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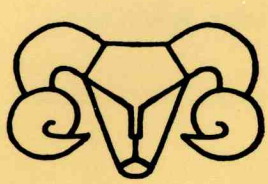
Small Ruminant Production Systems in South and Southeast Asia

Proceedings of a workshop held in Bogor, Indonesia, 6–10 October 1986



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Editor: C. Devendra

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Abstract This publication presents the results of a meeting held in Bogor, Indonesia, 6-10 October 1986, that focused specifically on the assessment of small ruminant production systems in South and Southeast Asia. It considered the prevailing circumstances, the innovations, and the strategies that are pertinent for stimulating increased productivity from goats and sheep. The present patterns of production were examined in detail with reference to characteristics of the small farms, existing management methods, and nature and components of the production systems. These systems include extensive systems, systems combining arable cropping, and systems integrated with tree cropping. The discussion of the systems were further highlighted by country case studies, issues and policies that considered the available production resources, especially the genetic and feed resources available, constraints to production, and potential means to achieve desirable improvements. An important session was devoted to examining research methodology, strategies for development appropriate to individual systems, and a conceptual framework for on-farm economic analysis. Together, these discussions enabled a definition of research protocols and the priorities for future direction that are likely to have a major impact on productivity from small ruminants.

Résumé L'ouvrage présente les conclusions d'une réunion tenue à Bogor, en Indonésie, du 6 au 10 octobre 1986, portant sur l'évaluation des systèmes de production touchant les petits ruminants en Asie du Sud et du Sud-Est. On y a brossé un tableau de la situation actuelle, des innovations et des stratégies susceptibles d'accroître la productivité dans l'élevage de la chèvre et du mouton. On a examiné en détail les méthodes actuelles de production dans la perspective propre aux petits exploitants, les éthodes actuelles de gestion, le type de systèmes de production et leurs éléments. Il s'agit ici des systèmes extensifs, des systèmes associant la culture des terres, et des systèmes intégrant la sylviculture. Les discussions ont été étayées d'études de cas, de problèmes et de politiques émanant des divers pays et portant sur les ressources disponibles pour la production, spécialement les ressources génétiques et fourragères, les contraintes à la production, et les possibilités d'amélioration qui existent. Une importante session fut consacrée à l'examen de la méthodologie de la recherche, des stratégies de développement convenant à chaque système, et d'un cadre conceptuel pour l'analyse économique des activités sur le terrain. Toutes ces réflexions ont permis de définir des plans de recherche et d'établir les priorités qui, dans l'avenir, auront vraisemblablement un impact majeur sur la productivité liée à l'élevage des petits ruminants.

Resumen Esta publicación presenta los resultados de la reunión celebrada en Bogor, Indonesia del 6 al 10 de octubre de 1986, cuyo temp principal fue la evaluación de los pequeños sistemas de producción de rumiantes en el

Sur y Sureste asiático. En la misma se analizaron las circunstancias imperantes, las innovaciones y las estrategias pertinentes para estimular la mayor productividad del ganado caprino y ovino. Se examinaron detenidamente los patrones actuales de producción con respecto a las características de las pequeñas granjas, a los métodos de manejo existentes y a la naturaleza y componentes de los sistemas de producción. Estos sistemas incluyen sistemas extensivos, sistemas que combinan el cultivo de tierras arables y sistemas integrados con plantaciones de árboles. La discusión de estos sistemas estuvo acompanada del análysis de etudios de casos en diferentes países, así como de problemas y políticas relacionados con los recursos de producción disponibles, especialmente los recursos genéticos y alimenticios disponibles, las limitantes de la producción y los posibles medios para obtener las majoras deseadas. Una importante sesión estuvo dedicada a examinar la metodología de las investigaciones, las estrategias para el desarrollo apropiadas para cada sistema individual, y un marco conceptual para la realización de análisis económicos en las granjas. En su conjunto, estas discusiones permitieron definir los protocolos de investigación y las prioridades para el futuro, que probablemente habrán de tener importantes repercusiones sobre la productividad de los pequeños rumiantes.

CONTENTS

RESEARCH METHODOLOGY FOR INTEGRATED SMALL RUMINANT AND TREE-CROPPING SYSTEMS

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Abstract *The methods and techniques available for measuring herbage production and utilization, and animal production under tree crops are reviewed. Relatively simple herbage clipping methods are suitable for measuring herbage mass, botanical composition, seasonal growth pattern, and annual yield. The value of oesophageal-fistulated animals for obtaining samples of what is actually eaten is stressed. Indirect in vitro methods of determining herbage digestibility are discussed: the nylon bag, rumen liquor-pepsin, pepsin-cellulase, and indigestible acid-detergent fibre techniques. Group animal intakes may be measured by "before and after" herbage clipping, but individual intake estimation is much more difficult, requiring knowledge of both digestibility and total faecal output. Carrying capacity may be determined by trial and error or from estimated annual herbage yield and animal feed requirement. No special techniques are required for the measurement of animal performance or of damage to trees or tree growth. There are, however, problems in the design, execution, and interpretation of grazing experiments. The degree of simplicity or sophistication should be appropriate to the objective required and the facilities available.*

Integration of livestock into tree cropping offers great potential, yet this potential is being realized slowly. There are technical difficulties in the maintenance and control of both the grazing and the livestock, there are some social changes to be accommodated, and there are human philosophical and attitudinal changes to be made. Integration involves replacing a relatively simple traditional monoculture with a more complex system that requires learning some new technologies and making compromises between the two components of the system: the trees and the livestock. The introduction of

livestock into tree cropping in the humid tropics differs only in scale and potential from the integration of timber trees into pastoral farming now being attempted in New Zealand and Australia.

If the plantation industries are to be encouraged to adopt managed livestock systems there must be a base of knowledge and a clear demonstration of how the objective can be achieved both physically and economically. This paper is concerned with the base of knowledge: the research methods and techniques available for studying the production system. In short, this means measuring herbage production and utilization, animal performance, and the interactions of animals and trees. Most of the methods have been developed for sown pastures and rangelands, but not specifically for the vegetation under tree crops. They will cover the range of situations from relatively simple methods available for measuring herbage dry mass, growth, botanical composition, and feed preferences on smallholdings, to the sophisticated methods of measuring herbage digestibility and individual animal intake, requiring laboratory facilities, equipment, and technical skills usually available only at universities and research stations.

The value of different grass and legume species, the determination of fertilizer requirements, the influence of grazing on plant species, and similar studies will not be discussed since their determination involves the same techniques as will be described.

PLANT OR HERBAGE MEASUREMENT

Herbage Mass, Growth, and Composition

Most research work has been done on sown temperate pastures grazed by cattle and sheep, and there are reviews of this work (e.g., Meijs et al. 1982). Tropical pastures tend to be more varied and more erect and, in the special case of vegetation under tree crops, one has to contend with the rapid botanical changes from the legume cover crop to volunteer grasses, weeds, and browse shrubs more reminiscent of range-country vegetation. Techniques available for measuring tropical pastures are reviewed in Shaw and Bryan (1976) and t'Mannetje (1978).

Herbage mass

The amount of herbage present per hectare is still measured by the long-established technique of clipping. The

main variants are the numbers of samples needing to be clipped to obtain acceptable representativeness and the height of clipping. The clipped samples should be separate, dried, and weighed to give percentages of plant species, leaf, stem, green, and dead material. They can be analyzed chemically.

Growth

Growth is measured as the increase in herbage mass over a given time on areas protected from grazing. To simulate as closely as possible growth under grazing, an initial herbage mass estimate is made and then a number of quadrats, cages, or enclosures are used to protect samples of pasture from grazing. These are then clipped at a later date, after which another initial herbage mass estimate is made on the grazed pasture; the process is repeated throughout the season or year. The same area must not be clipped twice. Growth estimates are important to obtain both total annual production and seasonal variation in yield, and botanical and chemical composition. The data obtained must be related to how the measurements were made, frequency of clipping, grazing pressure of the animals, and the general degree of simulation of the actual grazing process.

Range vegetation

The determination of herbage mass and growth in regions, such as range country, having a mixed vegetation containing grasses and browse shrub trees is much more difficult. There is an extensive literature on this in several parts of the world, but especially in the United States.

Methods are laborious, usually involving taking an inventory of species and edible parts of species before and after grazing. The trend has now been, in the case of browse, toward developing regression of browse yield on plant height, number of and length of branches, and stem diameter (Rutherford 1979; Holechek et al. 1982; Allison 1985).

Capacitance meters

Herbage mass and growth may also be measured through the use of capacitance meters. These measure the change in electrical capacity brought about by the intervening herbage between a probe pushed through the herbage to ground level and a metal plate or cylinder above herbage level. Many readings can be taken in a short time and these are automatically recorded (James et al. 1977; Vickery et al. 1980). It is not accurate enough for research purposes but has some application.

Visual estimation

Visual estimation has very wide application, especially in practice on farms. Human beings can be trained to estimate herbage mass by eye. Training consists of calibrating visual observation against a set of plots or pieces of turf of known measured herbage mass. Many dairy and sheep farmers in New Zealand have attended demonstrations and now regularly estimate herbage mass. Knowledge of the feed requirement of the animals enables the farmer to calculate the number of animal grazing days on hand at any time and to make relevant management decisions (New Zealand Ministry of Agriculture and Fisheries 1976). Visual estimation is also being examined in range studies. The application of this method, although it may be approximate, especially for mixed vegetation, is nevertheless a simple method for all occasions.

Plant Species Selected by Animals

A major problem and error in the determination of food value and intake of herbage by grazing animals is obtaining a representative sample of what is eaten by the animal. In qualitative terms, preferences for plant species can be observed fairly easily and probably accurately enough for practical purposes. For example, the order of preference (asystacia > grasses > legumes) has been recorded for sheep under mango and cashew in Ghana by Asiedu et al. (1978), under rubber in Malaysia by Arope et al. (1985), and under rubber and oil palm by Pillai et al. (1985). The problem lies in quantifying these differences and even more importantly in obtaining a sample of what is eaten. Before the mid-1960s, this was done by human simulation of the animal: close observation of the grazing animal and manually plucking samples.

Oesophageal fistula

Fortunately, the development of the oesophageal fistula technique altered this (Van Dyne and Torell 1964). Animals surgically prepared with an oesophageal fistula are now used to obtain representative samples of the diet selected by grazing animals. Samples so obtained are used for botanical, chemical, and in vitro digestibility analysis. At research stations or universities, it is normal to have several such animals available at any one time. They require more care and attention than do rumen-fistulated animals. Sheep are preferred to goats: their neck is a better shape, they are less stressed, and they do not rub the cannula on trees and fences. The only real doubts about oesophageal-fistulated animals are whether the sample collected in the short experimental grazing time

(<1 h) is representative of a daily intake by a normal animal and the extent to which contamination with saliva influences the composition and in vitro digestibility of the sample (Holechek et al 1982). Despite any doubts, the technique is now recognized as the best method of determining what an animal eats and of providing a sample for analysis.

Digestibility

Digestibility is the first simple measure of feed quality. It is also a component of most methods of estimating intake. Although recent thinking indicates that potential digestibility and rate of digestion may be better measures of feed quality, apparent digestibility is still the measure being used. The old method using sheep in crates is still the standard method against which indirect methods are calibrated. There are several indirect methods of estimating digestibility. The following techniques should be within the capabilities of a research station or university, but not necessarily those of a field station or plantation.

Fecal index and feed-feces ratio

The fecal index method is based on regression relationships between fecal nitrogen and digestibility. It has application for certain specific situations but is now not widely used. Of more interest now are recent developments in the indigestible marker system of determining feed-feces ratio, which formerly was based on lignin or silica. Recently, indigestible acid-detergent fibre has been shown to be a good marker (Penning and Johnson 1983), giving good agreement with actual apparent digestibilities. The n-alkenes of cutible wax have also been suggested (Mayes and Lamb 1984). All that is required is a measurement of the market in the feed (obtained from oesophageal fistula) and in a grab sample of the feces.

Nylon bag technique

This technique involves inserting a small-mesh nylon bag containing the dried ground sample through a rumen fistula into the rumen and measuring the loss in sample weight. In sheep, 2-4 samples can be done simultaneously; in cattle, up to 20 samples. The method has been used in remote situations where chemical analytical facilities are not available (Whittington and Hansen 1985).

In vitro digestion

In the previous methods, digestion is carried out in the rumen. In in vitro methods, ruminal digestion is simulated in

the laboratory. The Terry and Tilley (1963) method, with minor modifications, has been used for the last 20 years. It uses as a measure of digestion the loss in weight of a dried ground sample after incubation first with rumen liquor and then with pepsin. The recent commercial availability of cellulase has led to the development of the pepsin-cellulase alternative, which obviates the need for rumen-fistulated animals (McLeod and Minson 1980; Clarke et al. 1982). It seems probable that this will supercede the Terry and Tilley (1963) method. Neither method requires elaborate equipment or laboratory skills and both give good correlations with in vivo estimates.

Measurement of Intake

The measurement of intake, or the amount of herbage eaten by the grazing animal, is an important aspect of pasture utilization and animal nutrition. Both direct and indirect methods of measurement are available. The subject has been reviewed by Langlands (1975).

Weighing the animal before and after grazing

This is an old method discarded because of inaccuracies, but now resurrected because of high technology: the availability of very accurate scales with extremely rapid microchip recording allowing live animals to be weighted to ±10 g (Penning and Hooper 1985). The animals are fitted with a harness to collect feces and urine. A correction for insensible weight loss is made. The method is still experimental but may become a practical possibility.

Estimating herbage mass before and after grazing

This method is suitable for estimation of intake of a group of animals, especially where herbage has been allowed to accumulate and is eaten off within 1-2 days, as in rotational grazing. Longer grazing periods require a correction for growth during the period to be made. For most purposes, this method is the one most commonly used.

Estimation from digestibility and fecal output

If digestibility of feed and the output of feces is known, intake can be calculated from the following formula:

$$\text{Intake} = \text{fecal output} \times \frac{100}{100 - \text{digestibility}}$$

This is currently the best method of determining intake, especially of individual animals. The preferred method of

digestibility determination is in vitro digestion of samples collected from oesophageal-fistulated animals. Fecal output is measured either as total collection using a harness and bag or indirectly using insoluble markers such as chromic oxide. If chromic oxide capsules are administered and grab samples of feces are undertaken at correct intervals to provide a uniform distribution in the feces, total fecal output can be estimated from the amount administered and the concentration in the feces. Slow-release capsules giving even release for 21- and 90-day periods are now being tested and should greatly reduce the work involved.

This method could be further streamlined by using two or three oesophageal-fistulated sheep to provide samples for in vitro digestion and applying the digestibility so obtained to all the animals. Individual intakes would be estimated from individual fecal outputs.

Despite these advances, it should be realized that individual intake estimation requires considerable equipment and skill. It should not be undertaken without sound reasons.

ESTIMATION OF CARRYING CAPACITY

While carrying capacity is usually determined in practice by experience or trial and error, it is an advantage to be able to estimate it. At the theoretical level, carrying capacity can be estimated from dry herbage yield and daily animal feed requirement. The annual feed requirement of a 55-kg ewe and one lamb in New Zealand is estimated to be 550 kg dry matter (DM) of feed quality 10.5 MJ metabolizable energy (ME)/kg DM. A pasture with an annual yield of 11,000 kg DM/ha should be capable of carrying 20 ewes/ha. In practice, 12-16 ewes/ha can usually be carried. The discrepancy is because the efficiency of pasture utilization on a year-round basis is only 60-80% for sheep and goats. In the most efficient system (dairy farming), utilization may reach 85%.

A 20-kg ewe or doe in Asia producing 1.5 lambs or kids per annum and consuming herbage of 9 MJ ME/kg DM is calculated to require about 250-280 kg DM. Estimates of percentage utilization are not available, but assumptions could be made and the carrying capacity estimated. Obviously, estimates of carrying capacity based on herbage DM yield cannot be more than approximations, but they are useful, nevertheless, as a beginning and

in causing one to seek reasons if large discrepancies occur between theoretical and actual values.

TREE CROP MEASUREMENT

There are no special techniques required for measuring the effect of grazing animals on the trees. In the early stages of tree growth, effects are simply measured as annual height or girth increase. Damage to trees is most likely to occur in young plantations because young or small trees are more susceptible to damage and because a greater density of stock is carried.

At later stages, yields of nuts, rubber, or palm oil, which are recorded, are the measures of animal effects. It is expected that, with the exception of damage, animals will have a beneficial effect on crop yield, through the more rapid turnover of soil nutrients and the control of weeds, and on costs, through a reduction of the labour and herbicide involved in weed control.

ANIMAL PRODUCTION MEASUREMENT

The final measure of herbage production and utilization is the production that grazing animals can attain and maintain. The difficulties of assessing animal production lie not in the measurement, but in the design, execution, and interpretation of the experiments. All that is required in measurement is a simple recording and analysis of vital statistics and weights (births, deaths, live weights, and dates of events). In the trials themselves, however, numbers of animals become important to enable some statistical assessment of reproductive performance and live weight gains, and to be representative of breeds in breed-comparison trials. Grazing-management studies, such as stocking rate trials, comparison of grazing methods, and cattle-sheep-goat comparisons, tend to be long term because of seasonal and long-range effects on pasture. The complex soil-plant-animal interactions make the interpretation of grazing trials especially difficult (Morley 1981).

Grazing trials, therefore, require considerable farm facilities in the form of area of land, number of animals, fencing, yards, and housing. They do not, however, require expensive laboratory facilities and equipment. In general, the conduct of experiments involving grazing animals is rather more

difficult in the tropical environment than in the temperate zone and slightly more difficult again in tree crop plantations because the animal enterprise will have second priority to tree crop production.

Despite any difficulties, animal-production experimentation and data are vital to understanding any grazing system. Not only are they the final measures of the system, but field trials are the means of transferring basic knowledge into practice and of demonstrating new methods and technology to the industry. In the context of encouraging sheep and goat production under tree crops, relatively simple grazing trials should probably be given the highest priority.

CONCLUSION

The objective should be to develop sheep and goat management systems appropriate to the many variations within the plantation industry: from the smallholder with four to eight animals to the large estate owner with several hundred animals, and from the coconut plantation to the oil palm estate. For most situations, very little is needed. Very useful experimentation can be conducted on all these variations, provided some fencing is permitted and animals are available. Herbage yield, growth, feed preferences, tree damage, and animal live weight can be measured by research workers with the minimum of equipment. In many cases, this is adequate to identify problems.

Detailed grazing and animal studies require the facilities available at research stations and universities. These, or at least some of them, should have the capability of measuring in vitro digestibility, maintaining oesophageal-fistulated animals, conducting grazing-management studies, breed, and animal species comparisons. These should form the basis of demonstrating improved systems of integrated animal - tree crop production to the industry.

The following areas of research, in the opinion of the author, should receive priority.

- Fencing or other means of exercising pasture and animal control and the degrees and types of fencing acceptable and appropriate to different plantations;

- Establishment of animal production potentials or targets (at grazing) against which performance in villages or plantations may be gauged;

- Measurement of seasonal herbage growth and quality patterns and research on supplementary feeding to assist development of optimal animal management systems;

- Comparison of sheep only, goats only, and mixed flocks in terms of pasture and animal production, weed control, and damage to trees;

- Breeding methods to improve rate of gain of lambs or kids, including selection within existing breeds but especially use of exotic-indigenous crosses;

- Basic physiology of indigenous and exotic x indigenous animals in regard to general fitness to the environment; and

- Animal health problems, in particular, internal parasitism.

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