MODELLING FEED RESOURCES BUDGETS IN THE MOIST SAVANNAHS OF WEST AFRICA

A. Naazie and J. W. Smith
International Livestock Research Institute, Moist Savannah Program, PMB 5320, Ibadan, Nigeria

ABSTRACT
A deterministic model was developed to evaluate the adequacy and utilization of ruminant livestock feed resources in the moist savannahs of W. Africa. Changes in land cropped and available as range, were used to project changes in feed resources over time and to evaluate whether these feed resources were adequate for the expected numbers of livestock in the region. Ignoring crop residues as feed resources would result in feed shortages especially in the drier northern parts of the moist savannahs. If 50% of the residues could be used as feed, feed shortage would be unlikely irrespective of area cropped. In that case range resources lost through expansion of cropped area are effectively substituted for by the resulting crop residues. Research on how much residues can be used as livestock feed without affecting land productivity is warranted.

KEYWORDS
Modelling, budgeting, feed resources, savannahs, Livestock

INTRODUCTION
The population of Sub-Saharan Africa will more than double by the year 2025 and the rural: urban population ratio will shift from 2.70:1 to 0.56:1 (Winrock, 1992). The large and more urban population will demand more and better quality foods, thus increasing demand for livestock products. This has to be met by cultivating more land, increasing productivity and crop-livestock integration. Land use patterns will change significantly as a consequence. Less range will be available, even though ruminant livestock products must increase by 3.4% per annum to meet the new demand (Winrock, 1992). Increased reliance on crop residues by ruminants (McIntire *et al*., 1992) will therefore be expected. The successive use of land for grazing and cultivation and the varying relative proportions of range and cropped areas has unknown consequences for both crop and livestock enterprises.

The objective of this study was to develop a model of feed budgets in the moist savannahs which could be used to evaluate the adequacy of the feed resource and utilization strategies. The budget accounts for spatial variability in availability and utilization of feed resources. Ultimately, it will account for temporal variability and budgeting at the household level.

THE MODEL
The moist savannahs of Nigeria were used as a template for a wider regional model. A survey and inventory of livestock resources conducted in 1989/90 by the Resource Inventory Management Ltd (RIM, 1992) provides good estimates of current livestock populations in Nigeria and good estimates of land use for parameterizing the model. The model consists of animal (demand) and resource (supply) submodels. The animal submodel deals with the numbers of ruminants in the zone and their projected increases. It was defined in terms of Tropical Livestock Units (TLUs; 1 TLU = 250 kg, Cattle=0.7 TLU, Sheep and Goats=0.1 TLU; Jahnke, 1982) and projection of desired increases in TLU numbers were based on 3.9% increase yr^{-1} (FAO, 1995). It was assumed that each TLU consumes 2.5% of its body weight in feed or 6.25 kg DM feed day^{-1}. A crude protein content of 7% and 8.368 MJ ME kg^{-1} diet DM were used (Winrock, 1992).

The other submodel projects the agriculturally useful land (cropped and range land) available, how much forage/crop residue resources are available and how these resources are affected by land use changes. 19.6% of the land in the moist savannahs is cropped, and about 72.4% is range (RIM, 1992). A survey by the Collaborative study of Cassava in Africa (COSCA) provided data on the types of crops cultivated in the region (Nweke, 1994). Estimates of the residue production of major crops and their degradabilities (Adewumi, 1996) were used to estimate the amounts of crop residue generated yearly in the moist savannahs in terms of DM, metabolizable energy (ME, MJ) or crude protein (CP, kg). Increases in crop production were projected on a 2% yr^{-1} expansion in cropped area (Winrock, 1992). For range, it was assumed that fallow lands, grasslands, shrublands and woodlands are equivalent. A conservative estimate of carrying capacity of 6 ha TLU^{-1} yr^{-1} (Fitzhugh *et al*., 1978; Winrock, 1992; Tacher *et al*., 1988; Penning de Vries and Djiteye, 1981) was used to project how many TLUs can be supported by range. The sum of the TLUs supportable by crop residues and range was then compared with the TLUs actually available or expected to determine if the feed resources were adequate.

There are few estimates of how much crop residue are actually utilized by livestock. Two scenarios were therefore assumed; utilization of crop residues was assumed to be close to 50% (upper limit) or 10%, (lower limit).

PRELIMINARY MODEL EVALUATIONS
The model was used to estimate the adequacy of feed resources in the moist savannahs. The results based on CP requirements, which are usually the most limiting, are presented in Table 1. Under current assumptions, there is no immediate feed resource problem in the moist savannahs of W. Africa. However, under low crop residue utilization, the gap between what is required and what is available is small, implying little room for future growth. This suggests that it is not feasible to ignore utilization of crop residues as feed resources in the medium and long term. It is also interesting to note that if approximately 50% of the crop residue could be utilized as livestock feed, it could probably support more animals than range. This is partly because the utilization of range resources was treated rather conservatively but also indicates the fact that the model is sensitive to estimates of how much crop residues are actually utilized.

Projections to the year 2025 indicate that under the scenario of high crop residue utilization, the numbers of livestock that can be supported by range and crop residue exceeds the actual numbers that would be required in the zone (fig. 1a). Under this scenario, feed resource inadequacy is unlikely in the next three decades. Under low utilization however, feed resources will be deficient by the year 2000 (fig. 1b). This reenforces the fact ignoring crop residues as livestock feed in the moist savannahs of W. Africa will be a blunder. The feed resource shortage is not immediately obvious as migration of animals from place to place offers a safety valve. When agriculture intensifies with the new demographics, this may not be possible any more.

At the sub-regional level, the northern guinea savannah will barely have enough feed resources by the year 2025 under high crop residue utilization. Under low crop residue utilization, however, none of the zones will have enough feed. The derived and southern guinea savannahs will be deficient by the years 2020 and 2005 respectively. The northern guinea savannah would already be deficient. The feed shortage is more severe up north under low crop residue utilization for two reasons. There are more animals and cropped land as we move north. As there is less range in the north, if crop residues are not utilized, the feed resource shortage is felt. It is common knowledge however that more crop residues are used as livestock feed in the north than in the south but there are no good estimates of this, hence this has not been worked into the model. This coupled with the seasonal migration of stock as stated earlier seem to mitigate the feed resource shortage.

These initial results highlight the importance of crop residues in the

moist savannahs where crop-livestock integration is becoming the norm. Temporal aspects of feed availability are being investigated as well as budgeting and allocation of feed resources at the household level. Research on optimal utilization of crop residues will however be of great importance.

REFERENCES

Adewumi, M. K. 1996. Feed resources evaluation and budgeting in the agropastoral systems of the derived savannahs of Oyo state, Nigeria. Ph. D. thesis, Univ. Ibadan (under preparation).

FAO. 1995. FAOSTAT-PC. CD-ROM produced by ILRI information Services, Nairobi.

Fitzhugh, H. A., H. J. Hodgson, O. J. Scoville, T. D. Nguyen and T. C. Byerly. 1978. *The role ruminants in support of man.* Morrilton, Arkansas: Winrock International.

Jahnke, H. E., 1982. *Livestock production systems and livestock development in tropical Africa.* Kieler Wissenschaftsverlag Vauk. 253pp.

McIntire, J., D. Bourzat and P. Pingali. 1992. *Crop - Livestock Interaction in Sub - Saharan Africa.* World Bank Regional and Sectoral studies, Washington D.C.

Nweke, F. I. 1994. Cassava distribution in Sub-Saharan Africa. COSCA working paper No. 12. Int. Inst. Trop. Agric. (IITA), Ibadan, Nigeria.

Penning de Vries, F. W. T. and M. A. Djiteye. 1982. *La productivé des pâturages saheliens.* Wageningen: Centre for Agricultural Publishing and Documentation.

RIM, 1992. Nigerian Livestock resources. Vols I - IV. Federal Government of Nigeria.

Tacher, G., H. E. Jahnke, D. Rojat and P. Kiel. 1988. Livestock development and economic productivity in tsetse-infested Africa. In *African Trypanotolerant Network: Livestock production in tsetse affected areas of Africa.* Nairobi: Int. Livestock Centre for Africa.

Winrock International, 1992. *Assessment of animal agriculture in Sub-Saharan Africa*. Winrock Int. Inst. Agric. Development. Morrilton, Arkansas. 125pp.

Table 1

Estimates of the numbers of TLUs that can be supported by various of feed resources of the moist savannahs of Nigeria under high and low utilization of crop residues.

	Number of TLUs (millions)	
Feed Resource	high[¶] residue use	low[§] residue use
Range	6.3	6.3
Crop residue	13.3	4.1
Subtotal	19.6	10.1
Actual numbers in zone	8.1	8.1

[¶]30% Maize stover, 50% Sorghum and Cassava residue, and 60% Cowpea haulms utilized as livestock feed.

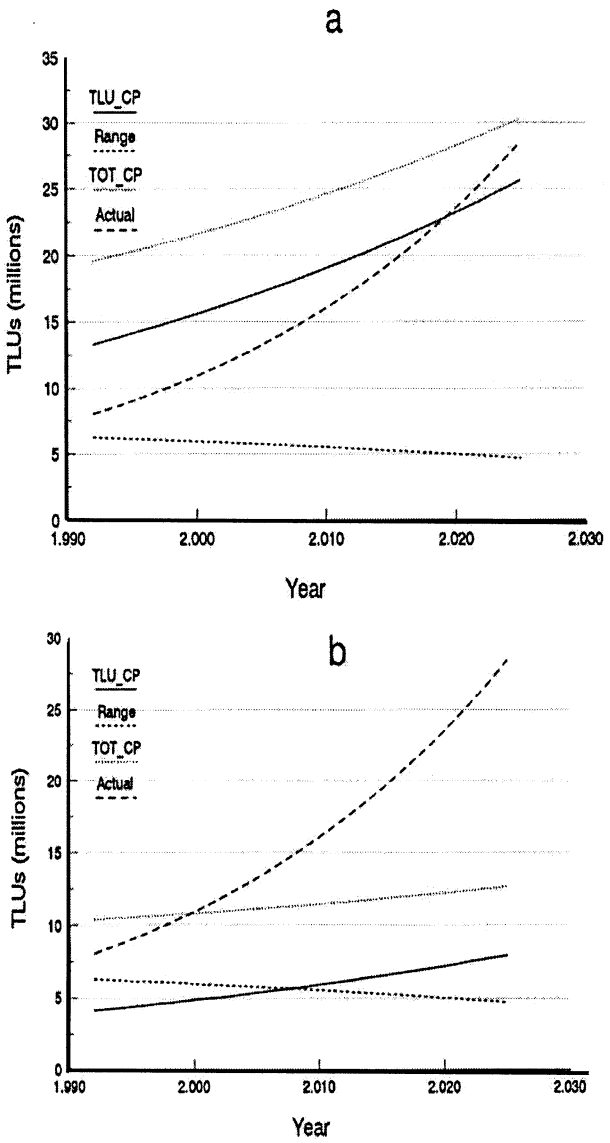
[§]10% of Maize, Sorghum and Cassava residue and 60% Cowpea haulms utilized.

TOT_CP - total number of TLUs supported by crop residues and range

Actual - projected TLU numbers (3.9% increase yr^{-1})

Figure 1

Projection of livestock growth trends and the numbers that can be supported by feed resources from range and crop residues in the moist savannahs of Nigeria.



a. High crop residue utilization _50% of the total produced.
b. Low crop residue utilization _ 10% of the total produced

LEGEND

TLU_CP - number of TLUs supported by crop residues on a CP basis

Range - number of TLUs supported by range