

## FEEDING STRATEGIES DURING NATURAL CALAMITIES

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### SUMMARY

Livestock production is affected by natural calamities that cause lack of water and feeds. The strategies for emergency feeding depends on whether animals have to be saved from starvation only or whether their production of milk etc. has to be maintained. The difficulty to slaughter animals in India, and the size of the nation, where floods and droughts can occur simultaneously, presents special problems of transport of feed. Some preliminary calculations about alternative strategies and their costs are explained. If transportation of feed (i.e. nutrients) is to be considered, the bulkiness of the feeds is a serious constraint by increasing the cost of transport. The use of high quality (i.e. concentrated) feeds, or the densification of straws are options to reduce the bulk to be transported. Some densification methods are briefly discussed here. If transportation of feeds is not feasible, nutrients can be diverted from the feeding of a relatively smaller number of animals that produce milk or liveweight gain, to the feeding of a larger number of animals at (sub)maintenance levels of production. In this case the survival of animals becomes the most essential form of animal production. The differential effects of these strategies on farmers' income (short and long term) and incurred risks are discussed. Finally some attention is given to important aspects like weather forecasting to assess risks and to facilitate precautions, improved use of conventional feeds and water requirements of the animals.

### INTRODUCTION

The average individual milk production for cows and buffaloes in India is very low i.e. 157 kg and 504 kg respectively (NCA, 1976; Dairy India, 1987). This is mainly due to insufficient feed quality and quantity. Cereal straws form the major source of feed for ruminants in India but estimates based on energy requirements indicate that there is not enough straw produced annually to feed all the ruminants in India. Even if the quantity of straw would be sufficient, the quality can restrict the use of straw, depending on the purpose of production (Zemmelink, 1986).

The shortage of animal feed is further aggravated by frequent calamities that can be classified on the basis of their effect on feed resources, their duration, extent, seasonality, certainty of occurrence and relative shortages of protein or energy. Natural

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calamities that directly affect the feed availability include: floods, droughts, cyclones, land slides, hailstorms. Political instability such as wars, fires and blockades also indirectly affect the feed availability. Such calamities increase the gap between the demand and supply of feed. The feed supply of Gujarat, Rajasthan, Karnataka and Maharashtra was badly affected in the serious drought of 1984-1987.

In fact, it has been estimated that 43% of the total livestock in India are perpetually affected by drought. Also, floods in the Northern region of the country take the lives of humans and livestock and it is reported that 10000 livestock and 1400 human lives were lost every year from 1953 - 1986 (Sastry, 1989). The government regularly spends large amounts of money for the protection of human lives and maintenance of livestock during these drought and flood periods. Milk procurement under the Operation Flood program was reduced by 9% per day in 1987 in some states as compared to 1988, only partly caused by organizational problems.

The feeding of animals during scarcity is discussed in many publications, e.g.: Champion (1971), Ranjhan and Khera (1981), Saville (1981), Leng (1986), Leng and Preston (1987), Sharma (1987), Kunju (1987), Rangnekar (1989), Cronjé (1990) and Fordyce et al. (1990). Most of these papers however merely list the feeds to be used without elaborating the strategies to be followed. Moreover, much of this literature elaborates supplementation of animals in situations where feed quality is low, but where sufficient dry fodder is available. This situation occurs in ranching conditions where the "animals are starving in a sea of plenty" (Altona, 1966), i.e. where the quality of the basal roughage does not permit optimum rumen functioning. In that case use can be made of catalytic effects of certain supplements on utilization of low quality fodder, and on animal survival and production (Preston and Leng, 1987; Cronjé, 1990; Prasad et al., 1993). However, Fordyce et al. (1990) elaborate feeding strategies and their applications for animals in different stages of pregnancy, age and body condition, to maximize survival rates and subsequently to minimize a reduction of reproductive performance after scarcity.

This paper discusses economic aspects of drought feeding strategies such as:

- adjustment of feeding strategies;
- purchasing the feed from areas with feed surpluses and
- reduction of transport costs.

The examples are fictitious and they have been kept very simple, e.g. no distinction has even been made between compensatory production of dairy or beef (Allden, 1970; O'Donovan, 1984; Robinson, 1990). Also, the assumptions on herd compositions or mortality can easily be challenged, but the paper is meant only to serve as an outline of work that needs to be developed and refined subsequently.

### SCARCITY FEEDING: OBJECTIVES AND STRATEGIES

The type of feed shortage determines the strategies for emergency feeding. Some nutrient shortages concern a lack of feed quality (energy and/or protein), others concern an absolute lack of quantity. Feeding strategies during droughts can have one or more of the following objectives:

- to feed animals for maintenance at a minimum body weight, leading to a strategy that ensures survival of animals from the available feed);
- to feed animals to maintain weight above the critical or minimum bodyweight including allowance for weight gain in growing animals. In a long drought this would mean that less animals would survive as the available feed would be used quicker;
- to preferentially feed productive stock, such as pregnant and lactating cows. This is called strategic feeding, it would again mean less feed for other animals).

Critical body weight is the body weight below which mortality rate rises rapidly. Definite threshold values are difficult to give and depend on duration and type of underfeeding, as well as on the loss of production that is considered acceptable. If the animal has good fat reserves it will use these as a source of energy during weight loss. Animal deaths in drought are mainly due to exhaustion of body fat reserves. The tissues of animals dying from starvation for example, contain less than one percent crude fat (Champion, 1971). As an example, the critical body weight is approximately 35 kg (at a condition score of 1.5) for Peppin type Merino sheep which is a relatively small body size in Australia. At maximum condition score 5, their weight would be around 65 kg. If the same sheep was to be maintained at 40 kg weight, 11% more feed would be required each day. For Indian farming systems these values are quite different, but no detailed information is available.

The survival or critical body weight varies with species, strain, breed and age of the animal. It has been reported that cattle will die if weight loss is > 20% of body weight, while sheep and camels can tolerate weight loss up to 30% of the body weight (Leng and Preston, 1987). Cronjé (1990) gives critical bodyweight losses of 30 - 40% in cattle and sheep. Obviously, the weight loss that can be tolerated depends on the original weight and condition of the animals, as well as on the physiological status of the animals: i.e. young stock tolerates less weight loss compared to mature animals (Cronjé, 1990). An adult animal in good condition can also lose more weight than the same animal in poor condition. Part of the weight loss may be caused by lower gut fill. A knowledge of critical weight losses for different species is required to optimize feed resource allocation during emergency, but these are not commonly available in India. It would also be useful to use or develop condition scoring techniques to estimate how much weight individual animals are able to lose.

The effects of temporary weightloss can be recovered by compensatory gain (O'Donovan, 1984) especially in growing animals. Farmers all over the world apply this principle especially in beef animals where they let the animals lose weight in time of scarcity, in order to gain weight in times of abundant feed supply. For milk production, the effects of periodic undernutrition on general health and fertility reproduction are however more likely to be of a long term nature. Lactation curves are unlikely to recover and calving rates and conceptions may be lowered (Allden, 1970; Robinson, 1990)

### **STRATEGIES BASED ON REALLOCATION OF A GIVEN AMOUNT OF FEED IN THE HERD**

The first major option to overcome a feed shortage is to adjust the animal production to the feed availability. Hypothetical and simplified calculations on the economics of different feeding strategies are given below to illustrate this option. The calculations have been done for a large herd with a given composition. Choices for smallholder herds will work out differently and they need special study since e.g. 10% mortality in a large herd works out different than 10% mortality in herd with one or two cows. Details on an assumed fictitious herd structure and production are given in Table 1. The mortality is assumed to be entirely caused totally by starvation because no pasture was available and no feed was given to these animals. Three strategies to adjust feeding patterns and reduce mortality rates are considered:

- a) diversion of nutrients from milk producing animals to all other animals of the entire herd;
- b) diversion of nutrients from growing animals and bullocks to save other livestock;
- c) diversion of nutrients from both milk producing and growing animals to the starving animals.

Ad a: Milk production is reduced and the nutrients are diverted to feed the undernourished animals as per their requirements for maintenance. It is estimated that the farmer has to divert the nutrients of 230 litres milk/day to save all the animals, e.g. about 30 INR/animal/day. This would **reduce total milk production** from 290 to 60 litres, greatly reducing farmers income, but securing the survival of more animals.

Ad b: This is the diversion of nutrients from growing animals and bullocks to save other livestock. If the growing animals were fed sufficient nutrients to gain 400 g/day and bullocks and old cows were offered 80% of their requirement, 10 out of the 29 animals at risk can be saved. In this strategy **milk production is not reduced**.

Ad c: If a farmer does not want to lose so many animals and if he/she cannot afford to cut milk production as drastically as in option A, the strategies can be combined. In this case some nutrients would be diverted from milking as well

as from growing animals, thereby **saving almost all animals** at the cost of 120 kg milk/day (Table 2).

The strategies differ in many respects and their applicability depends on the conditions in the farming system under study. A reduction of milk yield results in a decreased daily income, which may be difficult to accept for farmers who do not have sufficient other sources of income or cash reserves. The feeding of animals below their requirements (strategy B) is risky because

Table 1 Assumed herd structure and mortality rates.

Type of animal	Body weight (kg)	No. of animals	Milk or gain per day	Mortality (%)	No. of animals dying of starvation
High prod.	400	20	8 kg milk	0	-
Medium prod.	400	20	5 kg milk	0	-
Low prod.	400	10	3 kg milk	0	-
Old cows	400	10	-	100	10
Ad.preg.	400	15	-	35	5
Bullock	500	10	-	40	4
2 - 3 yrs	250	9	600 g/day	11	1
1 - 2 yrs	150	8	600 g/day	12	1
0 - 1 yr	75	8	500 g/day	100	8
TOTAL		110	290 kg milk + 9 kg growth/day		29

Note The nutrient requirements of the animals have been calculated as per NRC (1989). The other values are assumptions based on field experience

Table 2 Mortality rate of animals under different feeding adjustments (based on field estimates)

Category of animal	Expected mortality without intervention	Mortality of animals		
		Strategy		
		A	B	C
Pregnant cows	5	0	0	0
Old cows	10	0	5	2
250 kg heifers	1	0	1	0
150 kg heifers	1	0	2	0
75 kg calf	8	0	6	1
Bullock	4	0	5	1
Total dying	29	0	19	4
Saved animals	0	29	10	25
Milkprod. (kg/day/herd)	290	60	290	170
Loss of LWG (kg/day/herd)	5.2	0	5.6	3.9
Number of animals at 80% of maint.	0	0	10	17
Cost of dying animals (*1,000 INR/herd)	140	0	75	18.5

Assumptions:

0. shortage of feed is the only cause of mortality. Dying animals are not fed at all.
1. cost of milk INR 4 per kg
2. cost of pregnant cow INR 8000
3. cost of old cow INR 6000
4. cost of heifer (250 kg) INR 5000
5. cost of heifer (150 kg) INR 3000
6. female calf (75 kg) INR 1500
7. bullock INR 5000

more animals may die eventually if the calamity continues for a longer time. The choice of strategy is obviously affected by the nature of feed shortage, whether it is regular and predictable or irregular and unpredictable. Both situations are common in the wide variety of Indian farming systems. Strategy B also results in underfed cattle that are less valuable after the calamity. The extra value or costs of these animals is, however, difficult to assess partly because of compensatory gain or lower fertility rates, especially of the younger animals. Also, the value of animal survival is much higher for predominantly Hindu society of India than in many other countries of the world. The relative need to possess an animal that can pull the plough at the next rainy season further complicates the valuation of mere survival as a form of animal production.

### STRATEGIES BASED ON THE PURCHASE OF FEED

The second major option to save animals is to purchase feeds from surplus regions. High transport costs are then involved, particularly in a large country like India where extreme droughts and rains can occur simultaneously and where slaughter of animals is generally considered taboo on religious grounds. It is essential that the cost of feeds are considered on the basis of their nutritive value and that transport cost be included.

On this basis highly nutritive feeds like grain may prove to be the most economical if feed is transported over large distances even more so if costs are expressed in terms of nutritive value, e.g. TDN or CP. The calculation of Table 3 shows that at larger distances, i.e. beyond 200 km. the cheaper transport of concentrates favours the cost of nutrients from grains over dry grass. Note that this applies to the cost of grass that is not densified, i.e. only loosely studied.

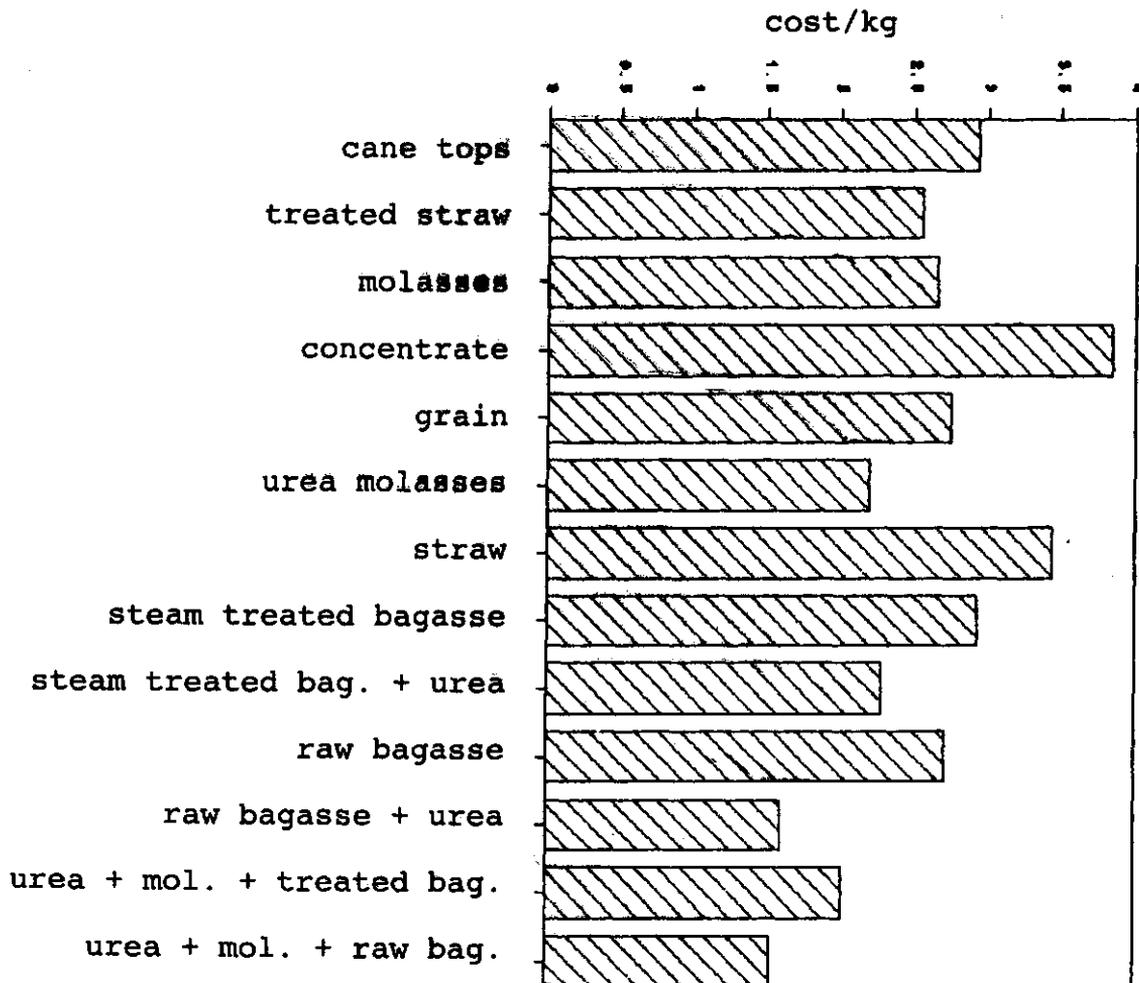
Table 3 Cost of grass and grain at different distance

Particulars	Unit	Grain	Dry grass (not densified)
Cost	(INR/1000 kg)	2000	1200
Quantity/truck	(kg/truck)	10000	2000
Cost of transport	(INR/km/truck)	10	10
Cost of feed for 100-400 km.			
	(INR/1000 kg/100 km)	2100	1700
	(INR/1000 kg/200 km)	2200	2200
	(INR/1000 kg/300 km)	2300	2700
	(INR/1000 kg/400 km)	2400	3200

The option of grain feeding however has limited value because good quality feeds are already scarce under normal circumstances. Market prices do not always reflect actual availability and grains are not likely to be diverted from human consumption if the calamity is of such a scale that it also affects human nutrition. Therefore, feeds available for purchase include agro-

industrial byproducts such as bagasse, grainmilling byproducts and molasses or grasses and straws from the fields. The daily requirement of CP and TDN to maintain the 29 animals which would die without intervention in the example of Table 2 would be 15 kg and 72 kg per day respectively. The milk production of the cows will be maintained in that case.

Figure 1 Cost of nutrients to save the animals (expressed in INR/kg)



Different feeds were compared to supply the required nutrients for the herd, and their chemical composition of feed was taken from NRC (1988). Transport charges are not included in the prices of these simplified calculations, but in reality transport costs can be substantial and need to be considered. The cost of the nutrients to save the animals with different rations is presented in Figure 1. The cost of nutrients from bagasse was lowest and the cost of nutrients from concentrate was highest (transport excluded). The cost to save the animals by diverting nutrients from milk production to the animals at risk was 230 kg milk per

excluded). The cost to save the animals by diverting nutrients from milk production to the animals at risk was 230 kg milk per day, i.e. INR 920, but by purchasing the feed the cost is only INR 250 per day on concentrate feed and INR 150 per day on unconventional feeds like bagasse. This situation changes considerably if feed is not available nearby and transport costs are incurred (Table 3). Experiences in the Gujarat drought were that the price of grass or straw doubled, due to transport costs and because the feed supply becomes limited. Hereunder some attention is given to the options to reduce transport cost for the bulky feeds by densification.

### REDUCTION OF TRANSPORT COSTS

Grasses from forest areas or crop residues from regions with surpluses are commonly transported to feed animals during droughts. The possibility of transport depends on the nature of the calamity as discussed in the introduction. Transportation of feed is only an option if the drought is regional. It has little or no value if infrastructure is highly damaged (floods) or if the calamity is of a much larger scale (severe droughts that occur throughout most of India). In the case of the 1984/1987 drought in Gujarat, it was observed that transport costs were at times higher than the costs of the feed itself.

One way to reduce transport costs is to compress or to densify the bulky feeds. Jadaï et al. (1990) reported that there was 2.25 - 2.70 times increase in bulk density of straw based complete feed. Densities can be increased from 65 - 75 kg/m<sup>3</sup> to 100 - 110 kg/m<sup>3</sup> by baling or even 300 - 500 kg/m<sup>3</sup> by briquetting (Bruhn et al., 1975), which seems very high however. The costs of baling grass by hand and bullock driven presses (pada press) is given in Table 4. The quantity of feed which can be transported in each truck is more than doubled after baling. The calculations of Table 4 show that when transport distance exceeds 50 km the costs of baling are recovered by reduced transport costs in case of pada press with our (over)simplified calculations. The cost for hand pressing is recovered when transport distance exceeds 150 km. Extra benefits like reduced storage costs, less spoilage

Table 4 Economics of baling

Particulars	Unit	Lose grass	Hand press	Pada press
Cost of baling	INR per 1000 kg	-	200	125
Weight of grass	kg per bale	-	50	100
Quantity of grass/truck	1000 kg	2000	3000	5000
Transport and baling cost	INR per 1000 kg			
* over a 10 km distance		50	230	145
* over a 50 km distance		250	367	225
* over a 100 km distance		500	533	375
* over a 150 km distance		750	700	425
* over a 200 km distance		1000	867	525
* over a 300 km distance		1500	1200	725

and consequently increased quality of the feed are likely to occur, but difficult to quantify at this stage. It also depends on the type of straw and the method of densification.

## **OTHER STRATEGIES TO OVERCOME FEED SCARCITY**

### **Reduction of wastage by chaffing**

If straw is insufficiently available for feeding of all animals, the reduction of wastage might be an option. It is reported by Shukla et al. (1988) that 15 - 20% of the the straw offered is refused when it is fed unchaffed. Therefore chaffing, may be worthwhile, even though it reduces the selection by the animals for the most digestible parts like leaves (see the discussion of selective consumption by Ranjhan, 1993). In Haryana and Punjab states chaffing is common on farms, but it is not widely practised in other areas, probably for nutritional reasons as elaborated by De Wit et al. (1993).

### **Straw treatment**

Treatment of straws would not be expected to contribute to the nutrient supply during emergency feeding, if the major advantage of treatment is the increased intake of the straw in order to save relative expensive supplement (Schiere and Nell, 1993). However, the transport of urea or ammonia, and treatment might be cheaper than the purchase and transport of additional concentrate or roughage. In that case the intake of treated straw is to be limited to what is required for the desired (sub-) maintenance level of nutrient supply.

### **Feed storage**

The surplus feed from good years can be stored for use during calamities or even during the lean seasons of the year when prices of fodder increase sharply. Making of hay or silage is unlikely to be useful in generalized rural conditions but a study is required to specify the (dis)advantages per farming system.

### **Complete feeds**

Complete feeds imply a system of feeding all ingredients including roughages, processed and mixed uniformly, to be made available at *libitum* to the animals (Sharma and Singhal, 1986). Complete feeds can be produced in mash and pelleted form when this product is fed as sole source of nutrients. Pelleting of complete feeds increases voluntary intake by 3-30% and processing cost by 57-130% depending upon the type, percentage and original cost of roughages in the ration (Reddy, 1986). If baling of fibrous feeds is practiced, it can be useful to produce complete feeds for use during droughts, i.e. to add some concentrate ingredients. Biologically, the use of complete feeds with an appropriate balance of roughage and concentrates may lead to

better utilization of locally available crop residues, agricultural-byproducts and waste. Complete diets for livestock could benefit rural farmers during periods of feed shortage if the feed and transport costs can be kept low. Otherwise city farmers will be more likely to buy them. Not many studies on economics of this system are known, but the BAIF Development Research Foundation (Rangnekar et al., 1986), Andhra Pradesh Agricultural University (Reddy, 1986), National Dairy Research Institute - Karnal (Sharma and Singhal (1986) and Hisar Agricultural University (Rathee and Lohan, 1986) are engaged in developing complete feeds on locally available byproducts like bagasse, mixed with tree leaves and other unconventional byproducts. However, the composition of the complete feed needs to be adjusted to the production level of the animals, which is a complication for processing and distribution of this type of feed.

#### **Weather forecasting**

The choice of the best strategy depends on the type and duration of the calamity. The weather forecasting and extension system should be well established which will help the farmers to prepare for the calamities in advance. For floods this might be a reasonable possibility. For droughts the decisions on preferred strategies would be easier if the duration of the drought was known. This is never the case, but historical records of climate and duration of droughts in different areas of India might enable development of predictive models to give best estimates of likely duration of droughts.

#### **Fodder trees**

Tree planting has been started on a large scale in India. Trees have the advantage that they produce fodder less affected by various calamities. Tree growing could also be done for other purposes like the production of timber (Hegd , 1992; Devendra, 1990).

#### **Small versus large animals**

Farmers in drought prone areas keep animals to supplement their income from crop production which is more directly affected by drought. A failed grain harvest can to some extent be compensated by using the stores for animal feed. In comparison to large animals, small ruminants like goats and sheep have some advantages:

- rapid recovery of the population after calamities are over because of their higher prolificacy;
- small ruminants are not affected by the religious taboo on slaughter;
- they are typically multipurpose animals combining the production of wool, mutton, milk and/or hides;

- their feed requirements per animal are lower, facilitating the possibility of diversified feeding strategies and thereby the survival of part of the herd.

### Water requirement of livestock

An essential requirement of a living organism is "water". The water availability during a drought is essential as water helps to regulate the body temperature, for transport of nutrients, etc. The water requirement is related to factors like heat load, production traits and DMI. The water requirement of an animal is in the range of 2.5 to 4.5 l/kg DMI. A more detailed review of water requirements is needed, but Murphy et al. (1983) give the following equation for lactating cows in early lactation in Western conditions mainly:

$$\text{Water intake (kg/day)} = 15.99 + [(1.58 \pm 0.271) * \text{DMI}] + [(0.9 \pm 0.157) * \text{kg milk/day}] + [(0.05 \pm 0.023) * \text{sodium intake in g/day}] + [(1.2 \pm 0.106) * \text{minimum daily temperature in } ^\circ\text{C}]$$

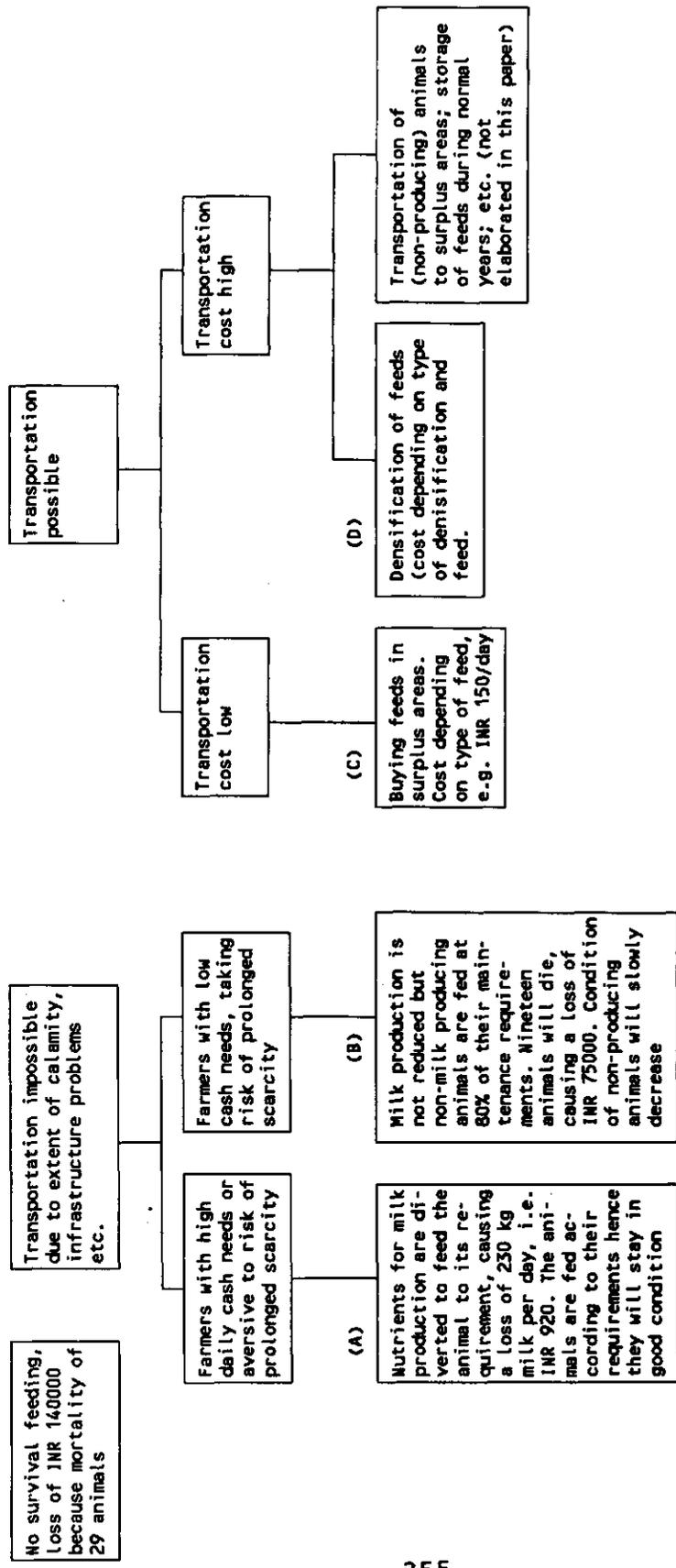
The ratio of Water Intake:DMI will also rise if feed intake is restricted. Therefore, it may be better to express water requirement as a percentage of body weight.

Required frequency of watering is not well studied and depends on the type of animal. Extending watering frequencies to 2-3 days have proven to be practical during drought periods for large ruminants when water is scarce. This has the advantage of reducing overall feed and water consumption with possible improved nutritional benefits in terms of increased feed digestibility (Leng, 1986). The increased feed digestibility is primarily due to increased retention time of digesta in rumen. Body reserves were unaffected due to extending water up to 3 days as compared to daily offered (Leng, 1986). The effects of restricted water intake include reduced urine output and reduced feed intake. If the water deprivation is severe, dehydration will occur, combined with protein catabolism and finally a failure of the renal function.

### A DECISION TREE ON FEEDING STRATEGIES

Some of the scarcity feeding strategies discussed in this paper, are again, systematically, shown in diagram 1 along the lines of a so-called decision tree (Dohoo, 1984; Chamberlain and Esslemont, 1990).

Diagram 1 : A simple decision tree for scarcity feeding



## CONCLUSIONS

Many authors discuss feeds to be used during droughts, but only few discuss feeding strategies according to type of calamity. Such strategies can vary from the feeding of many animals at (sub)maintenance levels to the feeding of a few animals for production, from supplementation to maintain production or accepting lower production with lower cost of supplementation. The suitability and economics of strategies for feeding animals during droughts differs between type and duration of feed scarcity, resource condition and objective of the farmers, as well as between locations and type of animals.

Cost of nutrients and transport of grains is often cheaper than transport of dry fodder, but since grains are food for humans they can not extensively be used for animal feeding. Transport of grass or straws is expensive but it may be the only way to feed the animals during calamities. Densification can reduce transport cost but is only economical beyond a certain distance, which is around 50 km in our hypothetical example.

A number of other approaches is possible and include reduced wastage, treatment, storage. The merits of each of these can only be discussed while considering the type of emergency and the appropriate strategy.

## ACKNOWLEDGEMENTS

The authors are thankful to P.T. Doyle, D. Muys and J.B. Schiere for their suggestions.

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