THE UTILISATION OF FEEDSTUFFS BY BUFFALOES

by

C. DEVENDRA**

(Division of Agriculture, Food and Nutrition Sciences,
International Development Research Centre
Singapore 9124)

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ABSTRACT

Efficiency in the utilisation of feedstuffs for buffaloes is dictated by an understanding of the types of feeds available, their characteristics, inherent limitations and knowledge of how these are digested in the alimentary system. It merits special focus and priority because of continuing low animal performance, the potential for increasing productivity and scarce feed resources. Dietary fibre is a major limitation, however, the preponderence of mainly coarse lignocellulosic feed materials in the tropics compels that it be addressed. This is especially the case with non-conventional feed resources which accounted for as much as 194.1 x 10^6m tonnes or 44.9% of the total availability of crop residues and agro-industrial by-products from field and tree crops in Asia and the Pacific; 87% of these are mainly ruminant feeds. Efficient feeding systems need to be viewed in the context of the importance of fibre in promoting rumen motility and function, energy yielding substrates, dietary protein sources that are more non-degradable and the absence of toxic and anti-metabolite factors. Innovations are necessary that are both pragmatic and realistic of farm conditions. Several pretreatments (physical, chemical, physico-chemical and biological) can be used to upgrade the quality of crop residues characterised by low nitrogen content and low digestibility. However, generally uneconomic results and inadequate widespread acceptance in real farm systems continue to prevail. Supplementation to alleviate the nutritional limitations is an important strategy and includes especially dietary proteins, energy, minerals and vitamins. The use of gelled urea-molasses block licks appears promising. Supplementation with forages, with a high nitrogen content needs to be encouraged and intensified since the production responses are equivalent to chemical pretreatments, is more economic and also realistic. These strategies together should provide for the most efficient utilisation of feedstuffs for buffaloes in the tropics.

I INTRODUCTION

The objective of ensuring high performance in buffaloes and maximising productivity from them assumes efficient utilisation of the available feed resources. It necessitates an examination of the quality and quantity of the feed resources, their potential value and effectiveness in feeding systems which are consistent with high response. This approach is justified by two reasons. Firstly, there is the question of the low level of individual animal output, including also draft capacity. Secondly, low animal productivity is also related to inadequate feed supplies in many developing countries. Clearly if both situations are to be alleviated, especially by careful choice of combinations of feeds, higher animal performance and product output can be identified with more complete utilisation of the available feeds. This in turn calls for detailed knowledge of the types of feed available to buffaloes and their quantitative supply.

The intent in this paper is to briefly consider the types of feeds available, their limitations and more particularly how improved strategies for their efficient utilisation can bring about increased animal performance. The central thesis in the presentation is more complete utilisation and efficiency of the feed resources. The emphasis in the paper will be the utilisation of crop residues, agro-industrial by-products and non-conventional feedstuffs, since the utilisation of grasses has been reviewed previously (8) and also the utilisation of nutrients, feeding systems and nutrient requirements of swamp buffaloes (9).

II INADEQUATE FEED SUPPLY

Inadequate feed supply is apparent in many countries, especially those with high concentrations of livestock. The situation is acute in Asia where the feed requirements by livestock are in excess of current supplies. Recent analyses of the feed resource base in Asia in terms of the area under pasture and fodder crops, quantities of available feed grains, oil cakes and agricultural by-products, the number of livestock necessary to provide human requirements and the services required, suggest a quantitative and qualitative insufficiency of feeds in relation to the total requirements for growth, reproduction and production (48).

The situation is exemplified by India where it has been estimated that there was a shortage of 8.5 million tonnes of concentrates (44%), 38.4 million tonnes of dry fodder (11%) and 129.4 million tonnes of green fodder (38.4%) for dairy animals (2). The National Commission on Agriculture report (32) also indicated that only 70% of digestible crude protein (DCP) requirement of dairy animals, 50% of the requirement of dry animals, 40% of the requirement of adult cattle and about 20% of the requirement for young cattle were being met from the available feeds. This situation has been projected to continue till the turn of the century (Table 1).

Table 1. Feed availability and requirements for livestock in India (1973-2000, 10^6 mt)

	Concentrates		Dry Fodders		Green Fodders	
YEAR:	1973	2000	1973	2000	1973	2000
AVAILABILITY	11.0	77.0	309.0	356.0	214.0	575.0
REQUIREMENTS:						
Buffaloes	6.3	13.2	84.9	88.8	160.5	454.6
Cattle	10.8	45.6	253.0	269.0	242.0	575.0
Others	2.4	24.0	9.5	14.6	-	135.5
Total	19.5	82.8	347.0	373.0	343.4	594.8
Feed shortage (%)	44.0	7.0	7.0	11.0	38.4	3.0

By comparison, the situation is less serious for non-ruminants, simply because of the ease of importing conventional feeds as cereals, oil cakes and meals and the use of traditional feeding patterns based on technology developed in essentially temperate environments that are both applicable and viable.

A similar situation also exists in Pakistan where despite the availability of 14.2 x 10^6 tonnes of total digestible nutrients (TDN) and 1.4 x 10^6 tonnes of crude protein, there is still a deficit of 49% energy and 42% digestible crude protein (DCP). More recently, it has been reported that the feed resource base in the Near East is also inadequate to support the total feed requirements of livestock, and substantial additional increases in energy and protein supplies are required (55).

Inadequate feed supply influences productivity and this is reflected for example in the ovarian activity of buffalo cows in Indonesia. 35 cows in poor body condition weighing about 275 kg and showing no ovarian activity were allotted to a high or low plane of nutrition for 30 weeks. At the end of this period, 17 of the 18 cows in the high plane of nutrition commenced ovarian activity whereas only 10 out of 17 in the low plane of nutrition did the same (38).

III NON-CONVENTIONAL FEED RESOURCES (NCFR)

Paradoxically however, there is one component of the feed resources that is underutilised and merits more attention in the quest to maximise productivity from buffaloes. This concerns non-conventional feed resources (NCFR). Table 2 summarises the total availability from field and plantation crops in Asia and the Pacific alone.

Table 2. The availability of non-conventional feed resources in Asia and the Pacific (12).

Category	Availability (10^6 tonne)
Field Crops	189.9
Tree Crops	4.2
Total	194.1+

+ Represents 44.9% of the total availability from field and plantation crops

The generation of NCFR is very much higher than these figures suggest as the calculated availability do not include production from a variety of other field crops, statistics for which are not available in the data. Additionally, there are also residues and wastes from animal sources and the processing of food for human consumption which have not been included. Finally, there also exists an abundant variety of tree fodders that are used for feeding ruminants which have also not been included. Likewise, there must also exist quite substantial other categories of NCFR in the other tropical regions such as the Near East, Africa and Latin America.

Non-conventional feedstuffs have a number of characteristics that are peculiar to them (12). These are as follows :
(i) They are the end products of production and consumption that have not been used, recycled or salvaged. (ii) They are mainly organic and can be in a solid, slurry or liquid form. (iii) Their economic value is often less than the cost of their collection and transformation for use, and consequently they are discharged as wastes. (iv) The feed crops which generate valuable NCFR are excellent sources of fermentable

carbohydrates e.g. cassava and sweet potato and this is an advantage to ruminants because of their ability to utilise inorganic nitrogen. (v) Fruit wastes such as banana rejects and pineapple pulp by comparison have sugars which are energetically very beneficial. (vi) Concerning the feeds of crop origin, the majority are bulky poor-quality cellulosic roughages with a high crude fibre and low nitrogen contents, suitable for feeding to ruminants. (vii) Some of the feeds have deleterious efforts on animals, and not enough is known about the nature of the active principles and ways of alleviating the effects. (viii) They have considerable potential as feed materials, and for some, their value can be increased if there were economically justifiable technological means for converting them into some usable products. (ix) More information is required on chemical composition, nutritive value, toxic factors and value in feeding systems.

Approximately 80% of the NCFR is field crops and 93% of the feeds in tree crop cultivation (table 2) are principally suited for feeding ruminants. The utilisation of these feeds by ruminants thus represents a most important function of these animals.

Crop residues, agro-industrial by-products and NCFR are essentially of three categories :-

(i) Energy rich feeds (eg bananas, citrus fruits and pineapple wastes).
(ii) Protein supplements such as oilseed cakes and meals, by-products of animal processing (eg. feather meal and poultry litter), low quality pulses and fishmeals.
(iii) By-products from cereal milling and milk processing.

IV DESIRABLE CHARACTERISTICS OF TROPICAL FEEDS

With most crop residues and the more fibrous agro-industrial by-products, the predominant inherent limitation is fibre. It presents a basic barrier to high digestibility due to a slow rate of fermentation, which further reduces intake. Inherent in most of these feeds is the low nitrogen and relatively high crude fibre contents. Decreased digestibility thus implies that a low proportion of the feed is digested and absorbed, with the end products of digestion, the volatile fatty acids (VFA) showing a high proportion of the energetically least useful VFA.

In cognisance of the characteristics of tropical feeds, the features in the feeds that are desirable for promoting high performance of buffaloes are as follows:

1. Minimum fibre for promoting rumen motility and function
2. Energy yielding substrates
3. Dietary protein sources which are relatively more non-degradable, and
4. Absence of toxic antimetabolite factors.

The significance of digestibility becomes more apparent by the demonstration that the efficiency of utilisation of DOM eaten (OM intake x digestibility) increases as the feedingstuff becomes more digestibile. Up to 60 to 70% digestibilities, increasing digestibility encourages increasing DMI and increasing efficiency of utilisation of the VFA constitutents.

Figure 1 which demonstrates that the efficiency with which ruminants use energy for maintenance is relatively independent of the type of feedingstuff. For fat synthesis (lipogenesis) the energy from highly digestible foods is much more efficiently used because of low acetic acid production, where as for lactation the maximum lies between 70 to 80% digestibility of organic matter. The situation regarding growth of young stock is not known, but is probably between the maintenance and lipogensis lines, and show as a dotted line.

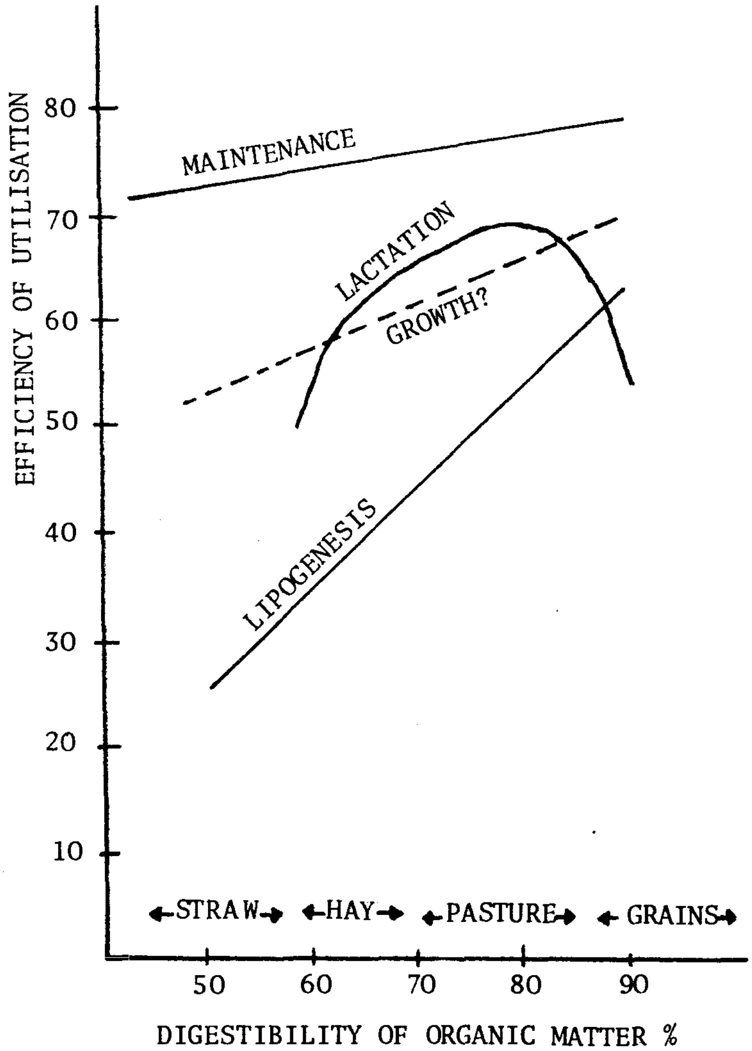

Figure 1. THE EFFECT OF DIGESTIBILITY ON THE EFFICIENCY OF UTILIZATION OF DIGESTIBLE ORGANIC MATTER (D.O.M.) FOR VARIOUS FUNCTIONS

The metabolic activity of buffaloes affects the pattern of voluntary consumption. It has been shown that a general proportionality exists within breeds of sheep and between sheep and cattle (2,3). Additionally, voluntary feed consumption is proportional to fasting heat production within breeds of cattle, between breeds of cattle and buffalo (16, 47).

V PRETREATMENTS

A number of pretreatments can be employed and include (a) physical treatments, (b) chemical treatments, (c) physico-chemical treatments and (d) biological treatments. It is not proposed to discuss these in view of the excellent reviews on the subject (14, 21, 15, 13, 29).

Of the various pretreatment techniques, chemical treatments (acid hydrolysis, solvation, oxidation and alkalis) have received the most attention. Within this category, the most widely examined techniques concern the use of alkalis (ammoniam hydroxide, calcium hydroxide, sodium hydroxide and urea). A summative statement concerning the use of alkalis to improve the feeding value of for example rice straw, is that in most cases, these have not shown to be economic and the technology not easily applied to small farm systems. However, pretreatments of rice straw with urea as a source of ammonia would seem to have the best prospects. Not surprisingly, considerable effort has been directed to examining its value in feeding systems for buffaloes. The improvements include increased intake and live weight gain from a sub-maintenance to maintenance situation of swamp buffaloes in Thailand (50, 43) and increased milk production in Sri Lanka (33, 34). In India, it has been concluded that urea supplementation of straw based diets can boost production markedly and was economical for farmers (49). With buffaloes, it has been shown that 6% urea was found to be better than 3%, (52) although 3-4% levels are said to be optimum in Europe (42).

VI SUPPLEMENTATION

Although energy, protein, minerals and vitamins are used as supplements, proteins are by far the most important. Urea, which is the most popular chemical used for upgrading the quality of rice straw, does not achieve much more than improve the quality of the feed to support maintenance needs. This means that in order to provide the necessary requirements for production, supplementation with specific requirements are essential. The inadequacies need to be corrected to provide additional nutrients, and is an important means to alleviate nutrient limitations. It is also an important component of efficient feeding systems.

Dietary protein is of three categories :- (i) rumen degradable protein (RDP) which is used for microbial protein synthesis, (ii) undegraded dietary protein (UDP) which escapes digestion in the rumen and is absorbed in the small intestines, and (iii) undigested UDP which escapes fermentation and absorption in the intestines. The RDP requirements are considered to be 187.5% g/kg of organic matter apparently digested in the reticulo-rumen (1). It has been estimated (25) that the minimum required crude protein of a poor quality diet with a digestibility of organic matter of 50% would be between 6.1 - 7.4%. With most crop residues with low nitrogen content, and especially cereal straws with 4% crude protein, protein supplementation is clearly necessary.

(i) With performed protein sources

There exist several types of preformed protein supplements that can be used. These include traditional sources such as coconut cake, soyabean meal, fish meal or rice bran and less well know sources which are essentially non-conventional. With fish meal for example, there has been a clear demonstration of response in terms of increasing live weight gain in calves fed 0-250 g fish meal per day. Likewise, there are several other examples of proteins that can also be used for this purpose and these are summarised in table 3.

Table 3. Some non-conventional protein sources and their approximate crude and digestible crude protein (for ruminants) contents (% dry matter basis)

	Protein source	Approximate crude protein content	DCP content+ (%)
1.	Banana leaves	18.3	7.4-13.1
2.	Casava leaves	22.6	11.5-20.3
3.	Cottonseed cake	18.6	11.6-13.0
4.	Guar meal	15.2	26.5-38.3
5.	Feather meal	88.5	78.6-84.6
6.	Leucaena leaves	27.8	13.8-22.9
7.	Neem seed cake	15.2	7.2- 8.9
8.	Palm kernel cake	19.0	12.8-14.7
9.	Palm oil mill effluent	10.6	5.8- 6.6
10.	Pigeon pea leaves	26.7	9.1-11.9
11.	Poultry litter	24.2	16.6-18.2
12.	Rubber seed meal	33.6	18.4-21.7
13.	Sal seed meal	9.2	2.4- 3.6
14.	Spent tea leaf	32.0	-

+For ruminants

(ii) With non-protein nitrogen (NPN)

Urea, usually with molasses supplementation has been traditionally used widely for sheep and cattle, but less so with goats and buffaloes. This has been shown to reduce weight loss in cattle and in sheep (7). In Thailand, inclusions of up to 4% urea with molasses has been shown to decrease live weight loss. Table 4 summarises the results which clearly demonstrate that the effects on live weight loss were dramatic.

Table 4. Effect of supplementing rice straw with NPN and molasses on live weight change in buffaloes (44).

Treatment	Rice Straw intake (kg/day)	Live wt change (g/day)
0%U*	5.02	- 260
0%U + 10%M	4.76	- 280
1.0%U + 10%M	5.68	- 160
2.0%U + 10%M	5.55	- 100
3.0%U + 10%M	5.57	- 100
4.0%U + 10%M	5.53	- 40

*% of total dry matter, U - Urea, M - Molasses

Biuret is another NPN source which has been used for buffaloes (31) and is a slow release nitrogen supplement. Dietary ammoniam sulphate has also been used (52). Poultry litter has uric acid which is also slowly degraded in the rumen, whereby the ammonia released can be more efficiently utilised. It has been shown to have beneficial effects in Thailand and Pakistan (45, 20). Efficient use of the ammonia released in the rumen necessitates however, the presence of readily available energy (eg. cassava chips) and also sulphur.

In recent years, considerable research and development effort has been directed in Pakistan at increasing the use of poultry litter especially in diets for ruminants. The two principal advantages that have been demonstrated are, firstly, potential increased use of the feed, and secondly substantial reduction in the cost of milk production when the diet is formulated from mainly local feeds.

The experience in Pakistan draws attention to the following issues (22):- (i) Prior to feeding, poultry litter should be ensiled, stacked, dehydrated or treated with chemicals or otherwise, to reduce the microbial count and totally eliminate pathogens; (ii) Poultry litter can be fed to different classes of animals as follows :-

(a) Up to 30% DM in the ration (4-6 kg DM/head/day) for high producing dairy cattle. Higher levels of about 45% are possible for brief periods when feeds are in short supply.

(b) Up to 40% DM in the ration for beef cattle. However, not more than 30% is recommended.

(c) Up to also 30% DM for fat lambs, but the copper content in poultry litter may limit the level of the litter below 30%.

(iii) High energy feed ingredients molasses, root crops, grain, etc. are necessary when large (25% DM and above of poultry litter) are used to ensure maximum utilisation of the non-protein nitrogenous component of the litter; (iv) Palatability problems are best overcome by ensiling or chemical treatment. Molasses inclusion increases the palatability and intake of the litter. A dust-free ration prevents irritation of the eyes and the respiratory system; (v) Adaptation to the feed is important and must be done gradually (3-5 days); (vi) When fed at or about the 20% level, poultry litter usually supplies all the calcium and phosphorous requirements; (vii) The critical constituent of poultry litter is ash which reduces the amount of organic matter in the total ration and adds to the total content of indigestibles; and (viii) Poultry litter containing high levels of antibiotics and other anti-microbials and chemotherapeutics should be avoided. Much more use can thus be made of this feed.

(iii) <u>With Urea-molasses blocks</u>

Recently, gelled urea-molasses blocks have been used to facilitate the availability of urea, minerals and possibly even drugs to support maximum use of least cost basal diets. The nature of these blocks and their advantages have been described (26, 24). They have been shown to be advantageous to buffalo calves in the Philippines (5) and for Jersey cows in India. In the latter study, the block licks significantly increased live weight gain (table 5).

Urea/molasses blocks have also been fed to milking buffaloes where up to 60% reduction in concentrate requirements have been observed (24). In India, it is envisaged that these blocks will have wide practical application to involve some 60 million dairy animals.

(iv) <u>With forages</u>

Supplementing with, and more intensive use of forages in feeding

Table 5. Intake of rice straw by Jersey bulls (4) (350 kg liveweight) given 1 kg of concentrate with or without access to a urea-molasses block (23).

Treatment	Straw intake (kg/day)	Intake of block (g/day)	Live wt. change (g/day)	Total feed costs (Rs/day)	Feed costs per kg gain (Rs/day)
Straw + 1 kg concentrate	6.4	0	220	2.0	9.3
Straw + 1 kg concentrate + block	6.8	530	700	2.6	3.7

systems, represents an alternative means of increasing the utilisation of especially dry roughages. There are several attendent advantages and include: (i) easy accessibility on the farm (ii) abundant variety especially in the humid tropics, (iii) many are valuable sources of protein minerals and vitamins; (iv) with some like leucaena a protein source is ensured even during the dry season. (v) provide variety in the diet, (vi) have a stimulating effect on intake, and (vii) a laxative influence on the alimentary system. While there are several examples of forages including a variety of grasses, some of the more important proteinaceous forages include banana (Musa spp.), cassava (Manihot esculenta Crantz), pigeon pea (Cajanus cajan), gliricidia (Gliricidia maculata), sesbania (Sesbania grandiflora) and water hyacinth (Eichornia crassipes). In integrated farming systems, the use of these supplements is clearly of advantage.

Examples of their use with buffaloes are not extensive, but include cassava leaves (50) and water hyacinth (51) in Thailand, and leucaena leaves in Indonesia and Thailand (30).

Forage quality is important in ensuring a high intake of it as well as the base roughage. In some cases supplements of leucaena to rice straw for example, had little effect on digestibility even when they comprised a significant proportion of the diet (30), whereas with the others there was a significant increase in metabolisable energy (ME) intake and nitrogen retention (10). Figure 2 illustrates the latter relationship in untreated rice straw diets substituted with up to 60% of leucaena forage.

The implication of these findings is that if higher dietary energy and nitrogen are to be made available to animals, then a more leafy forage (with less twigs and stems) needs to be provided. In this context (46) demonstrated that when high quality leaf meal or gliricidia leaf was included at between 10-12% of dietary dry matter of a rice straw-based diet, live weight losses were small over a 45 day period.

In terms of practical application, (39) recommended that feeding straws with green fodders, whether these are grasses or legume in the ratios of 3:1 or 1:1 should meet the requirements for maintenance and growth respectively. On the other hand it has been suggested that green forage, preferably legumes, can be given up to a maximum of about 0.7% (dry matter basis) of live weight or about 25% of the diet (36). Palatability of the forage is important and as far as is

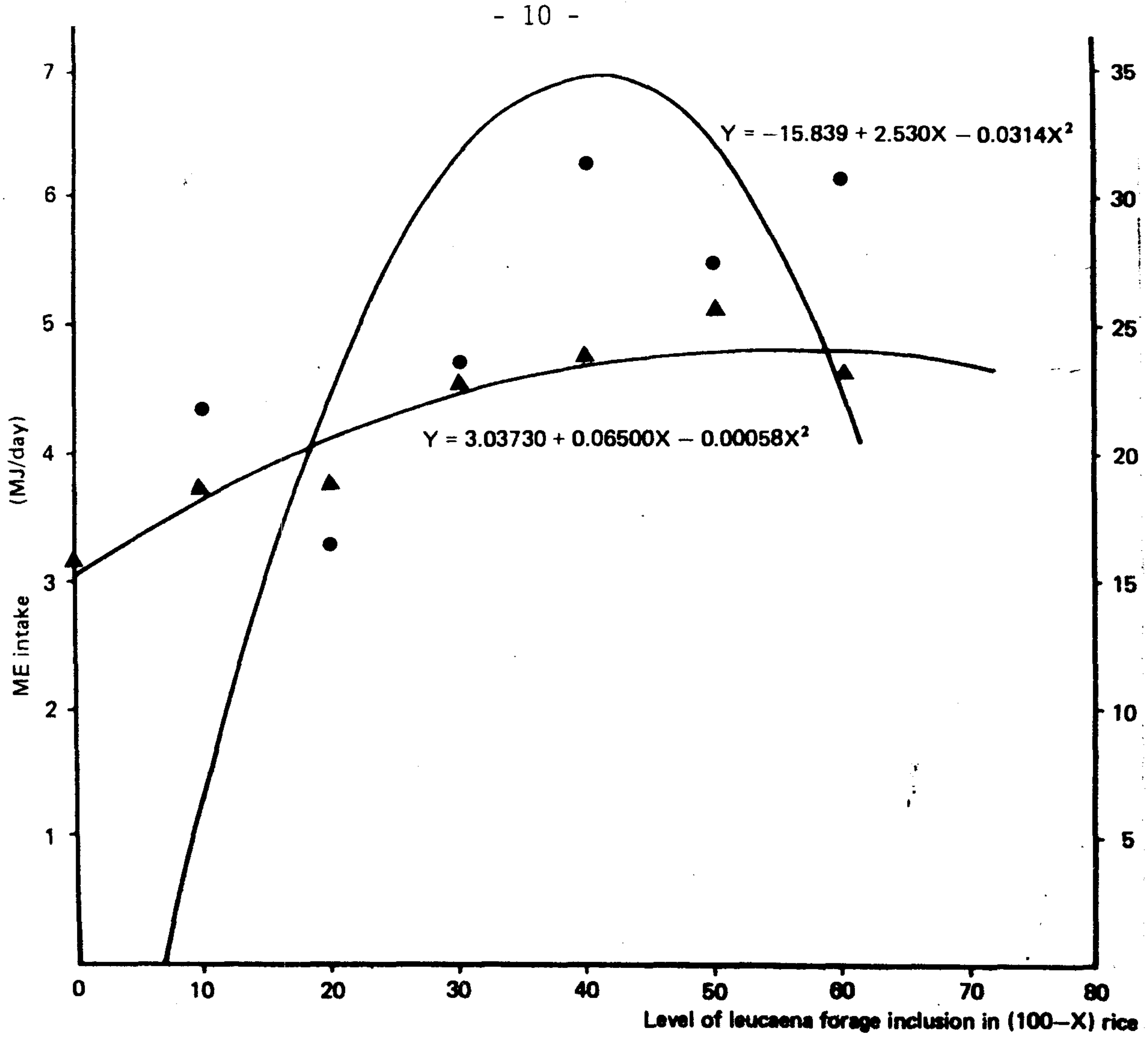

Figure 2. Trends in the intake of ME and N retention in sheep with increasing level of dietary leucaena forage

possible, there should also be minimum toxic components in the feed that limit their utilisation.

It is of interest to note that comparisons between supplementation of straw-based diets with green forages versus urea pretreatment of the straw for growing cattle (6) and lactating cattle (37) have given similar production responses, emphasising again the limitations of nutritive upgrading on the one hand, and the value of judicious combination of available feeds on the other. The appropriateness of the right option needs to be considered carefully in relation to the prevailing circumstances.

(v) Economic aspects of supplementation

The final value of any pretreatment technique is the economic advantage to be derived and this aspect has been emphasised (17, 18). The total costs of the pretreatments need to be weighed against the beneficial effects, including the extent of the animal response. To be economic, maximum advantage should be sought from the effects of treatments (41). However, most research reports have not addressed this issue in feeding trials which determine nothing more that the value of a pretreatment with or without supplementation in the response in animals, usually meat, milk and draught capacity. It is essential that more attention to be given to this aspect as one important determinant of the value of pretreatment.

(vi) With mineral supplements

Mineral deficiencies are widespread throughout most parts of Latin America, Africa and Asia (28), and need therfore to be given adequate attention. In Malaysia, it has recently been reported based on extensive surveys, that there existed definite Ca, P, Mg, K, Cu and Zn deficiencies which are associated with poor constitution and low productivity (53). Corrective measures are thus essential, based on the nature and extent of the prevailing deficiencies. Beneficial effects of such supplementation have been reported in India with Murrah buffaloes (14), in the Philippines (4) and in Malaysia (54).

VI CONCLUDING COMMENTS

Attention to more efficient use of feedstuffs for buffaloes is possibly the most important intervention in the production system. Increasing this efficiency calls for more intensive use of the available feed resources, especially since production systems are unlikely to change in the forseeable future. In view of the peculiarities inherent in tropical feeds, an important prerequisite is an understanding of the characteristics of these feeds and especially their limitations. This enables an approach to ensure a better balance of the digestion end products, improved feed efficiency and therefore, higher performance in animals.

In the search for more efficient utilisation of the available feedstuffs, low productivity due to inadequate nutrition in many tropical regions, justifies a more concerted effort to utilise especially the non-conventional feed resources (NCFR). Innovations need to be introduced that are pragmatic, realistic of farm situations, and which can provide for optimum use of available feeds (27). Several pretreatments are potentially advantageous, but economic benefits and widespread use of these remains to be seen. Supplementation with energy, protein, minerals and vitamins appear however to have much better prospects, need to be more vigorously addressed and widely applied in production systems for buffaloes in the tropics.

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