CUT-AND-CARRY FORAGE SYSTEMS BASED ON NITROGEN-FIXING PLANTS FOR ASIA'S TROPICAL SLOPELANDS

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ABSTRACT

Increasing population growth and limited resources present a challenge to the development of Asia, especially in the impoverished uplands. The people living in the slopelands of Asia are generally plagued by poverty and constant soil erosion, both of which hasten the downward spiral in their quality of life. Livestock systems show a great potential for improving the Asian uplander's quality of life and helping to break this poverty cycle. However, as more and more animals are introduced into these fragile areas, good-quality management schemes for raising the livestock are needed to ensure sustainability. This Bulletin discusses the cut-and-carry forage system which shows promise as a way of meeting these requirements. It draws heavily on the SALT 2 program developed in the Philippines, and looks at the positive as well as the negative aspects of cut-and-carry systems utilizing primarily nitrogen-fixing plants as a feed source.

INTRODUCTION

The countries of Asia face a serious problem of relatively high population densities as well as high population growth rates. While Asia encompasses about 30% of the world's land area, it carries about 56% of the world's population. The pressure to feed, clothe and educate the children of tomorrow calls for ever-increasing production by Asia's agricultural sector.

While great strides are being made in high-technology agriculture such as genetic engineering, hybridization and improved fertilizer/pesticide technologies, many of the newer technologies are beyond the reach of the average small-scale farmer in the region. High-cost inputs are risky, and also too expensive for subsistance farmers to afford. Therefore, a portion of new technology should be developed in a way that it can be easily adopted and replicated by poor farmers. Moreover, technologies should be developed which maximize output while minimizing the area of land used for production.

This Bulletin will focus on the benefits and drawbacks of cut-and-carry forage system for small livestock in tropical Asia, based on nitrogen-fixing forage crops. It will largely draw upon the experience of the Mindanao Baptist Rural Life Center (MBRLC) and its SALT 2 (Simple Agro-Livestock Technology) program.

A CASE FOR NITROGEN-FIXING SYSTEMS

Nitrogen-fixing farming systems are those which integrate nitrogen-fixing plants into as many parts of the system as possible (Palmer 1996). The hypothesis is that the effective and efficient utilization of nitrogen-fixing trees and/or shrubs, as well as other nitrogen-fixing plants, can contribute to the overall sustainability of farming systems because of the addition of extra N through biological fixation.

In a cropping scheme, nitrogen-fixing plants are primarily used for soil amelioration, as well as for erosion control, rotational choice, etc. Examples would be the use of *Desmodium rensonii, Flemingia macrophylla* and *Leucaena leucocephala* double contour hedgerows for erosion control and soil fertility maintenance in a Sloping Agriculture Land Technology (SALT) system (Watson and Laquihon 1981).

In a reforestation scheme, nitrogen-fixing trees and shrubs would be used as pioneer/nurse species, and as soil enrichers to give better growth of high-value timber species. Examples would be *Indigofera tyesmani* (Anil) utilized as a pioneer species in reforestation plots in Vietnam (personal observation), or the fast-growing leucaena species (*Leucocephala diversifolia*) and acacias (*A. mangium, A. ariculiformus*) as a nurse crop for

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mahogany (*Switenia macrophylla*) and narra (*Pterocarpus indicus*) in the Philippines (MBRLC Editorial Staff 1992).

In animal production schemes, nitrogen-fixing shrubs would be the principal source of feed. High-protein plants such as *Desmodium rensonii, Gliricidia sepium* ("Madre de Cacao"), *Indigofera tyesmani* (indigofera) and *Leucaena leucocephala* (*"ipil-ipil"*) are planted in a forage garden and cut at selected intervals as feed for animals. After cutting, they are left to coppice and grow fresh forage to be fed once again. Fig. 1 gives some good examples of commonly used legume species used in the southern Philippines, along with a brief description of their characteristics.

THE CUT-AND-CARRY SYSTEM

The cut-and-carry production system for animals is not a new concept. It has recently been popularized in the Philippines with the SALT 2 system, but Asian farmers have been using a similar system for hundreds of years.

The idea is to pen the animal, preferably off the ground with some type of slatted flooring for ease of waste collection and to prevent disease. Adequate space is given for the animal in the pen to move about, but not too much so it does not waste too much energy in exercise. The feed, primarily forage, is then brought to the animal in appropriate amounts and intervals to effect maximum growth.

This system works best with the ruminants who depend upon a high forage intake. Thus cattle, goats and sheep show the greatest potential for cut-and-carry systems based on nitrogen-fixing legumes. Some smaller exotic animals such as rabbits and guinea pigs also seem to be highly suitable for cut-and-carry systems. A general rule of thumb is to give freshly cut forage to an animal equivalent to about 10% of its body weight each day. Ideally, half should be given in the morning and the remaining half in the evening, so the animal can make more efficient use of the forage.

More research is needed on how to feed cut-and-carry forage to other animals, including non-ruminants such as swine, poultry and even fish.

ADVANTAGES OF THE CUT-AND-CARRY SYSTEM

Land Utilized More Efficiently for Production

In the SALT-2 project, which utilizes Nubian goats in a dairying scheme, a stocking rate of 10 to 12 head per one-half hectare of well-established forage was achieved (MBRLC Editorial Staff 1992). In contrast, average stocking rates for free-ranging goats are only 6 animal units per hectare. The cut-and-carry system almost quadruples the land use potential.

Better per Unit Production

Milk production by goats is not officially measured in Philippine government statistics. However, Nubian goats raised in free grazing systems in local villages have shown little or no milk production, and also have a slower growth rate (personal observation). Where they have been penned and fed by cut-and-carry systems with adequate forage, production has ranged from 1 to 4 kg of milk each day. Villagers in Bacungan Magsaysay, Davao del Sur, have recorded an average of 1 kg milk per goat per day, using a cut-and-carry system containing 60% leucaena, 20% rensonii and 20% flemingia (Alon and Alimoane 1997). Nubians under intensive management (fed cut-and-carry forage as well as locally mixed feeds) produce up to 4 kg per day (Tabugoc and Munsen 1998) (Table 1).

Better Control of Animals

Having animals penned allows for easier control and management of the herd. Ease of handling and more farmer/animal interaction allows better management. It also permits regular monitoring of disease, breeding cycles and parturition.

Centralization of Animal Waste Production

An added benefit of the penning of animals under a cut-and-carry system is centralized production of animal waste. The manure can be used as fertilizer on the farm, or sold as a fertility amendment, bringing extra cash to the farmer.

Addition of “Free” N into System

Generally speaking, the highest cost in an animal production system is the feed, while the most expensive feed ingredient is protein. The utilization of nitrogen-fixing plants such as rensonii, leucaena, "Madre de Cacao" and indigofera as high-protein forages can help supply a great deal of this needed protein. Moreover, the N utilized to build the proteins in the forage comes largely from atmo-

Fig. 1. Nitrogen-fixing plants (trees/shrubs) utilized in the southern Philippines as animal feed in a cut-and-carry system along with selected characteristics

Name	Origin	Elevation	Raipfall	Latitude	Coppicing	Feed rating	Other
Calliandra callothyrsus	Central America	150 to 1,500m	1,000-3,000 mm	10-18 N	Excellent	Very good	Strong light demander; Forms shrubby tree up to height of 12 m; Established by direct seeding: Moderately drough resistant; Does not tolerate poorly drained, infertile and compacted soils; Leaves bi-pinnately altemate
Desmodium rensonii	Central/south America	0-1,000 m	1,000 mm+		Excellent	Excellent	Trifolate leaves; Likes medium to high soil fertility; Not tolerant of acid soils or water logging; Erect shrub propagated by direct seeding; Needs good seedbed for establishment, and care for up to 4 months.
Flemingia macrophylla	SE Asia	0-2,000 m	1,125-3000 mm		Excellent	Medium/poor	Trifolate leaves; Woody stem; Deep rooted; Ratooning; Shrub 1 to 4 m tall; Tolerates shade; Propagated by seed; Possibly most widely adapted NFP for this purpose.
Gliricidia sepium	Central America	0-1,600 m	800-2,300 mm	6-19 N	Excellent	Excellent	Fair to poor tree form; Tolerates poor soils, drought and a wide range of soil conditions; Doesn't like water-logged soils; Can be propagated by seeds (rarely) but mostly by cuttings.
Indigofera tyesmani	India				Very good	Excellent	Forms a small, shrubby tree 6 to 10 m high; Well adapted to a wide variety of soils and conditions; Readily established by direct seeding.
Leucena diversifolia	Central America	0-2,000 m	500 mm+		Very good	Excellent	Forms a medium sized tree (up to 20 m); Good seed yield; Good tree form; Fast-growing.
Leucena leuco-cephala	Central America	0-1,500 m	500 mm+	15-17 N	Excellent	Excellent	Forms a medium sized tree (up to 20 m); Strong light demand; Fair to good tree form; Propagated by direct seeding or from nursery seedlings; Likes deep and fertile soils

Table 1. Cost and return analysis of SALT 2 (1993 and 1998 data, presented in US$) (one half hectare project)

Particulars	1993	1998
1. Returns		
1. Cash income		
a. Crops		
1. Corn	$58.12	$38.28
2. Citrus	$33.82	$3.48
3. Black pepper	$28.88	$0.00
4. Misc. crops	$7.63	$131.99
b. Breeding and sale of kids	$1,016.68	$2,100.00
c. Goat meat	$0.00	$0.00
d. Milk	$2,161.68	$2,606.26
A. Total cash income	**$3,360.13**	**$4,880.00**
2. Value of non-cash income		
a. Replacement stock	$100.00	$144.00
b. Added value to the stock	$760.00	$760.00
c. Goat manure	$656.80	656.80
B. Total non-cash income	**$1,556.80**	**$1,560.80**
C. Total gross returns	**$4,862.93**	**$6,440.80**
II. Costs		
1. Cash		
a. Crop seeds	$0.48	$4.96
b. Seedlings	$0.00	$0.00
c. Forage expenses	$3.00	$29.21
d. Feed	$1,195.51	$2,743.58
e. Veterinary supplies	$26.92	$33.18
f. Tools and equipments	$24.69	$12.76
g. Office supplies	$4.55	$0.00
h. Repair of buildings	$0.00	$27.14
i. Loan interest	$97.60	$0.00
j. Loan payment	$240.00	$0.00
D. Total cash cost	**$1,593.02**	**$2,850.83**
a. Labor	$1,739.89	$1,254.23
b. Depreciation	$120.96	$145.15
c. Livestock mortality	$154.00	$0.00
E. Total non-cash costs	**$2,014.85**	**$1,399.38**
F. Total costs	**$3,607.87**	**$4,250.21**
Net profit (C-F)	**$1,255.06**	**$2,190.60**
Net cash returns (A-D)	**$1,713.11**	**$2,029.18**
Return on investment	**34.78%**	**51.54%**
Benefit:Cost ratio	**1.35**	**1.52**

1993 - 1US$ = 25 Philippine pesos
1998 - 1US$ = 40 Philippine pesos

spheric nitrogen, fixed by the roots of the plants through a symbiotic relationship between their roots and soil organisms.

Good Community Relations

A growing problem of free grazing systems in Asia is the competition between animals and human beings, as well as animals and the environment. Traditional farming systems allow certain animals to roam at will and browse for their food. This system is seen as economical, as well as labor-saving. However, with increasing population pressure, free-grazing animals are often a nuisance as well as a source of conflict in many villages across Asia, destroying garden, crops and forests. Man the caretaker needs to find improved systems such as the cut-and-carry approach, in order to live harmoniously in a community.

DISADVANTAGES OF THE CUT-AND-CARRY SYSTEM

Labor Demand

One of the complaints about the cut-and-carry animal husbandry system is that a high labor input is needed to manage such a system. The penning of animals requires that the feed be brought to the animal, instead of the animal finding its own feed. Also, water must be supplied. A penned animal requires constant attention, rather than the out-of-sight-out-of-mind approach to a free-grazing animal.

Possible Adverse Effects of Feeding High Levels of Legumes

Some nitrogen-fixing plants have adverse side effects when high concentrations are fed to certain animals. Leucaenas which are high in mimosine have been shown to cause poor performance in cattle, manifested in low weight gain and hair loss (Brewbaker 1975). Feeding sheep with large amounts of "Madre de Cacao" and rensonii sometimes causes bloat (Personal observation). Problems of this type can be fairly easily overcome by introducing these forages slowly into the livestock feed, combined with a good testing program for capability.

Possible Infectious Disease Outbreaks

Another common complaint about penned animals is the possibility of outbreaks of infectious diseases. Animals raised in close proximity to each other do have a higher risk of disease spread. Good sanitation and good management practices will do much to correct this problem.

Cost of Housing

One of the biggest deterrents to adopting a cut-and-carry system is the cost of the pens to house the animals. If a farm family is already at a subsistence level, housing for animals, no matter how basic, will seem a luxury. This can partially be overcome by using local materials which are low-cost and grown on the farmer's own farm.

Management Skills Required

Penning animals for a cut-and-carry system requires different and more advanced skills than rearing free-grazing animals. First, feed must be brought to the animals, and a common problem is providing too little feed. Also, special care must be taken for animals' needs such as hoof trimming and dehorning/disbudding to ensure safe and healthy confinement. Breeding habits and signs for each animal must be learned by the farmer, in order to ensure timely breeding of penned animals.

CONCLUSION

Cut-and-carry animal production systems are the future for most of Asia. Increasing population pressures make the confinement of animals necessary. Free-grazing animal systems compete with food production, and contribute significantly to the destruction of Asia's remaining forests.

Forage systems based on nitrogen-fixing crops for cut-and-carry production show great potential for increasing productivity and promoting more sustainable systems. There are both advantages and disadvantages to this type of production system, but the advantages tend to outweigh the disadvantages.

Our experience with the SALT 2 production system has shown it to be a successful production system based on the cut-and-carry of forage from nitrogen-fixing plants. In addition, our experience with local farmers shows the ability of smallholders to adopt this type of systems.

In Asian agriculture in the future, there will be an ever-increasing need to maximize production from limited land resources. Cut-and-carry animal production systems show great potential, while the use of nitrogen-fixing forage crops will make those systems more productive and sustainable.

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DISCUSSION

Participants at the Workshop discussed the problem of establishing a cut-and-carry system based on nitrogen-fixing plants. Mr. Palmer emphasized the importance of encouraging farmers to adapt the technology to their own needs. Farm families decide for themsleves what slopes to farm, what forage and food crops to plant etc., in partnership with SALT workers. Extension staff working for the SALT project live in a village for several years ("immersion") when they are establishing a project.

Mr. Palmer was asked about the seasonality of the system, and the rate of weight gain in the goats. He explained that the SALT project does not have a research facility. The data available come mainly from farmers' herds, and few of the tests carried out would reach the standards of experiments by the research community. He hoped that this kind of livestock production system would be put on the research agenda in Asian countries, so that he and his colleagues would have more information on weight gain per day on various feeding regimes, biomass production per hectare, etc.