (Ebong 1986, pers. comm.).

The near absence of urinary DHP in these sheep and goats indicates the vitually complete hydrolysis of DHP. Rumen bacteria obtained from the same animals effectively degraded mimosine, 3,4 DHP and 2,3 DHP in culture media (Ebong 1986, pers. comm.).

In a recent study, cattle infused with mimosine and DHP-degrading bacteria gained 1.2 kg/hd/day on a Leucaena pasture, compared with 700 g/day for those grazing the same pasture but without the microorganisms (Jones 1986, pers. comm.). This means that animals having these bacteria can be given virtually 100% Leucaena diets without any toxic effects, although Leucaena's very low sodium content may create other nutritional problems (Lowry 1982). Leucaena is therefore used most efficiently as a supplement (30% or less) to other roughages (Jones and Hegarty 1984). When fed with other feeds, some of the toxic effects of mimosine and DHP may be alleviated through dilution effects of the higher intakes of those feeds (Jones and Hegarty 1984).

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ANNOUNCEMENTS

1. The Schedule of ILCA's 1986 Training Courses:

Training is one of ILCA's strengths. Each year, ILCA sponsors training courses given in English or French. Our readers are encouraged to examine the following schedule and contact the ILCA Directorate of Training and Conferences about sending participants to some courses.

Title	Date	Language	Application deadline
Rural dairy husbandry and technology	20 Jan. - 7 Feb	English	1 Nov. 1985
Standardization of livestock production data	2-13 June	French	1 March 1986
Range ecology and management	23 June - 4 July	French	15 Mar. 1986
Economics of animal health and disease control	21 July - 8 Aug.	French	15 Apr. 1986
Headling and dissemination of agricultural information	18-29 Aug.	French	15 May 1986
African livestock policy analysis	1-26 Sep.	English	1 June 1986
Animal nutrition and forage analysis	6-24 Oct.	English	1 July 1986
Aerial survey methods	3-21 Nov.	English	1 Aug. 1986

Important: Nominations will be accepted only from the candidate's employer. These must include the candidate's name, address, educational qualifications, experience, description of present duties, duties following the training course and primary language. Self-nominations will not be considered.

2. A New Publication by International Poultry Practice:

International Poultry Practice (IPP) provides information and ideas for better poultry production. Its publication, which provides a continuing education program for new and experienced poultry farmers, covers all aspects of poultry production, including authoritative articles on nutrition, disease, physiology, anatomy, breeding, environment, problem-solving and financial matters.

Readers who wish to receive this publication should contact: International Poultry Practice; P O Box 237; Cambridge CB4 3AW, England.

3. An Appropriate Technology Venture Enhances Animal Nutrition Research at ILCA and Elsewhere in Africa

A small-scale (Appropriate Technology) enterprise capable of making abomasal and rumen cannulae, and livestock urinary collectors has been located in Addis Ababa. After several months to a year of field testing in training courses and research by the ILCA Animal Nutrition Unit, the rumen cannulae and urine collectors (see Plates 1 and 2) have worked satisfactorily. The abomasal cannula (Plate 3) is still being tested.

Obtaining any of these items from abroad delayed implementation of some research projects because of high purchasing and shipment costs, and long delivery time. By greatly reducing the cost and delays in delivery time, these durable, technically effective and locally-manufactured products have enhanced aspects of nutrition research at ILCA. At the completion of the 1985 ILCA course on Animal Nutrition and Forage Analysis, each participant was presented with a cattle or sheep rumen cannula as an encouragement to use the products in some of their research work. Requests for some of these items have already been made by other researchers in Africa.

Inquiries about purchasing should be sent to: Mr Berhanu Mewa; General Manager; Processing of Poly-industrial Chemicals; P O Box 30848; Addis Ababa, Ethiopia. Telephone: 11-60-35.

The ARNAB Secretariat, involved extensively in developing these products, will advise the company in responding to requests for them.

Plate 1. A sheep fitted with a locally-made rumen cannula.

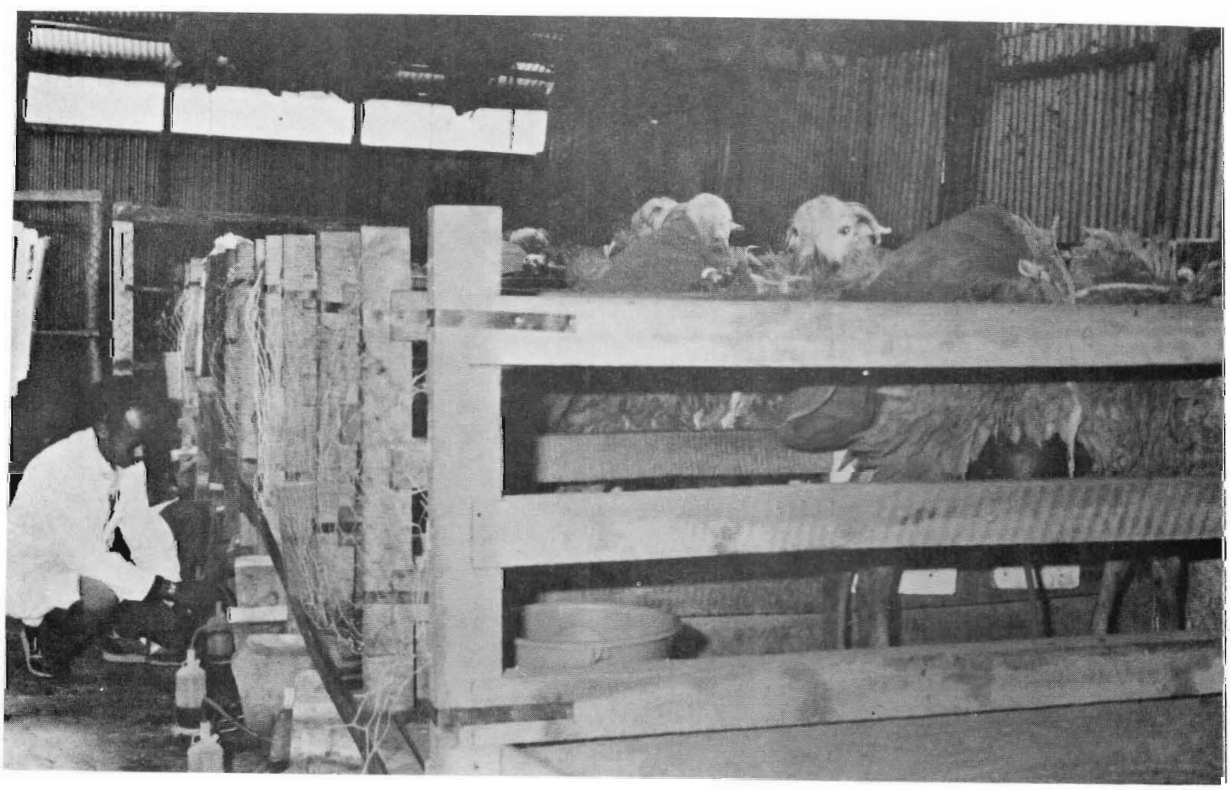

Plate 2. Sheep fitted with urinary collectors (funnel and urine drainage tubing). Urine is collected and acidified in plastic bottles.

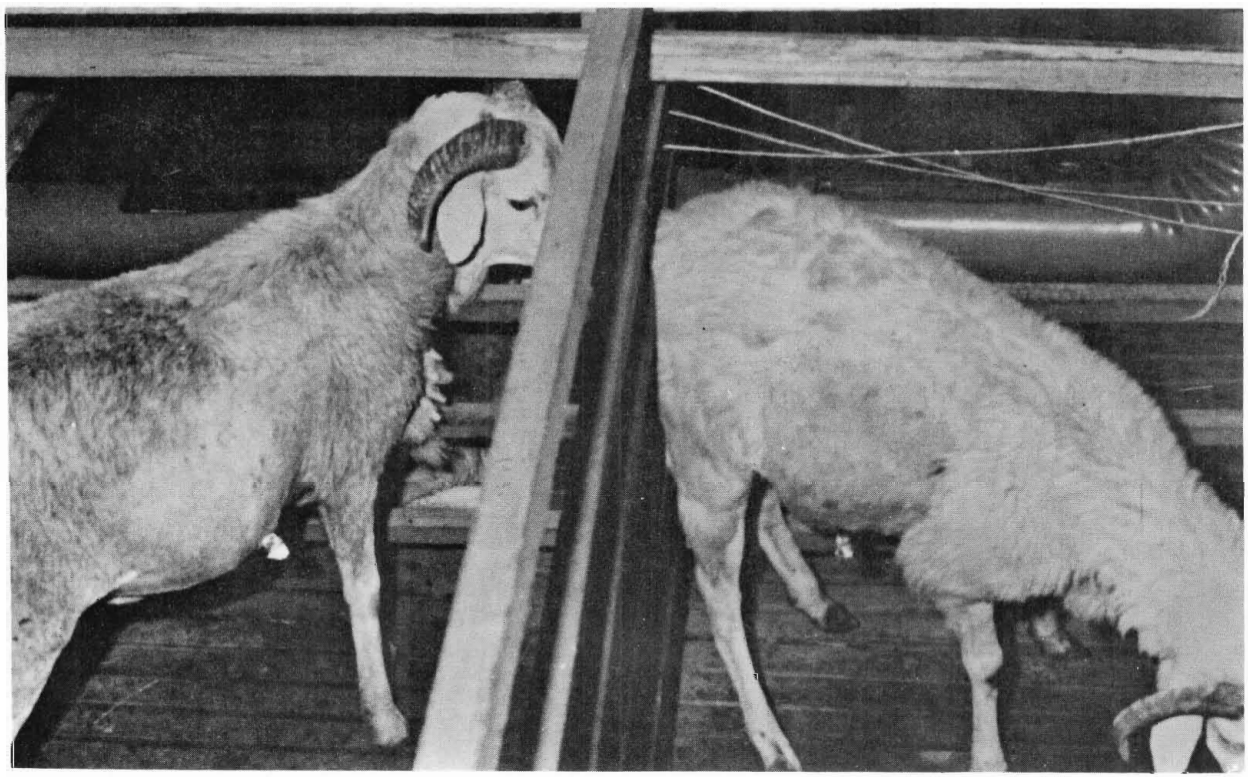

Plate 3. Sheep with abomasal cannulae.

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TOPICAL COMMENTARY

The Effects of Tannins on Animal Nutrition

A Brief Look at the Literature Compiled by

M.Y. Nuwanyakpa
ILCA, HQ

1. Introduction

Herbivores generally select their diets according to protein, mineral and digestible energy content (Marten 1978). However, secondary plant compounds in many forages may have a greater effect on diet selection than nutrient content (Mckey et al. 1978; Bryant 1981; Palo 1985; Palo et al. 1985). Polyphenolic compounds, which include tannins and lignin, are quantitatively the most important secondary plant compounds in livestock feeds. The effects of tannins on animal nutrition have been reviewed by Mcleod (1974) and Kumar and Singh (1984). This article summarizes the material in these reviews as well as other publications in order to introduce reader of the ARNAB Newsletter to the problem of tannins in livestock feeds.

2. Tannin Chemistry

Naturally occurring vegetable tannins were probably known to prehistoric man because of their ability to preserve skins through the formation of leather. Tannins can be defined as phenolic compounds that contain a large number of hydroxyl groups and have a high enough molecular weight (MW) to form stable complexes with proteins, carbohydrates and other molecules. These complexes usually precipitate

ANNOUNCEMENT

FOURTH ARNAB WORKSHOP/ANNUAL GENERAL MEETING

1. THEME: Overcoming Constraints to the efficient utilization of Agricultural By-Products as Animal feed.

Sub-themes:

1.1. Physical constraints - collection, transportation, processing etc.

1.2. Agronomic constraints - pre harvest treatments, fertilizer application, early harvesting versus late cropping, breeding for low lignin variety crops vis-a-vis grain/pulses yields.

1.3. Design of experiments for on farm research - how to minimize extraneous sources of variations by carefully planned statistical designs and data analyses.

1.4. Feeding packages constraints - grazing and stall feeding, and use of leguminous crops/fodders in by-products utilization. Manipulations of feeding regimes with mineral, energy and protein sources; with or without simple physical treatments and other practical treatments. Species to include both ruminants, rabbits, poultry, pigs and fish.

1.5. Farm Management constraints - farming systems; an evaluation of the response of the rural communities to new technologies/packages and interventions on by-products utilization: labour availability (calendar of activities) and other cost effective considerations.

1.6. Dissemination of research results - identification of constraints to by-products utilization in rural communities prior to initiating interventions; the importance of healthy interactions between researchers and smallholders in initiating new innovations to the farmers: exploiting productive avenues of interactions between researchers, extension agents and farmers.

2. VENUE: BAMENDA CAMEROON - West Africa

3. DATE: 19th - 23rd October , 1987

4. FORMAT OF PAPERS

4.1. Papers should include an abstract, introduction, methodology, results, discussion, conclusions and a list of quoted references.

4.2. Follow the format of the Animal Feed Science and Technology Journal.

4.3. Length - not more than 10 pages, double spaces A4 pages (29.7cm x 21cm)

4th ARNAB WORKSHOP PARTICIPANTS FORM

1. I am/we are interested in participating and contribuitng a paper(s) titles: _____

2. On the Sub-theme(s): _____

3. Names of author(s): _____

4. Current position/occupation: _____

5. Name of country: _____

6. Institution/organization (a) Address: _____

   b) Telex No. _____

   c) Telephone No. _____

   d) Telegraphic No. _____

7. Signature(s) _____

8. Date: _____

Send to : Abdullah N. Said, ARNAB Co-ordinator
ILCA
P. O. Box 5689, Addis Ababa, Ethiopia.

from aqueous solutions. Low MW phenolics (<500 daltons) form less stable complexes that do not precipitate and are not considered to be tannins. However, low MW phenolics are the monomeric precursors for tannins and may polymerize through enzymatic and non-enzymatic (heat and UV radiation) processes to form molecules with tannins activity (Haslam 1966). Many chemical assays for tannins do not separate tannins from low MW phenolics and it is recommended that biological assays such as protein precipitation and enzyme inhibition be included in tannin determinations (Martin and Martin 1982; Reed et al 1985).

The two major groups of tannins are the hydrolyzable tannins and the condensed tannins. Hydrolyzable tannins are gallic and ellagic acid esters with a core molecule of glucose. Other sugars and some other phenolics may also serve as the core molecule. The name derives from the ease of hydrolysis by acids or enzymes (tannases).

Condensed tannins are polymers of flavan-3-ols. The monomeric units are linked through carbon-carbon and ether bonds which are very resistant to hydrolysis. Condensed tannins form red pigments (anthocyanidins) when heated in strong acids. This property has led to the use of proanthocyanidins as an alternative name for condensed tannins (Bate-Smith, 1975).

3. Negative Effects of Tannins

Tannins have been found in several important forages, crop residues, agro-industrial by-products, fodder trees and food grains (Bate-Smith 1973; Ford 1978; Reed et al. 1982; Kumar and Singh 1984; Reed 1986; Price and Butler 1980). Tannins have been found to lower nutritive value of these feeds through the following mechanisms:

1. Low palatability due to astringency and bitter taste.
2. Complexing proteins and carbohydrates which lower their digestibility.
3. Inhibition of digestive and microbial enzymes.
4. Toxicity to rumen microorganisms or the animal.

Other potentially negative effects include reduction in gut wall permeability, estrogenic effects and interference with mineral metabolism.

The shortage of feeds in many developing countries makes it necessary to utilize tannin containing feeds, especially fodder trees and agro-industrial by-products.

Metabolic disturbances and death in livestock are rare but may occur when animals have restricted selectivity (especially during droughts) and are forced to eat feeds high in tannins and other phenolics (Van Hooven 1984).

4. Positive Nutritional Effects of Tannins

Although most research on tannins have concentrated on their negative effects, there are cases in which low to moderate levels in feeds may be beneficial to ruminants. The two main positive effects of tannins are prevention of bloat and improved efficiency of protein utilization.

Tannins are believed to prevent bloat through inhibition of foam formation in the rumen by forming complexes that reduce the level of soluble protein (Reed 1960). Legumes that contain low to moderate levels of condensed tannins are nonbloating (Jones et al. 1973; Ross and Jones 1974). Recent research suggests that rapid disintegration of plant structure and high initial rates of gas production are also important in legumes that cause bloat. Non-bloating legumes that contain tannins (sainfoin, birdsfoot trefoil and cicer milkvetch) have a lower rate of tissue disintegration and gas production when compared to legumes that cause bloat and do not contain tannins (alfalfa, red clover and white clover) Cheng et al. 1981).

Birdsfoot trefoil (Lotus pedunculatus) and sainfoin (Onobrychis **viciifolia**) contain low to moderate levels of condensed tannins. When fed to sheep, these legumes have an increased N retention and flow of N to the lower tract as compared to other forages with similar N content (Barry and Manley 1984; Egan and Ulyatt 1980; Thomson et al. 1971). These positive effects of protein utilization have been attributed to the escape of feed protein from the rumen fermentation because microbial enzymes are unable to degrade and deaminated the protein/tannin complex (Driedger and Hatfield 1972). The protein should subsequently become available in the lower tract. However this theory is inconsistent with the depressed apparent digestibility of protein in birdsfoot trefoil and sainfoin. Increased efficiency of protein utilization by rumen microorganisms and increased urea recycling are alternative explanations for the positive effects of tannins on protein utilization in ruminants (Beever 1983; Egan and Ulyatt 1980). These theories are consistent with lower urinary loss of N and greater microbial N in the faeces.

5. Conclusion

Tannins in feeds for ruminants can have both negative and positive effects on animal performance. More research is needed on tannins in important feed resources. Negative effects may be avoided, where possible by selecting crop varieties with a lower content of tannin. Positive effects may be exploited by using new species in combination with other feeds and forages to prevent bloat, where it is a problem, or to increase the efficiency of protein utilization. Research on the nutritional effects of tannins in important African feed resources is currently being conducted by the ILCA Animal Nutrition Programme.

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(Topical commentaries and other contributions from our readers are always welcome).

THE NUTRITIVE VALUE OF FORAGE LEGUME CROP RESIDUES AND NATIVE PASTURE IN SOUTHERN ETHIOPIA

By
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INTRODUCTION AND MATERIALS AND METHODS

In the semi-arid rangelands of Southern Ethiopia, browse is in short supply because most of the species are drought deciduous. Therefore from the middle to the end of each dry season, fodder is composed mainly of mature, annual native grasses (standing hay). During this period, animal production is low because of the reduced quantity and (mainly) quality of these grasses.

The Borana pastoralists of Southern Ethiopia are increasingly adopting small-scale agriculture by cultivating cereal and legume crops near their homesteads. As the rate of cropping increases, residues from these crops may become more and more important as livestock feeds.

The primary nutritional deficiency of both standing hay and cereal crop residues is nitrogen (N). This dificiency may be partly overcome by supplementation with legume crop residues. Three forage legume crops: pigeon pea (**Cajanus cajan**), Lablab (**Lablab purpureus**) and cowpea (**Vigna unguiculata**) were grown at two sites: Mendecho and Melbana (with 394 and 457 mm annual rainfall, respectively in 1985). The yield and nutritive value of the residues of these legumes were measured relative to those of native pasture grasses.

Table 1. Biomass yield of three legume crop residues and native pasture in Southern Ethiopia during the 1985 long rains

Forage species	---------Biomass yield, kg DM/ha----------	
	Mendecho	Melbana
Cowpea	1292 ± 572	7517 ± 239
Lablab	896 ± 196	14875 ± 939
Pigeor pea	2279 ± 134	6050 ± 731
Native pasture grasses	8200	6800

Table 2. Nutritive value of three legume crop residues and native pasture in Southern Ethiopia during the 1985 long rains.

	Nutritive parameters, % DM*						Phenolic contents	
Forage species	IVDMD*	N	NDF*	ADF*	Lignin	Ash	Soluble Tannins (% OM)	Insoluble Phenolics (A550/g NDF)
Cowpea	68.9	3.1	34.0	25.2	4.7	1.5	9.1	0.04
Lablab	60.7	2.7	41.6	32.6	6.7	1.0	18.7	0.04
Pigeon pea	53.8	2.8	42.6	30.8	9.0	0.7	18.1	0.62
Native grasses	28.0	0.2	69.5	44.4	7.3	13.0	8.5	0.03

* Abbreviations: IVDMD = **in vitro** dry matter digestibility:
NDF = neutral-detergent fiber, ADF = acid-detergent fiber.

RESULTS AND CONCLUSION

As shown in Table 1, biomass yields of legume residues were significantly higher ($P<0.001$) at the wetter (Melbana), than at the drier (Meñdecho) site (Melbana also has more fertile soils and a better rainfall distribution). The trend in yield of native pasture between the two sites was unexpectedly contrary to that of the legumes.

The nutritive value of cowpea was highest and that of the native pasture lowest (Table 2). The higher yield (Table 1), but poorer quality (Table 2) of native grasses relative to some of the legume residues, indicate the potential role of the latter as dietary (especially protein) supplements for range livestock in Southern Ethiopia. The tannin and phenolic contents of Lablab and pigeon-pea were substantially higher than those of the native grasses. The effects of tannins and other phenolics on forage quality are discussed in this issue of the Newsletter.

Differences in yield and nutritive value of the legume residues underscore the need for screening potential legume crops for their adaptability, productivity and nutritive value in semi-arid regions.

ABSTRACTS OF SOME RESEARCH ON CROP RESIDUES AND-AGRO INDUSTRIAL BYPRODUCTS

ADDITION OF WATER TO CHOPPED MAIZE STALK IMPROVES ITS CONSUMPTION

By

M. A. EL-Naga

Department of Animal Production, Alexandria University, Egypt

The intake of dry chopped maize stalk (240 g/head/day) was less than that required for the maintenance requirements of sheep weighing 38 kg. Sheep therefore lost 50 g/hd/d when fed this diet. Addition of water (1:1, w/w) to the stalk (without ensiling) improved its intake by 27% and reduced weight losses to below 50 g. Dissolving 1.5% urea (w/w) in the same amount of water added to the dry cereal residue increased feed intake by a further 12%, and resulted in a slight positive nitrogen balance and liveweight gain in sheep.

FEED INTAKE AND UTILIZATION BY INDIGENOUS TANZANIAN GOATS FED CHLORIS GAYANA HAY WITH AND WITHOUT SUPPLEMENTS CONTAINING DIFFERENT PROTEIN LEVELS*

By

Aichi J. Kitalyi, L. A. Mtenga and A V Goodchild

c/o Mpwapwa Tairo, Private Bag, Mpwawa, Tanzania

Two digestion trials were conducted during which growing indigenous Tanzanian goats (initially weighing 15-19 kg, Trial 1; 13-17 kg, Trial 2) received daily 600 g air-dry Rhodes grass (**Chloris gayana**) hay and 200 g/hd of one of three supplements. The supplements (S) were formulated from locally available ingredients (maize bran, cottonseed cake, sunflower cake, molasses, salt and minerals) and contained 11.2, 16.8 and 19.7% crude protein (for S1, S2 and S3, respectively).

Hay intake, growth rate and fiber digestibility were not significantly ($P<0.05$) different for unsupplemented and supplemented goats. Supplementation significantly increased total DM and CP intakes ($P<0.001$), and DM and CP digestibilities ($P<0.05$). For goats given the Control, S1, S2, and S3 diets, DM intakes (g/kg $W^{0.75}$/day) were 52, 63, 65 and 70 (Trial 1); and 56, 79, 73 and 73 (Trial 2), respectively. Dry matter and CP digestibilities (%) were 53, 63, 58 and 61; 38, 63, 62 and 73 (Trial 1); 57, 68, 66 and 65; 28, 49, 54 and 56 (Trial 2) respectively.

Supplements were generally similar statistically with respect to DM intake, and DM, CP and fiber digestibilities. Nitrogen retention was highest in goats given S3 ($P<0.001$), but this, unexpectedly, was not reflected in liveweight gains. These data therefore suggest that the optimum level of supplementation was S1 (last paragraph by ARNAB).

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* The paper on which this abstract is based has been accepted for publication in Tropical Animal Production (as indicated by author).

PAPERS OF INTEREST ABSTRACTED FROM ANIMAL FEED SCEINCE & TECHNOLOGY

(with permission from Elsevier Science Publishers)

Cevera, C., Fernandez-Carmona, J. and Marti, J., 1985. Effect of urea on the ensiling process of orange pulp. Anim. Feed Sci. Technol., 12: 233-238

Orange pulp was ensiled fresh or after adding 18 g urea/kg pulp dry matter and the ensiling process was studied over a period of 90 days, in laboratory silos. Fermentation was very intense for the first 10 days; at the end of the experiment both silages were stable and well-preserved. Average figures at this stage were, respectively: pH 3.5 and 3.6; ammonia nitrogen 1.2 and 1.7% of the total nitrogen; acetic acid 3.0 and 2.5% DM; lactic acid 2.2 and 2% DM and butyric acid 0.05 and 0.05% DM. High losses of dry matter (32.4 and 32.1%) were registered, those in the effluent accounting for about 15% of the total. Addition of urea delayed fermentation slightly and increased production of gases, but did not affect either the quality or the stability of the silage.

Adebowale, E.A., 1985. Organic waste ash as possible source of alkali for animal feed treatment. Anim. Feed Sci. Technol., 13:237-248

On the basis of the analytical investigations carried out on the alkali contents of some ashes obtained from agricultural wastes, it was found that 1 kg of sodium hydroxide was equivalent to 4.4 kg cocoa-pod husk ash or 7.8 kg palm-bunch ash (without the fruits). Maize straws treated with these alkali sources were thereafter fed to West African Dwarf goats.

Treatment slightly reduced the crude protein, cellulose, gross energy (except for palm bunch ash) and increased ash contents of feed. A significant increase in digestibility of dry and organic matter, cellulose and gross energy ($P<0.05$) of treated feed (both ashes and NaOH) over untreated were recorded. While dry matter digestibility of NaOH-treated feed was better than untreated by about 36.5%; 26.4 and 26.5% were obtained for cocoa-pod husk and palm bunch ashes, respectively. Dry matter intake and digestible energy intake increased significantly ($P<0.01$), resulting in better growth rate. Average daily gain was lowest (20.1 g) for untreated straws and highest ($P<0.01$) for NaOH-treated straws (48.1 g). Goats fed cocoa-pod husk and palm bunch ash-treated straws gained 41.9 and 42.3 g respectively. A 1% level of alkali treatment produced the best growth rates. The results are discussed in relation to the utilization of these farm wastes for increased livestock production among rural farmers.

ARNAB

Newsletter

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INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA, P.O. BOX 5689, ADDIS ABABA, ETHIOPIA

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8. First instalment of Abstracts from papers presented at 3rd Annual Workshop, Blantyre, Malawi, September, 1986.

1. INTRODUCTION

ARNAB members will have noted that the production of Newsletters has been lagging behind schedule. Volume 6 Nos. 1 and 2 for March and June 1986 were circulated recently. Substantial difficulties have caused these delays, and we plan that this volume 6 Nos. 3 and 4 will be followed soon by volume 7 Nos 1 and 2; so that by the end of 1987 we will be on schedule with Newsletters for the year and in a position to maintain a strict quarterly basis for 1988. We do however, request your assistance to make this possible. We need your contributions in the forms of information on your work and brief research reports. Progress reports on your work and the research you are conducting on by-products will be of interest to our readership. News about National networks or animal/agricultural societies/associations is most welcome. We would especially urge ARNAB Regional Representatives to be more active in soliciting material for Newsletters from their colleagues at National Agricultural Institutes and from Institutions of higher learning in their mandate regions. We also welcome comments on he topics covered in these Newsletters.

The Secretariat devoted a lot of time through 1986 in editing and preparing proceedings of the 2nd Annual Workshop held in Alexandria Egypt in October 1985. Other activities included preparation for the 3rd Annual Workshop, barn and other experiments, travel to member countries on ARNAB related matters and conducting individual and group courses in Nutrition.

2. A TRIBUTE TO DR MOPOI NUWANYAKPA

It is with regret that we record the recent departure of Dr Mopoi from ILCA. Mopoi is well known to many of our members as a tireless organizer with a very friendly and cooperative manner. ARNAB is most grateful for the efforts he devoted to furthering the objectives of the network, and we wish him every success in his new venture; the foundation of African Integrated Development Associates (AIDA) based at Bamenda, Republic of Cameroon, and commencing operations with Bamenda Animal Feed Company, (BAFCO), Ltd.

3. THE THIRD ANNUAL WORKSHOP AND GENERAL MEETING BLANTYRE, MALAWI, 31ST AUGUST - 5TH SEPTEMBER 1986

The theme of the workshop was "Utilization of crop residues and agro-industrial byproducts with special emphasis on technolgies applicable to small scale African farmers". Thirty one participants, inclusive of organizers, from 12 African countries were scheduled to attend. Because of travel protocol problems only 29 delegates from 9 African countries were able to attend, together with some observers from the National Agricultural Research Stations in Malawi; the host country for the workshop. Dr E R Ørskov from Rowett Agricultural Research Institute attended as the FAO representative.

3.1. Programme

- 31st August arrival of participants.
- 1st September to 5th September workshop programme.

3.1.1. Opening remarks by:

Dr Douglas A Little, ARNAB Team Leader and Head of Nutrition, ILCA.

Professor Moustafa A El-Naga, Chairman ARNAB, Steering Committee, University of Alexandria, Egypt.

Professor Jackson A Kategile, Programme Officer Crops and Animal Production Systems, IDRC Regional Office, Nairobi.

3.1.2. Keynote address by Dr S S Kamvazina, Controller of Agricultural Services, Republic of Malawi.

3.1.3. Scientific sessions - presentation of 24 papers, questions and discussion.

3.1.4. Field trips to small scale farms (dairy and beef stall feeding) and to a feed mill and a commercial feed lot unit.

3.1.5. Annual General Meeting.

3.1.6. Rapporteurs' report, discussion recommendations and adoption of recommendations.

3.1.7. The 3rd Steering Committee meeting was held on 3rd September, late into the evening.

3.2. The Third Annual General Meeting.

The following is a summary of the minutes for general information:

3.2.1. Minutes of the 2nd Annual General Meeting held in Alexandria on 16th October, 1985 were adopted.

3.2.2. The venue for the 4th Annual Workshop and General Meeting was voted upon and it was agreed that it will be held in Cameroon in October 1987.

3.2.3 Eight topics for the Cameroon Workshop were discussed for the Steering Committee to deliberate on and come up with a specific theme (see recommendation No. 4.8.)

3.2.4. Discussed and agreed on procedure for editing the papers for proceedings.

3.2.5. To facilitate the distribution of the proceedings of the 2nd workshop participants were requested to provide ARNAB Secretariat with names and addresses of people/institutions in their home countries whom they think will benefit from getting copies of the proceedings.

3.2.6. Agreed that ARNAB Secretariat develops guidelines on style, content and length of papers for future ARNAB workshops; beginning with the 4th workshop in 1987.

3.2.7. Agreed that future workshops should include a paper from a practical farmer and non-ruminant scientists, sociologists and socio-economists and extension personnel. Members expressed appreciation to the contributions made by Dr E R Ørskov and recommended that for future workshops a moderator of international repute be invited; preferably under the sponsorship of an International organization.

3.2.8. Agreed to prepare ARNAB advertising brochure and a dossier of research projects being conducted by member countries. Members were requested to help in these efforts by sending to the Secretariat outlines of research protocols from their respective institutions/countries.

3.2.9. Agreed that ARNAB produces national bibliographies and brief literature reviews on by-products and crop residues. Nine participants volunteered to do these for their respective countries.

3.2.10. Noted the real need to increase active ARNAB membership, solicit funds for by-products and crop residues research and for other special activities such as study tours and training courses.

3.2.11. Discussed and agreed that ARNAB puts up a training package on by-products and crop residues studies.

3.2.12. Agreed that elected Steering Committee members be elected once every two years and at the end of that period they will not be eligible for re-election.

4. **WORKSHOP RECOMMENDATIONS** (Full version coming out in proceedings).

4.1. Need to concentrate on technologies appropriate to small scale farmers.

4.2. Standardize research methodologies, discourage indiscriminate chemical analyses and futility of calculating apparent nitrogen digestibility. Recommended use of biological measurements using productive indices and other relevant chemical analyses.

4.3. In sacco nylon bag studies recommended; less costly and appropriate research tool. ILCA requested to help in design and supply of cannulae and nylon bags and in providing guidance.

4.4. Recommended to concentrate research on:

- the role of forage/browse legumes to improve utilization of crop residues.
- cereal crop varieties vis-a-vis by-products yield and anti-nutritional factors.
- leaf stripping of cereal crops; their feeding value and effects on grain yields.
- simple, feasible and practical chemical and physical treatments of crop residues and by-products.
- use of molasses-urea blocks using locally available ingredients.
- hydroponic culture techniques of producing feed from deep litter beddings.

4.5. Recommended collaborative surveys amongst animal and crop scientists on grain: stem ratio of cereal crops, availability and strategic utilization of agro-industrial by-products and assessment of opportunity costs in their utilization.

4.6. Recommended that studies should be conducted on suckling management, calving/kidding/lambing intervals, health of the young ones and on lactation length in cows.

4.7. Agreed that proven packages be passed over to farmers through national extension workers.

4.8. Discussed the following topics for the 4th Annual workshop in Cameroon in October, 1987 and agreed that the Steering Committee considers them in their deliberations for a specific "theme".

4.8.1. Statistical designs and data analyses of experiments on crop residues and agricultural by-products.

4.8.2. Design of on-farm trials with smallholders to minimize extraneous sources of variations.

4.8.3. Indentification of constraints to by-products utilization at the researchers - smallholder levels before interventions are initiated.

4.8.4. Other physical constraints to by-products utilization.

4.8.5. By-products utilization by non-ruminants; rabbits, poultry, pigs and fish.

4.8.6. Rural communities response to new technologies on by-products utilization (see also 4.8.3 above)

4.8.7. Communications and contacts amongst researchers, extension agents and small scale farmers in the effective transfer of packages on by-products utlization.

4.8.8. Manipulation of compensatory growth, supplemental strategy with by-products during the dry season and at fattening feed lot units.

5. RESPONSES FROM SOME ARNAB MEMBERS ON THE 4TH ANNUAL WORKSHOP.

As a result of the announcement of the workshop in Volume 6 Nos 1 & 2 Newsletter the following responses have so far been received.

Country	No. of responses (forms filled)	No. of papers
Botswana	2	2
Burkina Faso	1	1
Egypt	3	4
England	2	2
Ethiopia	2	3
Ghana	4	5
Kenya	3	4
Madagascar	1	1
Malawi	5	6
Mali	1	1
Mauritius	1	1
Nigeria	12	12
Senegal	1	1
Somalia	3	3
Sudan	1	1
Swaziland	2	2
Tanzania	5	8
Thailand	1	1
Uganda	2	2
Zimbabwe	5	5
Total	57	65

6. GUIDELINES FOR ARNAB WORKSHOP PAPERS

The 4th Steering Committee Meeting held on 5th and 6th March resolved that ARNAB adopts guidelines of the Animal Feed Science and Technology Journal for papers to be published in workshop proceedings and in Newsletters. Members are therefore requested to refer to the said guidelines printed in the first issue of the Journal each year. You could also write to us for the detailed guidelines of the Journal. The following is an extract of the guidelines for ease of reference:

Title: - clear, descriptive and not too long.
Name(s) of author(s)
Affiliation(s)
Address(es) of author(s)
Abstract (preferably not more than 400 words)
Introduction
Materials studied, area descriptions, methods, techniques.
Results
Discussion
Conclusion
Acknowledgements (if any)
References (in alphabetical order and on separate sheet)
Tables (metric system should be used. Compiled on separate sheets)
Figures (numbered consecutively and referred to in the text and should be on separate sheets)
Words to be printed in italics should be underlined.

7. ANNOUNCEMENT

If you have not received a copy of the proceedings of the 2nd ARNAB Workshop held in Alexandria, Egypt in October, 1985 write to us to send you one.

8. FIRST INSTALMENT OF ABSTRACTS OF PAPERS PRESENTED AT THE 3RD ANNUAL WORKSHOP, BLANTYRE, MALAWI, IN SEPTEMBER, 1986.

It is planned to have proceedings of the 3rd workshop ready for distribution by October 1987. But as at present some authors have not sent back their edited revised papers to the secretariat. Abstracts of some of the papers are given in this Newsletter. The rest will be printed in Vol. 6 No. 4.

METHODS OF ESTIMATING NUTRITIVE VALUE OF FIBROUS CROP RESIDUES

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FAO Representative

ABSTRACT

The present methods of estimating nutritive value were discussed including chemical analysis such as crude fibre, acid and neutral detergent fibre, lignin and soluble carbohydrates and biological measurement such as **in vitro** and **in vivo** determination of digestibility and determination of rate and extent of digestion using the nylon bag method. It was shown that the chemical analyses were very poor predictors of differences in nutritive value between different types of fibrous residues and also between different varieties of straws and also in estimating improvements occasioned by chemical treatment. Only biological measurements estimated utilization with any degree of accuracy and of the biological measurements the nylon bag method of describing rate and extent of degradation was by far the best predictor and better than **in vivo** digestibility determined in restricted fed animals.

THE EFFECT OF PROTEIN SOURCE ON THE PERFORMANCE OF BROILERS

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ABSTRACT

Two experiments were conducted using 270 commercial broiler chicks per experiment to investigate the effect of four protein sources in home compounded feeds on the performance of broilers. Five diets were used in experiment one. Diet 1 contained groundnut cake with meat and bone meal. Diet 2 contained roasted soybean meal with meat and bone meal. Diet 3 contained groundnut cake with fish meal. Diet 4 contained roasted soybean meal with fish meal. Diet 5 was a commercial broiler feed (control). Three diets were used in experiment two; diet 1 contained groundnut cake with 2.50% meat and bone meal, and 5% fish meal; diet 2 contained roasted soybean meal with 2.50% meat and bone meal and 5% fish meal, and diet 3 contained roasted soybean meal with 10% cottonseed meal, 2.50% meat and bone meal and 5% fish meal. The birds were randomly assigned to the diets (treatments).

The results of both experiments indicated that diets containing groundnut cake with either meat and bone meal or fish meal or both gave significantly better weight gains ($P<0.05$) than diets containing roasted soybean meal with either meat and bone meal or fish meal or both. Feed conversion efficiency was significantly better for diets containing groundnut cake with either meat and bone meal or fish meal in experiment one but in experiment two the diet containing groundnut cake with meat and bone meal and fish meal gave numerically better feed conversion efficiency than diets containing roasted soybean meal ($P<0.05$).

From these trials, it can be concluded that feeds containing groundnut cake with meat and bone meal or fish meal (Mangochi) or both could be used in place of the commercial feed without adverse effect on the performance of broilers.

INTAKE AND DIGESTIBILITY OF UREA-TREATED GAMBA (*Andropogon gayanus*) HAY BY CATTLE

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ABSTRACT

The intake and digestibility of urea-treated and untreated gamba (*Andropogon gayanus*) hay with or without urea supplementation was studied. Organic matter intake was improved from 57.5 to 72.8 g kg $W^{0.75}$day while organic matter digestibility was improved from 56.4 to 69.9 percent. Results indicate no significant differences in the utilization of all hays containing urea either as feed additive or for treatment. All treatments involving the addition of nitrogen gave positive nitrogen retention. It is concluded that urea supplementation at the rate of 1 percent of total dry matter intake sprayed on hay at feeding time would elicit similar improvement in utilization as would urea treatment.

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PROSPECTS OF UTILIZING UREA TREATED MAIZE STOVER BY SMALL HOLDERS IN KENYA - WHAT OTHER FEED ALTERNATIVES

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ABSTRACT

In the last two decades, a large part of the small holder sector in Kenya has been transformed from a traditional subsistence oriented sector into a more commercialized system. In 1981, the small holder sector produced 75% of the total milk output, 65% of the total beef production, and a substantial amount of eggs and chicken. However, the major constraint in ruminant livestock production is the quantity and quality of available feed. The average land per caput, as per 1982 estimates, by the small holders in two of the highly populated districts, Kakamega and Kiambu, is 0.26 and 0.21 ha respectively. Within these small hectarages there is a severe competition on the available land for food and feed crops.

Amongst the productive areas of research in alleviating the above problem is the enchanced utilization of arable farm by-products such as maize stover, millet and sorghum stovers, and other home offals. In recent years studies have been undertaken to improve the nutritive value of stovers and straws. Of probable practical significance for the small holders is the use of urea solution for treating maize stover, the most abundant by-product on their holdings. Some work on urea treatment is reviewed in this paper. Urea treatment improved both intake, digestibility and live weight gain by cattle and sheep.

Other alternatives to treatments are chopping the stovers and supplementing them with maize bran and/or molasses. The use of forages as dual purpose legumes either in pure stands or as inter-crop fodder will increase both the utilization and availability of feeds and improve soil nitrogen, albeit at probable variable reduced yields of the main food crops. However, other studies have reported improved main crop yields.

IMPLICATIONS OF INCREASED NATIONAL MAIZE CROP PRODUCTION: EFFORTS TO ENHANCE MAIZE STOVER UTILIZATION FOR SMALLHODLER LIVESTOCK PRODUCERS IN MALAWI

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ABSTRACT

An attempt to boost the smallholder livestock farmer feed resources qualitatively and quantitatively through the integration of improved forages in maize crop production systems is discussed. Where the testing of different forage systems undersown to maize was done on smallholder dairy farms, the Rhodes grass-silver leaf desmodium appeared to make a better contribution to the overall forage production.

On station, the time of sowing/undersowing the forage legumes to a maize crop had no effect on all components of yields, except forage legume yield which was depressed by delayed planting systems and maize stripping intensities. There was a tendency for the climbing forage legume species to enhance the crude protein value of the maize stover component.

MAIZE STOVER AND COBS AS A FEED RESOURCE FOR RUMINANTS IN TANZANIA

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ABSTRACT

Maize is the most important crop in Tanzania and total grain yields amount to 2 million tonnes annually, with the production of residue (stover and cobs) totalling more than 4 million tonnes. Maize stover is largely grazed in situ and maize cobs are used for cooking in small scale farms. The nutritive characteristics of both residues were studied through digestibiity studies of diets formulated to contain 35 -70% residues followed by production feeding trials on the most promising diets. It was shown that diets containing proportions of maize stover and maize cobs could support reasonable growth rates and milk yields.

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The application of research results on farms are being investigated in a follow up project. It is obvious that the use of maize cobs as a ruminant feed is limited to large scale farms where adequate quantities are produced and grinding mills are available. In the case of maize stover, the major constraints to application of better feeding strategies is bulkiness which renders storage and transportation difficult. Further research is still required to elucidate the specific roughage x energy supplement interactions.

EFFECT OF LEVEL OF CANE MOLASSES IN FATTENING DIETS ON PERFORMANCE OF BEEF STEERS AND HEIFERS

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ABSTRACT

The performance in feedlot of 100 each of 18 month old steers and heifers, one half of which comprised Sussex x Africaner and the other half Hereford x Mashona x Sussex breeds, was determined in a 2 x 5 factorial trial. Five groups of 18 animals (mean starved body weight 280 kg) for each sex were balanced for breed and body weight and randomly allocated to one of five dietary treatments containing 0, 10, 20, 30 and 40 per cent molasses respectively. The animals were fed **ad libitum** for 90 days and slaughtered. The results show that molasses can be included in fattening diets up to a maximum level of 30 per cent without any adverse effects on body and carcass weight gains, efficiency of feed-use and carcass grade. There was little difference in feedlot performance between steers and heifers.

FEEDLOT PERFORMANCE OF YEARLING STEER PREVIOUSLY MAINTAINED ON DIFFERENT CROP RESIDUE/SUPPLEMENTATION REGIMES

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ABSTRACT

Forty-two Bunaji and Friesian/Holstein crossbred yearling steers averaging 192 kg liveweight were randomly assigned to 6 phase I treatments: dry grain sorghum stover; dry grain sorghum stover plus groundnut cake; dry grain sorghum stover plus urea-molasses;

untreated grain sorghum stover silage; untreated grain sorghum stover silage plus groundnut cake and urea-molasses treated grain sorghum stover silage plus additional urea-molasses supplement. After the treatment study lasting 56 days all the steers were placed on a phase II feedlot diet, consisting of dry grain sorghum stover and a concentrate mixture, for 42 days.

In phase I ensilage significantly ($P<0.01$) improved dry matter intake per head per day but there was no economic advantage in overall performance. Supplementation with limited quantities of groundnut cake or urea-molasses maintained liveweights.

In phase II the steers, in their respective groups, maintained their relative and significant differeences ($P<0.05$) in feed intake per head/day but when expressed in intake per metabolic liveweight these differences were not significant. There were no significant differences in liveweight grains between group.

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1. WORKSHOP PARTICIPANTS TAKE AN EDUCATIVE FIELD TRIP

A field visit related to the theme of the workshop is an activity that has been appreciated by all the participating ARNAB workshop members. Apart from the advantages of looking at and discussing practically oriented issues of by-products utilization, field visits enable members to interact at field level with colleagues, farmers and extension personnel who may not have had time to attend indoor workshop sessions.

At the 3rd Annual Workshop in Blantyre, Malawi, on the theme "Utilization of crop residues and agro-industrial by-products with special emphasis on technologies applicable to small-scale African farmers", a full day field trip was organized on 3rd September 1986. Five sites in the Southern Region were visited. The following notes have been extracted from Dr Mopoi Y Nuwanyakpa's back to office report and from Mr L P Nkhonjera's briefs.

SMALL SCALE FARMS

Bvumbwe Milk Collecting Centre:

Situated near the town of Bvumbwe, 16 km from Blantyre. The centre was started in 1973 with only 5 farms. When visited its membership was 201, calling themselves Bvumbwe Milk Bulking Group. The centre has two cooling tanks with a total capacity of 6000 litres, and an annex where feeds and veterinary drugs are stored for sale to members. The Executive Committee, consisting of Chairman, Treasurer and the plant operator are paid from funds generated by membership fees, commission from resale of milk and from interest on loans and milk bonuses paid by the Milk Marketing Organization.

Bvumbwe and other milk collecting centres in Malawi are centrally located points to which small scale farmers carry their milk daily, mostly on bicycles. About 1500 litres of milk are bulked at Bvumbwe centre daily; an average of 7.5 litres per day from each farmer. Cooled tank transport by the Milk Marketing Organization collects milk to the processing plants. Processed milk in Malawi retails at US$0.36/litre. The farmers are paid monthly a net price of US$0.21/litre. At lactation lengths of 250-300 days and a daily average delivery of 7.5 litres, each member receives between US$472.50 - 393.75 for his milk. Participants were told that that was a profitable enterprise, comparable to or better than other cash earning enterprises by small holders in the Southern Malawi Region.

Nearly all the technical and administrative matters at the field are organized by the Executive Committee with very little help from the Extension Department; a good example of small holder organization which got initial proper guidance, a good marketing outlet and developed their own incentives to manage their own affairs effectively.

Small Scale Dairy Farms:

Visited three of the small holder dairy farms in the vicinity of Bvumbwe. Holding sizes ranged from 1.2 - 2.4 ha. Other farmers within the scheme fall within the same ranges.

By-products used by the farmers are groundnut and bean haulms, maize stover, maize bran and germ meal, banana stems and leaves and other household offals.

All the farmers visited and others within the scheme, grow Napier grass and Leucaena leucocephala. One of the farmers had made maize silage from some of his maize food crop, and claimed that it was economical to do so. This particular farmer was delivering between 60 - 70 litres of milk a day to the Centre.

The Scheme was initiated by the Malawi Government to increase national milk production and to generate cash income to the farmers. Under the Scheme each farmer was given two milking cows; ½ Malawi Zebu x ½ Holstein or Friesian, a sprayer and 5 litres of acaricide and enough barbed wire for fencing, all the items to a total of US$600 payable in 3-5 years. Selection of the potential dairy farmers was done by the Government Extension Officer together with officials of the Bvumbwe Milk Bulking Group.

Thunga Stall feeding Group:

It is a group of women engaged in small scale cattle fattening operation. The group has been operating since 1975. Two steers, consisting of crosses of Brahman, Friesian and the local Malawi Zebu, from the government Livestock Breeding and Multiplication Centres are issued to the farmers on credit. They are fed on locally available by-products and fodders; Napier green chop, leucaena, sweet potato vines, bean and groundnut haulms and husks, locally produced maize bran and germ meal and some salt. The following figures were given:

- Liveweight of the steers on arrival at the stalls 240-300kg.
- Finish off at between 320 - 350 kg liveweight.
- Feeding for around 160 days.
- Average daily liveweight gain 0.44 kg.
- Average gross margin to the farmers 45 Malawi Kwacha per steer (US$29)
- Additional benefit to the farmers - Manure generated at the stalls.

FEED MILL:

Situated a few hundred meters from the Enchalo sugar factory. Within the sugar cane estate. The Mill compounds a dairy meal for commercial distribution and a fattening ration for the Mill's own beef feedlot unit not far away from the Mill; the latter feed contains large proportions of bagasse and molasses. The inclusion rate of molasses varies with the type of roughage used, depending on its ability to absorb molasses. For example rice husks will absorb little if any, delinted cotton seed husks will absorb more, whereas bagasse absorbs a greater amount. Inclusion rates of molasses at the Mill go up to 58 percent. Other ingredients used are wheat offals, maize bran and germ meal, whole cotton seed cotton seed cobs, cotton seed husks, common salt, minerals and vitamin premix.

Participants were told that the Malawi government plans to initiate small scale dairy farms, similar to the Bvumbwe ones, in the vicinity of the Mill for the benefit of both the investors and the community.

COMMERCIAL FEEDLOT

The feedlot, owned by the Feed Mill has the capacity for fattening 2,000 cattle at any one time. Cattle are purchased locally (Malawi Zebu and their crosses) and are fattened for 95 days. Steers aged 18 months to 3 years averaged daily liveweight gain of 1 kg over the 95 days. Feed conversion rate was 10:1.

2. SECOND INSTALMENT OF ABSTRACTS FROM PAPERS PRESENTED AT THE 3RD ANNUAL WORKSHOP HELD IN BLANTYRE, MALAWI SEPTEMBER, 1986

PRACTICAL UTILIZATION OF AGRO-INDUSTRIAL BY-PRODUCTS IN A FEEDLOT IN MALAWI

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ABSTRACT

The paper gives a brief background information on the siting of the Feedlot in Shire Valley where the supply of the various by-products used in the formulation of the feeds are within easy access. Molasses, bagasse cottonseed husks, cotton seed cake, whole cottonseed, rice husks, wheat offals and hominy chop (maize germ and bran meal) are used successfully.

Combinations of some of the above ingredients are used to produce rations which when fed to local steers aged 18 months to 3 years produce daily liveweight gains approximating 1kg with a conversion ratio of 10:1 over an average feeding period of 95 days. Dressing percentage are average 52; with very good carcass grades. Some dairy formulations are also compounded for sale to other farmers.

EFFECTS OF UREA, MOLASSES, MOLASSES-UREA, NOUG CAKE AND LEGUME HAY ON THE INTAKE AND DIGESTIBILITY OF TEFF STRAW BY HIGHLAND SHEEP

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ABSTRACT

A 37-day digestion trial was conducted to evaluate feed intake utilization by male castrated Ethiopian highland sheep (initial weight, 17.9 _+ 0.80 kg). Sheep were randomized across twelve treatments (3/treatment) on the basis of fasted body weights. The treatments were: teff (**Eragrostis tef**) straw **ad libitum** (basal), basal + 3 g urea, basal + 88 g molasses and 86 g molassesurea (2.5% urea). The latter two were also given with 6.5 and 13 g noug (**Guizotia abyssinica**) cake or 65 and 130 g **Trifolium steudneri** hay.

Addition of urea to TS increased N digestibility significantly, and increased intake, dry matter (DM) and neutral-detergent fiber (NDF) digestibilities by 3.7, 8.3 and 7.3%, respectively over teff straw alone. Supplementation of teff straw with molasses alone (about 15% of diet DM) depressed teff straw intake, DM, N and NDF digestibilities, and depressed N retention below the levels attained with teff straw + urea, teff straw + molasses urea (fed at also 15% of diet DM) and with teff straw alone. The depressing effects of molasses were reversed by including urea at 2.5% (2.2 g) of the mixture. Response of sheep to N (urea) supplementation was greater than to energy (molasses) supplementation, indicating that N deficiency in cereal crop residues is a greater cause of poor animal performance than energy deficiency. In addition to showing that molasses-urea was a better supplement than molasses, the date indicated that the effects of urea as non-protein N supplement on increasing the intake of low quality roughages, nutrient digestibility and N retention were enhanced (often significantly) by giving urea with molasses instead of dissolving it in water and sprinkling onto the straw. Hence, molasses was also a better supplement than urea alone.

The effects of feeding noug cake or trifolium hay with molasses or molasses-urea on the measured parameters were significantly greater than those of feeding molasses or molasses-urea alone. Additional responses to the higher levels of noug cake and trifolium were not significantly greater than to the lower ones. The lower levels of noug cake and trifolium would therefore be more appropriate for peasant farmers using molasses or molasses-urea to supplement cereal crop residues. Although noug cake in Ethiopia is a cheaper source of N than trifolium (0.37 vs 0.95 cents/kg N), the latter is more appropriate and available to small-scale farmers.

THE EFFECT OF DIFFERENT PROTEIN SUPPLEMENTS ON THE VOLUNTARY INTAKE OF MAIZE STOVER

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ABSTRACT

Twelve (12) Zebu bulls of Gudali breed, 276 kg average liveweight and 2½ years of age were randomly put into 4 groups of 3 animals under intensive feeding system to determine the effect of different protein supplements on growth and intake of chopped, dried maize stover. A control group was fed stover ad libitum, and the other groups were fed daily 750g cottonseed cake/head, 1kg leucaena hay or 900g of leucaena hay or 900g of leucaena hay/cotton seed cake (66:34; W/W).

Significant differences (P = 5%) were observed on average daily liveweight gains. Animals on leucaena and its mixture registered higher daily gains (236 g) and (325 g) respectively; followed by cotton seed cake (154 g). The control group lost weight (-8 g).

Contrary to the liveweight gains, animals fed on leucaena and its mixture had lower maize stover intake; 3.35 kg DM and 3.70 kg DM/animal/day respectively; while those on cotton seed cake and the control group ingested respectively 4.72 kg DM and 4.16 kg DM maize stover/animal/day.

It is concluded that during the critical period in the Southern part of Cameroon, small scale farmers can prevent loss in liveweight by utilizing simple available rations.

ESTABLISHMENT OF FODDER LEGUMES IN TWO COMMUNAL AREAS OF ZIMBABWE

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ABSTRACT

The Farming Systems Research Unit (FSRU) entrusted with the task of improving and testing livestock technologies for the Communal Farming Areas, has selected two representative areas to carry out its programme, Mangwende and Chivi. In both areas a mixed crop/livestock farming system is practiced. The major constraint to improving livestock management and productivity is the limited availability of feed particularly in the dry season due to the low productivity of the grazing areas and the low quality of the grain stovers.

A review of previous research on forage legumes in Zimbabwe has shown marked increases in the dry matter yield and crude protein percentage of herbage and improved body weight gains per hectare of up to 60% where fodder legumes are established. These improvements have occurred in the large scale commercial farming areas but not in the communal areas because of a general shortage of land, the role of animals in the system and little attention to these areas by researchers.

The FSRU is working on the establishment of fodder legumes - Fine Stem **Stylo** and **Siratro** on fallow land in the high potential area (Mangwende) and **Leucaena leucocephala** as a living fence around homesteads and gardens in the low potential area of Chivi. The first year results of the planned four year trial show that the legumes can be established. Protection against destruction by animals and by white ants and crickets (for Leucaena) is necessary in the first year of planting. There has been no response in yield to fertiliser application in both areas and Leucaena appears very sensitive to excess moisture.

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CASSAVA BY-PRODUCTS IN RABBIT AND SHEEP DIETS

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ABSTRACT

Sun dried cassava leaves were fed to rabbits and peels were fed to sheep in an attempt to determine suitable rations that can prevent dry season animal weight losses. Rabbits fed 50, 62.5 and 75% levels of leaves in test diets ate 65.8, 73.5 and 71.8 g/d and gained 17.4, 19.4, 18.2 g/d respectively. There were no differences in growth traits between female and male rabbits.

Sheep fed 0, 50 and 100% levels of cassava peels with cottonseed cake as the protein source significantly ($P<0.05$) gained 227.1 g/d for the 100% peel based diet compared to 106.7 g/d for the sheep fed 50% peel based diet. Sheep fed elephant grass diet gained the least weight of 45.2 g/d. These diets show promise as dry season feedstuffs.

FEEDING GRAIN SPROUTS WITH POOR-QUALITY BY-PRODUCTS AS A SUPPLEMENT

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ABSTRACT

The nutritive value of poor quality by-products may be improved by supplementary sources of easily fermentable carbohydrates, crude protein, minerals and vitamin A-precursor.

The technique herein described was found successful in providing most of these requirements at a relatively low price. Grains (one kg) were sown on double their weight of chopped by-products and irrigated daily with 7 litres of tap water. Some urea and traces of foliar fertilizer were added to the water on the seventh day. One kilogram grains gave sixfold its weight of sprouts within two weeks. This product contained 11% crude protein and 55% TDN and it was palatable.

A NOTE ON THE EFFECT OF SUPPLEMENTATION WITH NOUG CAKE (GUIZOTIA ABYSSINICA) ON THE MILK PRODUCTION OF CROSSBRED COWS

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ABSTRACT

Thirteen mature Friesian x Zebu lactating cows were randomly allocated to 3 treatments, after stratification based on stage of lactation, for approximately 15 weeks. The basal diet consisted of poor quality grass hay and molasses/urea blocks fed ad libitum. Treatment diets were a daily allowance of 0, 1 and 2 kg noug cake. Daily records of milk yield and feed intake were kept. All the cows were weighed weekly. Linear contrasts of least squares means were computed to determine the significance of differences between treatment groups.

Supplementation with 1 kg noug cake allowed for a little more than 1 kg extra milk/day ($P < 0.01$) but there was no added benefit from increasing noug supplementation to 2 kg; the response was economically very favourable.

FORAGE RESEARCH IN SMALLHODLER AND PASTORAL PRODUCTION SYSTEMS

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ABSTRACT

Progress in the incorporation of forage legumes into farming systems in sub-Saharan Africa to alleviate livestock nutrition problems has been slow. This paper explains the reasons by showing how forages fit into smallholder and pastoral systems. It then speculates on the kinds of technical research that might accelerate their incorporation into current production system.

FEEDING OF CROP RESIDUES TO MILKING COWS IN SMALL SCALE FARMS

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ABSTRACT

The Dry matter (DM) yield and nutritive value of crop residues and legume fodders fed to lactating cows by small-scale farmers in Botswana was assessed. The average DM yields, tons per hectare, for sorghum, millet and maize stovers were: 1.22, 1.15 and 1.16 respectively. The average DM yield of lablab hay (Lablab purpurens) was 1.20 tons per hectare.

The average crude protein (CP%) and crude fiber (CF%) contents for sorghum, millet and maize stovers were 5.6 and 32.8; 5.2 and 39.4; 7.8 and 28.3 percent respectively. Average **in vitro** dry matter (DMD%) and organic matter (OMD %) digestibilities for sorghum, millet and maize stoverswere: 48.6 and 40.0; 40.1 and 28.9; 59.1 and 53.2 percent respectively. Average CP% and CF% values for lablab and cowpea hay and for sorghum bran were: 16.1 and 22.7; 13.6 and 26.3; 11.5 and 3.2, respectively. **In vitro** DMD% and OMD% for lablab and cowpea hay and for sorghum bran were: 60.5 and 53.8; 66.4 and 58.8; 56.9 and 48.3, respectively.

On-farm feeding trials, using Simmental crossbred and pure Tswana lactating cows fed diets containing 15% lablab hay and 85% sorghum stover (Trt A); 25% Sorghum bran and 75% sorghum stover (Trt B) and 100% sorghum stover (Trt C) was conducted. Mean daily dry matter intakes (kg) per 100 kg of body weight during the trial period were 2.27, 2.85 and 2.79 on diets A, B and C respectively and were not significantly different ($P < 0.05$).

During the initial four-month milk recording period daily milk yield (kg/cow/day), excluding milk left over for calf to suckle, for the Simmental crosses on diet A (2.7 kg) was lower ($P < 0.05$) than for Simmental crosses on diets B (4.1 kg). There were no significant differences ($P < 0.05$) in daily milk yields (kg/cow/day) for pure Tswana cows on diet A (1.7 kg) diet B (2.1 kg) and diet C (1.5 kg).

very little effective practical application has been achieved. This paper concentrates on their use for ruminant nutrition, as due to their ability to digest low quality feeds and roghages, ruminants can utilise these products more effectively than monogastic livestock, and in doing so, they are not competing for human food resources. If this optimal utilisation can be achieved, then considerable increase in animal production will follow, helping to reduce the acknowledged animal protein deficit. This production will be achieved at a lower cost than before, resulting in improved net profits and most importantly, in foreign exchange savings. By-products with the greatest potential for expanded use in Nigeria are dried brewers grains and palm kernel cake.

STRATEGIES FOR RURAL DEVELOPMENT WITH EMPHASIS ON LIVESTOCK PRODUCTION RESOURCE UTILIZATION AND FAO ASSISTANCE

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The author discusses different aspects of rural development and emphasizes that the most important single factor is the correct identification of constraints. It emphasizes that this can only be done by understanding of and involvement with the target group otherwise the wrong constraints are often identified. Problems of risk factors play a very important role in whether new technologies are accepted. Cost of new technolgies must be recovered in a guaranteed sale of the excess produced. Improvement in resources are most readily accepted by producers of milk when resources are limiting production and when a high and predictable price of milk can be obtained. Appropriate methods of improving resource utilization is discussed but it is emphasized that such technologies should only be attempted when resources utilization or availability is identified as the first constraint.

UTILISATION OF CROP-BYPRODUCTS AND AGRO-INDUSTRIAL RESIDUES FOR RUMINANTS FEEDING SYSTEMS IN ZANZIBAR

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ABSTRACT

Two trials were conducted to investigate daily weight gains of yearling bulls fed on rations containing various combinations of crop and agro-industrial byproducts.

Crop residues are widely available in Botswana. Based on their nutrient composition, digestibiilty and voluntary feed intake data they are useful in lactating cows. However, due to their low crude protein contents and low digestibilities, crop residue based diets need to be supplemented with higher protein legume fodders or locally produced milling by-products.

PRODUCTIVITY OF DAIRY COWS UNDER SMALL HOLDER FARMS BASED ON AGRO-BYPRODUCTS

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ABSTRACT

The paper gives background information on the policy on smallholder dairy farms. Various production parameters for different regions are looked into as they affect productivity and performance of Friesian/Holstein crossbred cows. The main agro-byproducts used by most farmers are groundnut haulms, banana stem and leaves green chops, locally produced maize germ and bran meal and rice bran. The bulk of the roughage comes from Napier grass and/or Rhodes grass that each smallholder grows for his dairy unit. Some farmers use proprietary dairy concentrates.

The paper stresses the need to look into alternative feed resources; especially in areas where the dry season is relatively longer. Data collected indicates that the Friesian/Holstein is not a suitable breed for the smallholders but their crosses produce acceptable levels of production and that production trends continue to be monitored under the recently introduced recording scheme.

THE OPTIMAL USE OF AGRO-INDUSTRIAL BY-PRODUCTS AND CROP RESIDUES IN NIGERIA

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ABSTRACT

Agro-industrial by-products and crop residues represent a vast animal feed resource, which is, as yet, largely unexploited. Considerable research has been, and is being, carried out into the potential of these by-products and crop residues but to date

In trial 1, a comparative study was conducted to measure performance of yearling bulls fed on urea treated rice straw and those fed on untreated rice straw supplemented with leucaena. During the 22 days trial period, the group fed on untreated rice straw with leucaena had a higher liveweight gain than those fed on treated rice straw without any supplement.

In trial 2 two groups of 5 yearling bulls each were fed on two combinations based on banana whole plant and napier grass. The groups were fed either 60:40 ratio while or 40:60 ratios (w/w) of banana - napier (DM basis). Records of liveweight gains were taken during the 7 months trial period. During the initial period, each group showed a gain in weight with that fed the 40:60 ration performing better than those fed 60:40. However, later the animals lost weight due to worm infestation and lumpy skin disease (LSD). Because of frequent outbreaks of disease during the trial period, it was difficult to obtain conclusive results from these trials. However, the trials demonstrated that the materials examined can be effectively utilised by ruminants.

3. RESEARCH NEWS

THE NUTRITIONAL EVALUATION OF DRIED POULTRY WASTE AS FEED INGREDIENT FOR BROILER CHICKENS

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Studies were carried out to determine the chemical and bacteriological compositions of variously dried poultry waste (DPW), and to evaluate DPW as a feed ingredient for broiler chickens. Poultry waste was collected every three days from laying hens, and immediately subjected to: (i) oven drying at 60°C, (ii) sun drying followed by autoclaving at 1.05 kg/cm^2, 121°C for 15 minutes, or (iii) Solar drying at 50-70°C. The differently dried poultry waste showed remarkable similarities in proximate composition, minerals, and amino acid contents, but differed quite significantly in metabolizable energy content, true protein digestibiilty, and gross protein value. Crude protein in the three samples of DPW ranged between 17.55% and 22.59%, while true protein ranged from 9.82 to 11.13%. Calcium in DPW ranged between 7.15 and 7.31%, while phosphorus ranged from 2.42 to 2.50%. The oven dried waste had the highest true metabolizable energy content (1152 kcal/kg DM), true protein value (56.88%), while the solar dried waste had the least energy content (506 kcal/kg DM), true protein digestibility (51.14%), and gross protein vlaue (28.16%).

The three differently processed poultry waste samples were not completely sterile. However, most of the bacteria isolated were believed to be normal inhabitants of the chickens' intestinal tract.

Four feeding trials were carried out to evaluate DPW as a feed ingredient in broiler diets. The dietary inclusion of 5, 10, and 15% oven dried, sun dried autoclaved, or solar dried poultry waste gave no significant differences in growth rate or feed intake of broiler chicks. The 15% level of DPW gave a poorer ($P<0.05$) mean feed efficiency than the 5% level, probably due to the lower dietary metabolizable energy content. Dietary metabolizable energy decreased slightly with the increasing level of DPW included in the diets.

In another experiment, broiler starter and finisher diets containing 5, 10, 15, and 20% oven or solar dried poultry waste were supplemented with various amounts of lard to attain the required energy level. No significant differences were obtained in growth rate and feed efficiency of broilers fed the diet without poultry waste or with levels up to 15% DPW. However, in further experiments, the level of DPW included in the diets was limited to 10% in order to avoid the use of uneconomic levels of lard required in diets containing 15% DPW. The diets containing 20% DPW resulted in significantly poorer feed efficiencies than the diet without poultry waste. This could be due to the high crude fibre and uric acid levels in dried poultry waste. The dietary inclusion of up to 20% oven or solar dried poultry waste in broiler diets had no significant effects on carcass yield and meat composition of broilers.

A further experiment was designed to identify the most efficient way of using dried poultry waste in broiler feeds. The oven or solar dried waste were included at 10% of broiler diets with various dietary energy and protein levels in an approximately constant calorie to protein ration. Starter diets were formulated to contain 2750, 2860, and 2970 Kcal. AMEn/kg and 20.80, 21.70, and 22.50% crude protein, respectively. Finisher diets were formulated to contain the same energy levels but with crude protein contents of 18.20, 19.20 and 20.00% respectively. No significant differences were observed in broiler performance, carcass yield, or meat composition of broilers fed the different diets. However, it was more profitable to feed the diets with the lowest dietary energy and protein levels.

The final experiment was designed to study the effect of dietary fat level on fat and mineral utilization by broiler chicks fed diets containing 10% solar dried poultry waste. The inclusion of up to 12% lard in broiler starter diets had no significant effects on broiler performance, or calcium and phosphorus utilization. Magnesium retention of broiler chicks was significantly reduced by the inclusion of 12% lard in the diet. The diet containing 3% lard gave a significantly higher fat retention, and higher calcium and phosphorus retention than the diet without lard. This appears to suggest that the level of lard in diets containing 10% DPW should preferably be limited to 3%.

From the results of this study, it was concluded that the oven or solar dried poultry waste may be safely included up to 15% of properly balanced broiler diets. Nonetheless, under conditions of this study, the 10% level of dried poultry waste appeared to be the most economical maximum limit of inclusion in broiler diets.

4. PASTURE NETWORK FOR EASTERN AND SOUTHERN AFRICA (PANESA)

PANESA was conceived by scientists, from Eastern and Southern African countries and from International / Regional research organizations who attended a workshop on "Pasture Research in Eastern and Southern Africa" held in Harare, Zimbabwe in September, 1984. A seven man Steering/working Committee was elected at that meeting to formulate the launching of PANESA whose broad functions were envisaged as communication of pasture research findings; pasture research financing, pasture germ plasm collection and distribution, training, support services in pasture research and other related aspects of pasture research and development.

PANESA is now a formally functional Network with a very strong administrative structure. Membership is open to all National scientists within its regional mandate. For more details write to:

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PANESA Co-ordinator
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P O Box 46847
NAIROBI, Kenya

ARNAB Newsletter
A quarterly publication of the African Research Network for Agricultural Byproducts
INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA, P.O. BOX 5689, ADDIS ABABA, ETHIOPIA
Vol 7 No 1 March 1987

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1. ARNAB - HISTORY AND INSTITUTIONAL STRUCTURE

Introduction

To answer the many requests that we have received, apparently from new members, we trace ARNAB from its inception, its objectives and aspirations and its institutional structure. What we would like to stress to members is that the Secretariat alone cannot be very effective in meeting the objectives and aspirations of ARNAB. As members your scientific contributions will go a long way towards ensuring effective networking. We do hope that you will give this request urgent serious thought and contribute effectively. We need material for Newsletters; research news, research papers, national reviews on crop residues and by-products work and any write up on topical issues relating

to crop residues and by-products utilization. National workshop news is also welcome.

Why a Research Network

Many documents have been written on the need for Networking in agricultural research. Amongst the most comprehensive advocacies is that of Plucknett and Smith (1984) "Networking in Agricultural Research".

There could be a thousand and one definitions of what a "NETWORK" is. The wider and deeper the aspirations and desires for making a success the more complex will the definition be. In the context of agricultural scientists the definition quoted by Kategile (1986) is probably about the simplest and neatest; that is, a network is a "cluster of scientists or institutions linked together by a common interest in working independently or interdependently on identified shared problem or problems". In the fabric of ARNAB one sees the need for involving government machinery and good will, extension agents and the very targets of the scientists efforts, the farmers, to achieve its objective. The algebraic equation, therefore, should consist of the following:

- the scientists, the problem (abundant and less efficiently utilized agricultural by-products, land scarcity and low food crop yields, poor nutritional status of the livestock and of the people, high feed costs, national development targets etc.) and research programmes. Each one of these components must be tangential to have a successful resolution of the equation.

The Birth of ARNAB

Whereas the seed for some form of collaborative efforts in crop residues and agricultural by-products work must have been very fertile amongst the African scientists and the international

scientific community with overseas experience/contacts, its actual insemination occurred at the Douala workshop on "agricultural, industrial and farm yard wastes" organized jointly by ILCA and the Association for the Advancement of Agricultural Sciences in Africa (AAASA) from 17th - 21st November 1980. Amongst the recommendations were that the "BABY" ARNAB should be nursed by ILCA. That recommendation was implemented by ILCA in 1981 with the assignment of the first scientific secretary to ARNAB (Dr. A.K. Mosi) and the publication of the first ARNAB Newsletter in July 1981.

ILCA was, however, aware that a similar initiative on by-products work had been launched by FAO in some West African Institutes. Therefore, in September 1981, ILCA and FAO organized a joint workshop on "crop residues and agro-industrial by-products in animal feeding" which was held in Dakar, Senegal. At that workshop it was "agreed that leadership of ARNAB should reside with ILCA". Workshops on related themes were also held in Tanzania in 1981, Kenya in 1982 and in Egypt in 1983; jointly organized by the Universities of Dar es Salaam, Nairobi, Agricultural University of Norway, and by the University of Alexandria, and sponsored by NORAD and IDRC for the Tanzania workshop and for Kenya and Egypt respectively.

In March 1984 ILCA and FAO organized an Expert Consultative Meeting in Addis Ababa "to develop guidelines for research on the utilization of crop residues and agro-industrial by-products". Attendance consisted of ARNAB nucleus national members and invited overseas scientists on by-products work. At this meeting ILCA's proposal for funding of ARNAB by IDRC was discussed. The final document was drawn up between IDRC and ILCA and the memorandum of grant conditions was signed by both parties in September 1984.

Aspirations and objectives of ARNAB

The objective as spelt out in the document is to strengthen and develop an African Network in support of research on utilization of crop residues and agro-industrial by-products through collaborative research. Some of the more specific aspirations are:-

1. To stimulate and strengthen research on utilization of crop residues and agro-industrial by-products through collaborative research.
2. To collect, analyze and disseminate literature on agricultural by-products utilization, processing methods and data base.
3. To prepare and distribute critical reviews of literature on by-products.
4. To develop standard evaluation methodologies (analytical and feeding trial criteria) and terminology for describing accurately, by-product feeds and on-farm study methods.
5. To conduct and analyse quantitative surveys and collect samples of important agricultural by-products in member countries.
6. To provide forums for exchange of information amongst scientists from national institutes and the planning of future research activities.
7. To develop technologies which improve the nutritive value of agricultural by-products suitable for smallholders in member countries and to support national institutions in such studies and also assess the economic and social impact of such technologies.
8. To provide training at technical and MSc levels in areas related to the improvement of by-products utilization.
9. To produce and disseminate ARNAB Newsletters as a vehicle to enhance the above objectives and to produce proceedings of workshops organized by ARNAB and/or collaborating institutions.

ARNAB Steering Committee

Yet another healthy development in the progression of ARNAB was the unanimous decision, endorsed by all the participants of the General Meeting on 16th October, 1985, held during the Alexandria Workshop, to elect an ARNAB Steering Committee. The Committee was elected and its terms of reference outlined.

Ex-officio Members

1. Professor Jackson A. Kategile IDRC Programme Officer (Crop and Animal Production Systems).
2. Dr. Reginald Preston (ARNAB Co-ordinator up to December 1985 and replaced by Dr. Douglas A. Little, Head of Nutrition Department as Project leader and prorata Co-ordinator).
3. Dr. Mopoi Y. Nuwanyakpa (ARNAB Scientific Secretary and Secretary to the Committee up to September 1986 and replaced by Professor Abdullah N. Said as Nutritionist and Co-ordinator in January 1987).

Elected Members: (One representing each of the following regions).

1. Northern Africa - Professor Moustapha A. El-Naga (University of Alexandria)
2. Western Africa - Professor Anthony A. Adegbola (University of Ife, Nigeria)
3. Eastern Africa - Professor Abdullah N. Said (University of Nairobi - Kenya)
4. Southern Africa - Mr. Simba Sibanda

Terms of Reference

1. Publish, as a matter of high priority, proceedings of each of ARNAB's annual workshops.
2. Review and monitor ARNAB's progress towards accomplishing its mandate.

3. Meet at least 4 months before each annual workshop to make plans towards the workshop and to discuss other matters relevant to ARNAB.
4. Present an award, at each annual workshop (starting in 1986), to one ARNAB member from each region (East, West, North, and Southern Africa) for the greatest number of articles published in the ARNAB Newsletter.
5. Present an award, at each ARNAB workshop (beginning 1986), to one ARNAB member for institution stimulating the use of crop residues and agro-industrial by-products by small-scale farmers (with specific mention of the scientists responsible).
6. Consider requests from ARNAB member institutions for assistance of varying nature (e.g. small financial assistance to facilitate research work). Requests should be endorsed by the Steering Committee member representing that region.
7. Encourage and sustain the interest of ARNAB members in supporting the Network. Committee members will bear special responsibility for the regions they represent.
8. Perform other duties as may from time to time be found necessary to fulfill ARNAB's mandate.

Tenure of Service of Steering Committee:

Ex-officio members will continue to be members for as long as they remain in ARNAB and/or institutional positions.

Regional elected members will be elected at the Annual General Meeting during workshops. However at the 4th Annual General Meeting, September 1986 Workshop in Blantyre the tenure of the Steering Committee was re-discussed. It was decided that Steering Committee members be elected once every two years. At the end of this period, they cannot stand for re-election.

ARNAB Secretariat

It was decided that ARNAB should have a Secretariat at ILCA headquarters consisting of the Coordinator and Scientific Secretary. The functions of the Secretariat were defined as follows:-

1. In consultation with ARNAB members, to promote and stimulate the application of certain principles and strategies of research on crop residues and agro-industrial by-products.
2. To respond to specific requests from ARNAB members regarding technical and research matters.
3. To publish the ARNAB Newsletter on a quarterly basis.
4. In collaboration with the Steering Committee to organize annual workshops/general meetings and to produce proceedings of such workshops.
5. To assist ARNAB members in obtaining publications and literature relevant to ARNAB's research mandate.
6. To facilitate communications between ARNAB members and ILCA's Directorate of Training in enhancing the participation of trainees selected from ARNAB member institutions in courses and workshops held at ILCA headquarters.

Membership

There is no constitutional membership in ARNAB. Anybody who is interested in effective utilization of crop residue and agro-industrial by-products is welcome to become a member.

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   Vol. 1. No. 1 July 1981.
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   Vol. 1. No. 2 October, 1981.

2. THE FIRST NATIONAL LIVESTOCK IMPROVEMENT CONFERENCE IN ETHIOPIA

(Extracted from notes written by Ato Lulseged Gebre-Hiwot, Institute of Agricultural Research (IAR), P.O. Box 2003, Addis Ababa, Ethiopia.

The first National Livestock Improvement Conference in Ethiopia organized by IAR was held from February 11th to 13th 1987 in Addis Ababa. The major objectives of the conference were:-

1. To create a national forum for scientists, development and extension workers and policy makers to get together and exchange ideas and views related to livestock research and development in Ethiopia.
2. To assess achievements made in livestock research in general and to point out development bottlenecks.
3. As a result of 1 and 2 above to discuss and formulate relevant research strategies.

There were 3 sessions; a plenary session dealing with development strategies and achievements, a research and technical session on animal nutrition, health and production and a third session for general discussion. A total of 46 papers was presented on animal production and health and on feeds and feeding. Out of the 46 papers there were 5 on forage production and agronomy, 4 on feed resources and ecology, 3 on various aspects of nutrition and 2 on crop residues. The rest were on other aspects of Livestock Improvement and Production.

Discussion centered mainly on applicability of research, development of packages and extension to smallholders, peasant associations and producer co-operatives. There were discussions on the need to concentrate research on pasture improvement, forage production, by-products utilization and the "cut and carry system" of forage production.

Some of the recommendations were:

1. that the National Livestock Improvement Conference should be held annually.
2. that IAR, Ethiopia should be the organizer of the Conference.
3. that government livestock research in Ethiopia should be organized on a commodity basis, viz. dairy, beef, draught power, sheep and goats, poultry, fishery
4. that IAR should look into the formation of research teams on Range Management and Wild Life.

3. RESEARCH NEWS

Utilization of crop residues and agro-industrial by-products for livestock production in Ethiopia

The Interafrican Bureau for Animal Resources, Nairobi, Kenya has circularized information on availability of funds for African countries to do research on crop residues and agro-industrial by-products. The objectives of their project are:-

1. To improve the status of animal nutrition and hence the performance of the animal by promoting the use of locally available aga -industrial by-products and crop residues and by transferring appropriate feeding techniques to small farm level;
2. To develop feeding methods for ruminants and non-ruminants based on optimal utilization of readily available agro-industrial by-products;
3. To study constraints to the utilization of locally available by-products;
4. To train extension personnel for the transfer of technology acquired through the project.

Applications should be addressed to the:
Director
Interafrican Bureau for Animal Resources (IBAR)*
P.O. Box 30786
Nairobi, Kenya

4. ILCA's GROUP AND INDIVIDUAL TRAINING

(Communication from Directorate of Training, ILCA Addis Ababa)

ILCA's training activities have developed substantially since 1985. We now organize training for both individuals and groups from about 38 sub-Saharan African countries each year. There are now annually from 8 to 10 regular courses for about 200 participants, and an additional 60 individual trainees ranging from technical to senior scientific, come to work with ILCA's scientific staff. In some cases they are purely for the benefit of the recipient but many are more mutually advantageous. The duration of individual training varies from 1 to 24 months. As an international livestock research Centre working at numerous sites in sub-Saharan Africa, we have research projects and training opportunities in ruminant nutrition, reproductive physiology, dairy production and technology, forage agronomy, agricultural economics and policy, animal traction, small ruminant production and animal health.

Through the Programme for African Animal Agricultural Research and Training (PAAART), a joint University - ILCA scheme for helping Africans to undertake graduate thesis research, we degree in recognized Universities. We can offer them, through their faculty advisor, possible assignments in an ILCA research

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*IBAR is an arm of the Organization of African Unity within the Scientific and Technial Research Council.

team. The objective is to provide practical experience in original research within Africa. It is a means of combining the training opportunities at ILCA with those of participating Universities.

Group training courses are usually of 2 to 4 weeks duration with a maximum 20-25 participants. Courses in animal nutrition, livestock project design and analysis, forage analysis and livestock systems research are offered. The language of instruction varies alternately between French and English.

For further information on ILCA group and individual training programmes please write to:-

Director, Training and Information
ILCA
P.O. Box 5689
Addis Ababa
ETHIOPIA

5. SOME REFERENCES ON CROP RESIDUES/FEEDS

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6. ABSTRACTS FROM ANIMAL FEED SCIENCE AND TECHNOLOGY

(With kind permission from Elsevier Science Publishers)

6.1 Animal Feed Science and Technology, 14(1986) 117-126
Elsevier Science Publishers V.B., Amsterdam - Printed in the Netherlands

EFFECTS ON DIETARY NITROGEN SOURCE ON MICROBIAL PROTEIN SYNTHESIS, DIETARY PROTEIN DEGRADATION AND NUTRIENT DIGESTION IN STEERS

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Effects of dietary nitrogen source on microbial protein synthesis, dietary protein degradation and nutrient digestion were examined with mature Holstein steers fitted with a permanent rumen cannula and "T" type duodenal and ileal cannulae. Animals were fed 40% hay and 60% concentrate mixtures containing urea, soya bean meal (SBM), canola meal (CM) and dehydrated alfalfa + urea (Dehy-U) as a supplementary protein source.

Nitrogen source in the diets did not alter duodenal or ileal flow rates of dry matter (DM) or organic matter (OM). Partial digestibility of DM and OM prior to the duodenum (mean 34.0 ± 3.24) and 45.5 ± 2.81), and in the small intestine (mean 46.9 ± 3.31 and 47.8 ± 2.72), and total digestibility in the whole digestive tract (mean 69.3 ± 1.89 and 70.4 ± 1.95) were similar across all dietary treatments. Steers fed SBM and Dehy-U had higher ($P<0.05$) concentrations of total nitrogen and non-ammonia nitrogen in duodenal digesta than those fed urea and CM. Dehy-U-fed steers had a lower ($P<0.05$) concentration of microbial nitrogen than the other groups. Although numerically higher flow of total nitrogen and lower flow of microbial nitrogen and,

therefore, lower ratio of microbial to non-ammonia nitrogen was observed with decreasing protein degradabilities of the diets containing the natural protein sources, the differences were not statistically significant. The degradabilities of dietary protein, in vivo, were 66.3, 57.9, 63.3 and 41.0% urea, SBM, CM and Dehy-U supplemented diets, respectively.

6.2 Animal Feed Science and Technology, 14 (1986) 193-202
Elsevier Science Publishers B.V., Amsterdam - Printed in the Netherlands

EFFECTS OF DIETARY CONCENTRATES ON RUMEN DIGESTION OF FIBROUS FEEDSTUFFS

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Instituto de Production Animal, Facultad de Agronomia, Universidad Centrale de Venezuela, Maracay (Venezuela)

Three mature rumen cannulated steers were given Pennisetum purpureum forage (60-65 days regrowth) ad libitum, with and without a concentrate supplement (1.0 kg maize bran dry matter (DM) per 100 kg live weight). Eight feedstuffs (bagasse, bagasse treated with 8% NaOH, Pennisetum purpureum, Digitaria swasilandensis, dried brewers grains, Canavalia ensiformis hulls and leaf and sweet potato forage) were incubated in nylon bags in the rumen and the disappearance of DM insoluble in 0.15 M NaCl after 0, 8, 16, and 72 h was measured.

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The half-time (T1/2) of disappearance of insoluble DM calculated for the first 24 h of incubation in the rumen was increased by dietary concentrates and this increase (△ t1/2 was related to the T1/2 of DM disappearance measured in steers given forage alone (T1/2) and to the cellulose content of the insoluble DM in each feedstuff. Also, separate linear relationships between △T1/2T1/2 and the cellulose content of insoluble DM were observed for the five graminaceous and the three non-graminaceous feedstuffs studied.

The experiment showed that concentrate supplementation reduced fibre digestion in the rumen more for graminaceous than non-graminaceous forages and this reduction was positively related to the rate of DM digestion in the absence of concentrates and to the cellulose content of the forage.

6.3 Animal Feed Science and Technology, 14 (1986) 215-220
Elsevier Science Publishers B.V., Amsterdam - Printed in the Netherlands

A COMPARISON OF ALKALI TREATMENT METHODS USED TO IMPROVE THE NUTRITIVE VALUE OF STRAW. II. IN SACCO AND IN VITRO DEGRADATION RELATIVE TO IN VIVO DIGESTIBILITY

M. WANAPAT[1], F. SUNDSTOL[2]2 and J.M.R. HALL[3]

A comparative study was conducted to evaluate the effects of alkali treatment of barley straw (cultivar 'Pernilla') on the in

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sacco dry matter degradability (ISDMD), in vitro dry matter digestibility (IVDMD) and in vivo dry matter digestibility (IVVDMD). The 15 treatments employed included chemicals such as urea, urine, aqueous ammonia, anhydrous ammonia, and dry and wet processes with sodium hydroxide. The rates of ISDMD were markedly enhanced ($P < 0.05$) by the wet (NaOH), dry (NaOH), NH_3 and urea/urine treatments, in the above order from highest to lowest. The ISDMD and IVDMD were both significantly correlated with IVVDMD ($r = 0.95$, $r = 0.90$, respectively). The in vitro and the in sacco methods both underestimated the digestibility of untreated straw, whereas the ISDMD estimates resulting from the wet (NaOH) treatments were higher ($P < 0.05$) than the IVVDMD estimates. The dry matter digestibility estimates by the three methods are summarized below.

	In vitro (48 h) IVDMD	In sacco (48 h) ISDMD	In vivo IVVDMD
Untreated straw	42.2	41.4	50.8
Urea/urine-treated straw	53.2	52.3	56.3
NH_3-treated straw	56.8	58.9	63.7
Wet (NaOH)-treated straw	69.2	82.0	73.7
Dry (NaOH)-treated straw	65.7	67.3	66.0

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CONTENTS

1. Introduction
2. University of Alexandria makes a wise move on their BSc Animal Science curriculum.
3. Research paper on technical and economic implications of feeding untreated and ammonia treated sorghum stover, with and without maize and sorghum bran supplement to beef cattle in Botswana.

1. INTRODUCTION

We are happy to note that some members are responding to our requests for News and Research papers to be published in ARNAB Newsletters. Members who may not wish to send us research papers could trim them into research news. Some of our readers are not fortunate to have regular access to scientific international journals. News about your work will be most useful in increasing awareness of what goes on within Africa. As a Secretariat we can help in meeting limited specific requests for scientific papers or abstracts of papers that would have been printed in international journals.

Please send us research papers, news about your research or news on your national professional conferences, societies or associations that have relevance to crop residues, agricultural by-products or to general animal production.

In the first of the four research papers which we have received Drs Farrington and Mayer look at sorghum stover only diets on liveweight performance and feed costs when fed at sub-maintenance and maintenance level. They then go on to examine the fattening performance and returns to labour of diets consisting of ammonia treated and untreated sorghum stover when supplemented with low and high levels of maize and sorghum bran mixture; a commonly available supplement by Botswana smallholders. They recognize the role of crop residue as a survival and maintenance feed resource during drought and in winter period. They point out the need to reduce mortality and loss of condition among ploughing animals in Botswana where 75-80% of the farmers depend on animal traction to prepare crop land. They look at fattening component of beef animals during winter to take advantage of the existing seasonal pricing structure in that country.

2. UNIVERSITY OF ALEXANDRIA - BSc ANIMAL SCIENCE CURRICULUM

Prof Mostafa A El-Naga writes from the Faculty of Agriculture, University of Alexandria to say that a complete course on "by-products feeds" has been included in their BSC Animal Science curriculum. Efforts have also been made to popularize technology in utilization of crop residues and agro-industrial by-products by the feed millers and that many state owned mills are now modifying sections of their outfits to handle crop residues in feed formulations.

For more information please write to Prof. El-Naga, Faculty of Agriculture, Univeristy of Alexandria, Alexandria, Egypt.

3. TECHNICAL AND ECONOMIC IMPLICATIONS OF FEEDING SORGHUM STOVERS WITH AND WITHOUT MAIZE AND SORGHUM BRAN SUPPLEMENTS TO BEEF CATTLE IN BOTSWANA

T. Farrington (1) and L. Mayer (2)

SUMMARY

Four different diets, two consisting of sorghum stover only and two of stover supplemented with a low and a high amount of bran, were used in the 100 day winter feeding trial. The cattle used were unfinished steers of a composite breed, half aged 18 months and half aged 30 months, weighing approximately 320 kg at the beginning of the trial. Each of the four diets were split to form eight treatments, four using untreated stover and four ammoniated stover. The stover only diets were aimed at examining liveweight performance and feed costs at sub-maintenance and maintenance levels. The diets including bran were aimed at examining fattening performance and returns to labour.

Animals with restricted access to untreated stover lost 6.4% of their initial liveweight whereas those on untreated stover ad libitum gained 4.4%. However, this was at the expense of a 76% higher intake and a 15% rejection of stover offered. Within diet comparisons with ammonia treated stover produced no significant differences in liveweight ($P<.05$).

With the two fattening diets liveweight gain ranged from 72kg to 100kg with untreated stover supplemented with the high level of bran producing the best results. There was no significant difference between untreated and ammoniated stover for either diet ($P<.05$).

Differences in liveweight between the four diets were significant ($P<.01$). Also, slaughter data was significantly affected by animal age and diet ($P<.01$).

Winter fattening based on untreated stover and a high bran diet was shown to give a good return to labour even if inputs were priced commercially. Selection of the right class of animal and use of stover harvested from their own fields can further enhance returns.

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Introduction

In Botswana crop residues are, by tradition, grazed communally as soon as grain is harvested. This is generally wasteful of a resource that could be used more selectively and hence more efficiently later in the dry season. During the past 3 years the Animal Production Research Unit (APRU) has demonstrated, under communal area conditions, what role crop residues may play in survival and maintenance feeding of selected cattle during the winter period (APRU, 1983-1984, 1985).

In order to more accurately assess the potential of crop residue based diets for winter feeding it was decided to carry out a trial, under controlled conditions, on one of the APRU's ranches in the Southern District of Botswana. The trial was divided into two distinct components, sub-maintenance or maintenance feeding based on a stover only diet and feeding for fattening based on stover supplemented with locally available bran.

With the exception of the past two seasons, when the government has heavily subsidised tractor ploughing as part of its drought relief programme, roughly 75-80% of all traditional farmers have depended on animals as their major source of draught power (Agricultural Statistics, 1984). This increased dependence on drought relief assistance for ploughing is directly related to mortality and loss of condition among ploughing animals due to reduced availability of grazing caused by the drought. Hence the need to look at the potential to maintain condition of animals.

The feeding for fattening component introduces a more commercial orientation with the objective of raising rural incomes by producing a top grade animal at a time when prices are highest. In an attempt to maintain a regular supply of animals for slaughter the Botswana Meat Commission (BMC) has a structured pricing system, the lowest prices being offered from April - July and the highest from September/October - December. However, farmers are often reluctant to sell their animals immediately after the winter because the benefits of the higher price are usually offset by poor grades and lower weights. Winter fattening is proposed as a profitable way to overcome this.

Elsewhere, research has shown that treatment of roughages with ammonia or urea may increase digestibility, intake and liveweight gain in ruminants, (Jackson, 1978; Sundstol et al, 1978.). To test the feasibility of such an option under Botswana conditions ammoniation was included as a factor.

Thus, the overall objective of the trial was to test the technical and economic implications of feeding untreated and ammoniated stover, with and without bran supplement, during the dry winter period.

Materials and Methods

The 64 growth retarded steers used in the trial, 32 aged 30 months and 32 aged 18 months, were allocated in pairs to 8 treatments in a 4 x 2 x 2 factorial design such that two pairs per treatment were older animals and two younger. The trial lasted for 100 days at the beginning of which animals averaged 320kg. Four diets with two replicates were tested, one using ammoniated (AT) sorghum stover and the other untreated (UT) sorghum stover. Diets 1 and 2 were aimed at sub-maintenance or maintenance and diets 3 and 4 at fattening for slaughter. The four diets were:

1 - Untreated stover, restricted
  - Ammoniated stover, restricted

2 - Untreated stover, ad libitum
  - Ammoniated stover, ad libitum

3 - Untreated stover, ad libitum plus low bran mix
  - Ammoniated stover, ad libitum plus low bran mix

4 - Untreated stover, ad libitum plus high bran mix
  - Ammoniated stover, ad libitum plus high bran mix

The intake of restricted stover was set at a level of 1.2% of initial liveweight (LW) based on stover having 90% dry matter (DM) and allowing for 5% wastage. Since there was no wastage in these groups, and as the stover was actually 94% DM, daily DM intake was slightly higher (see below). Bran consisted of a mixture of maize and sorghum bran (2:1), both available locally, and was fed at an initial rate of 2.5kg per animal per day at the low level and 5kg at the high level. This was based on an estimated 300kg LW and was adjusted every four weeks in proportion to liveweight gain (LWG). Dicalcium phosphate (DCP) and salt (1:2) were provided ad libitum to all animals. In addition, half of all animals across treatments received small quantities of magnesium sulphate (up to 6g/head/day). This was a precaution against side effects from the potentially toxic compound 4-methyl-imidazole which may be present in ammoniated roughage (Vosloo, 1985).

Each of the 32 pens included a rack for feeding roughage and troughs for minerals, water and bran as necessary. Shade netting (75%) was stretched over the pens to reduce exposure to the sun.

All sorghum stover used was of the "8469 Pioneer" variety. Ammoniation was carried out in an 18m cubic metre kiln (AN-STRA-VERTER) for 24 hours per batch. Concentration of anhydrous ammonia was approximately 3%.

Animals were adapted to stover consumption for 5 days prior to entering their pens and then to their actual diet for 8 days before the initial weighing in mid-August. Subsequently, all animals were weighed every two weeks using a mobile electronic scale until the final weighing prior to slaughter in November.

Stover was weighed in every morning, either in predetermined quantities (for the restricted treatments) or in quantities that it was estimated would not cause rejects to exceed 20%. Bran mix was weighed in every afternoon. Mineral mix was weighed in as necessary and water was continuously available except on the afternoon of the day prior to weighing when it was withdrawn.

Before entering the pens all animals were treated for internal parasites and, shortly after, were injected with vitamins A, D and E. Few ticks were present in the winter months and one spraying was sufficient to control them.

Results and Discussion

Nutrition

Results of some proximate analysis determinations are presented in Table 1

Ammoniation increased CP of stover by some 3%. As would be expected, CP of rejects was lower and crude fibre (CF) higher due to the high proportion of stem. Both the CP and CF content of maize bran were higher than those of sorghum bran.

Table 1 Analysis of Feed Ingredients as Percentage of Dry Matter

	CP	Ash	CF	Ca	P
Stover : untreated	6.4	10.0	37.1	.46	.07
Stover : ammoniated	9.5	9.6	37.1	.54	.08
Rejects : untreated	4.0	9.6	41.3	.38	.06
Rejects : ammoniated	6.5	10.0	40.1	.40	.06
Sorghum bran	11.6	3.3	6.6	.04	.38
Maize bran	16.9	3.6	8.1	.04	.68
Maize/sorghum bran mix (2:1)	15.4	3.4	7.5	.04	.55

CP = Crude protein; CF = Crude fibre

Daily consumption of stover and liveweight performance (based on actual and metabolic body size) for the two stover only diets (1 and 2) are given in Table 2.

Table 2 Daily Intake and Liveweight Performance of Steers Fed Sorghum Stover Only

		Restricted		Ad libitum	
		UT	AT	UT	AT
Intake (kg DM/100kg LW)	(1)	1.38	1.38	2.26	2.00
(g DM/kg $LW^{0.75}$)	(2)	57.20	56.90	95.30	84.30
LW change (kg over 100 days)		-19.1a	-29.9a	+13.6b	-0.5b

(1) Based on actual LW
(2) Based on metabolic body size ($LW^{0.75}$)
Means followed by common letters are not significantly different ($P<.05$); (LSD = 15kg).

In both the restricted stover treatments (diet 1) daily intake was 1.38kg DM/100kg LW. The AT stover groups lost about 11kg more than those on UT stover.

At the ad libitum level (diet 2) intake of AT stover was 11.5% less than that of UT stover with a corresponding LW loss in the AT stover groups compared to a gain of 13.6kg in the UT stover groups. Differences between the feeding of UT and AT stover were not significant. However the difference between the restricted and adlibitum diets was significant.

Stover intake based on LW compared well with that based on metabolic body size (see Table 2 and Table 3). Feeding of bran decreased voluntary intake of stover from some 90g DM/kg $LW^{0.75}$ in the ad libitum stover only groups (see Table 2) to 77g at the low level of bran and 55g at the higher level. Total intake, however, was slightly higher at the high level of bran. Intake level was well reflected in LWG although, as expected, conversion of total feed was somewhat better at the high level of bran. At the low level of bran total intake and LWG were slightly higher with AT stover than with UT stover but the difference was not significant. At the high level of bran the trend was similar to that with groups on ad libitum stover only (see Table 2).

Table 3 gives daily consumption and performance data of steers on the two fattening diets (3 and 4).

Table 3 Daily Intake, Liveweight Gain and Feed Conversion of Steers Fed Sorghum Stover ad libitum and Bran Mix at Two Levels

	Low Bran		High Bran	
	UT	AT	UT	AT
Intake (g DM/kg $LW^{0.75}$)				
(a) stover	72.6	81.8	56.9	52.3
(b) bran	30.3	30.0	58.7	59.5
(c) total	102.9	111.8	115.6	111.8
LW gain (kg, 100 days)	71.5a	80.6ab	100.3c	89.8bc
Kg all feed/kg gain	13.0	12.4	10.5	11.4

For statistical significance see note to Table 2.

Stover rejects were weighed out once a week and averaged from 14% to 27% for the ad libitum stover groups. Wastage of bran mix was negligible. As with the stover only diets LWG was only significantly different between diets and not between UT stover and AT stover groups.

On the stover only diets (1 and 2) a small energy supplement would almost certainly have increased performance as, for example, shown with rice straw by Creek et al. (1984). These diets, however, were intended to examine levels of maintenance and sub-maintenance feeding appropriate to cattle grazed in communal areas during winter. Such feed is usually in short supply during the winter in Botswana and it was expected that ammoniation would enhance the quality of roughage required to maintain LW. Results from several workers experimenting with other straws appear to point in this direction (The Rowett Research Institute, 1983; Wongsrikeao and Wanapat, 1984; Khurana and Naik, 1978).

On the two fattening diets (3 and 4) a significant response to AT stover in terms of intake and LWG was expected but not realised. Creek et al. (1984) working with rice straw obtained a response to ammoniation of 27% in intake and 45% in LWG. Nicholson et al. (1977) using ammoniated barley straw with 50% concentrate showed a 7.3% and 35.9% increase in

intake and LWG respectively. However, the effect of ammoniation is influenced, to a certain extent, by type of roughage and quality prior to treatment (Sundstol et al., 1978). In general this means that materials of lower digestibility respond better to treatment than those of higher initial value. Thus, the nutritive value of stover used in this experiment was probably sufficiently high that it would not be improved by ammoniation. The possible decreasing effect of ammoniation on N digestibility could also have been a contributing factor to the lack of a significant response to ammoniation. In this respect differences have been observed by other researchers in the response of various types of roughage. For example, in experiments with rice straw (Garrett et al., 1974), maize stover (Oji et al., 1977) and wheat straw (Coxworth et al., 1977), the apparent digestibility of N was decreased by ammoniation, whereas in experiments with barley and oat straw (Sundstol, 1977) it was increased by 20 to 40 percentage points.

Slaughter Data

Slaughter data for all steers are presented in Table 4.

Dressing percentage (CDW as % of final LW) was 46.7% on average for the younger group ranging from 44.5% at diet 1 to 49.5% at diet 4 whereas the corresponding data for the older animals were 49.5% and 46.9% to 53.9%.

Average CDW for the younger group was 157kg increasing from 107kg to 200kg from diet 1 to 4 and for the older group 188kg, increasing from 147kg to 237kg. Average MCV was P283 (P173-396) and P358 (P247-500) respectively.

Analysis of variance of grade, cold dressed weight (CDW) and monetary carcase value (MCV) showed that the 3 variables were significantly affected only by age and diet ($P<.001$); this, therefore, allowed pooling of the results by age and diet.

Average grade (see note to Table 4) of the younger steers was 2.31 improving from 3.13 at diet 1 to 1.00 at level 4 whereas that of the older animals was 1.75 improving from 2.88 to 0.25 respectively.

Table 4 Slaughter Data of Steers Pooled by Age and Diet

Age (Months)	DIET 1	2	3	4	Average Total
	(a) BMC Grades - Grade Index (1)				
24	3.13	3.00	2.13	1.00	2.31
36	2.88	2.50	1.38	0.25	1.75
Average	3.00	2.75	1.75	0.63	2.03
	(b) Dressing Percentage (CDW x 100/LW)				
24	44.5	44.8	47.9	49.5	46.7
36	46.9	47.1	50.3	53.9	49.5
Average	45.7	45.9	49.0	51.7	48.1
	(c) Cold Dressed Weight (CDW, kg)				
24	107	130	192	200	157
36	147	161	207	237	188
Average	127	146	200	218	173
	(d) Monetary Carcase Value (Pula)				
24	173	216	346	396	283
36	247	281	403	500	358
Average	210	249	375	448	321

(1) Grades alloted by the Botswana Meat Commission (BMC) are Super and Grades 1 - 4. Super has been given an index of 0.

Economic Implications

Obvious difficulties exist in trying to extrapolate the results of a controlled feeding experiment directly into the communal area situation. The following discussion provides only a guide as to what it may be possible to achieve and is supported by evidence from a recent trial on farmer's fields.

The two components of the trial, feeding at sub-maintenance or maintenance and feeding for fattening, are interpreted in different ways. The first requires a somewhat subjective assessment of the benefit of keeping animals in fair condition and able to perform ploughing and planting activities as necessary and applies primarily to the

small-scale, resource poor, farmer. The second can be assessed in terms of the increased cash return resulting from selling a well finished animal in October/November when prices are high, compared to the alternative of selling in July when the condition of communal area cattle is usually at its peak before grazing deteriorates during the dry season (see introduction). This option applies to the more progressive traditional farmers with enough cattle to be interested in selling one or more for slaughter.

It is important to note that the trial was carried out with the small-scale communal area farmer in mind and not large scale feedlot production. The possibility of productively utilising otherwise underemployed labour, and strategically feeding crop residues, further enhance the attractiveness to the communal area farmer.

Costs used in the following analysis are shown in Table 5.

Table 5 Feed Costs (Pula per tonne)

Untreated stover	110
Ammoniated stover (1)	145
DCP/Salt mix	210
Bran mix	143
Magnesium sulphate	600

(1) Includes cost of ammonia, equipment and extra handling costs.

As magnesium sulphate was only consumed in minute quantities (on average 0.45g/animal/day) and did not have a significant effect on liveweight (see earlier), it has not been included as a cost item in the following analysis.

Feeding for Sub-maintenance and Maintenance

The major results of these four treatments (diets 1 and 2) are illustrated in Table 6

Table 6 Feed Offered, Feed Cost and Weight Change Over 100 Day Period Maintenance and Sub-Maintenance Diets (1 and 2) (kg/head)

		Total Stover	Total DCP/Salt	Feed Cost (Pula)	Initial Weight	Final Weight	Weight Change (%)
Sub-maintenance	UT	427	10	49.02	299.9	280.8	-19.1 (-6.37)
	AT	419	9	62.66	300.4	270.5	-29.9 (-9.95)
Maintenance	UT	884	9	99.12	306.3	319.9	+13.6 (+4.44)
	AT	821	9	120.95	312.4	312.4	- 0.5 (-0.16)

As discussed earlier the ad libitum stover diets produced a better response than the restricted diets. However, this was at a much higher cost to the farmer.

Research has shown that in drought years weight losses among (surviving) non-supplemented animals in communal area range situations can be as high as 18% over the winter period (APRU 1983-84). As weight loss increases the greater will be the effect on an animals work capacity and therefore restrict the time they can be inspanned during the early part of the cropping season. Also, animals under severe nutritional stress will have a lower reproductive capacity and mothering ability than animals in fair condition.

At commercial prices for stover it would cost approximately P49 and P99 per animal for the UT stover ration at diets 1 and 2 respectively. (It is assumed that stover would not be ammoniated because it produced no significant technical response). Without a heavy subsidy on stover costs this is likely to be out of the range of many traditional farmers. What they must consider is whether the effort required to harvest and feed stover from their own fields (if available) can be offset by the improved condition of animals. Feeding of animals most at risk, nursing/pregnant cows and calves, would have much more obvious benefits where survival could be a major issue.

Feeding for Fattening

Some of the main results of these four treatments (diets 3 and 4) are illustrated in Table 7 and Table 8.

Table 7 — Feed Offered and Weight Change Over 100 Day Period High and Low Bran Levels (kg/head)

		Total Bran	Total Stover	Total DCP/Salt	Initial Weight	Final Weight	Weight Change (%)
Low Bran	UT	277	806	7	334.4	405.9	71.5 (21.38)
	AT	272	842	8	326.3	406.9	80.6 (24.70)
High Bran	UT	539	690	6	322.1	422.4	100.3 (31.34)
	AT	550	657	6	329.8	419.6	89.8 (27.23)

Table 8 — Costs and Returns Over 100 Day Period High and Low Bran Levels (Pula per animal)

		Initial Value	Final Value	Gross Profit	Feed Costs(1)		Net Return	
					Stover Purchased	Stover On-farm	Stover Purchased	Stover On-farm
Low Bran	UT	214.28	362.94	148.66	129.75	41.11	18.91	107.55
	AT	209.09	382.93	173.84	162.81	70.16	11.03	103.68
High Bran	UT	206.40	447.08	240.68	154.32	78.36	86.36	162.32
	AT	211.33	445.24	233.91	175.25	102.91	58.66	131.00

(1) Assumes all DCP and bran mix is purchased commercially.

Again, ammoniation produced no significant response at either bran level. However, UT stover proved to be superior in economic (cash) terms in combination with a high level of bran. At this level it produced a net return to labour of P86.36 or P162.32 per animal depending on whether stover was bought in commercially (in both cases it is assumed that all DCP and bran mix was purchased) or whether the farmer was able to harvest and feed his own stover. The analysis also assumed

that had the animals been slaughtered in July they would have graded at an average of 2.75 (25% grade 2 and 75% grade 3) with a dressing percentage of 48% of liveweight (this is based primarily on the results of animals on diet 2 - maintenance).

Assessed in terms of the communal area farmer the potential impact on net farm income appears to be substantial. The amount of P162.32 represents the possible increased return to a farmer's labour (for harvesting and feeding) for each animal he is able to fatten over the winter for sale to BMC in November. The Farm Management Survey (FMS 1983) quoted total annual net farm income from crops and livestock as P1036.50 for all survey farms in 1983. However, the dilemma remains that the more animals a farmer tries to fatten the greater will be the required input in terms of labour and stover. Thus, a balance needs to be reached between requirement for and availability of these resources. (The possibility of buying in animals in July specifically to fatten, on either commercially purchased or home produced stover, definitely exists but is not considered here).

Previous research (EFSAIP 1984) indicated that in the Gaborone region average cereal stover yields, even in fairly dry years, are about 600kg DM per hectare for a broadcast planted crop and 800kg/ha from a row planted crop. Thus, it will require approximately one hectare of sorghum to provide sufficient stover for the feeding of one animal. For farmers wishing to feed more than one or two animals the harvesting and transport of stover is likely to present one of the biggest bottlenecks. It may be necessary to hire some labour to assist with this task to avoid losses after harvest, especially if fields are not fenced. With average planted area in excess of 4 hectares in the Gaborone region (Agricultural Statistics, 1984) the possibility does exist for farmers to feed more than one animal.

Because animals are stall-fed, water will also have to be brought to the kraal to avoid excessive waste of energy in walking to water. On average cattle need about 40 litres of water per day. Most farmers have access to a donkey/ox-cart and 200 litre drums so, assuming it is possible to get two drums on a cart, one load would be sufficient for one animal for 10 days.

Sorghum bran is often available locally and maize or wheat bran from the larger milling companies. Where collection and transport are a problem this could possibly be alleviated by making the bran available through cooperative outlets.

Other than for transport of water and harvest and transport of stover, the labour requirements are minimal. Daily watering and feeding of animals does not require more than an hour of the farmers time even if he is feeding several animals. Similarly, materials required for the building of

individual stalls for feeding of cattle can mostly be gathered locally at no cash cost to the farmer. A small amount of wire for securing poles in the feeding rack is likely to be the only item that would have to be purchased.

The implications of this research at farm level have recently been demonstrated in an on farm trial carried out in the Southern District of Botswana (Chandler and Marsh, 1987).

Following detailed discussions with farmers a total of 17 animals were put forward for inclusion in the trial. The farmers assumed responsibility for the day to day management of animals (feeding and watering) while some assistance was given by project staff in terms of logistical arrangements and technical advice.

The animals in the trial were of considerable weight and age variation and so not ideal from the point of view of increasing both weight and grade. However, because farmers had specifically chosen these for slaughter, all animals were included.

This difference in age and weight of animals at the beginning of the trial is clearly reflected in the variation in response of individual animals over the 13 week feeding period. Average profit to the farmer over all animals was P75 assuming stover is produced on farm. However, a 385kg grade 3 ox gained 90kg and achieved grade 1 (net profit P140), whereas a 513kg grade 2/3 ox gained only 7kg and achieved grade 2 (net profit P26). This clearly indicates the importance of selecting the most appropriate animals for inclusion in a fattening programme (i.e. those with a potential to increase both weight and grade).

Conclusions

Ammoniation of stover produced no significant technical response and proved to be comparatively uneconomic. However, the benefits of winter feeding based on stover only or stover supplemented with bran have been clearly demonstrated. On farm trials have shown that fattening of animals for slaughter in November can considerably enhance farm income with only a small cash outlay on the part of the farmer, especially if it is possible to utilise crop residues produced on the farm. If animals are to be selected specifically for fattening then it is important to choose those which have the greatset potential for improvements in both weight and grade.

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5. Some useful references

1. EDITORIAL

Two research papers that of Farrington and Mayer in ARNAB Newsletter, Vol 7 No. 2 (June 1987) and the one in this issue by El-Hag, Gaafar and Salih, amongst many others in published literature, stress the need to study and extend strategic utilization of crop residues and agricultural by-products at both the smallholder level and in large-scale production systems.

The paper by Farrington and Mayer has thrown farther light on the merits and demerits of restricted and ad libitum feeding of sorghum stovers and the effect of supplementation with nitrogen and energy in the form of maize and sorghum bran in improving animal performance. They also assessed the effect of

ammonia treatment of the stover in Botswana. The paper points to the relevance of strategic supplementation of crop residues to take advantage of particular production situations such as dry season price differential, the need for keeping animals in fair condition to perform ploughing and planting activities as it applies to the small-scale, resource poor, farmer, or the feeding for fattening to increase cash returns from selling a well finished animal when prices are high.

El-Hag, Gaafar and Salih in their paper in this issue have shown that animals fed high roughage diets took 7-8 weeks longer to reach finishing weights but that the finishing cost was reduced by 15-24 percent, and that neither system of management (traditional in the Sudan versus semi-modern) nor season of finishing was important, albeit carcass scores were not given in their paper.

Other important features of crop residues and industrial by-products utilization are the need to increase quantity of crop residues, efficiency of handling and storage and balancing crop yields and crop residue quality. It has become abundantly clear that in many situations agro-pastoral smallholders do select seed varieties that will give low crop yields in favour of increased quantity and quality of crop residues. In Mexico, Syria and India, farmers discriminate on high yielding maize, barley and sorghum/millet seed varieties respectively in favour of the traditional seeds simply because they get low and less palatable crop residues from the improved seed varieties. These is a need for collaborative efforts amongst Plant Breeders and Animal Nutritionists to meet the farmers needs. An equally important aspect is the question of alternative uses of crop residues and also opportunity costs of farm labour on by-product utilization at the small-scale farm level. A careful assessment of the many factors involved in the efficient utilization of crop residues and agricultural by-products revolves around the need for a whole farm systems approach.

Some of the features that are important to consider in large-scale production systems are the utilization of crop residues and agro-industrial by-products at production sites to reduce haulage costs, the pricing and marketing policies of agro-industrial by-products, the economic advantages of using by-products nationally and their impact in the stratification of the livestock industry. Of special advantage is the role of the stratification system (i.e. stages of production from pastoralists to ranching and to semi-fattening or fully fattening feedlot systems) in increasing percentage offtake of livestock from the fragile arid and semi-arid pastoral areas.

2. USE OF CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS IN BEEF FEEDLOT FINISHING RATIONS IN THE SUDAN

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ABSTRACT

Agro-industrial by-products formulated rations were compared to a control ration under feedlot types, for finishing mature beef cattle (4-6 years, 306.6 ± 1.09 kg LW). Ration (E) based on sorghum straw and (F) based on groundnut hulls were compared to a traditional finishing ration based on sorghum grains (G).

IVDMD, cell wall and energy digestibilities were all significantly lower in rations (E) and (F), ($P < 0.01$). DCP and energy (DE, ME and TDN) were also significantly lower in the two rations ($P < 0.50$).

Comparable animal performance (DM intake, LW gain and FCR) resulted from feeding the three rations ($P < 0.05$). However, rations (E) and (F) resulted in relatively lower gains, (F) being the lowest. System of management and season of finishing exerted no effects on animal performance ($P < 0.05$).

Feeding of rations (E) and (F) decreased the cost of finishing (cost of feed/kg gain) by 24.2 and 15.1% respectively - but, longer periods of finishing were needed on these two rations (7-8 weeks).

INTRODUCTION

Finishing feedlot beef cattle on agro-industrial by-products is not a common practice in the Sudan (Ahmed et al, 1985), despite the availability of cheap and huge amount (more than 10 million tonnes/annum) of these by-products (A.O.A.D., 1983). Lack of technical know-how and scientific ration formulation by the feedlot owners, bulkiness of the by-products and their low nutritive value are some of the reasons for this limited use (El-Hag and Kurdi, 1985).

The current high levels of sorghum grains (50%) in beef feedlots rations could be reduced by the inclusion of agro-industrial by-products into these finishing rations. this, in essence, would lead to less competition for grains between ruminants, gastric animals and humans, and at the same time stabilize both grains and animal products prices (el-Hag and Kurdi, 1985).

This study was undertaken with the objective of assessing beef cattle response to feeding of rations based on agro-industrial by-products. Other objectives were to study the effects of season of finishing and the prevailing systems of management on animal performance.

METHODOLOGY

Feeding trials: Two on-farm feeding trials were conducted during winter (normal season) and summer (dry season) in 1984/85. Two privately owned feedlot farms were chosen for these trials, each representing a different system of management; traditional and semi-modern, as described by Ahmed et al, (1985). Each trial lasted for a period of 70 days.

Experimental animals and treatments: sixty Western Baggara (Zebu type) mature bulls (4-6 years), recently arriving from range, were used in each of these trials. Animals were provided by the feedlot owners. Average initial liveweights (LW) of the animals during the normal season were 283.83 and 310.83±1.09 kg for the traditional and semimodern systems respectively. Those used during the dry season averaged 311.03 and 320.83±1.03 kg for the same respective systems.

During both seasons, animals upon arrival were eartagged, weighed and divided into three groups on equal weight basis. Three rations; (E), a by-product ration based on sorghum straw, (F), a by-product ration based on groundnut hulls and ration (G), a concentrate ration based on sorghum grains, were randomly assigned to the three groups of animals under each system.

Rations (E) and (F) were by-product rations formulated to meet the specifications of the NRC, (1976) for finishing mature beef cattle, while ration (G) was the traditional type of ration commonly used by feedlot owners for finishing their cattle, and it was used here as a control (table 1 gives the ingredients, % on as-fed basis, of the three rations).

Feeding regimes: Animals were group-fed. Feeds were offered ad libitum for the three rations at 8.00 and 16.00 hours everyday. Animals fed on rations (E) and (F) were gradually introduced to these rations over a seven day period, to get

adapted to urea included in these rations. Refusals were collected each morning, weighed and re-incorporated into the day's meal. Daily feed intake was calculated for each group. Water was offered, ad libitum, twice daily. All animals were weighed individually every week after an overnight fasting.

Sampling and analyses procedure: Feed and hand-grab faecal samples were randomly taken at 10-day intervals. Collected samples were weighed, oven dried at 105°C, re-weighed and stored at -20°C for analyses.

Chemical analyses: Dried feed and faecal samples were ground to pass a 1 mm. mesh using a Christy-Norris mill. Ground dried samples were re-dried before weighing for chemical analyses.

Analytical methods: In vitro dry matter disappearance (IVDMD) (Tilley and Terry, 1963) of feeds, proximate analysis (A.O.A.C.,) 1980), cell wall constituents (Goering and Van Soest, 1970), and gross energy (GE) using oxygen bomb calorimeter (model 1341), were carried out in both feed and faecal samples.

Digestible energy (DE), and metabolizable (ME) were computed from the GE values. Total digestible nutrients (TDN) were estimated from the DE values by assuming 1 kg. of TDN as equal to 4.4 Mcal DE according to NRC, (1976).

Statistical analyses: Data for both trials were finally pooled, and adjusted to metabolic body weight ($W^{0.75}$). It was then analysed as a 2x2x3x10 factorial using a completely randomized design (2 seasons versus 2 systems of management with 3 rations and 10 animals per treatment) according to Steel and Torrie, (1980).

RESULTS

Chemical composition of the rations: Table 2 shows that rations (E) and (F) contained lower protein and energy (low EE contents) than ration (G). However, these two rations were bulkier (high NDF) and of lower DM contents. Moreover, these two rations (E and F) were of high ash contents, indicating a probable soil contamination of the by-products used.

Nutritive value of the rations: Digestibility coefficients and nutritive value of the three rations are given in table 3. IVDMD, cell wall and energy digestibilities of rations (E) and (F) were significantly lower than those of ration (G), ($P<0.01$). They were also significantly low ($P<0.05$) in DCP, DEE, and energy contents (DE, ME and TDN).

Animal performance: Although the by-products rations resulted in relatively lower gains in comparison to the control ration during both seasons and under the two systems of management (table 4) the differences were not significant ($P>0.05$). However, it is interesting to note that comparable animal performance (DM intake, LW gain and FCR) resulted from feeding the three rations ($P>0.05$). Seasons and management systems appeared to exert no effect on animal performance ($P>0.05$) even though animals finished during the normal season and under the semi-modern management system appeared to perform relatively better in comparison to the other treatments.

Animals finished on the concentrate (G) needed relatively shorter time to attain market weights (3-4 weeks), while those finished on the by-product rations (E and F) required relatively longer periods (7-8 weeks).

Feeding of agro-industrial by-products resulted in decreasing cost of finishing (cost of feed/kg LW gain) by 15.1

and 26.6% in the normal season and 23.5 and 13.3% in the dry season under the traditional and semi-modern systems, respectively (table 4). Cost of feed (cost/kg ration) was reduced by an average of 43.1%, when using agro-industrial by-product based rations relative to that of sorghum grain based ration (table 5).

DISCUSSION

Feedlot finishing of beef cattle in the Sudan is traditionally practised around consumer centres and export terminals. Feeds used are based mainly on concentrates particularly sorghum grains, which is the staple diet of the majority of the Sudanese people (Ahmed et al, 1985). In recent years, however, and particularly in the drought season of 1984/85, attention was focused on agro-industrial by-products as feed resources for ruminant animals. Fortunately, over 10 million tonnes of these by-products are produced annually in the Sudan (A.O.A.D., 1983), but their potential has not been exploited (El-Hag and Kurdi, 1985).

DCP and energy values of the traditionally used concentrate ration (G) were higher than optimal. This indicated a wasteful use of protein and energy feed, and reflected the lack of technical know-how by the feedlot owners of the scientific nutrient requirements for finishing beef cattle.

IVDMD, cell wall and energy digestibilities of the by-product rations were significantly lower than in the control ration (G) ($P<0.01$). This could be attributed to the high cell wall and lignin contents of the rations (Van Soest, 1982 and Reeves III, 1985). The low DCP and energy values of the by-product rations (E) and (F) were expected due to the intrinsic characteristics of agricultural by-products used. Nonetheless, the resulting protein and energy of these two rations were optimal for finishing mature beef cattle and they were in line

with the specifications of the NRC, (1976). This may be ascribed to the inclusion of urea (1.75%) and molasses (20%) in these rations, and their respective effectiveness in rectifying CP and energy contents in these by-products. Supplementation with urea and molasses, per se, could be the probable cause for the relatively similar animal performance resulting from feeding by-products in comparison to those fed on the concentrate ration. Potter et al, (1985) and Umoh, (1983) reported improved animal performance when feeding urea-molasses supplemented by-products rations.

There was no effect or evidence of interaction between seasons, management systems and rations fed on animal performance ($P<0.05$). This could be attributed to the fact that these animals, being Zebu, are well adapted to tropical environments, hence shade and shelter are of relatively limited effects in improving animal performance.

CONCLUSION

The results of this study indicate that:-

* Agro-industrial by-products based rations are effective in replacing high grain rations for finishing beef cattle.
* Under the conditions of the study in the Sudan, cost of feed is reduced by 43.1% and cost of finishing by 25.0% when using by products rations, although it takes about 4 weeks longer to achieve market slaughter weights.
* Feedlots owners lack the technical know-how of scientific finishing requirements of their beef cattle, hence extension is badly needed to introduce low cost packages using by-products which are cheaper and about as effective as concentrate rations.

ACKNOWLEDGEMENT

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Table 1: Ingredients (% on as-fed basis) of the three rations used in the study.

Ingredients	Ration (E)	Ration (F)	Ration (G)
Sorghum grains	15.0	15.0	59.0
Wheat bran	30.0	30.0	--
Berseem hay (*Medicago sativa*)	7.5	7.5	--
Sorghum straw	24.75	--	--
Groundnut hulls	--	24.75	--
Molasses	20.0	20.0	--
Cotton seed cake	--	--	50.0
Urea	1.75	1.75	--
Common salt	1.0	1.0	1.0
Total	100.0	100.0	100.0

Table 2: Chemical composition (% DM-basis) of the rations used in the study.

Item (% DM-basis)		Ration(E)	Ration (F)	Ration (G)
Dry matter	(DM)	88.7	88.91	93.96
Organic matter	(DM)	80.0	79.33	88.46
Crude protein	(CP)	15.0	15.55	21.83
Crud fibre	(CF)	14.9	15.81	14.81
Ether extract	(EE)	1.9	2.22	4.74
Nitrogen free extract	(NFE)	59.4	45.75	47.08
Ash		8.7	9.58	5.65
Neutral detergent fibre	(NDF)	65.8	70.28	50.0
Acid detergent fibre	(ADF)	24.3	27.05	26.53
Hemicellulose		41.5	43.23	23.46
Cellulose		26.6	20.18	20.71
Permanganate lignin		4.6	4.48	3.96

Table 3: Digestibility coefficients and nutritive value of the rations used in this study.

Item		Ration (E)	Ration (F)	Ration (G)	SE
In vitro DMD	(%)	62.3[a]	60.0[a]	69.2[b]	±1.3
Digestible CP	(%)	8.8[a]	9.5[a]	15.7[b]	±1.1
Digestible EE	(%)	1.7[a]	2.0[a]	4.3[b]	±0.2
Digestible CF	(%)	8.1[a]	7.7[a]	6.7[b]	±0.5
Cell wall digestibility	(%)	55.6[a]	52.3[a]	63.8[b]	±1.4
Gross energy	(Mcal/kg)	4.2	4.1	4.5	±0.3
Energy digestibility	(%)	63.4[a]	61.1[a]	70.0[b]	±1.4
Digestible energy	(Mcal/kg)	2.7[a]	2.5[a]	3.2[b]	±0.4
Metabolizable energy	(Mcal/kg)	2.1[a]	2.0[a]	2.5[b]	±0.2
Total digestible nutrients (TDN)	(%)	58.3[a]	55.4[a]	69.5[b]	±1.6

Means in the same row with different superscripts differ significantly.

($P = 0.01$ and/or $P = 0.05$).

Table 4: Average performance data of feedlot beef cattle as affected by rations, season of finishing and system of management.

PARAMETERS		NORMAL SEASON (Winter)						DRY SEASON (Summer)						
		Traditonal system			Semimodern system			Traditional system			Semimodern system			
		Ration (E)	Ration (F)	Ration (G)	Ration (E)	Ration (F)	Ration (G)	Ration (E)	Ration (F)	Ration (G)	Ration (E)	Ration (F)	Ration (G)	SE
Number of Bulls		10	10	10	10	10	10	10	10	10	10	10	10	
Days on test		70	70	70	70	70	70	70	70	70	70	70	70	
Average Initial Liveweight/Bull	(kg)	283.6	283.6	284.3	311.0	310.5	311.0	311.1	311.1	310.9	321.0	321.0	320.5	±1.09
Average Final Liveweight/Bull	(kg)	364.1	329.9	369.9	400.6	386.5	424.0	386.7	350.3	397.3	395.9	378.0	434.5	±1.56
Average Total Weight gain/Bull	(kg)	80.5	46.3	85.6	89.6	76.0	113.0	75.6	39.2	86.4	74.9	57.0	114.0	±1.02
Average Daily Gain/Bull	(kg)	1.15	0.66	1.22	1.28	1.09	1.61	1.08	0.56	1.23	1.07	0.82	1.63	±0.16
Average daily DM intake/Bull	(kg)	9.70	8.16	8.58	10.10	10.34	11.04	9.20	7.68	8.89	10.52	9.50	10.58	±0.29
Average daily DM intake/kg 0.75W	(kg/kg0.75)	0.12	0.11	0.11	0.12	0.12	0.13	0.12	0.10	0.11	0.12	0.12	0.12	±0.03
Feed Conversion Ratio (FCR)	(kg feed/kg G.)	8.43	12.36	7.03	7.90	9.49	6.85	8.52	13.71	7.23	9.83	11.59	6.49	±0.44
Cost of Finishing (cost of feed/kg gain	(LS*)	4.22	5.44	5.69	3.95	4.18	5.55	4.50	5.90	6.80	5.60	4.98	6.10	--
Improvement in Cost of rations(E) and (F) relative to (G)	(%)	25.83	4.39	--	28.83	24.39	--	33.82	13.24	--	8.2	18.36	--	--
Average improvement in cost of finishing of (E) and (F) relative to (G)	(%)		15.11			26.61			23.53			13.28		

No significant main effects for rations, systems of management and seasons of finishing, or interactions, were detected (at P = 0.05).

*LS 2.93 = 1.00 US$ (agricultural rate).

Table 5: Prices of rations' ingredients during the normal season (August, 1984) and the dry season (March, 2985) in Sudanese pounds(LS)*

Ingredients	Normal season		dry season	
	LS/tonne	LS/kg.	LS/tonne	LS/kg.
Sorghum grains	1290.0	1.29	1420.0	1.42
Wheat bran	215.0	0.215	215.0	0.215
Berseem hay	2000.0	2.0	2140.0	2.14
Sorghum straw	275.0	0.275	437.5	0.4375
Groundnut hulls	54.0	0.054	64.0	0.064
Cotton seed cake	360.0	0.36	480.0	0.48
Molasses	70.0	0.07	70.0	0.07
Urea	460.0	0.46	600.0	0.6
Common salt	100.0	0.1	210.0	0.21

*LS 2.93 = 1.00 US$ (agricultural rate).

Table 6: Prices of rations/100 kg in (LS).

	Normal season			Dry season		
	Ration(E)	Ration(F)	Ration(G)	Ration(E)	Ration(F)	Ration G
Sorghum grains	19.35	19.35	63.21	21.3	21.3	69.58
Wheat bran	6.45	6.45	--	6.45	6.45	--
Berseem hay	15.0	15.0	--	16.05	16.05	--
Sorghum straw	6.8	--	--	10.85	--	--
Groundnut hulls	--	1.34	--	--	1.58	--
Cotton seed cake	--	--	18.0	--	--	24.0
Molasses	1.4	1.4	--	1.4	1.4	--
Urea	0.81	0.81	--	1.05	1.05	--
Common salt	0.1	0.1	0.1	0.21	0.21	0.21
Total price/100 kg(LS)	49.91	44.45	81.31	57.31	48.04	93.79
Price/kg	0.5	0.44	0.81	0.57	0.48	0.94
Reduction in cost of feed (cost/kg ration) of rations(E) and (F) relative to ration (G) (%)	38.3	45.7	--	39.35	48.9	--
Average reduction of by-products rations relative to (G) (%)		42.0			44.13	

*LS 2.93 = 1.00 US$ agricultural rate.

3. RESEARCH BRIEF

SORGHUM BRAN SUPPLEMENTS FOR SHEEP AND GOATS

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Bran from two high yielding sorghum varieties, one bird resistant (MW5020) and one non-bird resistant (Melkamash) were compared as supplements in diets for sheep and goats. Two levels of supplementation were used (150 and 300 grams per day). Growth rate was measured over a 90 day period.

Sheep had a greater rate of gain than goats Table 1. There was no significant differences between the varieties at the 150 gram level of supplementation. However, growth rates were over 20 grams per day greater for Melkamash as compared to MW5020 at the 300 gram level (Table 1). The 300 gram level of MW5020 gave similar growth rates to either variety at the 150 gram level. Supplementation with 300 grams per day with bran from MW5020 lowered hay intake.

Table 1: The effect of variety and level of sorghum bran on the growth rate of sheep and goats.

Species	Rate of gain (g/day)							
	Melkamash				MW5020			
	150		300		150		300	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Sheep	28.6	3.1	53.7	3.1	30.8	3.1	33.1	3.6
Goats	13.2	4.4	38.7	4.4	14.2	4.4	18.6	3.1

Sorghum production is limited by bird damage in the semi-arid areas of Africa. Bird resistant varieties contain tannins in the grain pericarp which needs to be removed in order to improve their food value for human consumption. Crop breeders are selecting for bird resistance and milling equipment is being developed. Sorghum bran from bird resistant varieties may become an important agro-industrial by-product with potential use for animal feeding. The results of this trial indicate that bran from bird resistant varieties may have an adverse effect on the productivity of sheep and goats at high levels of supplementation but could be useful at low to moderate levels.

4. ABSTRACTS OF RESEARCH PAPERS

4.1 Abstract from Animal Research and Development 15(1982) 79-90

TANNIN CONTENTS OF AFRICAN PASTURE PLANTS: THEIR EFFECTS ON ANALYTICAL DATA AND IN VITRO DIGESTIBILITY

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and
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Photometrical tannin determinations yielded extraordinarily high values for some West African pasture plants (4 samples, more than 20% of DM). Gallic acid was taken as the standard.

Significant relationships existed between crude fat content and total phenolic compound content and between the content of crude protein in the acid detergent fibre (van Soest) and the

tannin content. The NfE fraction contains the other phenolic compounds in addition to part of the lignin.

As the highly significant logarithmic relationship between *in vitro* digestibility of protein and the tannin content demonstrates, knowledge of the tannin contents of West African pasture plants is extremely important. The extremely low digestibility coefficients for the crude protein of *Acacia albida* and *Adansonia digitala* leaves, as determined in digestibility tests with wethers, can primarily be explained by the tannin contents of these leaves. The results therefore indicate that some leaves are less suitable as protein supplement for farm animals than might be expected from their high crude protein content.

4.2 Animal Feed Science and Technology, 15(1986) 95-100
Elsevier Science Publishers B.V., Amsterdam -
Printed in the Netherlands

THE VALUE OF BANANA STALK AS A FEED FOR GOATS

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Ten samples of banana stalk of different varieties of unknown origin and one sample of robusta (*Musa cavendishi*) were analysed for proximate composition and fibre fractions. On average, the stalks contained 9.8% dry matter (DM) and 8.8% crude protein, 31.7% crude fibre, 35.2% cellulose, 18.7% hemicellulose and 9.2% lignin in DM. The stalk of robusta had similar values.

A 45-day feeding trial was conducted with three adult fistulated goats. The banana stalk provided 22% of the total dry matter consumed. The body weight of the bucks and the bacterial and protozoal populations of rumen liquor were recorded. Studies of digestion in vitro revealed that 50% of the total dry matter of the ground banana stalk disappeared after 24 h fermentation. The digestibility of cellulose, NDF and ADF after 24 h fermentation was 25.2, 28.7 and 19.5%, respectively. After 48 h fermentation, the dry matter digestibility was increased to 52.3%, NDF to 41.0% and ADF to 39.6%.

4.3 Animal Feed Science and Technology, 15(1986) 183-187
Elsevier Science Publishers B.V., Amsterdam -
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NUTRIENT AND AMINO ACID COMPOSITION OF LECUCAENA LEUCOCEPHALA (LAM.) de WIT

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Leaves and dry seeds of *Leucaena leucocephala* (Lam.) de Wit contain protein ranging from 25.25 to 30.81%. Dry seeds have higher levels of fat (7.24% than leaves (6.61%). Calcium, phosphorus and potassium appear to be adequate. *Leucaena* seeds are rich in isoleucine (8.0 g kg^{-1}) and have a greater content of lysine, leucine, proline and serine than soya bean proteins (10.8, 15.3, 9.1 and 11.9 g kg^{-1}, respectively). Two peaks of unknown amino acid-like compounds with calculated of 26.05 and 0.90 g kg^{-1}.

4.4 Animal Feed Science and Technology, 16(1986) 25-35
Elsevier Science Publishers B.V., Amsterdam -
Printed in the Netherlands

EFFECTS OF SUPPLEMENTING A WHEAT STRAW DIET WITH UREA OR A UREA-MOLASSES BLOCK AND/OR COTTONSEED MEAL ON INTAKE AND LIVEWEIGHT CHANGE OF LAMBS

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A feeding experiment was conducted in which lambs were given a basal diet of wheat straw plus 0.5% mineral mixture, supplemented with either 2.5% urea, 150 g day^{-1} cottonseed meal (CSM), 2.5% urea + 150 g day^{-1} CSM, urea-molasses block (ad libitum) alone or with 150 g CSM.

Supplementation of the basal diet with the urea-molasses block increased straw dry-matter intake by lambs significantly ($P<0.001$) from 333 to 420 day^{-1}, and a liveweight loss of 53 g day^{-1} on the basal diet was improved to a liveweight gain of 10 g day^{-1}. Supplementation with CSM alone or CSM plus urea increased straw dry-matter intake from 333 to 439 g day^{-1} and consequently converted a mean liveweight loss of 53 g day^{-1} on the basal diet to mean liveweight gains of 38 and 40 g day^{-1}. The combined supplement of CSM and urea-molasses block further increased straw dry-matter intake to 475 g day^{-1} and lamb liveweight gain to 90 g day^{-1}. The supplementation of 2.5% urea alone did not affect either straw intake or liveweight gains. The use of the urea-molasses block as a urea supplement was superior to urea alone.

The digestibility of straw as indicated by the loss of dry matter from straw in nylon bags in the rumen was increased by supplements of protein meals, but was highest when the urea--molasses block was also consumed.

Wool growth was increased by 60% above that on the basal diet by supplementation with the protein or protein plus fermentable-N sources.

4.5 Animal Feed Science and Technology, 16(1986) 99-107
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THE INTAKE AND DIGESTIBILITY BY SHEEP OF OAT STRAW AND MAIZE STOVER OFFERED WITH DIFFERENT LEVELS OF NOUG (*GUIZOTIA ABYSSINICA*) MEAL

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In two experiments, noug meal was given to groups of five castrated male sheep to provide 14, 26 and 40% of diets based on maize stover and 18, 34 and 45% of diets based on oat straw, both roughages being given ad libitum. Two periods, each of 7 days, were used for the determination of total dry matter (DM) intake and digestibility by total collection. Nitrogen balance and rumen NH_3, concentration were also determined. The cereal straws were each given without supplement to one group of sheep.

The intake of the roughages when given alone was similar but the apparent digestibility of cell wall constituents was higher for the maize stover than for the oat straw. The apparent digestibility of N was negative for both straws. The addition of noug meal caused an increase in total DM intake of the complete

diet but this was accompanied by a decrease in the intake of the cereal straw. The intake of NDF was similar in all the diets studied but there was a small but significant decrease in intake of both diets containing high levels of noug meal. With both roughages the addition of noug meal significantly increased the digestibility of DM, organic matter (OM) and most cell wall constituents. The return attributable to noug meal diminished as its rate of inclusion increased and the relation could best be described by an equation of the form $y = a+b \log x$. There was strong evidence of a positive associative effect of the noug meal on the digestibility of the cereal straws. The digestibility of the various components of noug meal was calculated by difference and the high values obtained provided further evidence of an associative effect. Nitrogen digestibility, rumen NH_3, and N balance were all increased by the addition of noug meal. Maintenance requirements for N calculated by regression of N balance on N intake were lower than recent recommendations. The addition of 15-30% of noug meal to the cereal straws studied would be expected to provide a production ration for ruminants.

4.6 Animal Feed Science and Technology, 16(1986) 179-186
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PALM KERNEL MEAL AS A FEED FOR POULTRY. 1. COMPOSITION OF PALM KERNEL MEAL AND AVAILABILITY OF ITS AMINO ACIDS TO CHICKS

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This paper examines the possibility of using palm kernel meal to replace groundnut cake in poultry diets. Palm kernel and groundnut cake samples were compared in terms of chemical

composition, amino acid content and amino acid availability to chickens. Palm kernel meal samples showed deficiencies in more of the essential amino acids than the groundnut cake. While the overall amino acid availability value for groundnut cake (91.1%) was significantly ($P<0.05$) higher than that of palm kernel meal (83.3%) most of the amino acids in palm kernel meal except valine, glycine and proline had availability values greater than 85% and could therefore be regarded as highly available. It appears that for palm kernel meal to effectively replace groundnut cake in poultry diets, it needs to be combined with other protein sources in order to increase dietary levels of some of the deficient amino acids.

4.7 Animal Feed Science and Technology, 16(1986) 187-194
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PALM KERNEL MEAL AS A FEED FOR POULTRY. 2. DIETS CONTAINING PALM KERNEL MEAL FOR STARTER AND GROWER PULLETS

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Two experiments were carried out to establish the level at which palm kernel meal can replace groundnut cake in the diets of starter and grower pullets and also to investigate the carry-over effect of palm kernel meal given during the growing stage on laying performance.

With starter pullets, palm kernel meal protein could replace up to 60% of the protein supplied by groundnut cake without any deleterious effect on their performance. This level of replacement amounted to 34% of palm kernel meal. Beyond this

level the rate of gain was significantly ($P<0.05$) reduced and feed/gain ratio significantly ($P<0.05$) increased. The replacement of all the groundnut cake protein by palm kernel meal in the diet of grower pullets did not significantly affect any of the parameters measured. Cost of feed kg^{-1} gain decreased as the level of palm kernel meal increased. The palm kernel meal in the grower diet did not significantly affect the rate of egg production, egg weight, weight of first egg dropped and feed intake.

4.8 Animal Feed Science and Technology, 16(1986) 195-202
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PALM KERNEL MEAL AS A FEED FOR POULTRY. 3. REPLACEMENT OF GROUNDNUT CAKE BY PALM KERNEL MEAL IN BROILER DIETS

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A total of 528 Ross broiler birds were used in two experiments to establish to what extent palm kernel meal can be used to replace groundnut cake in the starting and finishing diets of broiler chickens and to study the effect of such replacement on rate of gain, cost of production and carcass characteristics. For both the starter and finisher broiler birds, palm kernel meal could be used to replace up to 60% of the protein furnished by groundnut cake in the control diet without any significant differences in production. The starter birds were able to utilize up to 28% of palm kernel meal without any significant effect on performance. Above this level rate of grain and feed conversion value significantly ($P<0.05$) declined. The finishing birds were able to utilize up to 35% palm kernel meal without any significant effect on performance. Beyond this

level there was a significant ($P<0.05$) fall in rate of gain and feed efficiency. Abdominal fat significantly ($P<0.05$) decreased as the level of palm kernel meal fed increased while the gizzard weight significantly ($P<0.05$) increased. Cost of feed decreased as the palm kernel meal level increased and the results show that the use of up to 35% of palm kernel meal in the diet of finishing broilers will reduce cost of production, improve feed efficiency and also reduce the fat component of finished broilers.

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1. The Fourth Annual Workshop

The theme of the Fourth Annual workshop was on "Overcoming constraints to the efficient utilization of agricultural by-products as animal feed". It was held at the Institute of Animal Research, Mankon, Bamenda, The Republic of Cameroon, from 20th - 27th October, 1987. The workshop was co-sponsored by the International Livestock Centre for Africa and the International Development Research Centre, Canada who are the funding agency for ARNAB.

The workshop was opened by His Excellency Mr Abdoulaye Babale, Minister of Higher Education and Scientific Research of the Republic of Cameroon. Dr Emmanuel D. Tebong, Director of the Institue of Animal Research, Cameroon officiated the opening ceremony.

The Steering Committee of ARNAB would like to record their appreciation first to His Excellency Mr Abdoulaye Babale for sparing his busy schedule to bless the workshop and for his wise and encouraging words and for his hospitality to a gracious treat to dinner to all the workshop participants. The Steering Committee would also like to express their appreciation to the workshop hosts, the Institute of Animal Research, Mankon, Bamenda. In particular we would like to express our gratitude to the Director Dr Emanuel D.Tebong and to the station Manager Dr Ruby Fomunyam and to all the staff at the station who spent so much of their valuable time assisting the Secretariat in the various aspects of the workshop organization and also in playing host to the workshop participants.

The total number of respondents on the participation forms from 23 African countries was 74; some submitting two titles per form; giving a total of 86 titles to select from. After careful scrutiny, based amongst other factors, on available workshop time and funding status, 42 papers were selected for the workshop programme.

2. Recommendations of the Fourth Annual Workshop

2.1 At the closing session Rapporteurs Report formulated into the set of recommendations was presented by Mr Simba Sibanda. The Report was discussed and adopted. The recommendations are.

2.1.1. The role of small ruminants as important utilizers of by-products should be recognized. Account should also be taken of their selective nature.

2.1.2. Caution should be exercised in extrapolating data from one species to the next, e.g. goats vs cattle, sheep vs cattle. It is recommended that more production studies involving the comparison of different species of equivalent physiological maturity be undertaken.

2.1.3. Development of simple machinery such as choppers or chaff - cutters would be beneficial in reducing by-product particle size and assist in the harvesting process. Collaboration with agricultural engineers on the design and use of appropriate machinery is called for.

2.1.4. Transport is recognized as a major constraint, both on-farm and on a regional basis where by-products may be located in a different area to livestock. This question will need to be addressed and where applicable integration of crop and livestock systems is recommended using a Systems Approach. It is also recommended that more thought must be given to the transference of technology to farmers and extension personnel.

2.1.5. The limitations of conventional statistical methods in the design, execution and interpretation of on-farm livestock experiments needs to be addressed in order to come up with appropriate solutions.

2.1.6. ARNAB members are urged to consult expert statisticians or biometricians for help in the design and analysis of experiments. Where expert advice is not available in National agricultural Systems (NARS) researchers may like to send their research protocols/proposals to ILCA, through the ARNAB Co-ordinator for advice and possibly subsequent analysis of data.

2.1.7. The importance of standardizing feed description through the use of the International Network of Feed Information Centres(INFIC) system would be desirable so that ARNAB members speak the same "language". This would help to unravel the causes of a lot of conflicting results on apparently similar materials. It is suggested that ILCA/ARNAB act as the coordinator for this excercise.

2.1.8. The need to collaborate with agronomists to get information on grain : stover ratios in order to obtain accurate inventories of by-products is stressed and to get information on the roles and effectiveness of multipurpose food crops. Available data from FAO and from NARS should be used.

2.1.9. Research on harvesting and storage of crop residues should be encouraged and researchers pay attention to the economic, labour, and other logistical problems which are likely to arise.

2.1.10. Processing of crop residues can improve utilization and there is a need to consider appropriate methodologies & tecnologies for different situations and locations. Some of the processing methods considered should include ensiling, drying, alkali treatment if economical, and hydration.

2.1.11. Antiquality factors which may limit the utilization of otherwise nutritive by-products need to be specified and quantified to enable appropriate solutions to be found.

2.1.12. Supplementation of by-product with appropriate materials has long been accepted as a way of improving utilization of these residues. The materials which may be used include :

a) legume crop residues.
b) browse legumes, e.g. **gliricidia, sesbania & leucaena.**
c) forage legume, e.g. lablab, and others that may be appropriate in the mixed farming system.
d) NPN and protein nitrogen.
e) energy e.g. molasses, bran, and other agricultural industrial by-products such as oil cakes.
f) mineral supplements.

2.1.13. There is a need to study the possible anti - nutritional factors of some materials under 2.1.12.

2.1.14. The use of by-products in non-ruminants feeding systems should be encouraged, but consideration should be given to toxic substances which may be passed, through animal products, to human beings.

2.1.15. Alternative and competitive uses of by-products should be borne in mind so as to diversify research to other products which show more potential as livestock feeds.

2.1.16. **Finally,** there is a dire need to follow up recommendations of workshops through early implementation. It is recommended that ARNAB secretariat expedite the circulation of recommendations - perhaps within two months of the Workshop, instead of waiting until the publication of the proceedings. **It is also noted that inspite of reminders to the authors only a few papers were trimmed to the theme of the Workshop which was spelt out as "Overcoming constraints to the efficient utilization of agricultural by-products as animal feed".** It is recommended that in future it is important to stick to the theme of the workshop to save time on editing.

2.2. Discussion of the Report

2.2.1. Members thanked the Rapporteurs for their comprehensive Report.

2.2.2. That the Co-ordinator collects names and addresses of possible companies/centres that are likely to respond to the recommendations on designing simple tools (recommendation No.

2.1.1. That the question of use of the INFIC system was in fact discussed at the Alexandria workshop in October 1985 and the inview of the present recommendations the Co-ordinator puts a write - up on the INFIC system in the Newsletter for members.

2.3. The Recommendations were accepted and it was agreed that the Co-ordinator circulates them to members that attended the workshop and that these recommendations be published in the Newsletter as well, for those that did not attend the meeting.

3. COCOA POD HUSK AS A SOURCE OF ALKALI FOR THE TREATMENT OF MAIZE COB FOR RUMINANT LIVESTOCK FEEDING

By

A.K. Tuah,[1] D. Adomako,[2] K. Owusu-Aduomi,[1] and Felicia Y.O. Ayeh[2]

ABSTRACT

Experiments were conducted to determine the efficacy of cocoa pod husk potash for the treatment of maize cob for ruminant livestock feeding. Samples of cocoa pod husk were ashed in a muffle furnace. The water soluble salts in the ashes were extracted with boiling water and the solutions were used to treat samples of maize cob. 5% NaOH solution, 10% NaOH solution and plain water were also used to treat maize cob samples. The 48hr dry matter disappearance (DMD) values were determined using the nylon bag technique described by Orskov et al (1983).

For the cocoa pod ash treated samples the 48hr DMD values ranged from 20.61% to 32.17%. The 48hr DMD values were 9.33, 50.41 and 61.44% for the plain water-treated, the 5% NaOH treated and the 10% NaOH treated samples, respectively. Thus compared to the plain water treatment cocoa pod husk ash treatment significantly ($P<0.01$) improved the 48hr DMD values of maize cob while the 48hr DMD values of the NaOH treated samples were significantly ($P<0.01$) superior to those of the cocoa pod husk ash treated samples.

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INTRODUCTION

In many parts of the world, efforts are being made to look for alternative feedstuffs to cultivated grassess and legumes for feeding ruminants. Agricultural wastes, especially straws, have been identified as alternative feedstuffs. In Ghana, maize cobs, for logistic reasons, seem easier to utilize for feeding ruminants than cereal straws. About 200,000 metiric tons of maize cob are produced a year. The rumen dry matter degradebility (DMD) of maize cob is very low although the lignin content is not very high (Tuah & Orskov, 1985).

The low DMD value of maize cob is due to the binding of hemicellulose, which is the major component of the material (46.35%, Tuah and Orskov, 1985) with the lignin. To make an effective use of maize cob as a feed ingredient, it is therefore necessary to delignify it. Tuah and Orskov (1985) observed that NaOH and ammonia were effective agents for delignifying it. NaOH is a very expensive product in Ghana and urea, for generating ammonia, or gaseous ammonia cannot be found on the market. Cocoa pod husk is very rich in potash. It is in fact used for soft soap manufacture in the country. Most of the cocoa pod husk is left to rot on farms.

This trial was therefore conducted to determine the effectiveness of cocoa pod husk ash as a source of alkali for treating maize cob. The major chemical component of the ash was also determined.

MATERIALS AND METHODS

EXPERIMENT 1

Treatment of maize cob:

Maize cob was obtained from the Ghana Seed Company, Kumasi and was from different Ghanaian varieties of maize. It was sun dried. The maize cob was ground through a commercial hammermill with a screen size of 8mm.

Cocoa pod husk was obtained from the Cocoa Research Institute of Ghana, Tafo. The husk was dried in the sun. Samples of the dried cocoa pod husk, weighing 1kg each, were ashed. The ash, after weighing, was boiled with either 500ml of 1000ml distilled water and filtered. The normality of the solutions was determined by titrating against IN HCL. Aliquots of the solutions (40ml for the 500ml solutions and 80ml for the 1000ml solutions) were used for treating the maize cob samples weighing 14g each. Diluted aliquots of the solutions (20ml of the 500ml solution diluted with 20ml of distilled water, and 40ml of the 1000ml solution diluted with 40ml of distilled water) were also used for treating samples of maize cob (14g each). Samples of maize cob (10g each) were treated with 10% NaOH solution (10ml) or diluted 10% NaOH solution (10ml plus 10ml distilled water). There was a control plain distilled water treatment (10g maize cob treated with 10ml of distilled water).

After the samples had been treated, they were kept in polythene bags for 48hr. They were then put in nylon bags and washed with tap water till the alkali was removed. They were then dried at 105°C for 48hr.

Animals :

Three rumen cannulated Djallonke' wethers (average weight 15kg) were used. The type of cannual and the procedures for cannulation were as described by Ganev et al (1979).

Feeding and Management :

The wethers were kept in individual slatted-floored pens as described by Tuah et al. (1985). They were fed ad **libitum** on freshly cut Panicum maximum grass. Water was provided in 10 - litre buckets.

Procedure for incubation for the determination of rumen dry matter degradability (DMD):

Samples (2g each) of the treated maize cob were incubated in the rumens of each of the three wethers for 48hr. The types of nylon bags and the procedures for incubation were as described by Orskov et al (1983).

Chemical Analysis :

The untreated maize cob was analysed for nitrogen (N) by the automated Kjeldahl method of Davidson et al. (1970) and dry matter (DM) by the method of AOAC (1975). It was also analysed for acid detergent fibre (ADF), neutral detergent fibre (NDF) and lignin using the method of Van Soest (1963) and Van Soest and Wine (1967). The hemicellulose, cellulose and the cell contents were calculated as follows : Hemicellulose = NDF - ADF; Cellulose = ADF - Lignin; Cell Content = 100 - NDF.

Statistical Analysis :

The data were subjected to statistical analysis using the two-way analysis of variance (Snedecor and Cochran 1976).

EXPERIMENT 2

Determination of the chemical nature of cocoa pod husk ash :

Samples of cocoa pod husk were ashed in a barrel with both ends removed. All the water soluble salts in the ash samples were leached and dry salt samples were prepared. The K_2CO_3 contents of the salts were determined by titrimetric methods. The pH values of the salt samples and pure K_2CO_3 were determined after dissolving 13g of salt in distilled water and making the volume to 100ml.

The quantities of salt or potash needed for large-scale treatment of maize cobs were calculated after dissolving samples of extracted salts in known quantities of distilled or tap water and the pH and normalities determined.

RESULTS

EXPERIMENT 1

Chemical composition of the maize cob.

Table 1 contains the chemical composition of the untreated maize cob.

Table 1: Chemical composition of untreated maize cob

Chemical constituent (g / 100g DM)								
DM	Ash	ADF	NDF	Lignin	Cellulose	Hemicellulose	Nitrogen	Cell Contents
93.27	1.96	47.61	93.96	9.60	38.01	46.35	0.50	6.04

DM - Dry Matter
ADF - Acid detergent fibre
NDF - Neutral detergent fibre

Weight of cocoa pod husk ash, normalities of cocoa pod ash solutions and rumen dry matter degradability values of treated and untreated corn cob samples.

Table 2 contains the weights of cocoa pod husk ash samples, normalities of cocoa pod ash solutions and the DMD values of the untreated and treated maize cob samples. The normalities of the 1000ml solutions were about half of the those of the 500ml solutions.

Table 2 : Weights of cocoa pod ash, normalities of solutions, and the DMD values of maize cob treated with cocoa pod ash solution, sodium hydroxide and plain water.

Weight of cocoa pod ash (g)	Volume of solution (ml)	Normality solution	Volume of aliquot of solution used to treat maize cob	DMD values treated maize cob
112	500	2.34	40ml (solution only)	26.49a
			20ml solution + 20ml water	20.61a
110	500	2.32	40ml (solution only)	25.07a
			20ml solution + 20ml water	32.17a
109	1000	1.11	80ml (solution only)	23.78a
			40ml solution + 40ml water	22.22a
112	1000	1.17	80ml (solution only)	30.06a
			40ml solution + 40ml water	25.92a

10% Sodium hydroxide treated samples	10ml (solution only)	61.44b
	10ml solution + 10 ml water	50.41b
Water treated samples	10ml	9.33c

Values in the same column bearing different letters (a,b,c,) are significantly ($P<0.01$) and ($P<0.05$) different.

Treatment of the maize cob with 10% NaOH solution significantly ($P<0.01$) improved DMD value compared to cocoa pod husk ash treated or water treated samples. Cocoa pod husk ash treated samples also had significantly ($P< 0.05$) higher DMD values than the water treated samples. Decreasing the concentration of potash solution by diluting with water did not significantly ($P> 0.05$) affect the DMD values of the treated maize cob. Increasing the volume of the solution without decreasing the amount of NaOH used did not significantly ($P> 0.05$) affect the DMD values of the treated maize cob samples. There were no significant ($P> 0.05$) differences between the animals with respect to DMD. The mean DMD values for the three animals were 28.82%, 33.07% and 28.25%.

EXPERIMENT II :

Chemical nature of cocoa pod husk ash .

The water soluble salts accounted for 38-40% of the ash. The pH values of the salt solutions were 11.20, 11.75, 12.60, 13.10 and 11.85 for light brown, dirty white, white, and blue - green coloured cocoa pod husk ash salts and pure K_2CO_3 respectively. The K_2CO_3 contents of the cocoa pod husk ash salts were 84.80, 82.43 and 78.66% for the white, blue-green and light brown salts respectively. The calculated amounts of salt or ash for large - scale batch treatment are shown in Table 3.

DISCUSSION

Treatment of the maize cob with NaOH compared with the treatment with water improved DMD value by about 499% while treatment with cocoa pod hush ash solutions improved it by about 176%. The cocoa pod husk ash solutions were not as effective as the NaOH solution in delignifying the maize cob for one main reason . K_2CO_3, which is the main compound in the cocoa pod husk ash solutions, is not as strongly alkaline as NaOH.

Table 3 : Data for preparation of soulutions from ash or potash salts extracted from ash of cocoa pod husk.

Sample	Weight of Sample (g/l)	Normality	pH	Weight of sample kg/ solution	Weight of Ash kg/2001 solution
K_2CO_3	150.07	2.7	11.70	30	
A^1	157.14	2.60	12.20	31.42	78.55-82.68
A^2	157.66	2.6	12.50	31.53	78.82-82.97
B^1	156.62	2.6	12.70	31.20	78.00-82.10
B^2	155.85	2.54	12.70	31.17	77.92-82.02
C^1	182.83	2.6	12.90	36.40	91.00-97.36
C^2	185.00	3.0	12.80	37.00	91.00-97.36
D^1	153.40	2.5	13.10	30.68	76.72-80.73
D^2	153.30	2.59	13.10	30.60	76.50-80.52

* Subscript 1 distilled water solution
* Subscript 2 tap water solution

A - light brown coloured salt
B - Dirty white coloured salt
C - White coloured salt
D - Blue - green coloured salt.

It is doubtful that increasing the quantity of K_2CO_3 from cocoa pod husk ash for treating the maize cob might improve the DMD value to a greater extent than was obtained in this trial. The mean calculated amounts of K_2CO_3 used to treat 1g of the maize cob were 0.25g and 0.125g for the undiluted and the diluted solutions respctively, while the amount of NaOH used was 0.1g of maize cob.

Nangole et al. (1983) improved the **in vivo** dry matter digestibility of maize cob from 44.7± 1.6% to 61.6 ± 2.7% with Magadi Soda (0.09g Na_2CO_3, $NaHCO_3$, $2H_2O$ 1 / g maize cob) treatment. The dry matter digestibility for NaOH (0.045g/1g maize cob) treated maize cob was 54.2 ± 2.0% in the same report.

The DMD values obtained in this trial were less than the values obtained by Tuah and Orskov (1985) for the same type of maize cob. They reported 48hr DMD values of 34.4, 42.5 and 82.4% for water treated, ammonia treated and 10% NaOH treated samples respectively. The lower values obtained in the present trial could be attributed to the large particle sizes of the samples (8mm screen) compared with the particle sizes (2.5 mm screen) of the samples used by Tuah and Orskov (1985). The surface areas of the samples exposed to the rumen microbes were reduced with the larger particle sized samples.

CONCLUSION AND PRACTICAL APPLICATION

Cocoa pod husk ash treatment was not effective as NaOH treatment in delignifying maize cob although it improved its nutritional value over plain water treated samples. A further experiment is being conducted to determine if cocoa pod husk ash treated samples will be

able to supply the maintenance energy requirements of the local dwarf sheep, when fed as the main ingredient in a ration as the method for extracting potash from cocoa pod husk is suitable for large - scale batch treatment of maize cobs.

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1.1 STRAGEGIES OF FEEDING STRAW TO SMALL RUMINANTS : UPGRADING OR GENEROUS FEEDING TO ALLOW SELECTIVE FEEDING

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ABSTRACT

Population growth will accelerate crop - animal integration, creating a need for stall - feeding systems for goats and sheep based on crop residues, especially on small farms. Five

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experiments with goats and two with sheep showed that allowing small ruminants to 'stall - graze' long barley straw will increase intake because of selective feeding. Allowing goats to reject 50% of the straw offered, instead of the conventional **ad libitum** refusal - rate of 10 to 20%, increased straw dry matter intake by 30 to 47%, and that of the estimated digestible straw by 41 to 78%. In one experiment, goats fed rejected straw (50% rate) after treatment with ammonia, consumed as much digestible straw as when the original straw was fed generously. Botanical fractionation of offered straw and rejected straw showed goats to select leaf rather than stem when the amount offered was large enough to allow selective feeding. Similar experiments with tropical straws are required.

1.2 SMALLHOLDER LIVESTOCK PRODUCTION : CONSTRAINTS ON THE ADOPTION OF IMPROVED TECHNOLOGIES

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ABSTRACT

This study made use of information collected from a formal survey of sheep and goat farmers in the North West province of Cameroon to test the hypothesis that the ability of a farmer to adopt a particular technology with which to increase production depends on the resources of the farmer, his/her socio-economic characteristics and expectations as well as factors outside his/her own control.

The framework of analysis was based on a multistage economic model of the adoption process relating to agricultural innovations. A general probit function was estimated by the method of maximum likelihood to derive coefficients and probabilities of explanatory variables likely to influence farmer attitudes towards increased sheep and goat production.

Estimated coefficients showed that current herd size, available pasture land, housing and fencing facilities, current income from sales, and market price for sheep and goats had significant effects on the ability to increase sheep and goat production through adopted technology. The variables family and hired labour, age and expected future returns from sheep and goat did not significantly affect the decision to increase sheep and goat production. From the interviews over 80 percent of farmers were willing to increase sheep and goat production if constraints on production and marketing were lifted. This suggested that a substantial number of farmers were being prevented by a number of factors from expanding production. Against this background of constraints, a strategy for developing the sheep and goat sectors in the North West Province should aim at not only minimizing constraints against increased productivity, but also exploiting the biological, economic, management and institutional possibilities available for sheep and goat production.

1.3 CONSIDERATIONS IN THE DESIGN OF ON FARM LIVESTOCK EXPERIMENTS AND EVALUATION OF RESULTS

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ABSTRACT

The paper identifies major extraneous factors which can have a significant effect on the variation of response variables in on-farm livestock research. The implications of such factors on the design of experiments and evaluation of results are discussed. Important statistical considerations are presented and their importance in guiding experimental designs demonstrated. The paper used a case study based on a feeding trial of dairy cattle under small farms to illustrate the design, management and evaluation problems resulting from the extraneous factors. A case is put forward to support the use of farmer evaluation and economic analysis as additional approaches to statistical methods in evaluating research results.

1.4 THE ECONOMICS OF PEASANT CATTLE FEEDING IN MALI

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ABSTRACT

On-farm cattle feeding activities of selected peasant farmers in the semi-arid zone of Mali were followed in the dry seasons of 1984, 1985 and 1986 under the "Embouche paysanne" project, financed jointly by the Government of Mali and the USAID. The sample fed abattoir destined cattle between eighty and ninety days during the dry season and sold them in May, taking advantage of prevailing high prices at this time of the year. Coarse fodder and cotton/seed residues were the main feed inputs, and producers benefitted from loans provided especially for the project.

The animals gained on average between 0.58 and 0.81 kg/day during the feeding period. Gross returns of approximately 25320 FCFA* and 35319 FCFA on average were realized in 1984/85 and 1985/86 respectively by the sample taken as a whole. Disaggregating the gross returns into its price and weight components, higher sale prices in May during the 3-year campaign contributed on average about 55% while weight gains and the interactions between weight gains and price changes accounted for 37% and 8% respectively. However, after deducting purchase and production costs, average profit per animal, including the value of unsold animals, was substantially reduced, affecting the ability of participants to repay loans. In 1985 for example, about 27% of the sample made no profit or lost money in the cattle feeding programme.

* FCFA 315.5 = 1US$ in 1987.

Since the fattening programme depended largely on cotton - seed residues of limited long - term availability, feed trials were undertaken to determine the economic viability of the project using reduced amounts or partly replacing cotton - seed residues with other farmer produced supplements. Although cattle fed reduced amounts of cotton - seed residues gained less weight than those on larger quantities, profitability was increased.

1.5 COMBINATIONS OF AGRO-INDUSTRIAL BY-PRODUCTS FOR USE IN DAIRY DIETS FORMULATED BY ON-FARM USE OF A LEAST COST RATION SYSTEM

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ABSTRACT

The main limitations to the use of by-products in diets for farm animals are the uncertainty of the likely response in terms of animal production and their need for supplementation other materials to provide a diets adequate for the needs of production. These problems are found at all levels of animal production from subsistence systems to commercial farming. In industrialized countries and some developing ones agree-industrial by-products are commonly incorporated into commericially compounded feeds on a basis of decisions made using computing methods. A computer package has been written to offer these same facilities at relatively low - cost to the individual or group of farmers. The system has application in in which there exists some element of choice in the feeding of animals. There are three components to the systems for caculating diets in this way;

1. A system for calculating the likely requirements of farm animals.

2. A knowedge of the nutritional properties of each of the materials which is likely to be fed expressed in same terms as those in which animal requirements have been described.

3. Some way of choosing from the information on feeds the most advantageous mixture needed to satisfy the needs of animals.

This paper describes the development and application of one such system as a decision making tool in the optimization of utilization of feeds, including agree - industrial by - products, on dairy farms in Zimbabwe. Copies of the computer package are available to organizations in developing countries for the cost of the media.

1.6 OVERCOMING THE CONSTRAINTS OF NITROGEN AVAILABILITY TO IMPROVE CROP RESIDUE UTILIZATION BY RUMINANTS IN BURKINA FASO

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ABSTRACT

The improvement in the efficiency with which ruminant animals transform crop residues into meat, milk and draught power will have important implications in the integration of animals in the strongly cereal crop oriented production system of the Soudanian zone of Burkina Faso. There is a mismatching of supply of nutrients and the physiological states of animals in the production system. The abundant cellulosic energy could not be

utilized effectively mainly due to the constraint of nitrogen (N) availability. The choice of source of N, non - protein or protein - N, is crucial to the development of a feeding system that is sound biologically and economically.

The biological aspects of utilization of crop residues with the aid of N supplements at ruminal and tissue levels are discussed to justify the choice of soruce of N that could fit into the objective conditions of the production system. The production system could be responsive to changes if the intervention is compatible with the long term productivity of cereal crop production through improved soil fertility and structure.

Amongst the sources of N emphasis was put on the use of forage or dual - purpose legumes for they could serve as the key link between animal and crop production systems, the latter through increased soil N and Organic Matter (OM) status. The patterns of in vitro degradation of OM and N of the forage legumes and sorghum and millet stovers were assessed and briefly discussed. It was shown that the forage legumes in addition to correcting the deficiency of rumen degradable nitrogen (RDN), if supplemented to cereal stovers, can also contribute substantial amount of Rumen Degradable Organic Matter (RDOM). However, due to the rapid degradation of N the available RDOM may not be able to match to the former. Suggestions are given to increase the supply of protein to the small intestine.

1.7 STRATEGIES TO OVERCOME CONSTRAINTS IN EFFICIENT UTILISATION OF AGRICULTURAL BY-PRODUCTS AS ANIMAL FEED

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ABSTRACT

The constraints in the efficient utilisation of agricultural by-products have been poor quality of the by-products, financial limitations for the procurement of chemicals and reagents and inadequate qualified man-power to carry on analytical work. Associated with this is inadequate laboratories and other facilities, lack of documented work on previous research work on the nutritive value of these feed resources making it impossible to derive suitable feed combinations for the various nutrient requirements. In general there has lacked a strategy in the promotion of utilisation of by-products. Consequently the development of the livestock industry has been affected. Intensive livestock production systems are currently implemented on a stratified model on a small scale. However, simple forumulated rations on a small scale have been used in beef cattle fattening and dairy cattle feeding. The resulting daily liveweight of 1 kg and milk yields of up to 16 litres respectively have been encouraging. Lambs fattened on groundnut haulms and maize bran have shown daily weight gain of 112g.

1.8 TOWARDS EFFICIENT UTILIZATION OF POULTRY WASTE BY RUMINANTS

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ABSTRACT

Feeding experiments were conducted to evaluate the utilization of poultry waste - based diets by cattle. Sunflower seed cake could be replaced completly by broiler litter to constitute 30% of finishing rations for steers without affecting average daily gain or carcass merit. Cross - bred heifers which were supplemented with a fermented 60 : 40 poultry layer waste/ground sorghum grain were able to attain a breeding weight of around 260 kg by 18 months of age. In both experiments, dry matter intake and digestibility coefficients of poultry waste-based diets were comparable to commercial - type rations. Ensiling sorghum forage (Sorghum vulgare) with layer waste making up 40% of the ensiled material improved crude protein (CP) for 6.5% in untreated silage to 12.2% in the treated silage. Steers that were supplemented with treated silage gained 0.87 kg/day and this was raised to approximately 1 kg/day when 1 kg of ground grain per day was fed in addition to treated silage. A ration compounded with 30% of the concentrate mixture as poultry waste could support about 10 litres of milk per day. Inclusion of the waste did not affect butter fat content of the milk. It would appear that CP values of around 12% in concentrate mixtures may be adequate for low producing dairy cattle.

1. 9 TEPHROSIA SPP & COTTONSEED CAKE (GOSSYPIUM SPP) SUPPLEMENTATION OF RICE AND MAIZE STALKS FED TO SHEEP AND GOATS IN THE DRY SEASON

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ABSTRACT

Tephrosia spp., a legume grown locally in Cameroon and cottonseed cake a by-product obtained from processing of cotton were used to supplement maize and rice stalk diets fed to sheep and goats in the dry season. There were 6 diets fed to 12 Dwarf forest sheep and 12 West African Dwarf goats. A 2x6 factorial design was used for the analysis. This supplementation increased the efficiency of utilization of the crop residues by the ruminants. There was a higher intake, weight gain and low mortalities for sheep than goats. There were high mortalities for goats but those which survived had intake above maintenance level. Diets supplemented with 50% Tephrosia and 50% cottonseed cake had the best results in terms of intake, weight gain and percent mortalities.

Apparent digestibility values for crude protein was quite high and similar for all the diets. Therefore Tephrosia can equally be utilized like cottonseed cake for protein supplementation in adult sheep as no mortalities were observed.

Apparent dry matter digestibility values were high for the control checks indicating better palatability and therefore high intake. More work should be done on this study to find out the appropriate levels and the combinations needed for protein supplementation using the above supplements so as to improve on the intake of agricultural by - products and to encourage the use of Tephrosia which can also be used for fuel and maintaining soil fertility.

1.10 THE POTENTIAL OF CROP RESIDUES, PARTICULARLY WHEAT STRAW AS LIVESTOCK FEED IN ETHIOPIA

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ABSTRACT

Crop and livestock production are important activities in the smallholder mixed farming systems in Ethiopia. Feed resources for livestock are natural herbage and crop residues. Cereal straws of teff (Eragrostis teff) barley, wheat and pulse crop residues are very important particularly during the dry season. Currently crop residues are used as is with no treatment to improve intake and digestibility. The quality and quantity of residues produced is also very low in relation to the total area of cropped land.

Results of experiments clearly indicate that the yield and quality of crop residues could be tremendously improved through agronomic practices and varietal selection. Undersowing of wheat with forage crops did not reduce grain yield but resulted in reasonable production of straw and undersown forages which could improve intake and digestibility of the residue. In the wheat improvement programme, significant variations were found among the varieties with respect to grain yield, straw yield and quality. There seems to be a wide range of possibilities to improve the production and utilization of wheat straws, and crop residues in general. Breeders and agronomists need to consider the residue aspect as part of the overall crop improvement programme.

1.11 DOLICHOS (LABLAB PURPUREUS) IN BY-PRODUCTS BASED DIETS FOR LACTATING COWS IN BOTSWANA

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ABSTRACT

Dairy cattle feeding was based on crop stovers supplemented with Dolichos lablab (Lablab purpureus) and post-harvest residues here in after refered to as lablab. Lablab was introduced to 30 small scale dairy farms. Average lablab dry matter yield from 30 farms (ton/ha) for 0 and 100 kg/ha single superphosphate (10.5%P) fertilizer rate were 1.23 and 1.44, respectively, but not different (P>0.05). Average dry matter tyield (ton/ha) at 0,100 and 250 kg/ha rate, on-station, were 1.41,1.56 and 1.70, respectively, but not different (P>0.05). Phosphorus fertilization did not show significant (P>0.05) effect in dry matter yield due to low seasonal rainfall and distribution patterns in the project areas (262 to 414 mm rainfall). Total quantities of lablab hay, sorghum/millet stover and sorghum chaff/husks harvested by 30 farmers was 34.1, 56.4 and 7.2 tons dry matter, respectively.

Sorghum and millet stover dry matter yield (ton / ha), on-farm, ranged from 0.66 to 1.74 and 0.78 to 1.00, respectively. On-station dry matter yield (ton/ha) ranged from 1.87 to 3.46 for different sorghum stover varieties. Dry matter yield (ton / ha) for millet, maize and cowpea stovers were 2.42, 3.04, and 1.19, respectively.

The dry matter and nutrient contribution of leaves, stems and twines and roots to whole lablab, Tswana cowpea and ER-7 Cowpea were assessed. Dry matter contribution by leaves to whole Tswana Cowpeas (57.8%) were higher than lablab (47.0%) and ER-7 cowpeas (57.8%) were higher than lablab (47.0%) and ER-7 cowpeas (48.0%). Overall the

total dry matter and nutrient contribution of leaves to whole plants was higher than stems and twines in all three crops.

Average daily milk yield/cow/day (excluding milk left for calf) for Simmental - Tswana crossbred and Tswana cows fed sorghum stover based diets supplemented with eigher 15% lablab (diet A) or 25% sorghum bran (diet B) were 2.2 and 3.4; 1.4 and 1.6 kg/day, respectively. The results showed significant differences ($P< 0.05$) between breeds but not within breeds fed the different diets. Average lactation length (days) and milk yield/cow/lactation (kg) for Simmental - Tswana and Tswana cows were: 273 and 223; 760 and 338, respectively. Average birth weight for Simmental - Tswana calves (34 kg) were greater than for Tswana calves (28 kg).

2.1 COMPLEMENTARY NATURE OF CROP-ANIMAL RESEARCH.

Ward, J.K.; Gracia, M. de - Paper Farming Systems Research, Kansas State University 1986, P. 498 - 512.

ABSTRACT

Quality improvement in fodder or crop residues from Panicum virgatum, Pennisetum purpureum, maize, grain sorghum, rice and wheat is discussed in terms of selection for improved DM digestibility. Data are presented on cv. differences in fodder quality. Chemical treatment of fodder with hydroxides and anhydrous ammonia is also considered. Data are given on feeding trials with cattle.

2.2 CROP-LIVESTOCK SYSTEMS RESEARCH IN ASIA : DESIGN AND TESTING OFR.

Calub, A.D. ; Roxas, D.B.; Carangal, V.R. - Paper, Farming Systems Research, Kansas State University 1986, P. 578 - 597.

ABSTRACT

Crop - livestock systems research projects undertaken as part of the Asian Rice Farming Systems Network at Santa Barbara, Pangasinan, Philippines, Khon Kaen, Thailand and Batumarta, Indonesia are described. At Santa Barbara sites in rainfed and irrigated lowlands were compared. Adoption of technology packages, including daily feeding with 2 kg leucaena or other fodder legumes, provision of urea - molasses - mineral blocks, establishment of improved fodders and animal health care, and farm size had no effect on cattle liveweight gains. Average daily feed offered to cattle over the year was 13.8 kg (as fed), equivalent to daily CP content and TDN of 0.38 and 3.17 kg/animal, respectively. In the irrigated lowland area 92% of farms used high yielding rice cv. giving average grain yields of 3.09 - 4.91 t/ha which supplied 11.09 - 15.50 t fodder/ha. At the rainfed sites research concentrated on intensifying the single rice cropping system to include upland crops e.g. legumes. In the Khon Kaen project the only cropping pattern to give a positive return under upland paddy conditions was groundnuts/maize corn-on-the-cob, the latter providing residue of 11.2 - 19.7 t/ha. Two periods of decline in cattle growth rate were apparent which coincided with periods of fodder shortage and farmer preoccupation with harvesting or planting field crops.

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INTERACTION OF DUAL - PURPOSE GOATS WITH SUBSISTENCE CROPS AND WEEDS

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ABSTRACT

The Small Ruminant Collaborative Research Support Programme (SR - CRSP) has been conducting farming systems research directed toward introducing dual - purpose goats to enhance household nutrition and cash flow in Western Kenya.

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[2] Winrock International, Route 3, Morrilton, AR 72110, U.S.A.

This paper presents results on how sweet potato (Ipomea batatas), a dual - purpose crop; maize stover (Zea mays), a crop residue; and couch grass (Digitaria scalarum), a weed, are used to enhance goat production for both milk and meat, on small - scale farms in Western Kenya. Leaves and vines of sweet potato (SPV) are used for creep feeding and as a proteinaceous supplement for lactating does. SPV qualified in these roles because of its digestibility of 68% and its crude protein content of 20%, and because it ranked number one in palatability among six proteninaceous fodders.

Maize stover, a crop residue of the staple crop in Western Kenya, is available in quantities of one or more tons per small holder farm annually. Results are presented to demonstrate how its intake and use can be enhanced through treatment with molasses and common table salt, and by feeding it in combination with proteinaceous forages.

Couch grass, which is a notorious weed, is used as a livestock feed. It ranked first in palatability among common grass forages of Western Kenya. Due to its palatability and high nutritive value, it is recommended for feeding goats and other livestock, after it is weeded from plots growing food crop. The results of on-farm and on-station performance of dual - purpose goats are compared and discussed.

INTRODUCTION

The objective of the Small Ruminant Colaborative Research Support Programme (SR-CRSP) in Kenya is to develop and evaluate dual-purpose goat (DPG) production systems in small scale farms in Western Kenya. Research on the DPG, which follows the farming systems research (FSR) is focused, on increasing production of food protein through milk and meat, and cash generation through sales of goats and their products.

In the first phase of FRS constraints were identified. Amongst the constraints identified, land size was found to be the most limiting (Sands et al 1982; Mukhebi et al 1986). Land reserved for pastures over the years have been taken for growing food crops due to population pressure. Therefore, for successful of any livestock production in these small farms, must rely heavily on dual - purpose crops, crop residues, weeds and multi - purpose legume trees. As a result DPG nutritional studies in Western Kenya are based on these feedstuffs.

MATERIALS AND METHODS

Study area

The study area is located in Western Kenya, about 400 km west of Nairobi and 100 km east of the Uganda border. The current sample of 72 farmers, which will increase to 250 next year, are drawn from Kakamega and Siaya districts in Western and Nyanza provinces respectively. The area is in a sub-humid zone with an annual bimodal rainfall range of 1000 to 2000 mm. The altitude ranges from 1200 to 1800m. The average, minimum and maximum land size of the 72 collaborating farmers is 1.9, 0.2 and 9.6 ha respectively. Land pressure is 300 people per square kilometer. The main food crops grown are : maize, beans, sweet potatoes, cassava, sorghum, bananas, millet, kale and cowpeas. Cash crops include coffee, tea, cotton, sugarcane and eucalyptus trees. Indigenous cattle, sheep and goats have been raised by the people since time immemorial. Lately exotic dairy cattle have been introduced with considerable success; where provision for feed and tick control are adequate. The research station is centrally situated within the study area; along the equator at an altitude of 1500m.

Sweet potato leaves and vines (SPV) Ipomea batatas

Kids born within the same week were randomly allocated into two treatments. In Treatment 1 kids had full access to the milk of their dams, while in Treatment 2 they had full access only in the first two weeks. From the third week access was gradually reduced, reaching zero by the end of the fourth week. At the age of four weeks they were weaned to fresh SPV, which was initially introduced to them ad lib from the age of two weeks. All the kids were weighed weekly and for those on SPV their intakes were measured daily. Milk intake from the dams were measured daily.

Maize stover Zea mays, Hybrid 612

Six castrates were used in a 6 x 6 latin square design to study the effect of maize stover on goat performance. The treatments included feeding of stover alone, stover plus sprinkled common salt, stover plus molasses, stover plus SPV, stover plus Tylosemma. spp and stover plus Sesbania sesban. The adaptation and the experimental period for feeding were ten days for each. In all the treatments the stover from Hybrid 612 was chopped into lengths of approximately two inches. Fresh stover plus the supplements were offered twice daily at 8 am and 4 pm. Stover was offered in excess of intake by 20%.

Couch grass (Digitaria sclarum)

Six crossbred pregnant does, with an average liveweight of 36 kg were used. Six grass species (Table 4) were offered in a cafeteria style for five adaptation, and five experimental days. The grass species were in the same vegetative stage and only the aerial parts were offered. There were two feeding sessions per day, lasting an hour each, at 9:00 to 10:00 am and 4:00 to 5:00 pm. In the cafeteria each species was presented randomly in two hanged bundles of one kg each. After each feeding session the orts were weighed and then discarded. Preference was determined by the level of intake. Chemical analysis included dry matter, crude protein and in vitro digestibility.

Productivity indices

The parameters of reproductive performance, doe and kid viability, milk production, growth and doe weight were combined (Table 5) to build an index of the total weight of one year old kid plus the liveweight equivalent of milk produced, both per doe per year and per unit metabolic body weight maintained per year. The doe productivity index was computed as the product of doe viability (%) x kidding (%) kid viability (%) x kid weight at 1 year (kg) + doe viability (%) x kidding (%) x lactation offtake yield kg divided by 11 (adapted from Trial and Gregory 1981).

RESULTS AND DISCUSSIONS

There was no difference in growth performance between the kids that were weaned on SPV and those with total access to their dams milk as shown in Table 1. A major and significant difference between the treatments was in milk offtake for human use. From the does whose kids were weaned to SPV, each doe was milked 87 kg in 120 days. So by utilization of the SPV, which farmers grow as a crop, the accrued side benefit was 87 kg of milk; or in monetary terms Ksh. 522/-(1 US dollar = 16 Kshs in 1987). Furthermore, early weaning has the added advantage of enhancing rumen development (Semenye et al 1986).

Table 1: Performance of kids and milk offtake

Age - days	0	30	60	90	120	Milk offtake
Total Suckle kg	2.9	2.9	4.6	5.6	7.3	NIL
Weaned on SPV * kg	2.4	6.3	6.6	8.4	7.9	87

SPV* = sweet potato vines

SPV is an ideal milk substitute because nearly all the farmers in Western Kenya grow sweet potatoes and also because of its chemical composition. Sweet potatoes are grown in small plots with estimated size range of 16 to over 100 sq. metres. From the smaller plots sufficient SPV can be harvested to meet the requirements of a kid, at 30g. DM/kg body weight/day. The chemical composition of milk and SPV are comparable in that the moisture content and digestibility of milk are 85% and 86%, while for SPV are 80% and 72% respectively.

The chemical composition of the maize stover treatments are presented in Table 2. Maize stover which was the basal diet of the six treatments had the highest and the lowest dry matter content and nutritive values respectively. Dry matter intake of chopped maize stover is shown in Table 3. Supplementation of maize stover with SPV, Sesbania sesban, Tylossema spp. and salt did not enhance intake beyond maize stover alone treatment. It is likely these protein rich forages were not balanced with other nutrients or were not quantitatively enough to enhance rumen utilization of the maize stover by the rumen microbes. The supplements of Sesbania sesban, Tylossema spp. and SPV comparised 9%, 9% and 5% of the basal diet dry matter respectively. These levels were taken because they were equivalent to one kg of as-fed : and is the level of supplementation by many farmers.

Table 2 : Chemical composition (%) of feed components.

Feed	Dry matter	Crude protein	Dry matter digestibility
Maize stover	89	4.0	36
Tylossema spp	43	14	64
Sesbania sesban	43	26	68
Sweet potato vines	25	20	68

Table 3 : Dry matter intake of chooped maize stover (kg)

Treatment	Stover alone	Stover + Salt	Stover + molasses	Stover + SPV*	Stover + Tylossema	Stover + Sesbania
n	54	54	54	54	54	54
Minimum	0.83	0.25	0.45	0.95	0.45	0.63
Maximum	2.14	2.11	1.91	2.66	2.14	2.70
Mean	1.55[a)]	1.49[ab)]	1.37[b)]	1.60[a)]	1.48[ab)]	1.60[a)]

* SPV = Sweet potato vines.

ab) Means followed by different letters in the same row differ significantly ($P < 0.05$).

The maize stover plus molasses treatment had the lowest intake. The effect of molasses that comprised 4% of the basal diet dry matter was negative. The negative impact of molasses was probably due to proliferation in the rumen of the fast-growing sugar digesting micro-organisms. This implies that the supply of nitrogen to goats feeding low quality rouhages such as maize stover is more beneficial than energy supply (molasses in this experiment). A combination of energy and nitrogen supplement to crop residue basal diet has been reported to be more effective than any of the components singly

(Nuwanyakpa and Butterworth 1987). The performance of the goats by liveweight changes is shown in Figure 1. The differences in liveweight changes depicted in the figure, should serve only as an indicator of the trend as these differences are not statistically significant ($P<0.05$).

It follows, therefore, that under the feeding situation reported here maize stover as a sole ration without any treatment is apparently sufficient for maintenance requirements of goats averaging 37 kg. Nonetheless daily sprinkling of maize stover with common salt should be discouraged because of its failure to maintain body weights. This is a common practice with some of the farmers. However, farmers do sprinkle salt only occasionally and not routinely as in the experiment. For all the treatments intake as a percentage of the body weight ranged from 3.7% to 4.3%. This figure might not be achieved for on-farm situations because goats usually donot have access to feed stuffs for 24 hours. Consequently, goats on-farm might not be able to maintain their body conditions on maize stover alone.

In this palatability study in which six graminoid species were ranked, couch grass (Digitaria sclarum) ranked first. The results of the rankings are presented in Table 4. For couch grass to have ranked first is a blessing in disguise because it is reputed as the most troublesome of all East African weeds (Ivens 1967). As couch grass has high palatability and nutritive value, it is an ideal feed for feeding livestock after it has been weeded. Soil attached to the root system should be shaken off and only the aerial parts taken for livestock feeding.

Table 4 : Preference ranking of grass species

Species	Rank	Intake g.	CP%	DMD %
Couch grass	1	1223a)	17	65
Napier grass	2	1080a)	9	63
Giant panicum	3	890b)	9	54
Brachiaria spp	4	741b)	11	51
Rhodes grass	5	703b)	8	50
Bana grass	6	672b)	13	57

ab) Means not having the same superscript in common differ at $P < 0.05$.

DMD = in vitro dry matter digestibility

Table 5 is a presentation of production parameters used to derive productivity indices shown in Table 6. The parameters for goats were obtained from the continuing monitoring exercise. The mean differences between the on-station and on-farm does were 9kg and 0.5kg or 39% and 33% respectively. So the on-station DPGs performance was better than the on-farm ones by at least 33%. Nutritional inadequacy as prompted by overstocking could have led to the big difference in the performance of goats between on-station and on-farm. This however, does not appear to have been the only cause of the difference between the on-station and on-farm DPGs. Differences in the doe and kid survival and in the kidding rate must have been equally as constraining as nutrition because of management and outlook differences. Kid survival was low on the farm, because some producers may have overmilked their does in an effort to satisfy their homes milk demands. Overmilking of does results in insufficient milk left for the kids to meet their nutritional requirements. The kidding rate on-farm was lower because of insufficient bucks to go round each farm. Due to lack of sufficient bucks, and the reluctance of farmers to keep bucks because of opportunity cost on feed, farmers opt for buck sharing despite its logistical problems.

Table 5 : Productivity parameters

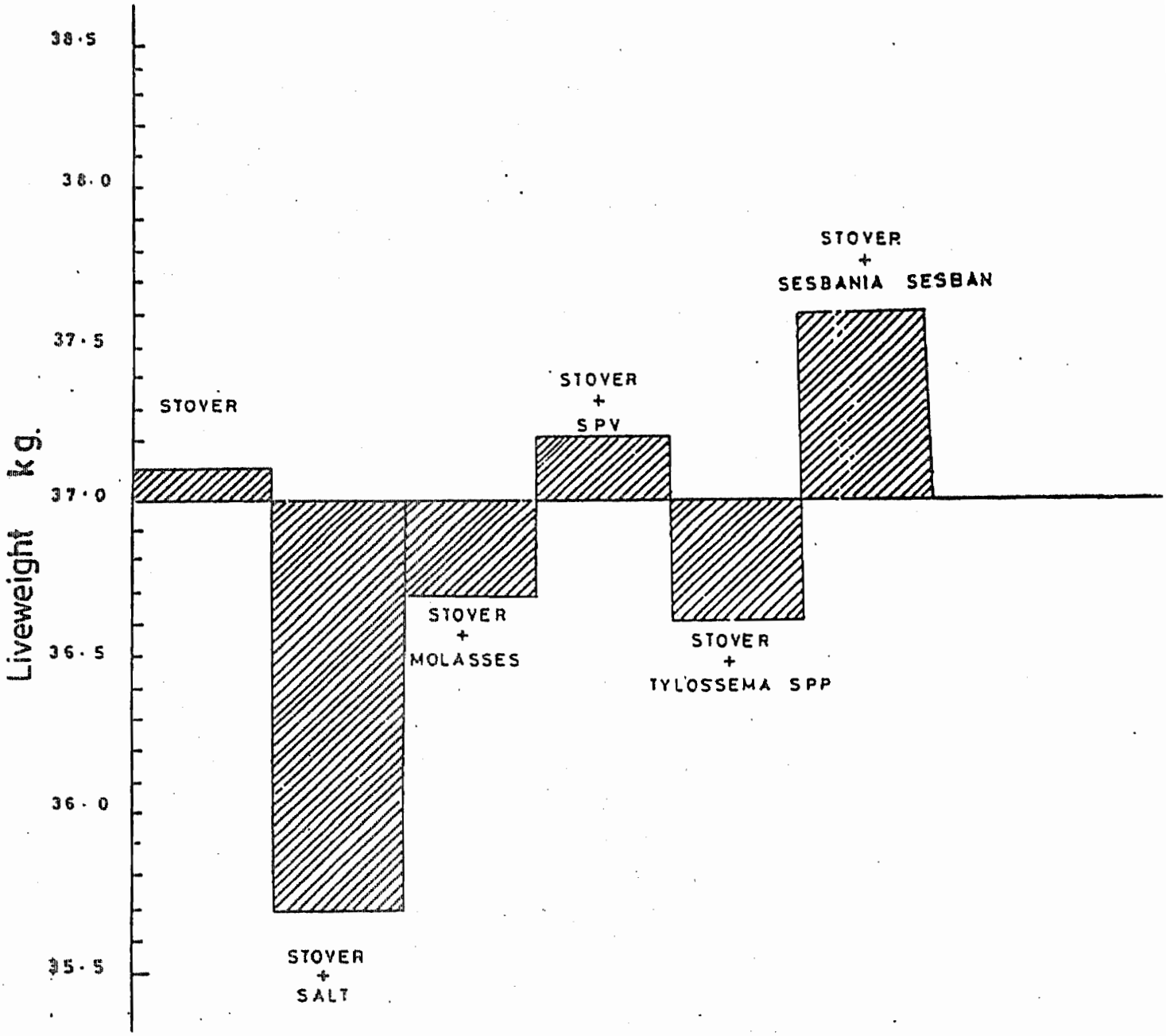
Variable	on-station	on-farm
Doe survival %	95	83
Kidding %	78	65
Kid survival %	90	80
Kid weight at the age of one year kg	26	24
Milk Offtake kg	38	35
Average doe weight kg	38	35

Table 6 : Productivity indices

Index	Production system	
	on-station	on-farm
Per doe / year kg	23	14
Per unit metabolic body weight kg	1.5	1.0

Another contributing factor to low kidding rate is the practice of tethering, which interferes with courtship and mating.

Figure 1 Mean Liveweight trends by treatment



Another source of variation between the on-station and on-farm is management. On-station goats were under one manager, while on-farm managers were as many as the number of farms, if not more.

Due to the shrinking land size in Western Kenya, as a consequence of rapidly increasing population, adequate land resource to provide sufficient feed for a cow is getting scarce. As a result farmers have resorted into buying expensive tetrapacked milk because cows are being phased out of the farming system. Consequently due to the lower maintenance requirements of the dual purpose goat, it may be taken as the most logical replacer of the cow for milk production.

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2. FATTENING PERFORMANCE OF CRIOLO AND HEREFORD X BRAHMAN STEERS GRAZING COLONIAL GRASS (PANICUM MAXIMUM CV COLONIAO) WITH OR WITHOUT SUPPLEMENTATION FOR BEEF PRODUCTION IN PARAGUAY

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ABSTRACT

Fifty steers (17 Criollo and 33 Hereford x Brahman) were allocated to 5 groups of 10 animals each. All animals grazed colonial grass for 68 days after which group 1 was left on grass alone whereas group 2 was supplemented with a mixture of molasses (93%), urea (3%), minerals (1%) and water (3%); group 3 was supplemented with blocks made of molasses (45%), cement (15%); urea (10%), rice bran (20%), limestone (5%) and minerals (5%) and group 4 was supplemented with concentrates made of sorghum (70%), cottonseed cake (25%), molasses (3%) and salt and minerals (2%). Group 5 was fed colonial hay (2 kg/head/day) and concentrates. The molasses-urea-mineral mixture and the blocks were fed ad libitum. The concentrates were fed at the rate 6.5kg/head/day at start and this allowance was increased by 0.5kg every 2 weeks. The supplementation lasted for 92 days after the grazing only period of 68 days.

The 5 groups did not differ in average initial weight or weight after grazing colonial grass for 68 days. The 2 genotypes did not differ in these 2 weights. During fattening and finishing the animals of the 4 supplemented groups had significantly heavier body weights and their daily gains were on average 28 - 75% higher than the non-supplemented animals (Group 1). The molasses-urea-mineral mixture was the best. This mixture and the blocks proved to be

* Nour A.M. was with Agropecuaria Deltapar S.R.L., Paraguay.

profitable. Supplementation to the animals on grass or hay with concentrates increased the body weight and daily gain but it was economically unprofitable. The Hereford x Brahman steers had significantly heavier weights and rates of gain than the Criollo when supplemented with the above mentioned supplements. The results showed clearly the need for providing beef animals on pasture with sources rich in energy, protein and minerals but depending upon price structures concentrate supplements may not be economical.

3. UTILIZATION OF WATER HYACINTH LEAVES (EICHHORINIA CRASSIPES MART SOLMS) IN FEEDING OF MIRROR CARP (CYPRINUS CARPIO L.) FINGERLINGS.

A.M.Nour., [1] Eglal All Omar[2] and A.R. Abou Akkada[1]

ABSTRACT

Fingerlings of mirror carp (cyprinus carpio L.) were alloted in twelve groups (2 tanks / group) and fed twelve different diets containing fish meal or soybean meal or a mixture of fish meal and soybean meal (1:1). Protein in water hyacinth leaves replaced 0,10,20 and 30% of protein in the fish/soyabean meal diets.

The feeding period lasted for 8 weeks. The experimental diets were pelleted and fed at the rate of 3.0% of the live body weight of fish 2 times daily 6 days a week. The feeding experiment was conducted in 24 circular plastic tanks (35L). Each dietary treatment was randomly assigned to two tanks, each stocked with 10 fish. The daily feed allowances were increased weekly on the basis of weight

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gain. Growth performance and feed utilization for the tested diets were compared. The results showed that the mixture of fish meal and soybean meal containing diets promoted faster growth than the diets containing only fish meal or soybean meal as protein sources. Replacing soybean meal protein with water hyacinth leaves protein decreased growth performance and feed utilization. However, replacing fish meal protein with water hyacinth leaves protein increased growth performance and feed utilization.

Replacing soyabean and fish meal protein sources with water hyacinth protein decreased dry matter, protein and fat content of fish crop. However, ash content was in-creased.

Productive protein value and energy utilization by mirror carp decreased by increasing the level of replacement with water hyacinth leaves protein to more than 20%. It is therefore recommended to use water hyacinth leaves protein at a rate of not more than 20% of the mixture of fish meal and soybean proteins in the formulation of the diets of mirror carp fingerling.

4. ABSTRACTS OF PAPERS FROM THE FOUTH ANNUAL WORKSHOP ON THE THEME "OVERCOMING CONSTRANT TO THE EFFICIENT UTILIZATION OF AGRICULTURE BY-PRODUCTS AS ANIMAL FEED".

4.12 CEREAL STRAW IN THE FEEDING SYSTEM OF RUMINANTS IN SENEGAL

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ABSTRACT

Cereal straws represent an important source of energy. However they contain low concentrations of nitrogen, minerals and digestible energy which requires a good supplementation. Preference should be given to agro-industrial by-product available in the areas of cereal

production. In the peanut basin and in the South, cereal straw can be supplemented by peanut cake, cotton seed, sorghum, millet and rice brans.

The rice agro-industrial by-products (rice polishings, rice bran) can be fed together to support high levels of production. This feeding package is suited to the Northern and Southern part of Senegal.

Treatment of straws with urea is the most promising alternative solution in order to enhance straw utilisation by ruminant. Urea is available to farmers at a low cost. Moreover it is an important source of non protein nitrogen.

On-farm research should be geared towards comparing the economic feasibility of two alternative solution treatment and supplementation of cereal straw with urea.

4.13 OVERCOMING SOME CONSTRAINTS IN FEEDING CROP BY-PRODUCTS FOR MILK PRODUCTION.

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ABSTRACT

Supplementation of concentrate and leucaena to dairy cattle fed on sodium hydroxide "dip" treated and untreated maize stover was compared with an elephant grass based diet in a latin square 3 x 3 change over design using 18 lactating dairy cows. Dry matter intake, energy intake and milk production were studied.

The dry matter intake of the test roughages and the ME intake from the total dry matter intake of treated maize stover based diet,

untreated maize stover based diet and elephant grass based diet were 3.37, 3.11 and 4.92 kg DM/cow/day respectively, and 86.50, 75.40 and 81.34 kg MJME/cow/day, respectively. The dry matter intake of the test roughages and ME intake were significantly different ($P<0.01$) between the treatments.

Actual milk yield and 4 percent FCM for TMS - based diet, MS-based diet and EG-based diet were 7.7, 7.6 and 7.7 kg/cow/day, respectively and 9.5, 8.8 and 9.3 kg/cow/day, respectively. The MS-based diet produced significantly low FCM yield ($P<0.01$); but yield of actual milk was not significantly different ($P<0.05$) between the treatments. Higher concentrate allowance in MS-based diet improved actual milk yield but not FCM.

4.14. TEE FEEDING VALUE OF SOME AGRO-INDUSTRIAL BY-PRODUCTS FOR BEEF CATTLE AT BAMBUI CENTRE.

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ABSTRACT

An investigation of the use of agricultural by-products as cattle feed was conducted at Bambui Experimental Station. Banana forage fed **ad libitum** with mineral supplementation supported maintainance and beef cattle and a daily gain of 9g over a period of 3 months. Intensive fattening rations with various levels of maize stover, palm kernel cake, cottonseed cake and rice polishings also give promising results. The ration with 34% palm kernel cake was associated with the highest net revenue of 49735 FCFA (1US$ = 315.5 FCFA in 1987) per head while that with the highest proportion of cotton seed cake

corresponded to the lowest but substantial profit of 27997 FCFA per animal. Banana forage and maize stover connot be used by local small holders due to the cost of collection, transport and processing. Integrated crop and livestock farming is recommended as a solution.

Importing cottonsed cake from the North for use as cattle feed in the North West Province was uneconomical. The introduction of a commercial feedlot in Douala to take advantage of low transport cost by train may be profitable. Further studies to determine economical location of feedlot and for better ration formulation based on agricultural by-products available in the North West Province are to be considered. Grass (Brachiaria ruziziensis) hay and legume (Stylosanthes guyanensis) hay produced locally are to be evaluated as dry season cattle feeds in the North West Province.

4.15. MAIZE STOVER AS A FEED FOR RUMINANTS

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ABSTRACT

Maize stover, the major crop residue in Zimbabwe, is characterized by a low protein and high fibre content. Little attempt has been made to improve its nutritive value. Two experiments have been completed, the first of which considered the effect of amount of plain untreated stover offered on intake in both cattle and lambs. Stover offered increased from 1.5 - 3.0% of body weight with increased intake at the higher level ($P<0.05$). There was little evidence of selectivity. A supplement of protein increased intake at all rates of offer in lambs.

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In the second experiment untreated stover was compared with stover treated with 3, 5 or 7% urea for 5 weeks. In cattle and lambs intakes were greatest with less than 7% urea ($P<0.05$). There results were supported by measurements of dry matter degradability in cattle. using the nylon bag technique, and **in vitro** digestibility. The **in vitro** study confirmed 5 weeks as being the optimum treatment period in the prevailing conditions. Between experiments intake was improved by coarse grinding and it is concluded that physical aspects of collecting and feeding residues should be considered together with alkali treatment and supplementation in order to reduce wastage.

4.17. GRAIN YIELD AND NUTRITIVE VALUE OF CROP RESIDUES FROM THREE VARIETIES OF MAIZE (ZEA MAYS L) CROP.

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ABSTRACT

An experiment was carried out to find the grain and crop residue yields, the nutritive value of the crop residues, the harvest and potential utility indeces of three varieties of maize.

The maize varieties used were "Ex-Volta", Pol-16 and "Legon Composite 4". The maize seeds were sown after ploughing and harrowing and fertilized with a compound fertilizer (20% N, 20% P_2O_5 and 20% K_2O) and also sulphate of ammonia. All three varieties were harvested at 65, 95 and 125 days after planting. After harvesting, the grains were reserved. Both the grains and crop residue were dried and weighed. The crop residue was then analyzed for crude protein content, cell wall constituents and **in vitro** dry matter

digestibility. The harvest index of the grain and the potential utility of the whole crop was then calculated.

Grain yield of the three varieties, Ex-Volta, Pol-18 and legon Composite 4 increased from 1.04, 0.56 and 0.03 t ha^{-1} at the initial harvest to 4.87, 5.67 and 4.07 t ha^{-1} at the final harvest. On the contrary there was a significant ($P < 0.01$) decline in the crop residue yield of all three varieties with advancing growth. The crop residue: grain ratio ranged between 1.1 and 1.8: 1 for the three varieties at different stages of growth.

The various botanical fractions showed a mixed trend of development. Whereas the leaves continuously declined with advancing growth period, other increased or decreased initially and later showed an opposite trend of development.

Crude protein content declined considerably with advancing age in all three varieties and all were below 8%. Cell wall constituent on the contrary increased with advancing age and only the difference in ADL between Ex-Volta and Composite 4 was singnificant.

In vitro dry matter digestibility significantly ($P<0.01$) declined from 80% to 64% with advancing age. No varietal differences were observed. Harvest index of grain increased with advancing age. Ex-Volta and Pol-16 had a significantly higher harvest index than Composite 4. Potential utility index was very high (78-82%) and remained constant throughout the growth period. No varietal differences were however observed.

4.18. STUDIES ON THE UTILIZATION OF BREWERS DRY GRAINS AND WHEAT OFFALS BY CALVES

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ASBSTRACT

Digestibility, metabolism and rumen studies were conducted to study the growth performance of 24 calves fed concentrates consisting of 20, 40 and 60% levels of both brewers' dry grains (BDG) and wheat offals (WO) to replace maize in a 16-week trial period.

There were no trends established between dry matter, total digestible nutrient and energy intakes and levels of BDG and WO except the digestible crude protein intake which increased 8.6-9.5 g/Wkg $^{0.75}$ with increasing levels of BDG and WO in the ration.

The growth rates of 0.26, 0.27, 0.24 and 0.31 kg/day of calves on diets A, B, C and D respectively were positively but not significantly ($P>0.05$) correlated ($r = 0.99$).

The N intake (av.49.7g/day) & N retention (av.52.5%) were high and increased as the level of BDG and WO increased in the ration.

The rumen pH ranged between 6.4 and 6.8 and was not different among the diets. The NH_3-N levels were high in all the diets (av. 14.0 mg/100ml) showing that N was not limiting and enough to support the growth of the calves. The total VFA showed no particular trend but moderate accumulation and averaged 9.8m-equiv/litre. However, the acetic acid level (av. 73%) was high enough to furnish energy for the N utilization. For the individual acids, no definite pattern was established in relation to the supplemental levels of BDG and WO.

The growth made by the calves indicated that both N and energy were not limiting even at 60% substitution level.

4.19. THE EFFECT OF MAIZE BRAN ON VOLUNTARY INTAKE AND DIGESTIBILITY OF PIGEON PEA (CAJANUS CAJAN) PODS BY GOATS.

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ABSTRACT

Three male Malawi local goats (about 19kg) were used in a 3x3 Latin Square design experiment to investigate the effect of maize bran supplementation on the voluntary intake and digestibility of pigeon pea pods by goats. The treatments were: (a) ad libitum pods; (b) Ad libitum pods plus 100g maize bran/goat/day; and (c) ad libitum pods plus 200g maize bran/goat/day. The voluntary dry matter intake and digestibility of pigeon pea pods by goats were improved with maize bran supplementation, but not statistically significant ($P<0.05$). It is concluded that pigeon pea pods supplemented with maize bran could be used as a dry season ration for goats in the villages when good quality forages are scarce.

4.20. THE OPTIMUM LEVEL OF ROUGHAGES IN THE DIETS OF SHEEP

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Egypt

ABSTRACT

Five groups of male lambs each of nine head Rahmany Barkin were used to investigate the effect of different levels of corn stover (10, 30,

50, 70 and 90%) in pelleted diets on the growth performance and feed utilization by lambs.

The results showed that voluntary feed intake, average daily gain and feed utilization were significantly decreased by increasing the level of corn stover in the diet from 10 to 90%.

The Digestibilities of DM, OM and CP were decreased by increasing the level of corn stover in the diet (with the exception of the diet containing 70% corn stover), however, crude fiber digestibility increased by increasing the level of corn stover.

The results recommended a pelleted diet containing 70% corn stover for growing lambs to achieve and good growth with lower cost of meat production. The cost of feed per one kg gain was 1.25, 1.12, 1.08, 0.91 and 5.88 LE for diets containing 10, 30, 50, 70 and 90% corn stover respectively.

4.21. RESPONSE OF THE WEST AFRICAN DWARF SHEEP TO DIETS BASED ON PROCESSED CASSAVA PEELS AND GLIRICIDIA SEPIUM.

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ABSTRACT

Three experimental diets consisting of 100% Gliricidia sepium; 80% ensiled cassava peel plus 20% Gliricidia, and 80% dried cassava peel plus 20% Gliricidia were fed to twele WAD sheep on an ad libitum basis for twelve weeks.

Animal fed on Gliricidia alone consumed 1044g DM per day to produce 106g weight gain per day over the twelve weeks, while those fed on the ensiled cassava peels with Gliricidia consumed 716g DM per day to achieve a weight gain of 81g/day. Animals fed on the dried

cassava peel based diet performed poorest consuming 642g DM per day and gaining 59g/day.

The higher dry matter intake and better growth rate of the animals fed on the ensiled cassava peel based diet over those of animals on dried cassava peel based diet were attributed to lower prussic acid content as well as the sweet and pleasant odour of the ensiled cassava peels.

4.22. UTILIZATION OF GLIRICIDIA SEPIUM AND CASSAVA PEELS BY WEST AFRICAN DWARF (WAD) GOATS IN NIGERIA.

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ABSTRACT

Three diets - 100% Gliricidia sepium (T1), 100% cassava peels (T2) and 70% Gliricidia sepium plus 30% cassava peels (T3)- were fed to 12 intact bucks of the West African Dwarf (WAD) breed in a completely randomised experiment. Four bucks were randomly assigned to each diet treatment. The experiment lasted 90 days.

Treatment effect on dry matter intake (DMI) was significant ($P<0.05$). Goats on T3 consumed the highest dry matterr (DM), organic matter (OM), nitrogen (N), acid-detergent fibre (ADF) and neutral-detergent fibre (NDF), digestible DM (DDM), digestible OM (DOM), digestible ADF (DADF) and digestible NDF (DNDF) while those on T2 consumed the least. Goats on T1 had the highest digestible N intake (DNI).

Goats on T3 digested DM, N, ADF and NDF most ($P<0.05$); those on T2 digested OM most; they also had negative N digestibility and digested ADF and NDF least ($P<0.05$). Goats on T1 digested DM and OM least ($P<0.05$).

The highest ($P<0.05$) body weight gain was by goats on T3 while those on T2 were losing weight daily.

Gliricidia sepium was the most and cassava peels the least ($P<0.05$) efficiently utilized as sole diets by goats.

Estimated meat yield per treatment was highest for animals on T3.

The intake, digestibility and utilization for weight gain of *Gliricidia sepium* by goats were increased by supplementation with cassava peels.

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1. STANDARDIZING FEED DESCRIPTION THROUGH THE INTERNATIONAL NETWORK OF FEED INFORMATION CENTRES (INFIC).

The Fourth Annual Workshop in Bamenda, in October 1987, agreed on a recommendation that ARNAB should work towards achieving a standardized feed description by using the system used by the International Network of Feed Information Centres (INFIC). It was agreed then that a brief description of the system be written in ARNAB Newsletter.

An outline on how the International Feed names and numbers can be put in manuscripts in given in the publication by Harris, Jager, Leche, Mayr, Neese and Kearl (1980). The publication also desirbes in detail the methodology of assigning names to the INFIC system by considering **SIX FACETS**. Briefly the facets used are :-

Facet 1 - Original material or origin (plant, animal, other basic material);

Facet 2 - Parts of the material used as feed as affected by processes;

Facet 3 - Processes or treatments to which the material has been subjected;

Facet 4 - Stage of maturity;

Facet 5 - Cutting or crop (for plants only);

Facet 6 - Grade (quality) for those feeds that do not fall within the descriptors describable in facets 1 to 5. For this facet descriptors used are expressed in terms of "more than" (minimum), "less than" (maximum) and "from to" of designated contents of crude fibre, protein, fat, etc.

Readers may also wish to refer to the paper of Kayongo-Male, Said and Kategile (1986) on the "Use of INFIC Nomenclature on crop residues and by-products produced in Kenya". **For more information on INFIC please write to Dr Terry F.Leche, Executive Secretary, INFIC, P.O.Box 239, Blacktown, NSW. 2148, Australia.**

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H. Kayongo-Male, A.N. Said, and J.A. Kategile (1986). Use of INFIC Nomenclature on crop residues and by-products produced in Kenya. ARNAB (African Research Network for Agricultural By-products). 1986. Towards optimal Feeding of Agricultural By-products to Livestock in Africa : Proceedings of a workshop held at the University of Alexandria, Egypt, October 1985. ILCA, Addis Ababa, Ethiopia.

2. DEVELOPMENT AND USE OF SIMPLE AND CHEAP MACHINERY TO ENHANCE UTILIZATION OF CROP RESIDUES AND BY-PRODUCTS.

At the Bamenda workshop it was agreed that ARNAB members should look into the possibilities and use of simple hand tools to some forms of cheap mechanized machinery to enhance the utilization of crop residues and agricultural by-products. The possibilities of cooperatively run machinery to process oil seeds or cereal grains so that the by-products should be used by members of the cooperatives for their livestock should be considered where it is feasible.

The International Institute of Tropical Agriculture (IITA) PMB 53200, Ibadan Nigeria is already addressing this issue in its Root, Tuber and Plantain Improvement Programme. A scientist with special skill and experience, Dr Y. W. Jeon has already designed and produced machines that can be made cheaply in village workshops. (write to either Dr Yeon or the Programme Director Dr S.K. Hahn IITA).

In Kenya the "JUA KALI" cottage industries are able to produce cheap and effective simple tools for processing crop residues and by-products. For more enquiries contact the nearest Kenya Embassy. You may also wish to write to KENS METAL INDUSTRIES Ltd P.O.Box 18583, Nairobi, Kenya for enquires on simple machines and tools.

Brazilian manufacturers have responded to farmers demands by producing cheap machines to meet small farmers needs. Much of the international extension of Brazilian expertise takes place through the Programme for Technical Co-operation among Developing Countries. For more information contact the nearest Brazilian Embassy or write to the Business Manager, African Farming and Food Processing, Alain Charles House, 27 Wilfred Street, London SWIE 6PR, U.K. You may also write to Mr Brian E. G. Simms, Agricultural Engineer, Institute of Engineering Research, Wrest Park Silsoe Bedford MK 45 4HS, England.

In West Africa inexpensive machines that dehull and grind cereals for home consumption are generating bran that is fed to livestock. The energy and time that womenfolk used to put on dehulling and pounding is put into the fields, growing more food and generating more crop residues (For more information on the impact of grinding machines read the article by **John Madeley Page 37 "Doing away with the daily grind" in African Farming and Food Processing September / October 1988.**

If any reader has any information or address of potential manufacturers of simple and cheap machinery for crop residues and by-products please write to the ARNAB Co-Ordinator ILCA, Addis Ababa, Ethiopia.

3. ABSTRACTS OF PAPERS FROM THE FOURTH ANNUAL WORKSHOP ON THE THEME "OVERCOMING CONSTRAINTS TO THE EFFICIENT UTILIZATION OF AGRICULTURAL BY-PRODUCTS AS ANIMAL FEED".

3.23. COMPARISON OF FEED UTILIZATION BY WEST AFRICAN DWARF SHEEP FED SODIUM HYDROXIDE TREATED SOYABEAN PODS SUPPLEMENTED WITH SOYABEAN FLOUR OR FRESH NAPIER GRASS FED ALONE OR WITH SOYABEAN FLOUR.

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ABSTRACT

A comparison of feed utilization and live weight gain was carried out with adult West African dwarf sheep fed sodium hydroxide (NaOH) treated dry soyabean pods supplemented with soyabean flour; or fresh Napier grass fed alone or supplemented with soyabean flour.

There were no significant differences in the intake of dry matter and proximate feed constituents between sheep fed alkali-treated soyabean pods supplemented with soyabean flour and those fed fresh Napier grass plus soyabean flour. Sheep fed only Napier grass consumed significantly more crude fibre but less dry matter, crude protein, ether extract and nitrogen-free extract than those on the other diets.

The digestibility of dry matter, organic matter, crude fibre and nitrogen-free extract were similar for sheep fed solely on Napier grass and those fed on fresh Napier grass plus soyabean flour. The digestibility of crude protein and ether extract by sheep fed only on Napier grass was significantly lower than the other treatments. All experimental animals had positive nitrogen balance.

Live weight gain was similar for sheep fed fresh Napier grass supplemented with soyabean flour (77g/day) and those provided NaOH treated soyabean pods plus soyabean flour (79/day). Animals fed solely on Napier grass gained 41g/day; which was significantly lower than the other treatments.

3.24. EVALUATION OF CASSAVA FLOUR AND GROUNDNUT CAKE AS CONCENTRATE SUPPLEMENTS FOR WEST AFRICAN DWARF GOATS.

Njwe* R.M. and Olubajo F.O.**

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** Department of Animal Science Ibadan University, Ibadan
Nigeria.

Forty eight West African dwarf goats ranging from 9 to 12 months and weighing between 9 and 15kg were fed fresh Guatemala grass and various combinations of graded levels of cassava flour (0,100,150 and 200g/day) and groundnut cake (0,50,100, and 150 g/day) as concentrate supplements in a split-plot design.

Incorporating increasing combined levels of both supplements in goat rations increased dry matter, crude protein and cell contents intake; and decreased intake of cell walls, acid detergent fibre and cellulose. While it positively affected the digestibility of dry matter, crude protein and cell contents, the effect on cell walls, acid detergent fibre and cellulose digestibilities was negative.

Each increment in the level of groundnut cake and cassava flour in goat rations resulted in an increase in live weight gain. Maximum live weight gain was obtained with animals fed either a combination of 200g of cassava flour with 100g of groundnut cake (52g/day) or 200g of cassava flour with 150g of groundnut cake (62g/day) as supplement to fresh Guatemala grass. Goats receiving zero to 50g concentrate supplement lost weight consistently as a result of inadequate energy and protein intakes.

3.25. PROCESSED AND UNPROCESSED SORGHUM STOVER IN BEEF FINISHING RATIONS.

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and
H.M. Khogali.
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Production, University of Khartoum
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ABSTRACT

Two eight weeks feeding trials using entire male cattle were conducted to evaluate the effects of incorporating processed and unprocessed sorghum stover in traditional concentrate diets used for finishing cattle in the Sudan. In the first trial milled sorghum stover was used to replace the concentrate mix at the rate of 0, 25, 35 and 45% (W/W). In the second trial the experimental animals were offered unprocessed sorghum stover ad libitum. in addition to the concentrate mix which was offered at 100, 75, 65 and 55% of the ad libitum. level of intake.

The first trial showed that incorporation of milled sorghum stover in the diets had no effect on the performance of the animals. Animal in all treatments consumed an amount of feed equivalent to 3.0% of their body weight and gained at an average rate of 1.40 kg/d.

The results of the second trial showed that the intake of unprocessed sorghum stover increased as the amount of concentrate offered was decreased. The rate of gain of the experimental animals was not affected by the treatment and was about 1.0 kg/d. However, the efficiency of feed utilization was higher when the animals were offered the concentrate mix ad libitum than when the concentrate mix was limited.

3. 26. HYDRATION AS A MEANS OF IMPROVING UTILIZATION OF MAIZE STOVER FED TO STEERS.

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ABSTRACT

Maize stover chopped to particles 4-6 cm in length was fed to steers either soaked in water (1 kg stover/1.5 l) for 24 hours or unsoaked. For each main roughage, four protein supplements were provided viz. control, urea, soyabean meal or blood-treated soyabean meal plus urea. (Blood treated = Soyabean meal coated with blood and baked for 36 hours).

Soaking increased ($P<0.05$) intake of dry matter (DM) (4.8 vs 3.7 kg/d) but apparent DM digestibility and rumen digestion kinetics were not affected by soaking ($P>0.05$). Protein supplementation increased ($P<0.05$) DM intake (4.9 vs 4.4 kg and 3.8 vs 3.4 kg) for hydrated and unhydrated stover, respectively. Apparent DM digestibility and nylon bag degradeability were, however, not affected by protein supplementation ($P>0.05$).

It was concluded that soaking *per se* has a potential to overcome constraints to intake of maize stover, particularly in situations where protein sources are scarce or expensive.

3.27. IMPROVING THE INTAKE AND UTILIZATION OF BY-PRODUCTS BASED DIETS.

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ABSTRACT

The volauntry feed intake or chopped maize stover was improved (23%) by just increasing moisture content from 30 to 60%. Due to such treatment, sheep performance turned from losing 54g/head/day to gaining 21.3g/head/day. Addition of 5% linseed meal doubled the

consumption of maize stover and resulted in a daily gain of 53g/head/day. Such percentage of linseed meal was comparable to 20% concentrate mixture supplement.

Supplementation of the urea treated maize stover with 1.5% urea and 3% molasses improved intake by 63%. Supplements varied in their effect on consumption, however, they did not affect the TDN content of the supplemented diet.

Recognizing the deficient minerals in a by-product based diet (by mineral balance trials) and supplementing the diet with the recognized deficient amounts of minerals, resulted in improving the TDN content, the rate of body weight gain and feed conversion efficiency.

3.28. THE DEGRADATION OF UNTREATED, AND TREATED MAIZE COBS AND COCOA POD HUSKS IN THE RUMEN.

A.K. Tuah[1] and E.R. Orskov[2].

ABSTRACT

The dry matter disappearance (DMD) values of untreated, 3.5% ammonia-treated and water-soaked maize cobs and cocoa pod husks were determined in the rumen of cannulated steers using the nylon bag technique. Although cocoa pod husks contained a higher level of lignin (26.38%) than the maize cobs (9.60%), the DMD values of the untreated cocoa pod husks were greater than those of untreated maize cobs for all the incubation periods (44% and 34% at 48h). Ammonia treatment of maize cobs increased the DMD values but soaking it in water for 24h before incubation had no significant effect. Cocoa pod husks were not improved by ammonia treatment.

The maize cobs and cocoa pod husks were treated with different levels of sodium hydroxide, 0,6,8,10 and 12g/100g of product and incubated in the rumen of four sheep for 48h. Sodium hydroxide treatment significantly ($P<0.01$) increased the DMD values of the products. Washing the products after sodium hydroxide treatment did not significantly ($P<0.05$) affect the DMD values of the maize cob. Washing cocoa pod husks after sodium hydroxide treatment caused a significant ($P<0.01$) reduction in the DMD values because of losses of soluble fractions during washing.

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[2] Rowett Research Institute, Bucksburn, Aberdeen, Scotland, U.K.

3.29 POTENTIAL OF AGRICULTURAL BY-PRODUCTS AS SOURCES OF MINERAL NUTRIENTS IN RUMINANT DIETS .

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ABSTRACT

Several crop residues and agro-industrial by-products, available in Ethiopia as potential ruminant feeds, were examined in relation to their potential to supply essential dietary minerals. In absolute terms, cattle diets based on crop residues are unlikely to supply adequate Na, and are marginal to deficient in P, Cu and possibly Zn, but these problems, except for Na, seem rectifiable by the inclusion of appropriate proportions of by-products in the ration. This however, takes no account of the possibility that mineral might be rendered, to some degree, unavailable through its association with e.g. indigestible fibre.

Thus the apparent availability of minerals was assessed, firstly following sequential extraction in vitro in neutral, acidic and alkaline solutions to simulate conditions respectively in the rumen, abomasum and small intestine, and secondly by analysis following intraruminal incubation in nylon bags for 48h; there was in general good agreement between the two methods. However, it is notable that the in vitro method removed Ca from roughages much more efficiently, while the reverse was true for the oilseed cakes, due possibly to differing extents to which Ca is bound to fibre.

The apparent availabilities of Ca from wheat and teff straws in vivo when fed to sheep were very similar to the values obtained in sacco, much more so than for other minerals. It was noted that roughage diets with low apparent mineral availability had much of their intrinsic minerals in association with faecal fibre. These could not be removed by water. It may thus be useful to pay close attention to the balance of minerals in diets based on fibrous crop residues whose utilization may have been improved through chemical treatment of NPN supplementation.

3.30 THE PRESERVATION OF BANANA CROP-RESIDUES THROUGH ENSILING PROCESS .

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ABSTRACT

A study to assess the susceptibility of banana crop-residues (stems and leaves) to ensiling was undertaken in order to utilize this material during the dry season when feed is in short supply.

Four treatments of ensiling banana crop-residues were examined: direct-cut silage (material with 90% of moisture); direct-cut silage treated with sugar cane molasses at a rate of 5% of fresh weight; wilted (material with less than 70% of moisture); wilted and treated with molasses (5% of fresh weight).

The chemical composition of banana crop-residues has shown that material high in moisture content and low in water soluble carbohydrate, is not suitable to be ensiled without any treatment prior to ensiling. Wilting to more than 30% DM and the addition of molasses gave satsfactorily ensiled product.

3.31 SOLUTIONS TO THE PRACTICAL PROBLEMS OF FEEDING COCOA PODS TO RUMINANTS .

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ABSTRACT

Data is presented showing that cocoa pods, a by-product of cocoa processing could be used as a ruminant feed. The widespread nature of cocoa processing sites which makes it difficult and expensive to collect and transport the cocoa pods to sites of utilisation. The need to grind the pods prior to feeding are identified as the main physical contraints while the high cell wall and low cell content of the material constitute the main nutritional constraints to its effective utilisation.

One way of overcoming part of the physical contraint is to develop technologies that will permit the use of the pods at the main sites of production. Chemical treatment using ash solutions of crop residues, ensiling the material with poultry manure or urea, and strategic supplementation with fermetable nitrogen and good quality forages are suggested as strategies to overcome the nutritional contraints to the utilization of cocoa pods as a ruminant feed.

3.32. COCOA POD SILAGE AND COCOA POD GRASS SILAGE IN GOAT AND SHEEP NUTRITION .

F.O. Olubajo[1], M.M. Asonibare[1] and
E.O. Awolumate[2].

ABSTRACT

Six digestion trials were conducted with West African dwarf bucks and dwarf rams to study the utilisation of cocoa pod silage and of graded levels of cocoa pod-elephant grass silages consisting of the following treatments : (1) 100% elephant grass silage (control) (2) 50 : 50, (3) 25 : 75; (4) 15 : 85, (5) 10 : 90, grass : cocoa pod (fresh basis), respectively; (6) 100% cocoa pod silage.

1. Department of Animal Science Univerity of Ibadan, Nigeria
2. Cocoa Research Institute of Nigeria (CRIN), Idi-Ayunre, Ibadan, Nigeria

The cocoa pod silage contained approximately 5.7% crude (C.P.) 22% crude fibre (C.F.) and a mean energy value of 4.4 kcal/g in contrast to the grass silage with a composition of 4.8% CP, 32% CF and 4.7 kcal/g of energy.

Results indicated that on metabolic weight basis more digestible dry matter (DDM; P<0.01), digestible energy (DE, P<0.001) cellulose or hemicellulose was consumed from the control diet. Intake of digestible nitrogen (N) was also significantly (P<0.001) higher for the control diet than for any of the silages. More N was excreted when either treatment 2 or treatment 3 was fed indicating that the N content of these treatments was metabolised less efficiently while N - retention was similar and slightly positive for all treatments.

3.33. THE EVALUATION OF BREWERS DRIED GRAINS (BDG) IN POULTRY RATIONS 1 BREEDER CHICKEN RATIONS .

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ABSTRACT

In an attempt to establish the optimum level of brewers dried grains (BDG) from a Cameroonian Brewery that can be incorporated in breeder rations without adverse effect on productive performance, a study was carried out with 120 laying hens and 12 cocks of Isa Commercial breed. A complete randomised design was utilised in which the dietary treatments contained 0, 10, 20, and 30% levels of BDG was fed. Feed and water were provided ad libitum over the five months experimental period. Parameters such as egg production, egg weight, feed intake, albumen height, egg shell weight, semen quantity, fertility and hatchability of fertile eggs were measured.

Results showed that when BDG was fed at 30% level in the ration, the hen-day production (50.6%) was significantly (P<0.05) depressed than when the 0% level (56.2%), 10% level (56.9%) and 20% level (56.7%) were fed. There was a significant increase in egg weight with the increased level of BDG in the ration. Also the feed intake per bird per day was significantly (P<0.05) and progressively increased with increasing levels of BDG. No significant difference was noticed between treatments for ratio of shell weight to egg weight, albumen height and semen quantity for birds fed the 0, 10,20 and 30% levels of BDG. Although the amount of feed to produce a dozen eggs increased significantly (P<0.05) as the level of BDG increased in the diet, it was noticed that the cost of feed required to produce a kilogram of eggs was progressively reduced as the level of BDG increased in the ration viz 455, 420, 406, 401 CFA (1 US$ = 295 CFA in 1987) for 0, 10, 20 and 30% levels respectively. It would appear that the 30% level of DBG can be tolerated but the 20% level of BDG was most appropriate for breeder birds.

3.34. EFFECTS OF INCORPORATING RUBBER SEED MEAL SUPPLEMENTED WITH BLOOD MEAL IN BROILER RATIONS UNDER TRADITIONAL CONDITIONS.

Nouke[1] and H.N. Endeley[2].
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Ministere de l'Enseignement Superieur et de la
Recherche Scientifique (M.E.S.R.E.S.)
Direction Generale

Yaounde - Cameroun.

ABSTRACT

A trial was carried out to investigate the effects of the incorporation of rubber seed meal supplemented with blood meal as sources of plant and animal protein on the performance, feed intake and the carcass of poultry birds from day old chick to 12 weeks under traditional system of management.

Unsexed 300 Jupiter chickens were randomly divided into 4 groups each of 75 birds. Four diets representing different levels of rubber seed meal (RSM) and blood meal (BM):- RO with 0% RSM and 0% BM; R10 with 10% RSM and 8% BM ; R20 with 20% RSM and 6% BM and R30 with 30% RSM and 4% BM, were fed ad libitum throughout the experimental period. Results showed significant differences between treatments indicating the superiority of the diet supplemented with 30% RSM and 4% BM.

3.35. THE EFFECT OF WATER LETTUCE (PISTIA STRATIOTES L.) AS A SUBSTITUTE FOR WHEAT MIDDLINGS IN BROILER FINISHING RATIONS.

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Centre Universitaire de Dschang,
Cameroon.

ABSTRACT

One hundred 6 weeks old broiler chickens with average weight ranging from 892 to 921 g were randomly distributed into 5 groups of 20 each in a completely randomised design. Each group was fed one of the following experimental rations containing 0,5,10,16 and 20% water lettuce (Pistia stratiotes L.) as a substitute for wheat middlings for 4 weeks.

The best performance in terms of feed efficiency (2.74) was obtained with birds fed the ration containing 10% water lettuce. The average daily weight gain was 44.56 g/day and cost per kg live weight gain was 284 CFA (1US$ = 295 CFA in 1987). This preliminary study indicated that 10% water lettuce may be recommended in finishing rations of broiler chickens.

3.36. THE USE OF ORGANIC MANURE IN AQUACULTURE. I. POLYCULTURE OF TILAPIA (OREOCHROMIS NILOTICUS) AND AFRICAN CATFISH (CLARIAS LAZERA) IN EARTHEN PONDS RECEIVING CHICKEN MANURE WITHOUT SUPPLEMENTAL FEEDING.

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ABSTRACT

An experiment was conducted at the Foumban Piscicultural Research Station in order to evaluate the efficiency of chicken manure on fish yields. The polyculture was composed of Tilapia (Oreochromis niloticus) and African catfish (Clarias lazera). Three 400 m^2 ponds were used and loaded with 1.75 fish/m^2. Chicken manure was applied at a rate of 40kg dry matter per hectare pond per day at the start of the experiment. Waste allowance was adjusted biweekly with an addition of 20 kg dry matter/ha. Ponds were manured 6 days a week. Cow manure (150 kg dry matter/ha) and mineral fertilizer, NPK 20, 10, 10 (100 kg/ha) were applied alternatively at 2 weeks intervals in order to strengthen the effect of chicken manure. Throughout the experimental period no other supplemental feeds were added to the ponds. Additional water was only added to replace losses due to seepage. The mean survival rate was about 66%. Fish kills were probably due to predation by birds during the dry season. The total fish biomass was 3.4 tons per hectare per year. This zootechnical value reveals that Tilapia and Clarias can thrive on natural foods (the manures and NPK used) in ponds (zooplankton and phytoplankton) without other supplemental feeding.

3.37. GOAT KEEPING .

MRS. E. TENDO .
BP. MBENGWI, MOMO DIVISION,

CAMEROON .

I thank you for the opportunity given to me to speak to you about my goat farm. I and my husband are parents of eleven children. And so in 1946 I started rearing goats in order to help our large family have enough meat, especially during the Christmas and New year celebrations. It was also to help me have manure for my gardens and farms. I use the manure to put in yam and maize farms. It helps greatly with more food and I use the same piece of land every year. I do not need to buy fertilizer. I started with 6 goats; 5 nannies and 1 buck. Now I have 24 adult females, 6 young females and 10 young males. In all I have a total of 40 goats now. I do not keep milk goats because I have no labour.

When I started goat rearing I used to tether or tie them singly with the help of my children to eat grass from place to place where we found good grass. In the evening, we would loosen them home into an old abandoned house for the night. But we could not increase the number because of frequent transfers of my husband who was a civil servant.

When my husband retired in 1984, and we acquired a large piece of land of our own I then started to increase the number of goats I keep. We built a small fence to keep them and also a goat shed for them. But we still took them and tied them from place to place to eat grass and only bring them into the small fence and shed in the evening. This is now a big problem on me as I have to do the job alone when the children return to school.

In the rainy season there is enough grass around our compound for the goats to eat but in the dry season, there is not enough grass and they grow thin. In the dry season we take water in a pan or basin to them where we have tied them to drink once a day. We sometimes give them salt.

Recently, I heard from the research people that to feed our goats with cassava peelings or waste, maize stalks, groundnut or haulms which we used to throw away or bury them in the farm as manure is good. This has really helped our goats to grow well especially in the dry season when there is very little grass for the goats. Also in this way, I can keep the goats in this little fence and feed them with these farm wastes. It also reduces the burden of tying them and solves the problem of destroying food crops when they break open from the tethers.

I just allow them to breed on their own. That is the buck lives with the nannies and mates them any time. I do not control the mating or breeding. And when I find a good male I buy it and sale the old one. The adult female produces a kid every year.

Usually when one of them or some of them are sick or they have scabies, or some other diseases I take them to the Veterinary Clinic for treatment. Sometimes I treat them myself, especially if it is diarrhoea, using medicine for humans for this disease.

I usually take my goats to the local market and sell them there when I need money. When my children come on holidays, I kill one to celebrate their good results and also during Christmas and New year celebrations we eat some. When I visit my children who are now married and working in Yaounde, I take a goat as a gift to them.

The problems I face in goat farming is the lack of money to build a good large fence and a shed to keep the goats in permanently, for I realy want to increase the flock up to over a hundred. It is very difficult for me to apply for a loan. I also need technical advice on how to apply for a loan. I also need technical advice on how to build fences and goat shed. The other problem is that there is no good grass in the dry season for the goats. I just let them eat whatever they find. I am very happy about my goat farm because it helps us increase our family income, pay school fees, buy clothes, eat fairly adequately and solve other family problems.

I take this opportunity to thank the organizers of this workshop for giving me the chance to be here and the Minisry of Women's Affairs, Mbengwi, Momo who have given me the encouragement to come to this meeting. Goat rearing is a traditional thing for men but now with their encouragement and advice many women will find it easy to keep goats.

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2. RECOMMENDATIONS OF THE JOINT WORKSHOP.

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1. THE FIRST JOINT ARNAB/PANESA ANNUAL WORKSHOP.

Readers will be happy to learn that the Steering Committees of both ARNAB and PANESA have been looking objectively to the areas of overlapping in the objectives and efforts of the two Feed Resources Networks. Some of the decisions that have been implemented, after approval by the Annual General Meetings of the two Networks, have been the cooptions of the ARNAB and the PANESA Co-ordinators to the PANESA and ARNAB Steering Commitees respectively.

The proposal by the PANESA Steering Committee that there should be a joint workshop with ARNAB on the theme "UTILIZATION OF RESEARCH RESULTS IN FORAGES AND AGRICULTURAL BY-PRODUCTS IN AFRICA" was discussed by the ARNAB Steering Commitee and put to the floor at the Annual General Meeting in Bamenda, in October, 1987. It was agreed at that meeting to accept the proposal and that the two Co-ordinators would work out a programme, listing the advantages and disadvantages of possible workshop venues for submission to their respective Committees for discussion. At the first joint ARNAB/PANESA Committees Meeting in Nairobi, from 30th - 31st May 1988, it was agreed to hold the joint workshop in Lilongwe, Malawi from 5th - 9th December 1988.

There were 90 respondents to the workshop announcement received from 22 African countries. After careful scrutiny, and based on available workshop time and funding the sub-committee selected 51 papers from 18 countries.

The key note address on "Research and Institutional Factors Optimizing Utilization of Research Results in Agriculture", was given by Prof. C.A. Onyango from Egerton University. Within the theme of the workshop there were four sessions:

Session I : Research Review on Utilization of Feed Resources (12 papers)
Session II : On-farm Feeding Systems (7 papers)
Session III : Feeding Resources Evaluation (16 papers)
Session IV : Technology Testing, Evaluation and Adoption (16 papers)
Abstracts of these papers will be published in the next issues of the newsletters.

The workshop was sponsored by the International Livestock Centre for Africa and by the International Development Research Centre, Canada, who are co-funding ARNAB and PANESA; and also by the Nairobi based Interafrican Bureau for Animal Resources, an organ of the Organization of African Unity, Scientific and Technical Research Commission. The Department of Agricultural Research, Ministry of Agriculture, Malawi were hosts to the workshop.

The workshop was opened by Honourable Mr L.J. Chimango, Member of Parliament and Minister of Finance, the Republic of Malawi. The Principal Secretary, Ministry of Agriculture Mr Ndisale officiated the openning ceremony.

The Steering Committees of ARNAB and PANESA, on their own behalf and on behalf of all the workshop participants, would like to record their appreciation to the Honourable Minister Chimango and to the Pricipal Secretary Mr Ndisale for sparing time from their busy schedules to bless the workshop and for their encouraging words and hospitality to a gorgeous reception. We would also like to express our appreciation to the Ministry of Agriculture, in particular to Dr J.T.K. Munthali, for all the logistical support rendered prior to and during the workshop. Once again we wish to record our appreciation to the Rapporteurs and to all the workshop participants for their contribution. ARNAB and PANESA co-ordinators are most grateful to Ato Asrat Wendem-Agegnehu, English proof reader, ILCA, for his immense editorial assistance at the workshop and to Ato Michael Hailu, Head of Information for allowing Ato Asrat to attend the workshop in that capacity.

2. RECOMMENDATIONS OF THE JOINT WORKSHOP.

2.1. At the closing session Rapporteurs report formulated into a set of recommendations was presented by Mr Simba Sibanda. The recommendations were discussed and adopted. The recommendations are :

2.1.1. Despite the long history of research in both pasture and agricultural by-products there has been little impact to the small scale farming systems. There are two possible reasons for this:some of this research might have been inappropriate; where research was appropriate the resultant technology had not been transferred to the farmers, mainly due to week extension services.

2.1.2. There is a need for continued monitoring and evaluation of the relevancy and effectiveness of research programmes if research is going to deliver the goods to the farmers.

2.1.3. Extension services need to be strengthened if progress is to be made in farmer adoption of research results. This may be done through, inter alia, improved linkages between researchers and extension workers (through joint research), involvement of networks in training extension staff and improved university training in extension.

2.1.4. Land tenure systems in most countries militate against improved pasture and animal management. There is therefore a need to involve and advise the policy makers. The workshop also highlighted the need for studies on ecosystems, grazing studies and degradation of the environment, and integration of soil conservation and forage production if sustainable land-use systems are to be designed.

2.1.5. The availability of pasture seed was identified as a constraint. This problem could be alleviated by importation of seed in the short term, but ideally efforts should be made to produce seed locally and at affordable prices. It will be necessary to train farmers in seed production.

2.1.6. The important role of networks in co-ordinating research programmes within and between Africa countries was acknowledged. This may be facilitated by increased publication of Network Newsletters, collaborative research and manpower development programmes.

2.1.7. There is a need for the authorities to provide conducive pricing policies and credit facilities in form of inputs in order to facilitate adoption of improved technologies by farmers.

2.1.8. It is imperative that the nutritive characteristics of available crop residues, by-products and pasture forages are measured and the information placed in data banks for use by all interested parties. An inventory of the products and their accessibility is necessary. The need for standardization of terminology in describing feed resources was also highlighted.

2.1.9. There is a need to develop appropriate experimental methodologies for on-farm research so that both the scientific merit and application of research results can be accommodated.

2.1.10. Economic appraisal should form an integral part of all research programmes.

2.1.11. Studies on feed resource budgeting and allocation should be encouraged in order to facilitate design of correct feeding strategies.

2.1.12. Reviews on topical subjects should be commissioned by the Steering Committees of the two networks in order to improve access to information which may be scattered in numerous publications.

2.1.13. Commercial feed manufacturers should be encouraged to produce stockfeeds from crop residues and agricultural by-products at prices which are affordable to the small scale farmers. It may, however, be necessary to first investigate the suitability of machinery.

2.1.14. There is a need for training in oral presentation of research results by scientists, for instance, this may be offered as part of training programmes put up by Networks or ILCA.

2.1.15. Recommendations from previous workshops should be referred to as most remain topical.

2.2. Amongst the matters discussed at the Joint Annual General Meeting was the possible merger of ARNAB and PANESA. There was an apparent consensus that a gradual merger would be the logical eventuality; considering the overlapping of objectives and membership of ARNAB and PANESA. The logistics of the merger will be discussed by the two Steering Committees, representing the National Agriculturals Research Systems, and in consultations with the Deputy Director General (Research) ILCA. It became obvious though that the most logical way to merge ARNAB and PANESA "would be to formulate two Animal Feed Resources Networks, one for Eastern and Southern Africa and the other far West and Central Africa, with an umbrella co-ordinators of the two networks".

3. ARNAB RESEARCH PLANNING MEETING

At the end of the Joint ARNAB/PANESA workshop 26 National scientists/research workers, represented by 15 amongst the African countries that attended the Joint workshop, stayed behind to participate in the first formal ARNAB Research Planning meeting. ARNAB Steering Committee is particularly grateful to Dr John C Tothill, Co-ordinator for the Animal Feed Resources Thrust at ILCA, for his active participation in this planning meeting. The general procedure adopted was as follows :

- Formulation of working groups to define problems and constraints to utilization of crop-residues and agricultural by-products.
- Developing regional research objectives to enhance effective utilization of crop-residues and agricultural by-products to achieve an integrated and sustainable crop-livestock production system.
- Development of research proposals by the collaborating National Agricultural Research Scientists to be edited and compiled into a research portfolio for submission to a donor agency.
- Upon acceptance of funding by a donor agency channelling of funds through in-trust arrangements with collaborating National Agricultural Research Institutions.
- Monitoring of funds and work programme.

After a group meeting in which the methodology of **logical framework Planning** was explained and discussed, the 26 members met as four separate "Agro-ecological Groups": Humid Zone (7 members), Sub-Humid Zone (6 members), Semi-Arid Zone (7 members) and Highland Zone (6 members). Each group was requested to develop a zonal research protocol developed through a logical framework planning procedure.

- Justification (statement of problems, constraints, definition of feed resources).
- Objectives (goals that are set to be achieved through research and which will lead to problem solution).
- Work programme (outline of the activities required to achieve the objectives; sub-projects, experiments, prioritization of activities according to the national requirements, resource levels and past research.
- Expected output (what the work is expected to achieve).
- Collaboration : research workers/scientists/institutions.
- Publication.
- Some groups looked at tentative broad aspects of budgetary requirements at zonal levels.

It was envisaged that at the end of the group discussions individual researchers will develop research protocols individually or in small groups based on the activities outlined and reflecting the priorities set. These will represent proposals for actual research at the sub-project or experiment level for submission to the Coordinator either before departure for their home destinations or for those that needed to consult their peers and colleagues at their institutions they will post their research proposals to the Co-ordinator. The following are the reports of the group discussion:

3.1 THE HUMID ZONE GROUP

Members:

Name	Country	
A.B. Orodho	Kenya	- (Chairman)
A.K. Tuah	Ghana	- (Rapporteur)
O.B. Smith	Nigeria	
R. Njwe	Cameroon	
F.B. Bareeba	Uganda	
K.M. Biwi	Zanzibar	

3.1.1. Justification

In the humid zone about 80% of meat and milk consumed is produced by small-scale village and urban backyard farmers. The major problem of these two groups of farmers is feed availability (throughout the whole year for the small-scale urban backyard farmer and during the dry season for the small-scale village farmer). In this zone a large number of crop residues and agro-industrial by-products is (are) available; these include cereal straws, cereal brans, maize cobs, legume haulms and vines, sugarcane tops, bagasse, molasses, tree crop by-products and residues, peels of tubers and fruits, pseudostems and leaves of bananas and plantains, oil palm leaves, oil seed cakes, brewers spent grains and poultry litter.

At present these crop-residues and by-products are not efficiently utilized because of problems of storage, conservation and processing at the village level and lack of interest of existing commercial feedmills in the urban areas to use them for the manufacture of ruminant livestock feed.

The main objectives of research on these feads are to devlop feed packages for commercial milling in the urban areas and to determine the most suitable supplements for grazing animals during the dry season in the villages.

3.1.2. Objectives

a. To carry out a survey to determine types and quantities of crop residues and by-products available in each locality.

b. To improve utilization of crop residues in the village through supplementation with browses, legume forages, legume haulms and vines, oil seed cakes, cereal brans and spent grains at the village level.

c. To determine the most suitable methods of conservation of crop residues and by-products at the village level.

d. To develop feed packages based mainly on crop residues and agro-industrial by-products that can be milled by small-scale commercial feedmills and be sold at affordable prices to the urban and peri-urban small-scale backyard farmers.

e. To develop suitable machines for processing crop residues in villages for (d) above.

3.1.3. Work Programme

a. A survey of types and quantities of crop residues & agro-industrial by-products available in each locality will be conducted

b. Nutritional studies to determine the most suitable supplements which can be used with crop residues available in the villages will be carried out on Research Stations.

c. The determined combinations of crop residues will be tested on farms in villages in collaboration with Agricultural Extension Officers/Rural Sociologists.

d. The most suitable methods of conserving crop residues will be determined.

e. Nutritional studies will be carried out to determine optimum levels of crop residues and agro-industrial by-products in complete ruminant diets on Research Stations.

f. In collaboration with Agricultural Engineers simple machines for processing crop residues (for village use) and complete feedmills (for use in the urban areas) will be developed.

g. Small-scale enterepreneurs will be encouraged (through dissemination of information and loan schemes).

3.1.4. Expected Output

a. Appropriate machines for processing crop residues and by-products (for both village and urban feed mills) will be developed.

b. Feeds will be made available to urban backyard small-scale farmers on a regular basis to increase meat and milk production.

c. Dry season feed shortages in villages will be alleviated and the farmers will increase their production of meat and milk.

d. Production of forage legume by small-scale farmers will be increased.

e. Efficient and effective utilization of crop residues and agro-industrial by-products will be achieved and this will stimulate crop production leading to stable and sustainable production of meat and milk and food crops.

3.1.5. Collaboration

a. Agricultural Extension Officers/Rural Sociologists.
b. Agricultural Economists.
c. Agronomists/Plant Breeders.
d. Agricultural Engineers.
e. Veterinarians.
f. International Organizations.
g. Universities/Research Institutes.

3.1.6. Publication

a. Refereed journals.
b. Workshop/Symposium Proceedings.
c. Network Newsletters.
d. Extension Bulletins.
e. Ministry of Agriculture Annual Reports.
f. National Newspapers, especially to attract small enterepreneurs to establish small-scale feedmills.

Appendix 1

List of Crop Residues & Agro-industrial By-Products

Crop Residues	Agro-Industrial By-Products
Sugarcane tops	Sugarcane bagasse
Plantain and Banana Peels	Mollases
Plantain and Banana leaves	
Plantain and Banana Pseudostems	Cocoa seed testa
Rejected Bananas	Coffee pulp

Cassava peels	Rubber seed cake
Cassava leaves	Brewers spent grains
Yam peels	Maize bran
Cocoa yam peels	Sorghum bran
Cocoa pod husk	Copra cake
Maize stover	Palm kernel cake
Maize cobs	Oil palm slurry
Sorghum stover	Groundnut cake
Miller stover	Rice bran
Oil palm leaves	Sunflower cake
Groundnut haulms	Wheatbran (imported)
Soyabean haulms	Cotton seed cake
Cowpea haulms	Noug cake
Cowpea pods	
Groundnut	
Soyabean haulms	
Soyabean haulms	
Soyabean pods	
Potato vines	
Sunflower tops	
Rice straw	

Supplements

Poultry manure
Browse plants : Leucaena, sp; Glyricidia, sp; Sesbania sp
Forage legumes : Centrosema, Siratro, Tropical Kudzu, Desmodiums

3.2. THE SUB-HUMID ZONE GROUP

Members :

Name	Country
C.W. Mwendia	- Kenya (Chairman)
R.B. Fombad	- Cameroon (Rapporteur)
M.A. Naga	- Egypt
B.H. Ogwang	- Swaziland
S. Sibanda	- Zimbabwe
J.T. Munthali	- Malawi

3.2.1. Justification

Sub-humid zone is recognized as one stretching from Southern Sudan to Senegal, with monomodal type rainfall, and some parts of Eastern and Southern Africa.

a. List of by-products available in the sub-humid zone:

Roughages	Supplements
	(i) Energy
	Wheat bran
Maize stover	Maize bran
Maize cobs	
Maize husks	Sorghum bran

Millet straw
Sorghum stover
Rice straw
Sunflower heads
Soyabean stover
Sugarcane tops
Groundnut tops
Sweet potato vines
Standing hay (bush hay)
Cottonseed hulls
Cassava peelings

Rice bran
Cassava
Molasses

(ii) Protein or NPN
Cottonseed
Cottonseed cake
Groundnut cake
Brewers grain
Fish meal
Urea
Poultry manure
Cassava leaves
Browses

Commercial feeds are considered to be generally balanced for energy, protein, minerals and/or vitamins.

b. Production systems based on commodities

(i) Milk from large and small ruminants
- Extensive system
- Semi-intensive (semi-zero grazing) system
- Intensive (zero grazing) system

(ii) Meat from large and small ruminants and non-ruminants
- Extensive system
- Semi-intensive system
- Intensive system

(iii) Traction from large ruminants and some non-ruminants like donkeys and horses. Non specific production system would be attached to this group of animals although an intensive system would be appropriate because the animals are specially managed for short periods to give the desired output (i.e. good feeding during ploughing season).

c. Problems related to the utilization of crop by-products listed under item 1.

- Lack of data on quantities of crop residues and agricultural by-products caused by inaccruate working ratios for estimating the amount of residues produced based on grain yields.

- Poor harvesting, storage and feeding systems of crop residues.

- Poor nutritional value of cereal crop residues : protein, energy, minerals and vitamins.

- Poorly integrated crops-livestock-soil production systems.

- Absence or near absence of sustainable feeding packages for smallholders; and where the packages are available, they are presented in a language a smallholder would not understand.

- Unco-ordinated extension of the few viable production packages that relate to crops, soil and livestock.

- Farmers dilemma in partitioning household labour into crops and livestock enterprises; a reflection of a number of institutional factors like pricing systems, loan availability etc which would affect the profitability of the enterprise.

- Lack of appropriate technology for processing crop by-products especially by smallholder farmers.

- Competition in the use of feed resources between using them as livestock feed and other alternative uses internally or as export commodities especially, oil seed cakes, molasses etc.

3.2.2 Objectives

a. To determine the grain to stover and/or grain to the milling by-product ratios that would give an accurate estimate of the stovers or milling by-products.

b. To investigate the appropriate stage and method of harvesting, and conservation of crop residues.

c. To improve the nutritional value of crop residues using sustainable packages.

d. To develop an integrated crop-livestock-soil production system that takes into account the alternative uses of the crop residues or by-products.

e. To evaluate the economics of each production system or package.

f. To develop appropriate research-extension-farmer collaboration in the production of packages.

g. To develop appropriate or relevant processing technologies for crop residues.

3.2.3. Work programme

a. Carry out surveys to estimate grain to stover or by-product relationships under various farming systems/conditions (taking into account factors like varieties, fertilizer, plant populations, disease or pest damage).

b. Determine the optimum stage & method of harvesting and conservation of the residue as either silage or hay.

c. Characterize the nutritional value of the crop residues to determine inherent deficient nutrients.

d. Supplement the deficient nutrients through legumes (forage), oil seed cakes, energy sources, minerals and vitamins.

e. Process crop residues either by :

(i) Physical means - chopping, grinding, pelleting
(ii) Chemical means urea, other appropriate alkalis, micro organisms,
acids or hydration

f. Intercrop with food or forage legumes to enhance soil fertility, and optimize grain and by-product production in the system.

g. Develop appropriate machinery for chopping and grinding the crop residues.

3.2.4. Expected output

a. Appropriate indeces or ratios for accurate estimates of quantities of crop residues or milling by-products.

b. Recommendations on harvesting and conservation of crop residues (silages or hays).

c. i) Data bank of the nutritive value of crop residues to facilitate ration formulations.
ii) Formulate feed packages.

d. Integrated crop-livestock production packages to improve soil, crop and livestock productivity.

e. Appropriate machinery for processing crop residues.

3.2.5. Collaboration

a. National - between National Agricultural Research Stations (NARS).

b. Regional (NARS) with farmers and extension.

c. International - with such Institutions as ILCA, Universities etc.

3.2.6. Publications

a. Annual reports.
b. Progress reports.
c. Proceedings.
d. Workshop/conference posters and circulars.
e. Field days and agricultural shows.
f. Radio programmes.
g. Newsletters.
h. Journal papers.

3.2.7. Budget

Protocol budget is dependent on the activities necessary for the achievements of the objectives as viewed from the regional point of view. Activities likely to be involved are:

a. Inventory surveys.

- Site selection.
- Sampling and relevant chemical analysis.

b. Improvement of nutritive value.

- Characterization of available residues through chemical analysis.

c. Supplementation of crop residues.

. with forage legumes and cultivated browses.
. would involve stages from establishment to harvesting and storage of the legumes and browses before feeding trials.
. with premixes to compensate for deficiences in energy, protein, minerals and vitamins. To correct such deficiencies with oil cakes, energy products and NPN.

d. Physical and chemical treatment.

- Would involve such activities as making above and below ground silos for treatment and conservation of residues using alkalis such as urea where practical and economical.

3.3 THE SEMI-ARID ZONE GROUP

Members :

Name		Country
L.R. Ndlovu	-	Zimbabwe (Chairman)
M.L. Kusekwa	-	Tanzania (Rapporteur)
T.A. Mohamed	-	Sudan
A. El-Wakeel	-	Sudan
F.P. Wandera	-	Kenya
I.M. Hashim	-	Sudan
S. Fall	-	Senegal
M. Njie	-	Gambia

3.3.1 Justification

a) Crops

Sorghum
Millets
Maize
Cow peas
Beans
Groundnuts
Lablab
Pigeon peas
Rice (irrigated)
Cotton

b) Industrial by-products

Cotton seed cake
peanut cake/peels, shells

Molasses
Bagasse
Cereal brans
Cotton gin by-products

c. **Target class of livestock**

Cattle:
young stock
cows
Oxen
Small ruminants :
Sheep
Goats
Donkeys
Horses
Camels

d. **Livestock production systems :**

Agro-pastoral
Transhumance
Nomadism

In the Semi-Arid zones of Africa, three major farming systems are found, the Agro-pastoral, Transhumance and Nomadism. However, in talking about utilization of by-products the latter two will be considered. Very little can be done in incorporating by-products in nomadic system of livestock production per se except if cattle from the nomadic system are brought in the cattle stratification system.

Under the Agro-pastoral and transhumance systems, livestock production is severely affected during the dry seasons. This is mainly due to shortages of feed. Natural pastures, which form the main source of feed to livestock is, at that time, low in dry matter and nutritive value. This leads to reduction in milk yield, weight losses, reduced draught power, and in severe cases high mortality rates. Crop by-products which are produced within the Semi-Arid zone by the agro-pastoralists have an important role to play as feeds, during the dry periods. However, there are a number of constraints that limit efficient utilization of these important feed resources: -

- Availability-amounts and types and competition with other uses e.g. fuel, building material or simply sold for cash. Harvesting, processing, transportation and storage.

- Low nutritive value - especially nitrogen, energy, minerals and vitamins and in some crop residues antinutritive factors.

- Socio-economics - attitudes towards using certain crop residues : cost-benefit, marketing/credit facilities, poor land use systems (shifting cultivation).

3.3.2. **Objectives**

a. General Objective

To improve livestock production (milk, meat, draught and survival) by alleviating feed shortages during dry seasons through improved utilization of crop residues.

b. Specific Objectives

i) To assess the amount and types of crop residues and other feed resources available on small scale farms in order to determine their contribution in the overall feed budget and possible allocation to other uses.

ii) To improve the nutritive value of crop residues through supplementation, by use of industrial by-products, home grown supplements and browses (local and introduced) and where practical and economical by physical and chemical treatments.

iii) To determine the types and levels of secondary compounds (contained in some of the by-products) that are deleterious to livestock.

iv) To develop approriate methods of processing and storage of the crop by-products.

v) To test the developed technologies on-farm, in order to determine their acceptance by farmers.

vi) To carry out sociological studies and market surveys in order to understand the production systems and marketing strategies of the livestock products.

vii) To enhance the dissemination of information on the developed technologies for improved utilization of by-products.

3.3.3. Work programme

i) Diagnostic surveys on representative sample of farmers and through questionnaires.

ii) Surveys effect of energy, nitrogen, minerals and/or vitamins supplementation for efficient utilization of crop residues.

iii) Study the effect of a range of commercial chemicals and home made solutions (e.g. ash) on improving the nutritive value of crop residues.

iv) Laboratory analyses to determine the types and levels of possible deleterious compounds, contained in some of the by-products.

v) Feeding trials will be carried out to establish effective feeding levels of such feeds.

vi) Development of simple techniques of processing (if possible pelleting), packaging and storage.

vii) On-farm feeding trials will be carried out, again with selected representative farmers within the semi-arid regions of Africa. An integrated approach will be adopted in this exercise.

viii) Intensification of contact with farmers through field days, farmers training programmes and mass media.

3.3.4. Expected output

i) Baseline information on the contribution crop by-products make to livestock feeding systems on small scale farms.

ii) Types and levels of anti nutritional factors contained in some crop residues.

iii) Technologies for improving the nutritive value of crop residues and by-products developed.

iv) Simple techniques for harvesting, storage and processing of crop residues developed.

v) Appropriate technologies for improving utilization of crop residues within the small-scale farming systems of semi-arid Africa, developed.

3.4. THE HIGHLANDS ZONE GROUP

Members:

Name	Country
Beyene C.	- Ethiopia (Chairman)
Zinash S.	- Ethiopia
N.A. Urio	- Tanzania
Getachew G.	- Ethiopia (Rapporteur)
Daniel K.	- Ethiopia
A. Abate	- Kenya (left after first meeting)

3.4.1. Justification

Discussion was based on the following sub headings :

. Status of current knowledge on the availability of crop residues (CR) and agro-industrial by-products (AIBPs) i.e. type, quantity and quality.

. Research and extension linkage.

. Need to develop, test and transfer feeding packages based on CR and AIBP's.

Following a thorough discussion of the above sub-headings, members agreed to work on a project document entitled :

"Inventory, characterization and development of improved feeding system based on crop residues and AIBP's in the Highlands of sub-Saharan Africa". This project will have two major components namely :

1. On-farm diagnostic survey and characterization of CR and AIBP's as feed resources in the Highlands of sub-Saharan Africa.

2. Development and transfer of crop residues and AIBP's based feeding packages in the Highlands of sub-Saharan Africa.

Due to the increased pressure on land there will be little land left for grazing. On the other hand, however, with the increased use of land for cultivation more and more CR's and AIBP's will be made available for feeding animals. These feed resorces are not being effectively utilized in the Highlands of sub-Saharan Africa due to various reasons :

. Lack of reliable data on the potential as well as actual availability of residues.

. There is lack of adequate knowledge on the value of the available residues for livestock feeding.

. Whatever knowledge is available, it is not at times utilized due to poor research/extension linkage.

Research results which should have been extended are still shelved. A lot of research is not based on diagnosis of the existing feeding systems and thus results are in most cases not practical and extendable to farmers.

. The potentianl of CR's and AIBP's is also determined by the time and place they become available. This information is essential to develop feeding packages based on existing resources per se.

. Most CR and even some AIBP's are reported to have certain nutritional commonalities. Alone and untreated most of them can only be consumed in amounts insufficient even to support maintenance. Consequently a lot needs to be done on strategic supplementation of these feed resources.

. Very little work has been done on the feeding value of legumes in the Highland mixed farming systems of sub-Saharan Africa. There is, therefore, a strong case for the integration of legumes and crop production system. Agronomically promising legumes are already available but much remains to be done on methods of introducing them into the farming systems and in increasing the awareness of their potential by carrying out on-farm trials.

. To be able to develop appropriate feeding packages, it is imperative that a study be carried out on the existing production systems and the potentials for development.

. Transportation cost of CR's and AIBP's from the site of production to the place they could be made available as feeds could be a limiting factor. Thus efforts made to develop feeding packages should consider the economic aspect as well.

3.4.2. Objectives

. To estimate the potential and actual availability of CR and AIBP's.

. To set up on-farm annual feed budget.

. To realize the potential of forage legumes/tree legumes supplementation of CR and AIBP's on on-farm and on station experiments.

. To develop CR and AIBP's based feed packages for sustainable animal agriculture.

. To test (on-farm) and recommend feeding packages for a transfer by extension agents.

3.4.3. Work programme

a) Survey and questionnaire :
   - CR and AIBP's - inventory
   - Survey and review on status of current knowledge on CR and AIBP's in the Highlands of sub-Saharan Africa.

b) Relevant chemical analysis of feed samples (CR) and AIBP's.

c) Testing of some processing and treatment methods in relation to their potential to increase the on-farm utilization of CR and AIBP's. Methods of treatment such as urea and physical methods like chopping will be studied.

d) Different agronomic/cultural methods of legume introduction into the farming system will be tested. Studies on the strategic supplementation of CR and AIBP's with legumes will be carried out.

3.4.4. Expected output

. Development of appropriate feeding packages.

3.4.5. Collaboration

. Nationally - disciplinary approach.

. Inter-regional-between researchers in the Highlands of sub-Saharan Africa.

. International - ILCA and others.

3.4.6. Publication

. Progress reports will be published in ARNAB Newsletters.

. Final results will be released through proceedings.

. Posters and booklets will be produced for use by local extension agents.

. Field days will be organized.

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ARNAB

Newsletter

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1. ABSTRACTS OF SOME OF THE PAPERS PRESENTED AT THE FIRST JOINT ARNAB/PANESA* ANNUAL WORKSHOP HELD IN LILONGWE, MALAWI FROM 5th 9th DECEMBER 1988.

1.1 FORAGE AND CROP BY-PRODUCT UTILIZATION: PRELIMINARY RESULTS ON FARMERS' ADOPTION WITH LACTATING DAIRY COWS

Kassim M. Biwi.
Ministry of Agriculture, P.O.Box 159, Zanzibar

ABSTRACT

Forage and crop by-products were utilized to feed lactacting dairy cows in a crop livestock integration package. Fourteen smallholder farmers owning 3-5 hectares of land and practising crop livestock integration with dairy cattle were monitored in Unguja and Pemba to see how well they adopted technological packages. A forage mixture of elephant grass (Pennisetum purpureum) Guatemala grass (Tripsicum laxum) gliricidia (Gliricidia maculata) or leucaena, (Leucaena leucocephala) and banana stems and leaves fed to lactating cows influenced milk yield to indicate a reasonable good adoption of the feeding practice by smallholders.

Number of insemination per conception were 2 and 3.4 and calving intervals were 13.1 months and 14.3 months for Unguja and Pemba respectively. Adoption in Pemba was slower compared to Unguja inspite of breed differences of the cattle used.

* PANESA = Pasture Network for Eastern and Southern Africa.

Occurrence of East Coast Fever was more frequent in Pemba and this indicated low adoption rate in the use of acaricides for spraying.

It is expected that intensifying extension and credit facilities will increase rate of adoption as these appear to be the main constraints.

1.2 PRELIMINARY EVALUATION OF RESEARCH ON AGRICULTURAL BY-PRODUCTS UTILIZATION BY MODERN SMALL SCALE FARMERS IN THE SUDAN

T.A. Mohammed and B.I. Babiker
University of Khartoum, P.O.Box 32,
Khartoum North, Sudan

ABSTRACT

This paper attempts to evaluate the state of research on agricultural by-products and its usefulness to modern small scale farmers and other potential users. It highlights the quality of the research reports generated and their relevance and applicability on small scale farms. For this purpose the authors reviewed the available research reports and conducted interviews with senior scientists and managers in the major research institutes and some agricultural production centres. Some modern small scale farmers and feedlot operators were also interviewed.

It was observed that the modern small scale farmer have received little, if any, benefits from the research undertaken on agricultural by-products. This observation is related to the relatively low quality research undertaken, so far.

1.3 THE USE OF CROP RESIDUES FOR LIVESTOCK FEED BY SMALL FARMERS IN THE GAMBIA

Sandra L. Russo
Animal Science Department University of Florida
Gainesville, Florida 32606 USA

ABSTRACT

The Gambia, one of the smallest countries in Africa, was the location of The Mixed Farming and Natural Resource Management Project from 1981-86. The goals of the project were to intensify and integrate crop and livestock enterprises in existing Gambian farming systems. Cattle production was to be improved by better nutrition during the dry season, by range management techniques including deferred grazing, improvement of rangelands through re-seeding and root transplants, and the storing and four feeding of crop residues. Village-level feeding trials were conducted in four villages in 1983 and had increased to 33 villages by 1986. Not all innovations were used in each village. Socio-economic factors such as the land tenure system, social value of cattle, high labour requirements, limited market access, low land pressure and farmers' goals had a profound effect on acceptance of the innovations. Development and farmer goals must converge before acceptance and adoption will occur.

1.4 BUDGETING AND ALLOCATION OF FEED RESOURCES

P.N. de Leeuw, B.H. Dzowela and R. Nyambaka
ILCA, P.O.Box 46847 Nairobi, Kenya

ABSTRACT

In most of semi-arid Eastern Kenya, farmers cultivate maize, beans, cowpeas and pigeonpea as well as keeping cattle, goats and sheep. Farm sizes range from 2 to 15 ha and most land is privately owned. Cropped land increases with farms size from 1.5 ha to 5 ha, the remainder being left for grazing. Annual rainfall is between 600 and 900 mm per year falling in two season with a growing period of 50-80 days each. Cattle are kept for milk, traction and cash sales while smallstock are sold for cash. Cattle are most important, comprising 75-85% of the total livestock mass. Stocking rates are high and decrease from 1.5 Tropical Livestock Units (of 250 kg) ha for a 5-ha farm to 1.0 ha for a 10-ha farm. Forage from rangeland and crop residues are the principal feed resources. Except in good rainfall seasons demand for livestock feed exceeds supplies resulting in overstocking, land degradation and low productivity.

On-farm research has shown that the fodder supply in smallholder farms can be increased by 1) establishment of grass-legume leys, 2) planting of grass and legume forages and 3) better utilization of crop residues. Household welfare and cash income was improved by channeling most of planted forage and high-quality fodder to one or two crossbred cows for milk production. Livestock productivity can be further enhanced by more efficient utilization of these increased feed resources through proper budgeting and allocation of feed resources to the various livestock enterprises maintained on farms.

In this paper computer-assisted procedures are described consisting of the following steps: 1) an assessment of the aerial extent of feed resources and their expected yields per hectare; 2) establishment of monthly totals of all sources in terms of dry matter yield, crude protein and digestible energy content; 3) estimation of DM and nutrient requirements of each livestock enterprise within farm.

From these initial inputs, monthly feed balances can be calculated followed by the partitioning of these sources amongst the different livestock classes according to the priorities set by the farmer. The procedures are flexible and can be adjusted for farm size, cropping pattern and feed requirement of age/sex groups within the herd. It can also become a tool to test the effects of feed resource utilization on farm output when it is linked with holistic economic farm models.

1.5. USE OF RESEARCH RESULTS TO FORMULATE A FEEDING STRATEGY FOR LIVESTOCK DURING THE DRY SEASONS IN UGANDA

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Kampala, Uganda

ABSTRACT

Livestock production in Uganda is limited among other factors by feed availability throughout the year. Research so far done has shown the potential of crop residues, molasses/urea blocks and poultry waste as ruminant livestock feedstuffs. These results together with orage conservation in the form of silage can be used to formulate a strategy for livestock feeding during the dry season. The use of these research findings has been limited by the weakness in the extension system in the country.

1.6. NUTRITIVE VALUE OF CROTALARIA VALUE OF CROTALARIA OCHROLEUCA : II THE EFFECT OF SUPPLEMENTATION OF FEED UTILIZATION AND PERFORMANCE OF GROWING SHEEP

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Animal Science Department Sokoine University of Agriculture
Morogoro, Tanzania

ABSTRACT

A study was carried out to determine chemical composition of Crotalaria ochroleuca ("marejea") at three stages of growth-pre-anthesis, anthesis and post-anthesis. Feeding trials were conducted to study the effect of marejea supplementation of low quality Chloris gayana hay on the growth rate and feed utilization of growing sheep. In the feeding trials 12 young male sheep were randomly allocated to four treatments: hay on (T), hay + 150g "marejea" (T), hay + 300g "marejea" (T) and hay + **ad lib** "marejea" (T).

The crude protein (CP) content was highest (30.5%) at pre-anthesis and decreased with advancing plant growth. The leaves with a CP of 34.5 were observed to be the most nutritious part of the plant. The crude fiber (CF) content was lowest ad pre-anthesis (36.7%) and increased to 40.0% at post-anthesis stage of plant growth. Calcium and phosphorus contents were highest at pre-anthesis.

Supplementation had a significant ($P<0.01$) effect on total and daily gain. Total and daily weight gain increased with increasing level of marejea supplementation in the diet but there was no significant differences ($P>0.01$) among supplemented animals as a group had significantly ($P<0.01$) with treatment T. Both faecal N and urinary N excretion increased with N intake and level of supplementary. The nitrogen balance value increased with increasing level of marejea supplementation. It was negative in treatment T and highest in T.

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1 P.O.Box 46847, Nairobi, Kenya

From the study it was concluded that marejea hay at pre-anthesis stage had the highest nutritive value and can be used as a cheap alternative protein supplement for growing sheep in areas where conventional proteins are expensive or not available.

1.7 RESPONSES OF WEST AFRICAN DWARF SHEEP FED CASSAVA PEEL AND POULTRY MANURE BASED DIETS

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Department of Animal Science
Obafemi Awolowo University, Ile, Ife Nigeria

ABSTRACT

Five diets containing 0,13,25,35 and 45% dried poultry manure (DPM) were formulated such that DPM replaced 0, 25, 50, 75 and 100% of the wheat offals and groundnut cake contained in the control diet 1. The diets were fed to 20 growing ewes in a 104 days growth study. Dry cassava peels and water were also provided **ad libitum**.

The intake of the animals fed the 0, 13, 25, 35 and 45% DPM diets were 87.1, 94.0, 88.6, 102.8 and 107.8 g/kg 0.75/day. The differences were not statistically significant. Also not statistical differences were observed in the growth rate of sheep which varied from 84.5g/head/day for sheep fed the 25% DPM diets to 100.6g/head/day for the animals on the 35% DPM diet. Efficiency of feed utilization decreased from 8.7kg feed/kg gain to 10.5 as the level of manure in the diets increased from 0 to 45%. The growth performance of al the animals showed that sheep can be reared on diets containing poultry manure as the sole protein supplement, with dried cassava peels constituting 40 to 60% of the total diet. Sheep supplemented with poultry manure diets had higher intake of the dried cassava peel than sheep fed unsupplemented control diet.

1.8 ON-FARM EVALUATION OF MAIZE BRAN AND COTTONSEED CAKE AND INTRODUCTION OF IMPROVED FORAGE TECHNOLOGIES FOR MILK PRODUCTION IN MZUZU MILKSHED AREA OF MALAWI

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Agricultural Research Station,
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ABSTRACT

On-station research work has developed promising animal feed resource technologies for increasing milk production and these are being evaluated on-farm with both research resources and those of farmers. Preliminary results show that the inclusion of cottonseed cake in maize bran-based dairy rations would raise dairy farmers' gross margin/cow. If the programme we would eventually lead to more feed resources of high quality resulting in increased livestock productivity with the end result of attaining food security and improved farm income of the smallholder farmers.

2. COURSE ANNOUNCEMENT ON-FARM RESEARCH METHODOLOGY IN ANIMAL FEED RESOURCES AND ANALYSIS

INTRODUCTION

It has been proposed by the Steering Committees of ILCA's Animal Feed Resources Networks, the Pastures Network for Eastern and Southern Africa (PANESA) and the African Research Network for Agricultural By-products (ARNAB) to hold a training course on "On-Farm Research Methodology and Data Analysis". Arrangements are under way to hold the first course in English at Egerton University, Agriculture Resources Centre, Njoro, Kenya from 6-17 November 1989. For this year the course will be funded by IDRC's Fellowships and Awards Division to which a tentative course project proposal has been submitted. This proposal has been favourably accepted and funding is anticipated.

BACKGROUND

The two Networks working on animal feed resources have encouraged the use of on-farm research methodology in the testing and evaluation of developed animal feed resources packages but very little progress has been made in the collaborating National Agricultural Research Systems (NARS). Among the many reasons it may be that most scientists in NARS have limited exposure to on-farm research experimental design and data analysis. Traditional statistical designs use randomized complete block and conventional factorial designs. Yet the statistical analyses of data from surveys is another area which uses special methods not commonly used by biological scientists working with animal feed resources.

TARGET GROUP

The course is targeted for senior research officers/fellows and lecturers from institutions involved in animal feed resources research and extension/training. There will be a maximum of 20 participants. It is hoped that these leading scientists and educators will be able, after the course, to develop curricula for imparting the on-farm research methodology to young early career scientists and technicians working in animal feed resources and animal production.

JUSTIFICATION

1. On-farm research approach is an effective tool of enhancing the technologies to small-scale farmers.

2. On-farm research approach provides a feedback to researchers on the appropriateness of already developed technologies and also in re-designing on-going research programmes.

3. On-farm research approach in animal production is fairly new and does not utilize the conventional research methodologies (statistical design, data collection and data analysis).

4. A sizeable number of scientists in NARS will benefit from a re-orientation on on-farm research and livestock methodologies especially statistical design and data analysis.

5. The most cost-effective method of disseminating new research methodologies is to train trainers and leaders of research in NARS.

COURSE CONTENT

The course will attempt to review the types of on-farm animal feed resources research that are most suited to generating the specific types of research information needed for technology development. Evaluation of methods will be made in terms of the effectiveness of inputs from both scientists and technology users (extension personnel and farmers). The course will be organized around the key questions:-

1. What is the role of on-farm research in animal feed resources technology generation.

2. What on-farm research methods can be used to help evaluate management of animal feed resources.

3. What on-farm research methods can be used to help in design and evaluation of animal feed resources technologies.

4. What criteria should be used to divide resources between on-station and on-farm animal feed resources research.

5. How can on-farm animal feed resources technology generation activities be organized to enhance collaboration between farmers and scientists, and between scientists of different disciplines (agronomists, animal nutritionists, animal health scientists, socio-economists, etc...).

The format will include lectures based on case study experiences, commentaries and group discussions. Working groups will be organized on particular topics of on-farm research methodology. The course will be augmented with a relevant field trip.

The major topics of the course will include:

1. The role of on-farm research in animal feed resources (forages and agricultural by-products) technology generation.

2. On-farm research designs for evaluating animal feed resources.

3. The role of the animal component in on-farm animal feed resources evaluation.

4. Institutional, organizational and management issues which affect the extent and depth of farmer involvement in research, and scientist effectiveness in integrating on-farm research into the overall research programme .

5. Use of scientific assessment methods to evaluate responses specific to animal feed resources technology, designs, data collection and analysis.

6. Computer packages for analysis of on-farm research data.

7. Evaluation of introduced methodologies (adoption rate and socio-economic impact).

Duration Two weeks, 6-17 November, 1989

Venue : Egerton University, Agriculture Resources Centre, Njoro, Kenya.

Funding : International Development Research Centre (IDRC), Fellowships and Awards Division (financial grant through PANESA/ARNAB).

Resource Personnel: Two world reknowned consultants, with hands-on experience on on-farm research and methodology and data analysis in animal feed resources. These will be assisted by three local consultants, with African experience in on-farm research, to share their experiences with course participants.

Selection/Nomination of Participants : If you or your colleagues would like to participate in this course please complete the nomination form attached on page 13. Depending upon the success of this course and future availability of funds it will be possible for the Steering Committees of the two Networks to sanction a repeat of the course so that more colleagues from NARS will have a chance to participate.

3. OTHER RESEARCH ABSTRACTS.

3.1 NUTRITIONAL VALUE OF AMMONIATED PEANUT HULLS IN BEEF CATTLE DIETS

G.M. Hill P.R. Utley
Nutrition Reports International 1987, (36) p. 1363-1370

ABSTRACT

In a 2x2 Latin square design trial 6 steers about 231 kg were given maize based diets containing 20% untreated groundnut husks (GH) plus 0.6% urea (control) or 20% ammonia-treated GH (A-GH) for 13 days at 4.54 kg/steer then for 7 days at 2.27 kg/steer. In a second trial with similar design 18,1 - year - old heifers about 302.9 kg were given free access to diets for 112 days. Crude protein content of control and A-GH diets was 11.6 and 11.3%, respectively. For steers digestibilities of DM, crude protein and gross energy were similar with both diets, however digestibility of neutral detergent fibre tended to be lower and of acid dtergent fibre higher with A-GH diets. Nitrogen intake was similar for both diets but steers given A-GH

retained more N than did the controls. For heifers given the A-GH diet, plasma urea N was lower than in controls. Weight after 112 days, daily gains, feed conversion and carcass trials were not affected by diet. Results indicate that A-GH may be used as a nitrogen and roughage source in cattle diets.

3.2 EFFECT OF SORGHUM STRAW ALONE OR IN COMBINATION WITH MOLASSES AND NITROGEN SOURCES ON PERFORMANCE OF SUDAN DESERT LAMBS

A.G. Osman A.E. El-Tayeb A.E. Sulieman T. A. Mohammed
Animal Feed Science and Technology 1988, (19) p. 351-358

ABSTRACT

Diets containing straw only (A), 70% straw plus 27% molasses (B), 68.6% straw plus 26.5% molasses and 2% urea (C), 63.6% straw plus 24.5% molasses and 9% blood (D), 58.3% straw plus 22.5% molasses and 16.7% blood (E), or 35% sorghum grain plus 35% cottonseed cake and 27% wheat bran (F) were given to 36 crossbred Sudan desert lambs 183.7 plus or minus 4.5 days old. Lambs given diets A and B had the lowest ($P<0.05$) feed intake. Nitrogen-supplemented lambs (groups C, D and E) had higher ($P<0.05$) feed intakes than unsupplemented lambs (groups A and B) (a.16, 1.05 and 1.07 vs. 0.65 and 0.87 kg/day); lambs given diet F had the highest ($P<0.05$) feed intake (1.32 kg/day). Growth and feed efficiency of lambs were relatively poor except for those given diet F. Average daily body weight changes were -55.9, -54.9, 6.6, 38.1, 50.8 and 170.0g for lambs given diets A, B, C, D, E and F, respectively. Dressing-out percentages were 37.9, 38.6, 38.7, 41.0, 39.7 and 45.7, respectively.

3.3 INFLUENCE OF PLANE OF NUTRITION AND DIET COMPOSITION ON RUMEN FERMENTATION AND ENERGY UTILIZATION BY DAIRY COWS

J.D. Sutton W.H. Broster E. Schuller D.J. Napper V.J. Broster
J.A. Bines, J. A. Journal of Agricultural Science 1988 (110) p 261-270

ABSTRACT

Mean digestible energy (DE) intakes of 147 cows of 3 parities given diets to provide digestible energy (DE) at 2.2, 2.6 or 3.3 times maintenance (MM) (diets contained hay plus 60, 75 or 90% compound feed) were estimated. Rumen samples were taken from three-quarters of the cows at monthly intervals throughout the experiment. Molar proportions of volatile fatty acids (VFA) in the rumen were not affected by stage of lactation over the 36 weeks of the experiment. The proportion of acetic acid decreased and that of propionic acid increased with greater intakes and with higher proportions of compound feed (CF) in the diet. The proportion of n-butyric acid was little affected by level of intake but decreased with increasing proportions of compound. In young, non-lactating cattle given the same diets but at lower intakes, VFA proportions were unaffected by diet composition at intakes of about 0.7 MM, but at intakes of about 1.3 MM the proportion of acetate decreased and that of propionate increased when the proportion of CF was increased from 75 to 90%. The efficiency of milk energy production in relation to DE or

metabolizable energy (ME) above maintenance decreased with increasing intake but was little affected by the proportion of CF. Partition towards liveweight increased with intake in early lactation but not in late lactation. It also increased with higher proportions of CF in mid- and late-lactation but not in early-lactation. Estimates of the ME requirement for liveweight change (LWC) were in reasonable agreement with recently published standards in early lactation when liveweight was decreasing, but later in lactation when liveweight gain was occurring, a much higher value was calculated which is difficult to reconcile with these standards. Rumen VFA proportions were related to dietary fibre concentration and level of intake additively. The relationship to VFA proportions was close for milk fat concentration, but less so for energy partition towards liveweight and none was apparent for the efficiency of ME utilization for milk energy production. It is suggested that both the reduction in milk fat concentration and the increase in milk yield in response to reductions in the fibre content of diets may be independently related to the increase in the proportion of propionate in the rumen VFA. It is concluded that further progress in studies of the dietary factors affecting the efficiency of milk production will require measurements of nutrient uptake from the digestive tract and description of milk production and LWC in terms of their chemical composition rather than energy alone. Descriptors: Plane of nutrition; rumen fermentation; cows; energy; utilization, Concentrates; hay; ratios.

3.4 NET ENERGY FOR GAIN (NEgain) OF CASSAVA TOPS

J.A. Kategile, J.G.J. Mngulwi A. Abate
Animal Feed Science and Technology 1988 (20) p. 97-109

ABSTRACT

For 70 days, 15 entire Black-Headed Persian lambs in 3 treatment groups, were given a basal maintenance ration of Chloris gayana hay without or with 200 g DM of cassava tops hay (CTH) or cassava tops silage (CTS). The amount of Chloris gayana hay in the treatment groups was adjusted weekly for each animal to meet maintenance requirements. A mineral supplement was provided and water was freely available. The gross energy of the carcasses, offal and blood was estimated from their protein and fat content. The difference between the gross energy of the controls and those on treatment gave the net energy (NE) of the cassava tops. Results showed that, on average, cassava tops contained 27.1% crude protein (CP), 24.6% crude fibre (CF), 5.9% ether extract (EE) and 782.5 mg/kg hydrocyanic acid (HCN) in the DM; hay making was the most efficient method of reducing HCN content. Overall, the digestibility coefficients (%) of cassava tops were: organic matter, 67.2; CF, 43.5; CP, 79.5; and EE, 51.7. Feeding cassava tops together with Chloris gayana hay, improved voluntary feed intake by the lambs. In the NE study CTS was significantly more digestible and resulted in greater metabolizable energy (ME) intake than CTH. However, the energy in CTH was better utilized for gain. The NE values of CTH and CTS were 2.22 and 1.67 MJ/kg DM, respectively. This apparent contradiction was explained in terms of thyroid malfunction as shown by the greatly enlarged thyroid glands of the lambs given CTS with a high HCN content.

3.5 INTENSIVE ANIMAL PRODUCTION TRIALS IN THE SAHELIAN AND SUDANESE AREA: INTENSIVE FEEDING OF LAMBS IN THE NORTH OF BURKINA FASO. (ESSAIS D'INTENSIFICATION DE LA PRODUCTION ANIMALE EN ZONE SAHELO-SOUDANIENNE: ALIMENTATION INTENSIVE DE JEUNES OVINS DANS LE NORD DU BURKINA).

D. Bourzat E. Bonkoungou D. Richard R. Sanfo
Revue d'Elevage et de Medecine Veterinaire des Pays Tropicaux 1987, (40) p. 151-156

ABSTRACT

Groups of Mossi and Peul Fulani sheep in the north of Burkina Faso were given diets comprising hay and concentrates or straw plus cottonseed oilmeal and by-products or urea. Of these intensive feeding systems, the best diet for sheep comprised of rice or millet straw, molasses and cottonseed oilmeal as sheep were not in direct competition with man for the individual feeds. For 25-kg sheep given this diet average DM intake and daily liveweight gain was 1 kg and 110g, respectively.

3.6 COMPARISON OF RUMINAL DIGESTION OF BRAN AND SUGARBEET PULP IN SHEEP AND COWS. (DIGESTION RUMINALE COMPAREE DU SON ET DE LA PULPE DE BETTERAVES CHEZ LE MOUTON ET LA VACHE)

M. Doreau B. Michalet-Doreau C. Poncet M. P. Guen
le Reproduction, Nutrition, Development 1988, (28) p. 119-120 (Fr)

ABSTRACT

Ruminal digestion was compared in cows and sheep receiving 40% hay and 60% wheat bran or beet pulp to appetite. Organic matter (OM) digestibility was 5% higher for pulp diet, but ruminal OM digestibility was the same for both diets. Ruminal retention time was shorter for pulp, but its rate of digestion seemed to be more rapid. Ruminal retention time for hay was longer in cows, but ruminal digestibility was not as great.

3.7 EFFECTS OF INTAKE OF STRAW TREATED WITH SODIUM HYDROXIDE ON SOME CHARACTERISTICS OF FERMENTATION IN THE RUMEN OF SHEEP AND GOATS. (EFFETS DE L'INGESTION DE PAILLE TRAITEE A LA SOUDE SUR CERTAINES CARACTERISTIQUES FERMENTAIRES DU RUMEN DES OVINS ET DES CAPRINS)

M. Focant M. Vanbelle A. July
Reproduction, Nutrition, Development 1988, (28) p. 121-122 (Fr)

ABSTRACT

Compared with hay diets, straw diets treated with sodium hydroxide were accompanied by a large increase of water intake and of rumen fluid volume in sheep and goats. Adding 1% urea to the NaOH-treated straw increased DM intake by 60% in both species with no change in rumen fermentation indices. Descriptors: Rumen fermentation; straw; sodium hydroxide treatment; goats; sheep; Alkali treatment.

3.8 THE SUBSTITUTION OF GRASS SILAGE BY A STRAW AND CONCENTRATE MIXTURE FOR DAIRY COWS

D.J. Roberts

Animal Feed Science and Technology 1988, (20) p. 135-143

ABSTRACT

In a 16-week winter-feeding experiment, 3 groups of Friesian cows were given Lolium perenne silage to appetite or restricted access to silage (6 an 4 kg DM/daily) and a straw and concentrate mixture (straw-mix) to appetite. The straw-mix contained (per kg DM); sodium hydroxide-treated straw 540 g, ground barley 260g, soyabean oilmeal 180g, mineral and vitamin supplement 20g. All cows were given a flat rate of 9 kg concentrate daily throughout the experiment. The silage had a lower metabolizable energy (ME) content than the straw-mix (9.8 vs. 10.2 MJ/kg DM) and a higher crude protein content (161 vs. 141 g/kg DM). Restricting the amount of silage and including the straw-mix in the diet increased the total DM and ME intake. The cows given silage to appetite had a significantly lower milk yield and protein yield than those given 4 kg silage DM daily plus the straw-mix. There were no significant differences between treatments in milk composition. Cows given silage to appetite lost liveweight over the 16 weeks, whilst those on the other 2 treatments maintained their liveweight.

N O M I N A T I O N F O R M

Animal Feed Resources Networks (PANESA/ARNAB) ON-FARM RESEARCH METHODOLOGY AND DATA ANALYSIS TRAINING COURCE.

Name of Participant : _____

Organization/Institution _____

Address : _____
_____
_____

Telex No : _____

Qualification : _____
_____
_____

Experience : _____
_____
_____

Language proficiency English ( ) French ( )

Nominated by :

Head of organization/institution

Participant's signature : _____

Date : _____

Please forward completed form to:-

Drs B.H. Dzowela / A.N Said

International Livestock Centre for Africa,

P.O.BOX 46847,	OR P.O.BOX 5689
NAIROBI,	ADDIS ABABA,
Kenya.	Ethiopia.

ARNAB Newsletter

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INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA, P.O. BOX 5689, ADDIS ABABA, ETHIOPIA

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2. THE USE OF CROP RESIDUES AS LIVESTOCK FEED ON SWAZI NATION LAND - A SURVEY.

3. ABSTRACTS FROM ANIMAL FEED SCIENCE AND TECHNOLOGY.

1. RESEARCH ON CROP RESIDUES AND AGRO-INDESTRIAL BY-PRODUCTS AS LIVESTOCK FOOD IN ZIMBABWE.

1.1 RESEARCH ON CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS AS LIVESTOCK FEED IN ZIMBABWE - A REVIEW

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University of Zimbabwe P.O.Box 167, Zimbabwe

INTRODUCTION

The population of livestock in Zimbabwe comprises 5.9 million cattle, 2.5 million goats, 0.2 million sheep, 0.3 million donkeys and 0.2 million pigs (Central Statistical Office, 1987). Zimbabwe has one of the highest human population growth rates of about 3.6 percent per annum. There is therefore a need to enhance the availability of animal products for human consumption. While efforts are being made to improve livestock production through the introduction of exotic germplasm for crossbreeding and improving livestock health facilities, nutrition is still recognized as the major production constraint.

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[1] University of Zimbabwe P.O.Box MP 167 Harare, Zimbabwe

The majority of cattle (60 percent of the national herd), goats and sheep are kept in communal areas where the level of overgrazing was estimated to average 164 percent (Sandford, 1982). Overgrazing in the wet season does not allow sufficient fodder for the dry season. Animal feed is therefore in shortest supply during the dry season and in some areas crop residues supply over 50 percent of energy consumed by ruminants (GFA, 1987). The estimated annual production of crop residues and other by-products in Zimbabwe is shown in Table 1. Smith (1988) estimated that if all the available stover were to be utilized as livestock feed in communal areas it would provide up to 54 percent of the animals' maintenance feed requirements over the 150-day dry season.

Table 1. Estimated annual production of crop residues and agro-industrial by-products in Zimbabwe (1986/87)

	Quantity ('000 tonnes)
Crop Residues[1]	
Maize stover	1 332.0
Sorghum stover	300.0
Wheat straw	426.0
Barley straw	45.0
Soyabean stover	367.0
Groundnut stover	71.1
Sunflower stover	64.0
Sugar cane tops[2]	210.0
Oil seed cakes[3]	
Soyabean	60.1
Cottonseed	80.6
Groundnut	3.6
Sunflower	8.7
Other by-products	
Molasses[4]	42.0
Bagasse[5]	252.0
Meat and bone meal[6]	4.3
Blood meal[6]	1.0

1 Estimated from grain yield (Central Statistical Office, 1986) using a factor of: 2 for maize, wheat and barley; 5 for sorghum and 4 for oil seed crops (Kossila, 1987).

2 Sugarcane yield: 3 500 000 tonnes (Anon, 1987); 20 per cent dry matter. For 2,4, and 5 use a factor of 0.3, 0.36 and 0.06, respectively, of cane dry matter yield (see Ranjham and Chadhokar, 1986).

3 Agricultural Marketing Authority (1988).

6 Cold Storage Commission (1986).

Maize stover

Maize stover is the most abundant crop residue in Zimbabwe and most of the research on crop residues has been concentrated on it. Early work on the evaluation of maize stover was aimed at assessing the use of the whole maize plant for production of beef, milk and mutton during the dry season (Grasslands Research Station, 1960). Maize stover plus grass silage (5.2 percent crude protein) was fed *ad libitum* with a daily supplement of urea (85 g/animal) or groundnut meal (0.5 kg/animal) to Afrikaner weaner cattle during the dry season. The mixture of grass silage and stover reduced liveweight loss significantly, with a greater response from groundnut meal than urea (Table 2). In a follow up trial, grass silage was fed a supplement (2 kg/day) to heifers grazing maize stover during the dry season, resulting in an average daily liveweight gain of 0.37 kg, compared to 0.19 kg for animals on stover grazing only (Table 2).

Subsequent experiments examined the effect of varying the ratio of maize grain to stover in milled complete diets on growth rate of steers in pens (Grasslands Research Station, 1968). In general, the performance of steers declined with an increase of stover in the diet (Table 2). The decline in performance was reversed by feeding a protein supplement.

Table 2. Performance of cattle receiving maize stover diets

	Liveweight gain	Source
	(kg)	
Maize stover + grass silage *ad libitum*[1]		
no supplement	-3.6	Grasslands Research Station (1960)
+ 85 g urea/animal/day	8.2	
+ 500 g groundnut cake/animal/day	8.6	
Grass silage basal diet[1]		
No supplement	-13.6	
+ 85 g urea/animal/day	1.0	
+ 500 g groundnut cake/animal/day	2.7	
Milled stover/grain diets + 0.9 kg protein concentrate[2]	kg/d	Grasslands Research Station (1967)
50 % stover + 50 % grain	1.2	
60 % stover + 40 % grain	1.0	
70 % stover + 30 % grain	0.9	
60 % stover + 40 % grain diet		
+ 0.9 kg protein concentrate	1.0	
+ 1.4 kg protein concentrate	1.1	
+ 1.8 kg protein concentrate	1.3	

[1] Liveweight changes during the dry season
[2] Protein concentrate with 50 % crude protein

Topps and Manson (1967) investigated the effect of early harvesting of grain on the chemical composition of maize stover. They showed that maize stalks contain more crude fibre (CF) and less crude protein (CP) than leaves and that as the plant matures, there is a decline in CP and an increase in CF in both fractions. Unless the cost of artificial drying of grain can be justified, early harvesting cannot be applied to improve the quality of maize stover. Further work on the nutritive value of various fractions of maize stover carried out by Goldschmidt (1971) confirmed that leaves and cob sheath have the highest nutritive value, followed by cobs and stalks (Table 3). The yield of nutrients per hectare, however, follow the order: stalks > leaves > sheath > cobs. Therefore loss of leaf material during harvesting of stover represents a substantial loss of nutrients.

Table 3. Crude protein content and digestibility of various parts of maize stover (Goldschmidt, 1971)

	Parts of maize plant[1]				
	grain	cobs	cob sheath	leaves	stalks
Percentage of whole plant	53.5	6.5	7.5	11.1	21.4
Yield (t/ha)	7.7	0.94	1.08	1.60	3.09
Crude protein content (%)	9.5	3.4	3.1	6.5	3.2
Yield of crude protein (t/ha)	0.73	0.03	0.03	0.10	0.10
In vitro digestibility (%)	89	42	57	42	31
Digestible dry-matter (t/ha)	6.88	0.39	0.62	0.67	0.96

[1] Variety SR52 yielding 7.81 t grain/ha

More recent work by Smith, Chakanyuka, Sibanda and Manyuchi (1987) has been focussed on aspects of feeding, including physical and chemical treatment and supplementation of maize stover. Where stover was offered to cattle and sheep in increasing amount from 1.5 to 3 percent of liveweight, intake was observed to increase with no evidence of stover selection. A supplement of protein increased intake across treatments in lambs, but the ranking of the treatments was not altered. The increase in intake was associated with an increase in refusal rate, indicating possible wastage where stover is offered ad libitum, for instance during free grazing.

In another trial (Smith, et al., 1987), maize stover was baled and treated with 3.5 and 7 percent urea by weight. The urea was added as a solution so that regardless of urea concentration, 20 percent water was added to stover and the stacks of bales were covered with plastic sheeting for five weeks. When the treated stover was offered to sheep and cattle, intake was greatest with less than 5 percent urea, although digestibility and rumen degradability were highest with 7 percent urea. In vitro studies confirmed five weeks as the optimum treatment period. In a related on-farm trial (Smith, 1987), replacement dairy heifers were fed a high protein supplement with ad libitum access to maize stover treated with either 5 percent sodium hydroxide or 5 percent urea. Feed intake and liveweight gain were in the order: 5 percent sodium hydroxide-treated stover>urea treated stover> untreated stover. This is in agreement with work reported elsewhere (Sundstol and Coxworth, 1984).

Maize stover treated with 5 percent urea as described previously was compared to stover supplemented with 1 or 3 percent urea sprayed as a solution at the point of feeding (Manyuchi, Smith and Mikayiri, unpublished data). The solution was made so that regardless of urea concentration 40 percent water by mass was added to stover. As in the previous trial, intake of stover by cattle was improved by 70 percent following treatment with urea, but there was a marginal response to urea supplementation (approximately 10 percent). An equivalent amount of water sprayed onto the stover improved intake of stover by 10 percent, indicating possible palatability problems associated with spraying a solution of urea on to the stover. In sheep, a higher intake of stover was observed when urea was incorporated into a daily supplement of maize meal compared to an equivalent amount sprayed onto stover at the point of feeding. The results indicated that a source of energy, for instance molasses, may be necessary for efficient utilization of urea as a supplement to poor quality roughages. A similar conclusion was reached by Nuwanyakpa and Butterworth (1987).

Other cereal crop residues

Limited quantities of sorghum stover are available, especially in the drier regions of the country. Wheat and barley are grown under irrigation during the dry season and the straw is only available during the later part of the dry season. Government policy to increase the cultivation of sorghum, in the more drought susceptible regions of the country, and wheat to meet the country's requirements is likely to result in an increase in the quantity of these residues. No research information is available on the feeding value of sorghum stover in Zimbabwe but some work has been carried out on barley and wheat straw.

Two methods of treating barley straw with a mixture of sodium hydroxide and urea were tested (Stoole, Kiwanuka, Sibanda and Zimanyi, 1986). The alkali was poured onto bales which were then milled after 72 hours (method 1) or added at the point of milling and the milled stover incubated for 72 hours (method 2). The treated straws were fed to cattle for 125 days. Animals on untreated barley

straw lost weight (-0.08 g/day) while those on straw treated by the first and second methods gained 60 and 145 g/day, respectively. Intake of straw and in vitro digestibility were also improved by these two methods of treatment.

In other studies carried out comparisons were made between cottonseed hulls and hay as sources of roughage in concentrate diets for calves (McCallum and Harrap, 1982) and in high energy diets to fatten steers (Groenewald and Hopley, 1975a). Liveweight gain, feed intake and feed conversion ratio were similar on the two roughage treatments. Similar studies carried out by Grant and Golding (1977) also indicated that groundnut hulls and cob meal can be used as sources of roughage in diets for ruminants. Although no experimental data for Zimbabwe is available, sugar cane tops and bagasse are used extensively in the sugar cane growing areas of Zimbabwe, especially during the drought periods, as feed for cattle.

Agro-industrial by-products

Molasses

Molasses is one of the major by-products of the sugar industry. Studies carried out in other countries (Preston and Leng, 1987) have shown that molasses can be used as a source of energy in ruminant diets. In one of the early trials in Zimbabwe, pregnant and lactating Afrikaner cows were kept in pens and given a diet comprising 64.4 percent molasses, 27.6 percent bagasse, 5 percent cottonseed meal, 2 percent urea and a daily allocation of 0.9 kg cottonseed hulls (Anon, 1968). This diet was observed to be palatable and the animals maintained condition and liveweight. Maize meal and a high protein concentrate were added to the diet which was then offered to calves after weaning. The calves gained 0.99 kg/day and weighed 409 kg at 13 months of age.

Groenewald and Hopley (1975b) evaluated the replacement rate of maize meal with molasses in high energy diets. It was calculated that diets based on molasses with 1.8 and 1 percent urea were equivalent to 70 and 76 percent, respectively, of high energy diets based on maize meal. When urea was withdrawn 19 percent more of the molasses based diet was needed for the same carcass weight gain.

Sibanda, Chakanyuka and Mlilo (1987) studied the performance of cattle on diets where molasses was incorporated at rates of 0, 10, 20, 30 and 40 percent in maize based diets comprising 92.6 percent broken maize 2.2 percent cottonseed hulls, 2.4 percent cottonseed meal, 1.7 percent urea and 0.3 percent salt (Table 4). The animals were fed ad libitum and slaughtered after 90 days. Results showed that molasses could be included in maize based fattening diets up to a maximum of 30 percent without any adverse effect on body and carcass weight gains, feed conversion ratio and carcass grades. Further work on the use of molasses as a livestock feed is currently hampered by availability since molasses is being used to manufacture industrial alcohol.

Table 4. Performance of cattle receiving poultry litter and cane molasses

	Daily gain Liveweight	Daily gain Carcass	Source
Poultry litter (PL)	(kg/d)		
Feedlot diet[1] no PL	1.7	1.1	Rudert and Hopley (1977)
19 % PL	1.3	0.8	
Supplement on dry season grazing	(g/d)		
150 g CP/animal/dry from: PL	-71.0	-29.2	Smith et al, (1987)
Cottonseed meal (CSM)	-8.0	-26.2	
200 g CP/animal/day from: 50 % PL + 50 % CSM	5.0	-5.0	
CSM	14.0	-13.3	
200 g CP/animal/dry from: CSM	108.0	0.8	Manyuchi, Smith and Mikayiri (unpublished)
67 % CSM + 33 % PL	184.0	29.0	
33 % CSM + 67 % PL	144.0	-5.0	
PL	64.0	-27.0	
No protein fed	-124.0	-128.0	
Cane molasses	(kg/d)		
Amount of cane molasses (%) in feedlot diet[2] 0	1.34	0.86	Sibanda et al (1987)
10	1.53	1.06	
20	1.55	1.11	
30	1.47	1.05	
40	1.30	0.95	

[1] Diet = 70 % maize meal, 20 % star grass hay, 10 % protein concentrate

[2] Diet = 92.6 % maize and cob meal. 2.2. % cottonseed hulls. 2.4 % cottonseed meal, 1.7 % urea and 0.3 % coarse salt

Defatted maize residue

Another potential source of energy is defatted maize residue (DMR) which has a crude protein content of 11 percent. This is a by-product of the oil extraction process. Naude, Jacobson, Grant, Golding and Spear (1980) evaluated the performance of steers in feedlot offered a standard high energy diet (70 percent maize meal, 20 percent roughage and 10 percent protein concentrate) in which DMR replaced maize meal at rates of 0, 25, 50, 75 and 100 percent. Diets with DMR were eaten readily and carcass and liveweight gains tended to increase as DMR was increased.

Protein sources

The need for supplementary nitrogen to ruminants on dry season grazing has been demonstrated by several workers (Murray and Romyn, 1939; Elliott and Topps, 1963; Ward, Richardson, Denny and Dye, 1981; Richardson, 1983). Liveweight loss representing 10 to 15 percent of late summer body weight occurs when no supplementary nitrogen is fed. A similar dietary nitrogen deficiency also occurs when cereal residues are fed to ruminants. Oil seed cakes (cottonseed, groundnut, soyabean and sunflower) and by-products from animal slaughter, for instance blood meal and meat and bone meal, have been used as sources of supplementary nitrogen (Grant, Jobson and Golding, 1980). Differences in their degradability and amino acid quality have been illustrated in studies by Sibanda, Zimanyi and Chakanyuka (1985) and Sibanda and Zimanyi (1985).

Poultry manure

Poultry manure (deep litter and battery) has been identified in many countries as a potential source of supplementary nitrogen in diets for ruminants (Bhattacharya and Taylor, 1975; Hadjpanayiotou, 1984). Rudert and Hopley (1976) showed that when poultry manure replaced a high protein concentrate in a feedlot diet (70 percent maize meal, 20 percent star grass hay and 10 percent protein concentrate) performance of animals was reduced (Table 4). Two recent trials (Smith, Sibanda, de Souza and Chihora, 1987; Manyuchi, Smith and Mikayiri, unpublished) have shown that poultry manure can be fed to supply 200 g crude protein/animal/day as a maintenance supplement for Mashona weaners on dry season grazing. Two mixtures of cottonseed meal (CSM) and poultry litter (PL) (67 percent CSM + 33 percent PL and vice versa) were compared to CSM and PL as sole supplements, supplying equal amounts of protein (200 g crude protein/day) to weaners on dry season grazing. There was no difference in the performance of animals receiving CSM and the mixed supplements and the highest liveweight gain was by animals on 67 percent CSM + 33 percent PL (Table 4). A substantial saving in the cost of supplementation was realized by feeding the mixed supplements. A trial is currently in progress to investigate the use of mixtures of CSM and PL as sources of nitrogen in feedlot diets to finish cattle and sheep.

Future work

Legume stovers as sources of protein

There is a growing interest in the use of legume stover as supplements to cereal stovers in diets for ruminants (Smith, 1988). In a survey carried out in two communal areas of Zimbabwe, Mombeshora, Maclaurin and Reh (1987) indicated that the value of legume stover as livestock feed in communal areas in not fully realized. Work is currently in progress to evaluate the use of legume stovers as supplements to maize stover. Three legumes, namely, cowpea, lablab and pigeon pea, are being examined (Smith, Manyuchi and Mikayiri, unpublished). Preliminary results show that total intake of feed, digestibility and nitrogen retention are improved by feeding legume supplements. Further responses in intake,

digestibility and nitrogen retention were obtained by feeding a supplement of cottonseed meal in addition to the graded levels of legume stover. These trials are being carried out in the light of the growing interest in the cultivation of fodder legumes on fallow land in communal areas of Zimbabwe (Mombeshora, Maclaurin and Reh, 1987).

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2. THE USE OF CROP RESIDUES AS LIVESTOCK FEED ON SWAZI NATION LAND - A SURVEY

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INTRODUCTION

Swaziland has a total land area of 17,365 square km which is divided into four distinct topographical regions: the highveld. middleveld, lowveld and the Lubombo plateau. Just over half of the country's area is vested in trust land for the nation and parts of it allocated by chiefs to individual Swazi families who engage mainly in subsistence agriculture. This sector is known as Swazi Nation Land. The rest of the land is known as Title Deed Land and is owned on freehold or concessionary tittle. It includes commercial forests, farmland, estates, ranches as well as land owned by the Swaziland Government. Agriculture on Tittle Deed Land is highly modernized and most of the country's cash income is derived from it.

Livestock have traditionally been an important component of the agricultural industry in Swaziland. According to a recent population census (HTS, 1983), there were some 636,000 head of cattle, 320,000 goats, 31,800 sheep and 16,450 pigs. Cattle are by far the most important class of livestock; the majority (about 80%) being owned by smallholders on Swazi Nation Land under a strongly traditional system of management characterized by communal grazing. The other 20% or so are held on Tittle Deed Land and are generally managed under commercial ranching systems.

Maize, the staple food in Swaziland, is the dominant crop grown on Swazi Nation Land. Other crops grown include cotton, groundnuts, sorghum, beans and cowpeas. While the commercial yields of these crops are often as low as one tonne/ha or less, their by-products constitute a major feed source for grazing livestock during the long dry season when the natural pastures become scarce and poor in quality. At present these by-products are not being effectively utilized partly due to inadequate definition of what they are, how much is available and to what extent they contribute to livestock productivity on Swazi Nation Land.

The present study was therefore undertaken with the following objectives:

I. to understand the general patterns of crop-livestock production systems on Swazi Nation Land and consequently.

II. to assess the potential contribution of crop residues to livestock production on Swazi Nation Land.

III. to identify the constraints currently limiting the use of these residues to improve livestock production.

Choice of study area

The investigations reported here were conducted in the middleveld of Swaziland. This topographical region experiences a long dry winter season (April to September) which promotes a vegetation type consisting mainly of tall grasses interspersed with varying densities of trees and shrubs. The grass species include *Hyperthelia dissoluta*, *Hyparrhenia cymbaria*, *H. filipendula* and *Themeda triandra* while *Acacia karroo*, *Ficus capensis*, *Dombeya rotundifolia* and *Combretum spp*. costitute part of the dominant tree species.

The climate, soil and vegetation of the middleveld provide an environment suitable for mixed farming and a wide variety of crops are grown both for subsistence and for cash. Production estimates of the by-products from some of these crops are presented in Table 1. While these estimates are subject to considerable variation depending on such factors as rainfall and time of planting, the figures indicate that the middleveld is a major region of crop residue production. It also carries 1/3 of the national cattle population (Anon, 1987).

Table 1. Estimates of crop residue production (in tonnes) for the various regions of swaziland.*

Crop	Highveld	Middleveld	Lowveld	Lubombo	Swaziland
Maize	53206	64278	28854	8437	154775
Groundnuts	143	863	482	37	1525
Sorghum	1672	1609	1717	855	5853
Beans	142	145	19	16	322
Cowpeas	192	522	188	6	908
Total	55355	67417	31260	9351	163383
%	34	41	19	6	-

* Adapted from de Lima (1982) based on the following residue to grain ratios: maize 1.6, groundnut 1.2, sorghum 3.7, beans 1.0, cowpeas 1.0 (Simpson, personal communication).

Survey design and methodology

Several students in the Faculty of Agriculture, University of swaziland, were selected to conduct a diagnostic survey which lasted 7 months (March to September). The survey was conducted most intensively over the students' long vacation (May to August 1986) and intermittently over weekends and holidays in September 1986 and March to April 1987. The total number of homesteads surveyed was 350 situated in 7 locations scattered throughout the middleveld (Figure 1). In selecting the locations, each student enumerator was associated by family with a rural homestead on Swazi Nation Land functioning both as the enumerator's residence and as the centre of the enumerator area (while also being more conducive to cordial acceptence of the operation). Once in the enumerator location, homesteads were selected on the basis of every third or fifth homestead (depending on population density) encountered in the particular direction for that day. Each homestead was interviewed with a questionnaire constructed to cover such aspects as: land use patterns, degree of interraction between crop and livestock enterprises, grazing patterns, feed sources and the use of crop residues (Appendix I). Some of the information such as calving rates and calf mortality were sought for the previous year. On the day of the interview, farm size per household and area under each crop were also estimated visually by the enumerator after intensive practice with using 30 meter tape measures to estimate field size.

In addition to the interviews, cattle activity was monitored monthly in 20 homesteads randomly drawn from the original 350 homesteads (Appendix II). On the 15th of each month, the number of hours spent by cattle from a homestead on various feed sources was recorded. This was assumed to be the daily pattern of livestock feeding for that month.

Since maize is the dominant crop on Swazi Nation Land, its stover yields were determined from 56 homesteads in June 1987. In estimating these yields, the residues were sampled at random from one field per homestead using either a meter square quadrat where the crop had been broadcast or a measured row length where the crop had

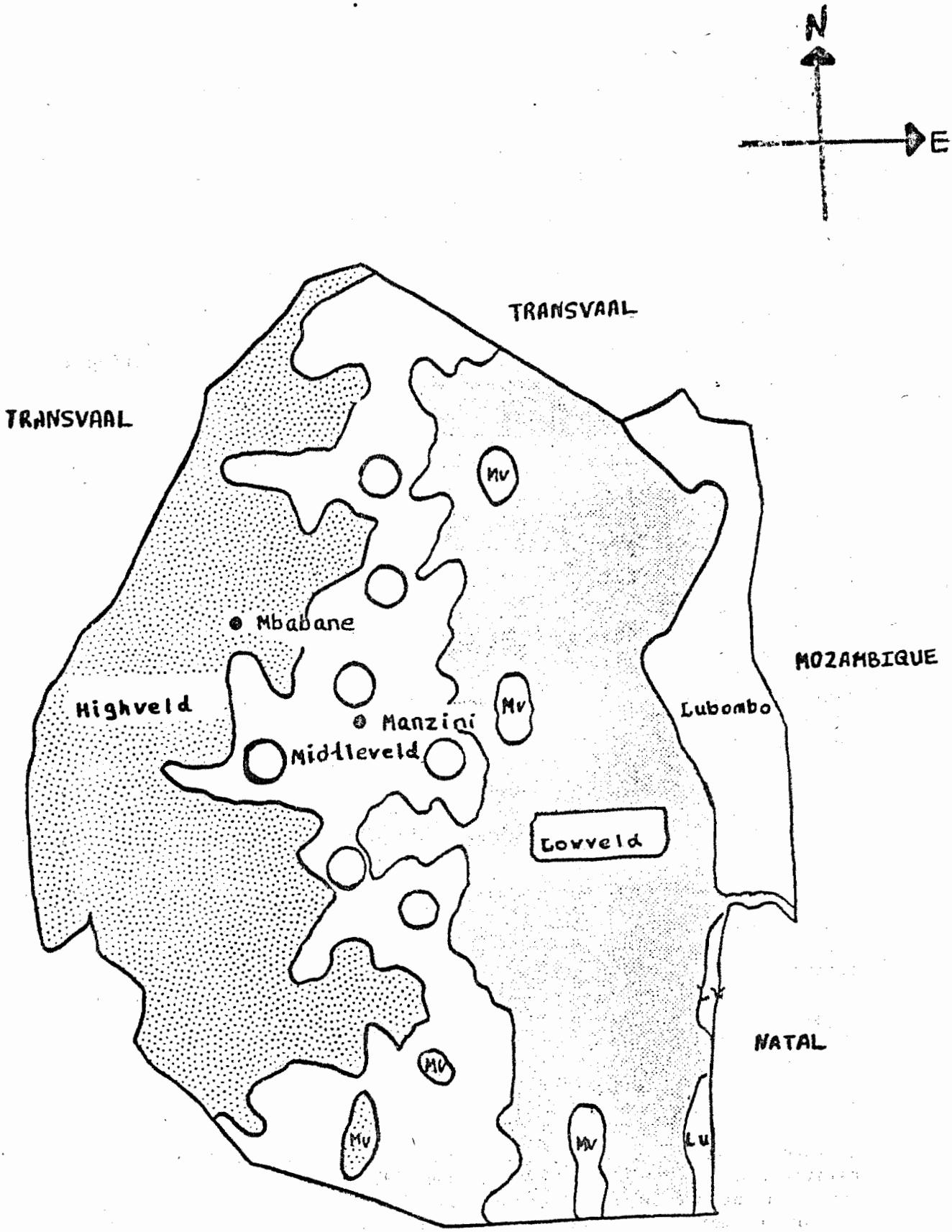

FIGURE 1. MAP OF SWAZILAND SHOWING PHYSIOGRAPHIC STRATA AND ENUMERATION AREAS FOR SAMPLING.
(O = ENUMERATOR LOCATION; Hv = HIGHVELD; Mv = MIDDLEVELD
Lv = LOWVELD; Lu = LUBOMBO).

been drilled. After cutting, the samples were weighed fresh and the average yield per hectare was calculated. Sub-samples were taken and dried at 80°C in an air-draft oven for 24 hours in order to obtain the moisture content from which dry matter yields in tonnes per hectare were then calculated.

Data from these surveys were hand tabulated and simple calculations of means, standard deviations and percentages were carried out using a computer.

Results and discussion

The results of this work stem largely from data gathered during a single homestead interview and are unlikely to represent the true overall picture of the crop-livestock interrelationships on Swazi Nation Land. They should therefore be evaluated not for their precision but for offering new insights into the nutritional constraints to livestock production on Swazi Nation Land and the potential of crop residues for alleviating the feed problems.

Cattle form an integral part of the farming system on Swazi Nation Land. They are important as a source of meat, milk, manure, draught power and transport. They are also intimately involved in Swazi custom and culture and are regarded as a store of wealth. A survey by de Vletter (1983) showed that almost two thirds of the rural homesteads in Swaziland keep cattle with an average herd size of 18.6 per household. In the present study the average cattle herd size per household was 14.7 (SD = 9.36, N = 339) which is slightly lower than the national average. Sheep and goats were reared by approximately one third (31.8%) of the sampled households with an average flock size of 18.2 (SD = 11.1, N = 108).

Traditionally cattle have been kept by the rural stock owner to meet domestic needs and customary requirements without much regard for their commercial value.

Consequently ownership has tended to emphasise numbers rather than productive capacity. But as the homestead economy moves into the modern sector, the need to keep more productive animals is becoming more apparent. The Nguni, a local cattle breed of the Sanga type, is a poor producer under the prevailing management condition. In the present study 18% of the households had some improved stock (usually Brahman crosses) mixed with the indigenours Nguni. No household had a full herd of purebred exotic stock.

Magnitude of the feed problem

Livestock owners were asked to specify the problems they face in raising their livestock. Most of them (93%) cited poor nutrition as their number one problem followed by disease. Seventy five percent of the farmers acknowledged that the problem is more serious in winter than at any other time of the year.

Inadequate nutrition was also implied through indirect responses. It was found, for instance, that although the majority of the stock owners kept their animals within the household, approximately 25% held some of their cattle under the "sisa" system

whereby the owner lends his cattle to someone else and the borrower uses the animals to meet his domestic needs although he cannot make decisions on their disposal for sale or for slaughter (Sibisi, 1979). The affluent Swazi town worker who has no time for herding often takes advantage of this system of ownership. The stock owners were asked to give reasons for keeping cattle elsewhere under the system. 68% of the respondents transferred their animals to the lowveld where they believed there is better quality grazing. 20% loaned their cattle to relatives and friends to provide them with milk, kraal manure and drought power. The rest gave theirs for other reasons such as widening of contacts, reciprocation favours or transfers to Government fattening ranches.

Based on information sought from the previous year, the calving rate was estimated at 32% which approximates the 36% reported for Swazi Nation Land in a recent national livestock survey (Anon., 1987). However calf mortality rate was four times higher than the 6.4% reported in the same survey. When asked about the causes of calf mortality, 43% of the respondents could not identify the causes. However, 24% attributed it to feed shortages, while 19% attributed it to disease and 12% to accidents. These findings indicate that the majority of rural stock owners are aware that nutrition is a serious constraint to livestock production on Swazi Nation Land and there is a need therefore to provide them with some guidence on ways and means of alleviating the problem.

Feed sources

The major feed resources on Swazi Nation Land include:

1. Natural pasture

Natural pasture or veld forms the basis of cattle production on Swazi Nation Land and practically all the sample households relied on it as the major feed source. The veld is communally grazed under a poor system of management involving very high stocking rates with hardly any fencing or fertilizer application. Its quality and quantity remain relatively high in summer (October to March) generally providing adequate grazing for the livestock. But for the remainder of the year grazing becomes very poor and the animals have to be moved to cropland or face starvation.

2. Planted pasture

Farmers in the study area do not seem to have recognized the value of established pasture and only 2% had some area reserved for it. These farmers also kept some improved livestock. However, there is a likelihood that other factors such as the communal land tenure system may restrict rural stock owners from reserving the land for pasture establishment so that perception cannot simply be guaged by behaviour.

3. Standing hay

The use of standing hay is also not a common practice on Swazi Nation Land and only 14% of the sampled households used it. These households were also associated with improved stock.

4. Supplements

Most of the livestock depend solely on natural grazing for their nutritional requirements. In the present study only one third of the households provided the cattle with some form of supplement especially during winter. The most common supplement used was common salt followed by maize cobs, commercial mineral mix and molasses.

5. Crop residues

As mentioned earlier, most farmers interviewed acknowledged that shortage of grass is one of the major causes of livestock deterioration in the dry winter season. Crop residues should therefore represent an important feed source during this period. An average homestead on Swazi Nation Land covers an area of 2.75 hectares of which 80% are devoted to crops, about 15% to fallow and the rest is taken up by woodland, rock outcrops, houses, cattle kraals and other structures (de Vletter, 1983). In the present survey the majority of the households had farms of between 1 to 2 hectares although there were large variations as indicated by the standard deviation in Table 2.

Table 2. Frequency Distribution of farm size across households

Range in hectares (SD = 1.81, N = 340)	Percent of households
1	10
1 - 2	52
2.1 - 3	25
3.1 - 4	8
4	5

Almost all homesteads on Swazi Nation Land grow crops mainly for human consumption. Table 3 shows that maize is the dominant crop taking as much as 88% of the total arable land in comparision to the next crop, beans, which occupied only 4% of the land. Sweet potatoes, groundnuts, vegetables, sorghum, cotton and cowpeas were also important in some homesteads.

Table 3. The proportion of households growing each crop and the area allocated to the crop per household.

Crop	% of homesteads growing crop	% of total area occupied by crop
Maize	99	88
Beans	29	4
Sweet potatoes	20	3
Groundnuts	20	3
Others	13	3

Most crops on Swazi Nation Land are harvested by the end of summer after which livestock are allowed into the crop fields. The actual date for allowing cattle to graze on cropland varies from community

to community and is usually declared by the chief of the area. Farmers were asked to indicate when they move animals to the crop fields, when all the crop residues are completely utilized by livestock and when the animals are removed from the crop fields back to the communal grazing land. Table 4 summarizes the response to these questions.

Table 4. Pattern of crop residue use during the year (Farmer Response in %)

Months	When stock move to cropland	When residues disappear	When stock move out of cropland
April	3	-	-
May	76	-	-
June	21	8	-
July	-	66	-
August	-	21	-
September	-	5	67
October	-	-	33

Almost 76% of the farmers released their livestock into the crop fields in May; the remainder moving in their stock in June. In terms of complete utilization of residues from the crop fields, only 8% of the respondents reported that crop residues normally disappear by the end of June, 66% reported that they disappear in July and by the end of August there are no more residues in the majority (95%) of the homesteads.

This pattern of crop residue utilization was also examined by monitoring monthly cattle grazing activities in 20 homesteads and the results are presented in Table 5.

Table 5. Total and crop residue grazing times (mean daily time/month, N = 20)

Month	Total grazing time hours/day		Crop residue grazing time hours/day		% of total time spent on crop residues
	Mean	SD	mean	SD	
April	8.8	1.09	0.2	0.04	2
May	9.3	0.84	3.1	0.27	33
June	9.2	0.92	6.5	0.55	71
July	8.4	0.96	4.6	0.39	55
August	8.7	0.97	1.7	0.33	19
September	9.2	0.93	0.5	0.03	5
October	9.4	0.89	0		0

Table 5 shows that crop residue grazing started soon after harvest accounting for 33% of the total grazing in May, peaking in June (71% of total grazing time) and ending round about August. These results concur with the farmers' response in Table 4. The period of maximum utilization of crop residues on Swazi Nation Land appears then to be

sometime between June and July. When all residues are finished the animals will generally be left to graze on weeds in the fields, on fallow land and on river valleys and swamps until they become completely dependent on communal grazing land. The movement of stock back to the communal grazing areas takes place between september and October (Table 4) coinciding with the onset of the rains and the beginning of the planting season. The exact date for removing livestock from cropland is usually announced by the area chief.

The potential of crop residues for ruminant livestock in the middleveld of Swaziland

The quantity of crop residue produced in any region is likely to be highly variable depending on factors such as climate, soils, fertilizer treatment and planting dates. In the present study, dry matter yield estimates for maize stover averaged 5 tonnes/ha (SD = 1.63, N = 56). This means that each household could produce approximately 11 tonnes of maize stover in a cropping season assuming an average farm size of 2.75 ha per homestead with 80% reserved for crop production (de Vletter, 1983). If this amount of residue is consumed by the indigenous Nguni cattle whose mature weights range from 400 to 600 kg, their daily intake for 9 hypothetical liveweight categories will approximate those presented in Table 6.

Table 6. The relationship between dry matter intake and cattle liveweight (Adapted from NRC, 1984)

Animal liveweight kg	Approximate DM consumption/head/day kg	% of liveweight
100	3.0	3.0
150	4.0	2.7
200	5.8	2.9
250	6.0	2.4
300	7.3	2.4
350	8.0	2.3
400	7.7	1.9
450	8.4	1.9
500	8.9	1.8
Mean	6.6 (SD = 2.03)	

Table 6 shows the average dry matter intake per head per day to be 6.6 kg with a standard deviation of 2.03 for 9 liveweight ranges which translates into a minimum intake of 4.6 kg and a maximum of 8.6 for a given herd. With a mean cattle herd size of 14.7 per household, a stover yield of 11 tonnes will feed the animals for 5 months (163 days) at 4.6 kg/head/day or 3 months (87 days) at 8.6 kg/head/day. There are no data to show if the animal's intake of crop by-products may exceed 4.6 or 8.6 kg/day. But it can be assumed that since there is no controlled grazing on Swazi Nation Land, when residues are abundant, the animal's intake may exceed these estimates and when the residues become scarce and less leafy, the intake may be much lower. While the impact of crop residues on the productivity of grazing livestock cannot be quantified in the absence of actual feeding trials, the possibility that crop residues could feed the household cattle for up to 5 months must be viewed in terms of their

potential for maintaining the grazing animal during the critical winter months and for reducing the grazing pressure on the already overstocked communal lands thus minimizing further veld deterioration.

Recommendations

The results of this study have confirmed that natural grass or veld is the major feed source for ruminant livestock on Swazi Nation Land. The study has also indicated that crop residues especially maize stover, could and probably do contribute significantly to the overall feed budget of the livestock in this sector. The main constraints which are likely to limit the use of these residues include their unsuitability for direct animal use and their inherently low nutritive value. Any future research should therefore focus on these broad areas with emphasis on the following specific areas:

1. Storage of crop residues

At present the most common method of utilizing crop residues on Swazi Nation Land is to allow animals to graze on standing stubble after grain harvest. This grazing is invariably uncontrolled and results in considerable selectivity and poor utilization (Mosimanyane, 1983; Alhassan et al., 1985). A more efficient means of utilization would be to harvest and store the residues before use. In the present study, only 15% of the households harvested and stored the crop residues. The residues were either heaped near the Kraal and fenced, piled on a raised platform or stored in a cribb. Factors currently inhibiting the storage of crop residues such as transportation and labour availability need to be investigated.

2. Strategic feeding of crop residues

This includes selectively feeding productive animals such as draught oxen and milking cows on harvested and stored stover. Draught oxen, for example, could be fed throughout the winter season until the stover runs out or just before the planting season.

3. The use of supplements

A large number of researchers have evaluated untreated crop residues and have come to the conclusion that these are uneconomical/impractical and cannot maintain an animal when fed alone. However, when supplemented with protein, energy and mineral sources, they can form the basis of a production ration which supports adequate gains in cattle (Butterworth et al., 1984). Urea and molasses are common protein and energy supplements for ruminant livestock. Mixing urea and molasses and adding them to drinking water or spraying the mixture on stover are two techniques that can easily be adopted by the small scale farmer. Molasses in particular is easily available in Swaziland and the possibility of using it in conjunction with crop residues needs to be investigated.

4. Chemical treatment of residues

Kategile et al. (1981) and Said et al. (1982) have summerized much of the work carried out in East Africa demonstrating the beneficial

effects of treating highly lignified crop residues with chemicals such as NaOH and NH_3. However, the use of such chemicals needs to be carefully evaluated since they are generally expensive, hazardous and must be obtained well in advance of the treatment period.

5. Supplementation of cereal stover with legume residues

Legume stovers such as groundnut haulms have a higher nutritive value compared to cereal residues. The practice of intercropping grain legumes with maize was noted in a number of survey homesteads. Experiments carried out at the International Livestock Centre for Africa (Butterworth and Mosi, 1985) have demonstrated the importance of forage legumes as supplements to fibrous crop residues. There is therefore a need to evaluate both grain and forage legumes in terms of relative profitability under various cropping and grazing systems, especially the impact of forage legumes on soil, food crops and on the livestock. In conclusion, it should be acknowledged that any technological improvement in the utilization of crop residues is likely to involve harvesting, storage and possibly treatment before feeding to livestock. The collection and transportation of these by-products from small farms scattered here and there will undoubtedly be tedious and time consuming. There is also bound to be great variability in the products from homestead to homestead as the planting and harvesting of crops are not synchronized. However, these constraints need to be viewed as challenges in the process of improving livestock productivity from the vast amount of agricultural by-products which are produced on Swazi Nation Land.

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Appendix I
Questionnaire

The use of crop residues as animal feed on Swazi Nation Land

A Personal data

1. Area Homestead No.
2. Date Name of Respondent
3. Position of Respondent e.g. head, son
4. Head of Homestead resident in Homestead/elsewhere if elsewhere, specify
5. Occupation: self employment, salaried worker, other If other, specify
6. List sources of income e.g. regular employment, crop sales, poultry sales, livestock sales, other (specify)

B Livestock data

1. Do you keep any of the following:

Type	Number	Lacal/Improved
cattle		
goats		
sheep		
rabbits		

2. If you keep sheep/goats, how many were born last year
   How many young ones died last year
   Cause of death (if Known)

3. If you keep cattle, any sisa'd away from homestead
   If yes, how many
   Why are they sisa'd

4. How many cows do you have
   How many of the cows gave birth last year

5. How many calves died last year
   Cause of death (if known)

C **Pasture and forage**

1. Main grazing source for your livestock: communal land, fenced natural pasture, improved planted pasture, other (specify).

2. Is there ample pasture where you customarily graze your animals?

3. Do your livestock experience any feed shortages?

4. If yes, when: all year round, summer only, winter only, other (specify)

D **Supplementary feeding**

1. Do you provide any supplementary feed to your animals.

2. If yes, which part of the year

3. Which type of supplement do you use: concentrates, salt only, mineral mix, other (specify)

E **Crop residues**

List of crops grown	area (ha.) under each crop	part harvested for sale/food
a.		
b.		
c.		
d.		
e.		
f.		

For each of the crops listed above:

1. Indicate type of residue left e.g., roots, stalk, cobs, vines.

2. Indicate when you harvest each crop
3. Indicate when the residue finally disappears from the field

4. Indicate if the residue is used to feed livestock

5. Is the residue used for other purposes
   If yes specify

6. Residue left in the field or stored

7. If stored, how and where

8. When is stored residue used

9. When do livestock start feeding on crop residues

10. When do livestock cease to feed on crop residues

F **General Questions**

1. In general terms where do cattle graze in summer?

2. In general terms where do cattle graze in winter?

3. Did you actually see any crop residues at time of interview?

4. If yes which ones?

5. Do you think the crop residues are finished or still present in plenty?

6. What time did you conduct the interview?

7. Where were the cattle at that time?

APPENDIX II

Pattern of livestock grazing

Grazing livestock can engage in several activities e.g. grazing on veld, grazing on improved pasture, grazing crop residues in owners field, grazing crop residues in neighbor's field, grazing crop residues at home, resting, or being milked. Based on such activities, record very carefully herd activity in the selected homestead over a 12 hour period thus:

Date activity monitored ---------

Activity over a 12 hour period:

Before 8.00 am ----------

8.00 - 9.00 am ----------

9.00 - 10.00 am ----------

10.00-11.00 am ----------

11.00-12.00 noon ----------

12.00 - 1.00 pm ----------

1.00 - 2.00 pm ----------

2.00 - 3.00 pm ----------

3.00 - 4.00 pm ----------

4.00 - 5.00 pm ----------

5.00 - 6.00 pm ----------

6.00 - 7.00 pm ----------

After 7.00 pm ----------

3. ABSTRACTS FROM ANIMAL FEED SCIENCE AND TECHNOLOGY JOURNAL. (WITH KIND PERMISSION FROM ELSEVIER SCIENCE PUBLISHERS B.V., AMSTERDAM, NETHERLANDS).

3.1 RELATIVE INTAKES, DIGESTIBILITY AND BACTERIAL PROTEIN SYNTHESIS BY SHEEP AND CATTLE FED HIGH-ROUGHAGE DIETS

K. Amaning-Kwarteng[1], R.C. Kellaway[1], J.C. Spragg[2] and A.C. Kirby[3]

ABSTRACT

Amaning-Kwarteng, K., Kellaway, R.C., Spragg, J.C. and Kirby, A.C., 1986. Relative in takes, digestibility and bacterial protein synthesis by sheep and cattle fed high-roughage diets. Animal Science Technology 16: 75-87.

Six each of yearling Merino and Border Leicester crossbred wethers (35.9 ± 0.67 kg liveweight) and yearling Hereford heifers (226.7 ±

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5.09 kg liveweight), all fitted with rumen and abomasal cannulae were offered coarsely-milled, NaOH-treated wheat straw ad libitum, either alone (W) or with supplements of cottonseed meal (WC) or barley (WB). Animals within species were arranged in two 3x3 latin squares which were combined in a single analysis of variance to determine species (Sp), diet (D) and Sp x D effects. Voluntary dry matter intakes by sheep and cattle were similar when expressed as g/kg liveweight $(W)^{1.0}$ (30.4 and 28.7, respectively), but were higher in cattle when expressed as g/kg $W^{0.9}$ ($P<0.05$) and g/kg $W^{0.75}$ ($P<0.01$). Cell wall (CW) digestibility and calculated metabolizable energy intakes (MEI) relative to maintenance requirements (Mm) were higher in cattle than in sheep ($P<0.05$). The relationship between relative metabolizable energy intakes by cattle and sheep was:

$Y = 0.79 (\pm 0.195) + 0.64 (\pm 0.120) x$. $r = 0.798$ ($P< 0.05$), where $Y = MEI/Mm$ for cattle and $x = MEI/Mm$ for sheep, $Sy{\cdot}x = \pm 0.0164$.

Sheep digested more nitrogen (N) ($P<0.01$) and had 6.7% higher digestible organic matter in dry matter (DOMD) values than cattle. The higher intakes by cattle (g/Kg $W^{0.9}$ and g/kg $W^{0.75}$) were associated with larger rumen pool sizes (g/kg $W^{0.9}$, and g/kg $W^{0.75}$) and higher liquid fractional outflow rates from the rumen of cattle. Higher CW digestibility by cattle was associated with a faster CW digestion when measured by incubating straw in nylon bags within the rumen. The higher apparent N digestibility in the whole tract of sheep was associated with a higher proportion of bacterial N in abomasal N of sheep (81 compared to 68% in cattle), and was accounted for by greater apparent N digestibility in the intestines of sheep. The much lower N digestibility in cattle would have contributed substantially to DOMD being lower in cattle than in sheep. It is apparent that measurements of nutritional value of alkali-treated straw diets should be made with the animal species for which the diets are intended.

3.2 THE RATE OF DRY MATTER DISAPPEARANCE FROM NYLON BAGS OF MAIZE SILAGE/GRAIN DIETS AS INFLUENCED BY BASAL RATION AND PROCESSING OF TEST SAMPLES

C. Thompson[1] and J.B. Moran[2]

ABSTRACT

Thompson, C. and Moran, J.B., 1986. The rate of dry matter disappearance form nylon bags of maize silage/grain diets as influenced by basal ration and processing of test samples. Animal Feed Science Technology 16: 225-231.

Four maize silage/grain diets were incubated in nylon bags for up to 72 h in the rumen of non-lactating cows. The test samples were frozen and either finely ground or coarsely chopped. The cows were fed basal rations containing either 0 or 50% grain. Increasing grain

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content in the test samples was linearly associated with rate of dry matter disappearance (k) and also with DM disappearance after 48 h in sacco. With k there was a significant interaction between processing of the test samples (grinding vs. chopping) and basal ration of the cows, but the ranking of the test samples was not influenced by either processing or basal ration. Rate of DM disappearance was also closely associated with DM digestibility measured in sheep ($r=0.97$; $P<0.01$), but not with dietary metabolizable energy content as calculated from productivity data of lactating cows ($r=0.75$; $P<0.10$). The possibility of interactions with other dietary nutrients would reduce the potential of nylon bag studies for assessing feeding value of mixed diets for milk production.

3.3 THE EFFECTS OF DIFFERENT SOURCES ON NITROGEN SUPPLEMENTATION ON THE DIGESTION OF FIBRE COMPONENTS IN THE RUMEN OF STEERS

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National Institute for Research in Dairying, Shinfield, Reading RG2 9 AT (Gt. Britain).

ABSTRACT

McAllan, A.B. and Griffith, E.S. 1987. The effects of different sources of nitrogen supplementation on the digestion of fibre components in the rumen of steers. Animal Feed Science Technology 17: 65-73.

Four protozoa-free steers were given diets consisting of approximately equal proportions of a concentrate mixture of rolled barley plus tapioca and ground and pelleted alkali-treated straw. The diets were supplemented with urea and casein (UC), soyabean meal (SBM), 'normal' whitefish meal (FMN) or white-fish meal designated as being of 'low' rumen degradability (FML). The diets were iso-energetic and were given in amounts calculated to provide sufficient metabolisable energy (ME) to support a growth rate of 0.5 kg day^{-1}. Rumen degradable nitrogen (RDN): ME values (g MJ^{-1}) were estimated to be greater than 1.40 for all diets. The diets were given in a 4x4 Latin square design. Polyethylene glycol and chromic oxide were given as flow markers and flows (g 24 h^{-1}) at the abomasum of structural carbohydrate fractions were calculated. Carbohydrate fractions were defined by detergent extraction procedures.

Digestibility coefficients for the ash-free NDF-ADF (hemicellulose) fractions were 0.72, 0.80, 0.85 and 0.83 for diets UC, SBM, FMN and FML, respectively. Values obtained with fishmealcontaining diets were significantly different ($P<0.05$) from those with UC diets. Digestibility coefficients of the ash-free ADF-lignin (cellulose) fractions were 0.63, 0.68, 0.76 and 0.74 for diets UC, SBM, FMN and FML, respectively. Significant differences were observed between UC and SBM diets ($P<0.05$) and between UC and FM diets ($P<0.02$). It was concluded that type as well as the amount of RDN provided in ruminant diets is important in optimizing the digestion of dietary fibre in the rumen.

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3.4 INFLUENCE OF PROCESSING METHODS AND STORAGE TIME ON THE CYANIDE POTENTIAL OF CASSAVA LEAF MEAL

V. Ravindran [1], E.T. Kornegay[2] and A.S.B. Rajaguru[1]

ABSTRACT

Ravindran, V., Kornegay, E.T. and Rajaguru, A.S.B., 1987. Influence of processing methods and storage time on the cyanide potential of cassava leaf meal. Animal Feed Science Technology 17: 227-234.

The effect of three processing methods (drying, chopping and wilting), their combinations and the storage time on the hydrocyanide potential (HCN_p) and the crude protein (CP) content of cassava (Manihot esculenta Crantz.) leafmeal (CLM) were evaluated. Limited observations on the effects of processing treatments on the tannin content of CLM were also made. Fresh cassava leaves contained an average of 1436 mg HCN_p. A combination of chopping and 3-day wilting before drying proved most effective, lowering the cyanide potential of the final product to about 55 mg/kg dry matter. The processing treatments had little effect on the CP and tannin contents of CLM. The HCN_p and CP content of CLM declined by 58.2 an 10.6%, respectively, during an 8-month post-processing storage. The results demonstrate that low-cyanide CLM, which is safer for use as an animal feed, could be produced using simple processing methods.

3.5 YIELD AND POTENTIAL FEEDING VALUE OF STRAWS OF GRAIN SORGHUM CULTIVARS DEVELOPED IN NIGERIA

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ABSTRACT

Alhassan, W.S., Obilana, A.B. and Bello, S.A., 1987. Yield and potential feeding value of straws of grain sorghum cultivars developed in Nigeria. Animal Feed Science Technology 17: 285-293.

The yield and quality of the leaf and stalk fractions of the straw and grain yield from various sorghum cultivars developed at the

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Institute of Agricultural Research (IAR), Samaru, Zaria, Nigeria were examined over 2 years. Yield [tonnes dry matter (DM) ha^{-1}] ranged from 0.4 to 2.9 for grain, 1.0 to 2.0 for leaf and 2.7 to 8.9 for stalk. Leaf crude protein (CP), soluble carbohydrate, total phenolics and in vitro organic matter digestibility (IVOMD) were generally higher than those for stalks.

Most of the differences in yield were not statistically significant. No significant correlations could be established between grain yield and leaf or stalk yield of the residual straw. The selection of cultivars with a tendency for high grain yield, like the SSH series, will not adversely affect the residue leaf or stalk yield and quality. Early harvesting of residues is, however, to be encouraged.

3.6 A REVIEW OF THE NUTRITIVE VALUE AND UTILIZATION OF WHOLE COTTONSEED, COTTONSEED MEAL AND ASSOCIATED BY-PRODUCTS BY DAIRY CATTLE[1]

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ABSTRACT

Coppock, C.E., Lanham, J.K. and Horner, J.L., 1987. A review of the nutritive value and utilization of whole cottonseed, cottonseed meal and associated by-products by dairy cattle. Animal Feed Science Technology 18: 89-129.

A review of literature showed that although the feeding of whole cottonseed (WCS) to cattle is not new, an appreciation of its special nutritive properties for high-yielding dairy cows is recent. The reasons include (1) a high genetic merit for lactation among much of the dairy cow population, (2) requirements for energy-concentrated but minimum-fiber diets by these cows and (3) a generally positive effect of WCS on milk fat percentage. The depression in milk protein percentage often seen with added fat, including WCS, seems to be an accepted trade-off.

A comparison of the nutrient profile of WCS with other oilseeds and protein supplements shows that only peanut kernels with skins and hulls have similar energy and crude fiber, and both exceed other commonly used protein supplements in TDN.

A tabular summary of 18 comparative feeding trails with WCS showed no consistent difference in dry matter consumption when WCS was included at up to 25% of the diet. This suggests that, in most studies, an increase in NEl probably occurred when WCS was fed. In

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1 Technical article 21169 by the Texas Agricultural Experiment Station.

most trials, an increase in milk fat percentage was evident, which was reflected in a numerical increase in FCM. About half the studies showed a depression in milk protein percentage, but only a quarter were significantly lower.

The only consistent effect of WCS on digestibility of nutrients was an increase in the digestibility of ether extract, a result of the dilution of metabolic fecal fats.

Compared to soyabean meal (SBM) had a consistently lower feeding value, attributable to less energy and lower lysine. Controlled heating improved the protein value of both WCS and CSM by causing less rumen degradation and greater transfer of amino acids to the small intestine.

In low-fiber diets, cottonseed hulls (CSH) seem to have greater feeding value than their digestibility indicates.

Gossypol toxicity and mycotoxin contaminations are potential hazards from feeding WCS and CSM. Although gossypol toxicity can occur in ruminants, it is rare and is unlikely at 3-4 kg/day of either feedstuff, but may occur in diets if a large amount of both are included. Where high moisture and temperature occur pre-harvest, aflatoxin contamination is a potential hazard, but prophylactic measures are available.

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3. Thesis-Support for research on crop-residues and agro-industrial by-products - Announcement.

* PANESA = Pasture Network for Eastern and Southern Africa, ILCA.

1. Abstracts of some of the papers presented at the First Joint ARNAB/PANESA Annual Workshop held in Lilongwe, Malawi from 5th -9th December 1988.

1.1. UTILIZATION OF AGRICULTURAL BY-PRODUCTS FOR VILLAGE AND COMMERCIAL PRODUCTION OF SHEEP RATIONS IN GHANA

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Abstract

Sheep constitute a significant proportion of the ruminant livestock population in Ghana. There is a growing interest in the raising of sheep in backyards among urban dwellers, but their major problem is the availability of feed as their animals are not allowed to roam and graze freely as is done in the village.

The agricultural by-product feeds available in Ghana include cereal and legume straws, maize cobs, cocoa pod husk, coffee pulp and peels of yams, cocoyams, plantains and cassava. The nutritional problems encountered in the utilisation of these by-products, the treatments needed to improve their nutritional values and the economics of feeding to sheep are discussed. The other major problems associated with the use of these by-products are bulking, transportation, storage and processing.

In the villages, in the southern parts of the country, it is suggested that grazing animals should be supplemented with peels. In the villages in the northern parts of the country, the feeding of cereal and legume straws should be encouraged. In the cities it is suggested that commercial feed mills should prepare diets from these by-products for sale. There is also the need to improve the growth rate and feed conversion efficiencies of the local breeds of sheep if they are to be raised intensively in the towns and cities.

1.2. DISSEMINATION AND UTILIZATION OF RESEARCH TECHNOLOGY ON FORAGES AND AGRICULTURAL BY-PRODUCTS IN KENYA

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Abstract

Agricultural research is an essential service to the livestock industry in Kenya. This is seen in the planning, execution of research programmes and in the promotion and adoption of research results and recommendations. Effective research on forages and agricultural by-products can only be measured in terms of its

contribution to the solution of problems faced in the national development. Research should start with identification of farmer's problems and opportunities, develop and test appropriate technologies under farmer's conditions and conclude with solutions that would enable farmers to increase their income.

Generation, dissemination and utilisation of appropriate technology depend on inter-disciplinary team approach, organised into an interacting and cohesive group involving researchers, extension workers and farmers. There is need for strong research-extension-farmer linkages in order to develop and test suitable and adaptable technology that will increase production. A lot of pasture and agricultural by-products research has been carried out in Kenya for many years and technologies developed and recommended to farmers. But not all these research results and technologies have been adopted by the Kenyan farmers.

This paper attempts to look at the past and present research and extension service organisation, their linkages and the efforts made by these agricultural services in the dissemination and adoption of the vast wealth of research technologies available in Kenya. The paper also discusses an on-farm research approach as an effective means of dissemination, utilisation and adoption of research technology.

1.3. THE KILIMANJARO DAIRY FEEDING SYSTEMS: AN ATTEMPT AT EVALUATING THE IMPACT OF ON-FARM LIVESTOCK RESEARCH

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Abstract

The paper presents results of an evaluation survey conducted in the Kilimanjaro highlands to determine the impact of phase I of the Dairy Feeding Systems Project. Deviations from the conventional experimental design is advanced as the major reason for employing ex-post evaluation instead of quantitative analysis based on statistical method in assessing the impact of on-farm trials conducted in phase I of the Dairy Feeding Systems Project.

The results of the evaluation survey reveal that the Project has had a positive impact on the performance of dairy cattle. Farmers felt that the Project has been instrumental for the current closer link between farmers and extension staff. However, extension staff would have wanted to be more involved in future project activities. Farmers considered shortage of veterinary drugs, improved dairy heifers and scarcity of feeds as the main factors constraining dairy development.

1.4. FEEDING SYSTEMS FOR MILK PRODUCTION IN THE HIGH POTENTIAL AREAS OF KENYA: ON-FARM TRIALS

A Abate[1], A N Abate[2] and S Gacugia[3]

Abstract

Composition of various types of feeds offered to Friesians, Ayrshires or their crosses were studied in several farms practising zero-grazing, semi-zero grazing and grazing systems of milk production. The experiments were carried out in the high potential except for the level of phosphorus which differed significantly ($P<0.01$) between farms. Composition of fodder varied significantly ($P<0.01$) in crude protein, detergent fibre, calcium and phosphorus. Farms differed significantly ($P<0.05$) only in the level of phosphorus in pastures. Pasture or fodder contributed most to dry matter intake averaging about 12.1 kg per animal each day under grazing and about 10.0 kg when animals were fed in confinement. A wide range of fodder was fed under semi-zero grazing and intake of dry matter from such supplements averaged 1.9 kg per animal per day. Fodder fed under semi-zero grazing were superior to that fed under zero grazing in terms of levels of critical nutrients. Daily concentrate consumption differed significantly ($P<0.01$) between farms and was highest (4.3 kg DM) and least (0.44 kg DM) per animal under zero-grazing and grazing respectively. Average milk production per farm was 12.0, 11.6, and 10.2 kg for zero grazing, semi-zero grazing and grazing systems respectively. Given the level of production, all the feeding systems were deficient in at least one nutrient. It was concluded that for all systems, protein, calcium and phosphorus supplementation seem desirable particularly when milk production per animal is in excess of 10 kg per day.

1.5. LEGUME SUPPLEMENTATION OF MAIZE

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Abstract

The value of legumes **Lablab purpureus, (Lablab),. Vigna unguiculata,** (Cowpea), **Cajanus cajan,** (Pigeonpea), as supplements to maize stover were assessed in two experiments. In the first experiment lambs received 0, 100, 200 or 300 g of legume, with or without cottonseed meal, and maize stover **ad libitum**. All the legumes increased total dry matter intake ($P<0.001$), digestibility ($P<0.05$) and nitrogen retention ($P<0.05$). Stover intake was not increased by the legumes but was by cottonseed meal.

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In the second experiment cowpea was compared with early or late cut pigeon pea as supplements to lambs receiving a small concentrate allocation and maize stover **ad libitum**. Total intake ($P<0.01$), digestibility ($P<0.05$) and nitrogen retention ($P<0.05$) were increased by all legumes, especially by cowpea. In a further trial lambs showed a marked preference for cowpea compared to pigeon pea especially early cut pigeon pea . Yield of early cut pigeon pea per ha was markedly lower than late cut pigeon pea.

The results indicate improved nutritional status in lambs receiving legumes. Some of the practical implications of under-feeding and the role of legumes are discussed.

1.6. RESEARCH ON MAIZE STOVER AS LIVESTOCK FEED ON SWAZI NATION LAND

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Abstract

The problem of feed shortage for grazing livestock in the communal areas of Swaziland has been widely recognised and many attempts have been made to rectify the problem. This paper highlights some of the research results that have been obtained relating to the potential contribution of maze stover to feed budget of the livestock. Hybrid maize varieties produce higher stover yields than traditional varieties but have comparable quality constraints to their adoption in the farming system and strategies to improve their quality are discussed.

1.7. FEEDING VALUE OF SESBANIA AND LEUCAENA BROWSE

Lemma Biru*, L J Lambourne**, and Fana Tesfahunei*

Abstract

Crossbred exotic x Barka and exotic x Boran milking cows in month 3-5 of lactation (mean initial yield 6-9 kg/d) were fed fresh-cut **Sesbania sesban** or **Leucaena leucocephala** to replace part of the concentrate ration normally given during dry season grazing of natural pasture. A concentrate was fed at the rate of 2 kg plus 0.5 kg per kg initial daily milk yields to a control group of 3 cows. In 4 similar groups either 0.3 or 0.6 of this concentrate allowance was replaced by fresh-cut **leucaena** or **sesbania** browse (1 kg browse dry matter per kg concentrate replaced) during 1 week change-over, and 2 weeks experimental feeding with a final week on the original concentrate ration. All cows had access to dry season pastures.

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Leucaena was eaten more freely (max. 12 kg fresh, 4 kg dry weight per day) than sesbania (max. 8 kg fresh, 2.5 kg dry). Milk yield of the browse fed groups was significantly higher in the two 7 day browse feeding periods than in the preliminary and final control feeding periods. Milk yield was higher in the experimental than the control periods by 0.45 kg/d in the controls, by 0.85 and 0.30 kg/d in the 0.3 and 0.6 sesbania groups, and by 0.76 and 1.18 kg/d in the 0.3 and 0.6 leucaena groups.

1.8. MOLASSES ENERGY BLOCKS FOR BEEF CATTLE

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Abstract

The study investigates the possibilities of the farmer making his own concentrated energy blocks from the locally available ingredients and determines at what cost he does so. The suitability and acceptability of the blocks by steers was also studied. Sixteen unreplicated blocks were made using molasses, urea, salt, cement, maize cob meal and wheat bran in 2^4 factorial experiment. Block hardness varied with block type, location, technique of manufacture and to some extent with temperature and humidity although there was no evidence that the blocks hardened any more beyond day nine. In a 15 minute intake observation, average consumption per 'visit' of molasses blocks containing wheat bran was 142 g which differed significantly ($P<0.05$) from the average consumption of 96 g for those containing maize cob meal. Consumption of blocks containing wheat bran was not affected ($P<0.05$) by method of preparation, proportion of molasses or even the location of the blocks. Consumption of maize cob blocks containing 50% molasses was 131 g which differed ($P<0.01$) from 68g for those containing 45% molasses. Placement of blocks containing maize cob meal in the sun resulted into average consumption of 116 g, an amount different ($P<0.05$) from 77 g for those placed in the shade. In all cases the cost of the blocks was between 20 and 25% the cost of crystaly, a standard commercial preparation.

1.9. LIVEWEIGHT CHANGES IN SHEEP SUPPLEMENTED WITH SEED PODS OF TWO LEGUMINOUS TREES IN SOUTH KORDOFAN, SUDAN DURING THE DRY SEASON

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Abstract

The paper examines the effect of supplementing seed pods of kadad (Dichrostachys cinera) and haraz (Acacia albida) on sheep liveweight change during the dry season. Seed pods were collected after

maturity in December. Diet selected by sheep was determined by the bite-count method, using 4 non-lactating sheep for the total faecal collection. Seed pods and diet selected were analysed for Nitrogen (N), neutral detergent fibre (NDF), in vitro dry matter digestibility (IVDMD) and in vitro organic matter digestibility (IVDOM).

Three groups of non-lactating sheep, with 4 ewes in each group were selected randomly from the stock of sheep belonging to western Sudan Agricultural Research Project at the research farm. The first group was supplemented with kadad seed pods, the second group with haraz seed pods and the third group was the control, which survived on range forage only. Supplements were offered every other day for 7 weeks. Sheep in the three groups were then mixed in a corral and weighed at random.

Crude protein (6.25 x %N) and NDF constituents of kadad were 10.9%, of haraz 16.5% and 59.2% and of the diet selected were 12.3 and 68.1% respectively. In vitro IVDMD and IVOMD were 50.5% and 48.1% for kadad, 43.9% and 45.8% for haraz and 31.5% and 28.7% for the selected diet respectively.

Dry Matter intake was 2.9 kg/100 kg body weight and crude protein intake was 8.4 $g/W^{0.75}$ kg/day. Kadad and haraz provided additional N supplements of 6.8 and 11.2 $g/W^{0.75}$ every other day, respectively and more energy that resulted in an increase in liveweight ($P<0.005$) for the supplemented group. Sheep supplemented with haraz, however, gained more liveweight ($P<0.05$) than sheep supplemented with kadad.

1.10. THE EFFECT OF SUPPLEMENTS OF OIL SEED BY-PRODUCTS ON THE UTILISATION OF LOW-NITROGEN FIBROUS DIETS BY SHEEP

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Abstract

Four experiments in which native pasture hay and sorghum stover supplemented with varying levels of cottonseed and cotton cake conducted with sheep are described.

Experiment 1 investigated the effects of supplementing native pasture hay (predominantly **Pennisetum pedicellatum** with two levels of cottonseed cake (0 and 60 g/kg diet DM) and three levels of cottonseed (0, 60 and 120 g/diet DM) arranged in 2x3 factorial using 6 Bali-bali sheep in a 6x6 Latin square design. There were increases in the apparent digestibilities of DM ($P<0.001$), N ($P<0.001$) and OM ($P<0.001$) due to the inclusion of cottonseed cake. Cottonseed and cottonseed cake interacted in their effects on the digestibilities of OM ($P<0.05$) and N intakes ($P<0.01$). Cottonseed cake increased both total and grass hay DM intakes ($P<0.05$) respectively. Cottonseed resulted in substitution effects as its level was increased ($P<0.05$). Experiment 2 investigated the effects of supplements of cottonseed cake without or with (60 and 120 g/kg diet DM) cottonseed on the liveweight change of Djallonke sheep fed native pasture hay. Twenty

one rams were grouped into three treatments of 7 animals each in a randomized block design. The animals gained 54, 76 and 74 g/day when 0, 60 and 120 g/kg diet DM of cottonseed respectively were combined with the cottonseed cake supplement.

Experiment 3 investigated the effects of supplementing sorghum stover with cottonseed cake at three levels (0, 60 and 120 g/kg diet DM) in a double 3 x 3 Latin square design using Bali-bali sheep. The diets containing cottonseed cake increased the apparent digestibilities of DM ($P<0.05$) and N ($P<0.001$), and total DM intake ($P<0.05$). The inclusion of 60 g/kg diet DM resulted in increases in sorghum stover intake ($P<0.05$).

Experiment 4 investigated the response of Bali-bali sheep in liveweight change to the diets in Exp. 3. Three animals were randomly assigned to each treatment and fed individually. There were progressive increase in liveweight gain ($P<0.05$) but with diminishing differences as the level of cottonseed cake was increased. Cottonseed cake at 60 g/kg diet DM increased daily intakes of total and stover DM. At 120 g/kg diet DM total intake was increased but stover intake reduced.

It is concluded that cottonseed cake supplement at 60 g/kg diet DM substantially improved the intake of both fibrous diets, and was as effective as the high level (120 g/kg diet DM) in liveweight gain. This level of inclusion may also be within the economic reach of the farmers.

1.11. PARTIAL REPLACEMENT OF MAIZE WITH GRADED LEVELS OF MAIZE COBS IN PIG WEANER/GROWER DIETS

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Abstract

A study was carried out to investigate the effect of graded levels of maize cobs as partial replacement of maize grains on the performance and carcass quality of weaner-grower Landrace pigs. Thirty two Landrace weaner pigs averaging 16.02 kg, initial liveweight were randomly assigned to four treatments with two replicates (2 females and 2 castrates/replicate) in a completely randomized design. Maize cobs were included at the levels of 0%, 10%, 20 and 30% in isoproteinous diets. The pigs were given feed on concrete floored pens and watered **ad libitum** through automatic nipple drinkers during a 12 week experimental period. Two pigs from each treatment (1 female and 1 castrate) were slaughtered for grading at the end of the experiment. Results showed significant differences ($P<0.05$) between treatments in average daily feed intake, daily weight gains and feed/gain ratios. When used up to 20%, maize cobs offer the most efficient and cost-effective diet for pigs. When properly publicised, this ration can cut down feed cost to farmers.

1.12. ON-SITE RESEARCH FOR THE ESTIMATION OF THE NUTRITIONAL STATUS OF SHEEP AND GOATS GRAZING AT EL-OMAYED PASTURE AREA

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Abstract

A governmental resolution which allowed the Bedouins of the Matrouh Governorate to export sheep and goats resulted in significant movement of flocks from the Nile delta to the Marsa Matrouh area. The number of heads of small ruminants moving to the new area was almost double that of the normal and led to overgrazing and a deterioration of many parts of pasture land.

Research was initiated to determine the present nutritional status of sheep and goats at El-Omayed, 90 km west of Alexandria. Two University of Alexandria employees introduced the research team to Bedouins at the site. Experiments to determine forage preference, feed intake, grazing periods, the nutritive value of consumed material the present and the proper carrying capacity were all conducted using flocks of one influential Bedouin. His flocks were managed by his five sons.

The grazing period and DM intake of goats in summer were between 1/3 to 1/2 their corresponding values in winter. Sheep did not show such degree of difference between summer and winter. The studied pasture area was capable of supplying the existing sheep with 77 and 85% of their total digestible nutrients requirements in summer and winter. The corresponding values for goats were 37 and 100% respectively. The proper carrying capacity of the studied area was about 5 feddan/head in summer and 2.5 feddan/head in winter (1 feddan = 0.5 ha).

Treatments for improving the nutritional status of animals were suggested. A mineral mixture was formulated to compensate for the recognised local mineral deficiencies. It was manufactured in the form of licking blocks. This supplement improved the performance of animals during summer by 22%. The first co-operating Bedouin helped in extending the distribution of these blocks to neighbours. Two years later, the number of clients using the blocks reached fourteen.

1.13. CAN AGRO-INDUSTRIAL BY-PRODUCTS AND CROP RESIDUES SAVE THE NIGERIAN LIVESTOCK INDUSTRY?

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Abstract

Nigeria is one of the countries where animal protein consumption per caput is still very low being about 9.36 kg/caput/year (Egbunike, 1988) without taking account of fish and game meat consumed. Yet

every sector of the livestock industry is having serious setbacks mostly due to the escalating prices of feeds which normally constitute 60-80% production costs, depending on species.

Hitherto, Nigeria had depended almost exclusively on imported feed ingredients for the production of compound feeds and, with the over-valued "Naira", appeared to be making some headway in livestock production especially in the poultry sector which utilised about 90% of compound feed produced in the country. With the economic recession and the non-commitant ban imposed on the importation of the major constituents of livestock feeds, especially grains, many entrepreneurs in livestock industry that are unable to withstand the tough competition have fallen by the wayside. Under this condition wide variations exist in feed supply and hence prices which have resulted in the present low level of productivity of the animals regardless of the system of management.

The capacities of livestock feed mills and average prices of poultry feeds are summarised in the text (Tables 1 and 2 respectively) considering that poultry feeds form about 90% of feed mill products. It can be observed that at 50 or 65% maize grain inclusion the amount of maize required cannot be met internally especially when viewed against the background that this commodity is in very high demand in other sectors of the economy viz. for human foods and for industries like the breweries. Thus Nigeria must look inwards for her feed resources. Fortunately the pioneering work of Oyenuga (1966) paved the way for the understanding that agro-industrial by-products and crop-residues could be economically used to supplement the erratic feed supply.

This paper assesses the potential of agro-industrial by-products and crop residues to meet the nutrient requirements and hence support the growth and productivity of livestock in Nigeria.

1.14. POTENTIAL OF RUBBER SEED AS PROTEIN CONCENTRATE SUPPLEMENT FOR DWARF SHEEP OF CAMEROON

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Abstract

The performance of West African Dwarf sheep fed concentrates containing graded levels of unextracted rubber seed flour was evaluated in two experiments. In the first experiment carried out in 1984,15 local sheep were fed concentrates containing 0, 10, 20, 30, 40, and 50 percent unextracted rubber for a period of three months. Results indicated that sheep fed concentrates containing 10 and 20% rubber seed had similar dry matter and crude protein intake as those on the control (0% rubber seed), while those maintained on 30 and 50% rubber seed concentrates consumed significantly ($P<0.05$) lower levels of dry matter and crude protein. The digestibility of dry matter, organic matter and crude protein was significantly lower in sheep fed 30 and 50% rubber seed concentrates compared to those on the 10 and 20% concentrates. Animals fed concentrates containing 0, 10 and 20%

rubber seed gained 9, 10 and 17 g/day whereas those on concentrates containing 30 and 50% rubber seed lost weight at the rate of 26 and 51 g/day respectively. It was concluded that the limit of 20% rubber seed in concentrate rations for sheep should not be exceeded.

In the second experiment, 12 uncastrated male dwarf sheep ranging in age from 8 to 14 months and weighing between 11 and 15 kg were used to investigate performance when fed fresh Elephant grass and concentrate supplements containing 0, 10, 15 and 20% unextracted rubber seed meal as a substitute for cottonseed cake during a period of 56 days.

Dry matter intake decreased as the level of rubber seed in concentrate supplement was raised. There were no significant differences in dry matter, organic matter and crude protein digestibility between the control and all other treatments containing rubber seed meal. Daily weight gain of sheep fed concentrates containing 0, 10, 15 and 20% rubber seed were 36, 50, 41 and 38 g/day respectively. Incorporation of rubber seed meal or flour in concentrate rations for sheep should not exceed 20%. Application of results on the industrial and smallholder scale is discussed particularly as regards collection, shelling, detoxification and extraction of oil to obtain the cake which is a valuable protein source for livestock.

1.15. THE POTENTIAL OF SWEET POTATO (IPOMEA BATATAS) AS A DUAL PURPOSE CROP IN SEMI-ARID CROP/LIVESTOCK SYSTEMS IN KENYA

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Abstract

The potential of sweet potatoes (Ipomea batatas (L.) Lamb) for use as a dual purpose crop in crop/livestock systems of semi-arid Kenya was studied on twelve accessions. Root initiation (fibrous and fresh roots), vine growth and nutritional quality and effects of supplementing vines and cottonseed cake (CSC) on growth of Boran weaner male calves were investigated.

Time to fibrous root initiation was similar ($P>0.05$) but differences ($P<0.05$) were observed in mean root numbers and lengths after 10 days of growth. Accessions differed ($P<0.05$) in time to freshly tuber initiation, enlarged tuber numbers and tuber weight. Trends in vine components (stem and leaves) yields showed a decline after 120 or 150 days from transplanting. A significant ($P<0.05$) time x vine dry matter (DM) accumulation rate interaction was obtained. Percent protein (CP), cell contents (CC), cell wall constituents (CWC) and acid detergent lignin (ADL) differed ($P<0.05$) among the accessions while acid detergent fiber (ADF) and ash were similar ($P>0.05$).

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Supplemental vines and CSC improved (P<0.01) intake of Rhodes grass hay, calf growth rates and feed conversion efficiencies. The data suggests that sweet potato vines could replace CSC as a livestock feed supplement.

Implications on the use of vines as livestock feed supplements are discussed. The variation exhibited in the attributes measured indicate that selections that optimise tuber and vine yields are possible.

1.16. LABORATORY EVALUATION OF THE EFFECTS OF PROCESSING METHODS, TREATMENT AND COFFEE CULTIVAR ON CHEMICAL COMPOSITION AND IN VITRO DIGESTIBILITY OF COFFEE PULP

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Abstract

Experiments were conducted to study: (1) the effect of dry processing of coffee cherries and ensiling with urea on the chemical composition and in vitro digestibility of coffee pulp, and (b) the effect of variety on fibre and phenolic components. Zero, 40, 50 and 60 grams of urea were dissolved in a litre of water and added to dry processed coffee pulp (DCoP) (1 litre/kg) of air dried coffee pulp) sealed in plastic bags (3 replicates) and incubated for 15 and 30 days.

The experiment on the relationship of variety to chemical composition was studied on the wet processed pulp. Fourteen varieties of coffee cherries were collected from high and low altitudes in Kaffa Administrative Region.

Treatment level had a significant effect (P<0.05) on the neutral detergent fibre, acid detergent fibre and content of soluble phenolics. Nitrogen (N) and content of soluble phenolics showed a significant increase at 5 and 10% levels respectively. However, urea treatment did not alter the in vitro dry matter digestibility.

There was a large difference in the content of soluble phenolics (15-41%), potassium, iron, and manganese. There was a trend for the content of phenolics to increase in varieties harvested at higher altitude. Neutral detergent fibre showed negative and positive correlation with the soluble phenolics and insoluble proanthocyanidins respectively. Varietal and environmental effects on the nutritive value of coffee pulp appear to be of considerable importance.

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1.17. A GUNNY BAG ENSILING TECHNIQUE FOR SMALL SCALE FARMERS IN WESTERN KENYA

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Abstract

Maize (Zea mays) stalks, sugarcane (Saccharum officinarum) tops sorghum (Sorghum bicolor) stalks and bana grass (Pennisetum purpureum P typhoides) were chopped and compacted in synthetic gunny bags which were then buried in a trench silo 5 m long, 3 m wide and 1.5 m deep. To some bags of each crop, molasses was added at the rate of 5% by weight of the material in the bags on green matter basis. The molasses was diluted with an equal amount of water before application. The silages was then sampled after two months. The pH of all the silages was in the range expected for good silages (pH 3-4) except that of bana grass without molasses which had a pH of 5.18. Addition of molasses thus improved the fermentation quality of bana grass. Maize stalks, sugarcane tops and bana grass with molasses silages had the highest condition scores based on appearance and smell. Bana grass without molasses had the lowest score. Ensiling appeared to lower the in vitro dry matter digestibilities of maize, bana grass and sugarcane tops by approximately 4.68%, 11.45% and 16.18% respectively and increased that of Sorghum stalks by 1.91%.

2. UTILIZATION OF MAIZE BRAN* AND COTTONSEED CAKE BY LACTATING DAIRY COWS IN MALAWI

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Abstract

A 55 day trial was conducted to determine the effects of varying proportions of maize bran and cottonseed cake on average daily dry matter intakes, milk yields and weight gains of sixteen cows averaging six years of age at 394 kg initial body weight in their middle to late lactation. The cows were grouped according to age, lactation number and level of cross (Malawi Zebu x Friesian) and randomly assigned to four concentrate diets: (1) maize bran alone, (2) maize bran (80%) plus cottonseed cake (20%), (3) maize bran (60%) plus cottonseed cake (40%), and maize bran (50%) plus cottonseed (50%). All cows were fed Napier and Rhodes grass ad libitum.

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2. Winrock International Institute for Agricultural Development, Morrilton, Arkansas, U.S.A.

* Maize bran produced by smallholders under village conditions using a pestle and mortar. It consists of both the pericarp, maize germ and some granules of the endosperm. It is invariably of higher nutritive value than the maize bran from commercial millers.

There were no significant differences among the four concentrate diets (P>0.05), but cows fed different proportions of maize bran and cottonseed cake apparently consumed more dry matter, produced higher milk yield, and gained more weight (except cows on diet 3) than those fed bran alone (diet 1 Tables 2 and 3).

The economics of the four diets was evaluated. Dairy farmers would be better off if they fed maize bran and cottonseed cake in the ratio of four to one (Treatment 2) with forage ad libitum. It is recommended that further studies be conducted with animals at early stages of lactation.

Introduction

Feeding adequate nitrogen (N) to lactating cows is one of the most expensive and important aspects of dairy nutrition. Nitrogen requirements can be met by feeding both natural proteins and non-protein nitrogen (NPN) (Casper et al, 1986). As more high quality proteins are used for direct human consumption, finding alternate sources nitrogen and efficient utilization of NPN in ruminant rations becomes increasingly important.

Agro-industrial by-products and crop residues represent vast animal feed resources which are, as yet, largely unexploited. In Malawi, the basic feed in dairy production is grazing both natural and improved pastures. In addition to the natural and improved pastures concentrates are generally fed to calves and milking cows as N supplements. Local feeds, as sources of N, commonly used by smallholder dairy farmers are maize bran and dried **Leucaena leucocephal** leaf. Maize bran is either fed alone as a sole concentrate or sometimes mixed with **Leucaena** leaf. Leucaena, previously considered to be the answer to protein deficiencies of most village cattle during the dry season, has gradually declined in importance due to problems associated with its establishment and management.

Thus, most of the experiments carried out on dairy production in Malawi have been conducted to investigate alternate sources of N to be fed with maize bran, a by-product of maize processing, for enhanced milk production. Maize is low in crude protein (10% CP) and if fed alone, it cannot suffice to meet the nutritional demands for protein of high milk producing cows. This maize by-product is locally available and relatively cheap to obtain.

One of the agro-industrial by-product feeds that has been found to give favourable milk yields when fed in combination with maize bran is cottonseed cake, the residues remaining after oil extraction from the seeds. Cottonseed cake is a good source of N (38.5% CP) and energy as a ruminant feed.

The current research program is geared at investigating the proportions of feeding maize bran and cottonseed cake to lactating cows that could be cost-effective for smallholder dairy farmers. This study was therefore conducted to determine the effects of varying proportions of maize bran and cottonseed cake on dry matter intake, milk production, and weight gains of lactating cows. The economics of the concentrate diets was evaluated.

Materials and Methods

The study was conducted at Chitedze Agricultural Research Station, 16 kilometres (km) West of Lilongwe, the capital city of the Republic of Malawi. It involved sixteen Malawi Zebu (MZ) - Friesian (Fr) crossbred cows in their middle to late lactation, averaging six years of age and weighing 394 kg initial body weight (BW). The cows were grouped according to age, lactation number and level of crossed (MZ x Fr), most of which were MZ with 87.5% Fr blood. They were randomly assigned to four concentrates (diets) (four cows/diet). The diets consisted of (on as-fed basis): (1) maize bran alone, (2) maize bran (80%) plus cottonseed cake (20%), (3) maize bran (60%) plus cottonseed cake (40%), and (4) maize bran (50%) plus cottonseed cake (50%); and contained 10.9. 11.8. 20.3, and 25.1%, CP, respectively (Table 1). These diets were fed at 2.5% of cows' BW.

In addition to the four diets, all cows were fed fresh grass forages; Napier grass (A) during the first four weeks of the trial and Rhodes grass (B) during the remaining part of the experimental period, ad libitum. Apart from common salt, which was added to the diets, no other mineral supplements were given to the animals. Cottonseed cake was ground in a mill before mixing with maize bran. Grass forages were manually chopped into small pieces before feeding to the animals.

TABLE 1. Concentrate constituents and chemical composition of maize bran, maize bran plus cottonseed cake, Napier grass and Rhodes grass (% of DM).

Component	Concentrate diet				Forage diets*	
	1	2	3	4	A[1]	B[2]
Concentrate Constituents						
Maize bran (%)	100	80	60	50	For the first 4 weeks	From 5th to 8th week
Cottonseed cake (%)	0	20	40	50		
Chemical Composition						
DM	90	90.3	91.1	93.0	94.0	93.3
CP	10.9	11.8	20.3	25.1	10.3	7.5
NDF	26.6	27.2	26.9	29.7	58.9	71.2
ADF	8.2	9.9	10.7	11.7	35.3	38.9

* A[1] = Napier grass; B[2] = Rhodes grass

Cows were allocated at random and kept in individual pens with separate managers for concentrates and forages. Water was available at all times. Feeds were offered two times daily (in the morning and afternoon). Pre-weighed amounts of the diets were split into two halves. One half was fed in the morning and the other half in the afternoon. Pre-weighed grass forages were fed in sufficient amounts. Feed refusals were collected and weighed every morning before feeding.

Samples of the concentrates and forages were taken weekly and composited over the duration of the experiment. Sub-samples were then taken and ground for chemical analyses. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analysed according to procedures described by Goering and Van Soest (1970). Crude protein was determined by Kjeldahl procedure.

Cows were weighed at the start of the trial and every week thereafter. Milk yields were weighed daily during the experimental period. One of the cows on diet 3 got sick and was removed from the trial at the end of week 4 since it was losing condition.

Data collected were analysed by analysis of variance for a completely randomized design (Snedecor et al, 1967). An economic analysis was carried out based on the concentrate diets consumed and milk produced during the experimental period.

The cost of forage production and preparation and of labour were excluded. This was done in order to have a rough picture of the cost-effectiveness of varying the proportions of maize bran and cottonseed cake for the small scale dairy farmer. In Malawi, the common practice in most of the dairy areas, is that farmers acquired maize bran by exchanging one kilogram (kg) of salt for 25 kg of maize bran. Thus when calculating the monetary value of maize bran, the quantity of maize bran used in the study was converted to salt monetary value (using the 25 kg maize bran = 1 kg salt exchange rate). The cost of maize bran (salt equivalent), cottonseed cake and salt used in the rations made up total concentrate costs. The value of milk produced was determined at current Malawi Dairy Industries (MDI) producer milk price of MK0.32/kg of milk. The total revenue from milk sales minus total concentrate costs gave returns over concentrate costs for the four diets.

Results

Concentrate constituents and chemical composition of concentrate and forage diets fed to cows

The chemical composition of the feeds used in this study is shown in Table 1. The dry matter (DM) content of concentrates were similar except for diet 4. Napier grass Rhodes grass had also similar DM contents (94.0 and 93.3%, respectively). Decreasing maize bran and

increasing cottonseed cake in the diets, increased maize bran and increasing cottonseed cake in the diets, increased CP content. Diet 4 had the highest CP content. CP for **Napier** grass was higher than that of **Rhodes** grass (10.3 vs 7.5% CP). The NDF and ADF contents of Rhodes grass were higher than those of **Napier** grass. There was little variation of NDF and ADF among the concentrate diets except for diet 4, which had the highest NDF and ADF values.

Average daily dry matter intakes (DMI), average daily milk yields (ADMY), and average weight gains (ADG) and dry matter intake expressed as percentages of BW of cows

Feed composition, milk production and changes in body weights of animals are some of the criteria used to assess the nutritive value of feeds. Concentrate DM and forage DM of the feeds fed to cows were added to make the total DM consumed (DMI). Concentrates diets were fed at 2.5% of BW and the rest of the DM was contributed by the forage diets.

Average DMI, ADMY, ADG, and DMI% BW for the lactating cows in this study are presented in Table 2. There were no statistically significant differences in DMI for the cows fed the four diets ($P<0.05$). However, cows fed diets 2 and 3 tended to consume more DM than those fed diets 1 and 4. DMI% of BW were similar for all the cows on four diets. Thus DM contribution from the forage diets was also about equal for the cows fed the four diets. DMI% of BW of about 0.7 was contributed by the forage diets. Cows fed the four diets produced similar ADMY ($P>0.05$). ADMY were apparently slightly higher for cows fed diets 2, 3, and 4 than those fed diets 1.

TABLE 2. Average daily dry matter intakes (DMI) milk yields (ADMY), weight gains (ADG) and DMI% of BW of cows

Parameter	Concentrate diets					
	1	2	3	4	SE[a]	Significance
DMI, kg	12.8	15.6	14.4	13.8	±0.74	NS (P>.05)
ADMY, kg	8.3	10.6	9.8	9.7	±0.62	NS (P>.05)
ADG, kg	0.7	0.8	0.1	1.1	±0.35	NS (P>.05)
DMI% BW	3.2	3.3	3.2	3.1		

[a] = Standard error of means

Varying the proportions of maize bran and cottonseed cake did not affect ADG of cows ($P>.05$). However, at the end of the trial cows on diet 4 apparently gained the highest body weight and those fed diet 3 had the lowest body weight gain (Table 3). Overall, it seemed feed DM was mostly used for weight gains rather than for milk production.

TABLE 3. Average initial body weights (BW) final body body weights, and body weight gains (BWG) of cows

	Concentrate diets			
	1	2	3	4
Initial BW, kg	363.9	425.2	426.7	381.6
Final BW, kg	400.0	468.8	444.6	441.0
BWG, kg (55 days)	+36.2	+43.6	+17.9	+59.4

Economic evaluation of the four concentrate diets

Table 4 contains an economic analysis data. The returns over concentrate costs were similar for cows fed diets 3 and 4. Diet 2 gave the highest return over concentrate cost and diet 1 gave the lowest; cows fed diet 1 apparently produced the lowest amount of milk.

TABLE 4. Concentrate consumption, concentrate costs, milk production and revenue, and return over concentrate costs for the four diets fed to the cows during the 55 day study period

Variable	Unit	Concentrate diets			
		1	2	3	4
Concentrate consumption					
Average amount of maize bran consumed	kg	500.5	468.9	332.8	221.4
Maize bran - salt equivalent	kg	20.0	18.8	13.3	8.9
Average amount of cottonseed cake consumed	kg	-	116.9	221.4	264.0
Salt in ration	kg	19.8	23.6	23.6	21.2
Concentrate costs					
Cost of maize bran-salt equivalent[1]	MK*	15.50	14.57	10.31	6.90
Cost of cottonseed cake[2]	MK	-	10.52	19.93	23.8
Cost of salt in ration[1]	MK	15.35	18.27	18.27	16.44
Total concentrate costs	MK	30.85	43.33	48.51	47.14
Milk production and revenue					
Average milk produced	kg	456.5	583.0	539.0	533.5
Revenue from milk sales[3]	MK	146.08	186.56	172.48	170.72
Return over concentrate costs	MK	115.23	143.23	123.97	123.58

* = Malawi Kwacha (1989) 1MK = 0.385 US$

1 Price of salt = MK15.50/20 kg bag

2 Price of cottonseed cake =MK90/metric tonne

3 Malawi Dairy Industry producer milk price = MK0.32/kg of milk

Discussion

Chemical composition of feeds is important since it is one of the factors that influences feed intake, especially forages (Mott, 1959). One of the feed components limiting the intake of feeds by animals is the cell wall (NDF) content. In this study, both NDF and ADF of the concentrate diets were similar except for diet 4, which had the higher NDF and ADF values (Table 1). Forage B had higher NDF than forage A. This forage could have limited the feed intake of the cows during the last four weeks of the trial. It is probable that lack of differences in milk yields and weight gains could be indicative of the poor quality of forage B such that the increase in CP of the diets as a result of increased levels of cottonseed cake might not have been significant enough to increase milk yields. Animal effects would have played some part; especially the age of the cows and their stage of lactation.

There were no significant differences among the four diets fed to the cows in terms of DMI, ADMY, and ADG ($P>.05$). However, increasing the levels of cottonseed cake and decreasing maize bran were associated with apparent increases in DMI, ADMY and ADG. Cows fed diet 3 had apparently the lowest ADG . Feed DM was mostly utilized for weight gains and for some milk production. Feeding high levels of cottonseed cake to lactating cows would mainly help during early lactation when animals are usually in negative energy balance. Munthali (1985) also found non-significant differences when cows were fed maize bran alone and maize bran plus either cottonseed cake and/or other concentrates in the ratio of four to one respectively. However, in both cases, milk yields were below the expected yield of 11.4 kg/cow/day of this type of MZ x Fr level of cross (87.5% Fr blood).

Comparatively, milk yields and weight gains obtained in this study were higher than those obtained by Munthali (1985) who reported an average of 7.8 kg and 6.3 kg of milk/cow/day for cows fed maize bran alone and maize bran plus cottonseed cake in the ratio of four to one respectively, compared to 8.3 kg and 10.6 kg of milk/cow/day of cows fed diets 1 and 2, respectively in the study.

These differences, among other factors, could have been due in part to the management of the experimental animals. In the previous study (Munthali, 1985), animals were grazed during the day and fed experimental concentrates or supplements at milking time. The amount of the supplement was fixed at 4 kg of concentrate/cow/day. In the present study, animals were confined in pens, fed, watered and milked indoors (concentrate were fed at higher amounts, 2.5% of BW than in the previous study). Animals were only moved out of the pens at weighing time. It was therefore expected that in the present study higher milk yields could have been obtained as the conserved energy would have been used for milk production. Instead the animals tended

to gain body weights. Age of the cows and their stages of lactation might also have contributed to the low milk yields obtained.

Feed costs usually make up 50% or more of the total cost of milk production. Therefore, any plan for improving the biological and economic efficiency of the dairy cow must include a strategy for lowering costs (Bath, 1985). The whole point of varying the proportions of maize bran and cottonseed cake was to come with a higher CP level than that of maize bran alone, while at the same time lowering the total concentrate costs of the desired maize bran and cottonseed cake ratio.

Although feed costs have a significant effect on profitability of a dairy enterprise, minimising feed costs does not necessarily increase profitability. Of more importance is maximization of return over feed costs which is the money the dairy producer is left with from milk cheque after paying off feed bills.

Because maximization of return over feed costs is a function of revenue from sales of milk and feed costs, minimising the cost of a ration that provides adequate nutrients for a cow to express her genetic potential for milk production should be the aim to strive for. In the present study although the total cost of concentrate diet 1 (maize bran alone) was the lowest of the four diets; it had also the lowest return over concentrate cost (Table 4). This was because cows fed concentrate diet 1 apparently produced the lowest milk.

Conclusion

Although varying proportions of maize bran and cottonseed cake did not have significant effects on DMI, ADMY and ADG, results showed that better performance of lactating cows can be achieved by feeding maize bran plus cottonseed cake than maize bran alone. Maize bran and cottonseed cake have potential benefits for increased dry matter intake and consequently milk production. However, feeding high levels of cottonseed cake would be beneficial in early lactation when animals are usually in negative energy balance. Animals in this study were in their middle to late lactation and tended to gain BW when fed increased and decreased levels of cottonseed cake and maize bran respectively. However, dairy farmers would be better off if they fed maize bran and cottonseed cake in the proportion of four to ten, respectively with high quality grass forages **ad libitum**. Further studies need to be conducted before recommending this maize bran and cottonseed cake proportion to smallholder dairy farmers.

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3. Thesis support for research on crop residues and agro-industrial by-products-Announcement

African Research Network for Agriculture By-products (ARNAB) of the International Livestock Centre for Africa (ILCA) has some limited funds available to support post-graduate training in Institutions of higher learning in Sub-Saharan Africa; an effort to increase the manpower working on crop-residues and agricultural by-products as animal feed.

Eligibility

Registered MSc and PhD candidates in universities in Sub-Saharan African countries. Candidates registered in universities outside Africa but are doing their research in Sub-Saharan Africa are also eligible provided they are nationals of Africa and are not already funded by overseas donor agencies. Applicants must be on scholarships which cover tuition and board expense. They must be citizens of African countries in the region, preferably employees of their respective government institutions or national universities.

Thesis topics

ARNAB puts emphasis on strategic feeding of crop-residues and agro-industrial by-products for increased animal productivity; including crop-livestock integration.

Types of costs to be covered

Consumables (reagents, feeds, etc.), laboratory glassware, labour, local travel, and thesis typing and binding. Grants will be used for supplementing already available funds. They will not be adequate to cover capital expenses.

Research proposal

Written proposals must be submitted to ARNAB Secretariat, clearly stating the justification for the study, objectives, research design and a statement on statistical analysis to be followed, and a detailed budget. The proposal must be approved by the candidate's university supervisor/s.

Supervision

It is assumed that supervision will be available locally (within the institution or university) but supplementary supervision, where needed, could be arranged mutually with ILCA through ARNAB.

Administration of funds

All funds will be channelled through the university's account system and administered in accordance with the laid out procedures. The university will be asked to account for the expenditures in accordance with the approved budget and countersigned by the Head/Chairman of department and the Institute's Accountant.

Level of funding

USD 1000 to 2000 for MSc thesis research and USD 1500 to 3000 for PhD for the entire period.

Tenure

One year for MSc and three years for PhD.

Other requirements

A sponsee must submit Annual Progress Report of his/her work to ARNAB Co-ordinator. After completion of the thesis he/she will be required to deposit two copies of the thesis with ILCA. It is anticipated that upon graduation the sponsee will be absorbed into the main pool of scientists working on sustainable feed resources, preferably at the smallholder level, in the National Agricultural Research Systems (NARS).

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