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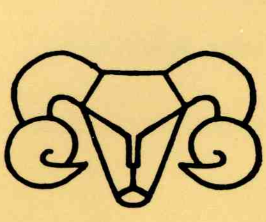
Small Ruminant Production Systems in South and Southeast Asia

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



Proceedings Series

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE • CENTRE DE RECHERCHES POUR LE DÉVELOPPEMENT INTERNATIONAL
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IDRC. Regional Office for Southeast and East Asia, Singapore SG

IDRC-256e

Small Ruminant Production Systems in South and Southeast Asia : proceedings of a workshop held in Bogor, Indonesia, 6–10 October 1986. Ottawa, Ont. IDRC, 1987. xii + 414 p. : ill.

/Animal production/, /goats/, /sheep/, /mixed farming/, /small farms/, /South Asia/, /Southeast Asia/ — /feed/, /crops/, /research methods/, /economic analysis/, /animal diseases/, /case studies/.

UDC: 636.3(5) ISBN: 0-88936-493-1

Technical Editor: W.M. Carman

A microfiche edition is available.

IDRC-256e

Small Ruminant Production Systems in South and Southeast Asia

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

Editor: C. Devendra

Cosponsored by the
International Development Research Centre
and the
Small Ruminant Collaborative Research Support Program

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

BREEDING STRATEGIES FOR SMALL RUMINANTS IN INTEGRATED CROP-LIVESTOCK PRODUCTION SYSTEMS

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Abstract *This paper stresses the importance of genetic potential and of breeding and management level in determining animal performance, and the importance of an appropriate match of these two factors for efficient animal production. A feature of crop-livestock production systems, as contrasted with strictly pastoral systems, is the availability of crop residues and by-products for supplementation during times of limited forage availability, making possible the effective utilization of genotypes with higher potential for reproduction, growth, and lactation. General performance traits of some breeds of sheep and goats in South and Southeast Asia are reviewed; the importance of adaptability in terms of net reproductive rate and viability of locally adapted stocks is emphasized. Breeding strategies suggested as being most applicable to the smallholder production systems under consideration are selection within local stocks, including intense initial screening for desired performance traits, and development of new stocks based on crosses between improved breeds and well-adapted, local breeds. The latter strategy may be particularly useful where milk production is a goal. Direct replacement of local breeds by imported, improved breeds or grading up to an improved breed may result in an unacceptable loss of adaptability. Repeat production of* F_1*'s or systematic crossing systems to exploit heterosis may lead to the highest levels of performance per animal, but may not be feasible in smallholder production systems. Methods of disseminating genetic improvement in such systems are suggested.*

The main feature of crop-livestock production systems is that they provide harvested feed, crop by-products, and residues that may be used as supplements to seasonal forage production to meet the nutrient needs of the livestock. This is a possibility not available or economically feasible for many pastoral producers and is often the only means of compensating for the low-quality forages of the humid tropics. The potential for supplementary feeding means that it may be possible to use animals with higher genetic merit for such important traits as reproduction, lactation, and growth to good advantage. Supplementary feeding can contribute to reduced pre- and postweaning mortality as well as to increased reproduction and growth rates. Of particular significance to small ruminant production systems is that supplementary feeding may permit exploitation of the shorter reproductive cycle of these animals: producing lamb or kid crops at 8-9 month intervals. This can lead to substantial increases in total productivity compared with the typical intervals of 1 year or more, which are dictated in pastoral systems by feed supply and in large ruminants by their gestation period. It is an avenue for improvement of small ruminant production that merits much more attention, from both genetic and management aspects, than it has received.

GENERAL STRATEGY

Livestock performance levels depend on the genetic potential of the animals and on nutrition, disease control, and management practices adequate to permit expression of this potential.

In considering the means of improving livestock performance and productivity in developing countries, two errors are sometimes made. The first of these is to assume that relatively low levels of performance, such as slow growth rates, are due to inferior genetic potential, and to import breeds with higher levels of performance in the environment where they have developed. For example, growth rates of sheep and goats in tropical countries are typically 100 g/day, while specialized meat breeds in temperate countries may achieve average growth rates of at least 300 g/day. Importation of temperate breeds into a tropical country is done in the expectation of doubling or tripling growth rates by breed replacement or grading up. Unfortunately, increases of this order are rarely realized. The imported breeds grow much more slowly in the tropical climate mainly because of the typically lower quality of tropical forages as well as disease and climatic stresses. Also, the local animals, if fed the levels of supplements necessary to obtain satisfactory growth rates of the imported breeds, often perform much better than expected. An even more important consideration is that reproduction rates of the imported animals tend to be low. For example, Patterson (1983) reported drastically lower fertility of imported Suffolk and Dorset sheep as compared with the local Blackbelly breed in Barbados (14°N). Data from interbreed matings in that study showed that imported rams and ewes both had impaired fertility compared with the local breeds. A second error, also with serious implications, is to assume that the relatively low performance levels of tropical livestock are due entirely to environmental constraints. This view holds that the genetic resources are present locally but simply need to be exploited by removing nutritional, disease, or management constraints.

The importance of specific knowledge about the genetic potential of the animals used can be illustrated with an example from Indonesian sheep. Javanese sheep (Priangan, Thin Tail, Garut) have been reported by a number of authors (e.g., Mason 1980) to be highly prolific, suggesting the potential of this type of animal for high productivity under good management. Mean litter sizes range from 1.4 to 1.9, i.e., moderately high but not exceptional. Examination of individual ewe records, however, reveal two kinds of ewes: those that never have more than two lambs and exceptional individuals that usually have three or more lambs (Bradford et al. 1986). Repeatability and heritability of ovulation rate and litter size were found to be very high, and daughters segregated into the two classes in a very striking fashion (Table 1). The data in Table 2 strongly suggest the presence of a gene that has a large effect on ovulation rate and litter size, similar to the Booroola gene (Bindon and Piper 1982). The occurrence of exceptionally prolific ewes in two other groups of Indonesian sheep, the Javanese Fat Tail and the Semerang, supports this hypothesis. If this hypothesis holds, it suggests a means of producing, relatively quickly, strains with mean litter sizes of 1.3-1.5 or above 2.5. Knowing that ewes can be expected to perform consistently in one or the other of these ways provides a means of much more efficient production of the sheep than the current situation, where the producer does not know until after one or more lambings whether a ewe has the potential to provide a return that will justify a high level of feed and management. A second example of the importance of specific genetic knowledge is the lower performance in the tropics of woolled sheep compared with that of hair sheep or of animals with less wool cover (Odenya 1982; Inounu and Sitorus 1984). The elimination of wool by selection or avoiding the problem by not

Table 1. Segregation of litter size in Javanese sheep.

	High dams (1 or more records≥3)			Low dams (all records = 1 or 2)		
	No.	No. records	$\bar{X}$	No.	No. records	$\bar{X}$
Dams[a]	23	74	2.74	37	103	1.48
All daughters	39	95	1.85	42	86	1.38
High daughters[b]	18	48	2.31	2	6	2.83
Low daughters[b]	21	47	1.38	40	80	1.28

Source: Bradford et al. (1986).

[a] Counting each dam only once, regardless of number of daughters.

[b] Classified on the same basis as high and low dams.

crossing hair sheep with imported woolled breeds are, therefore, potential means of achieving higher performance.

We suggest that to improve livestock performance and productivity, it must be recognized that all phenotypes are a function of both genotype and environment and that output/input, i.e., efficiency, will be maximized by an appropriate matching of genetic potential with level of feeding and management. Such matching requires consideration of all the important components of performance, especially reproduction and viability. For this reason, locally adapted genotypes should always be the reference point in any evaluation of stocks for improvement.

SMALL RUMINANT BREED RESOURCES OF SOUTH AND SOUTHEAST ASIA

Certain indigenous breeds are reported to be better adapted to harsher conditions and to lower than average feed and management levels. These breeds tend to be characterized by small size and, usually, low prolificacy. They include, for sheep, the indigenous Malaysian (Devendra 1975), the Jaffna from Sri Lanka (Buvanendran 1978; Goonewardene et al. 1981; Ravindran et al. 1983; Goonewardene et al. 1984), and an indigenous Thai breed (Falvey 1979). Goat breeds in this category

Table 2. Fertility of local (Barbados Blackbelly) and imported (Suffolk and Dorset) rams and ewes in a tropical environment.

Breed of ram	Breed of ewe					
	Blackbelly		Suffolk		Dorset	
	No.	% lambed	No.	% lambed	No.	% lambed
Blackbelly	299	78.3	15	63.3	-	-
Suffolk	76	47.4	52	25.0	-	-
Dorset	162	51.8	-	-	53	5.7

Source: Patterson (1983).

include indigenous stocks of Malaysia, Thailand, and Indonesia, commonly called Kambing Kacang (Katjan) (Gall 1981; Devendra and McElroy 1982).

Where feeding and management will support animals with higher prolificacy potential, the Javanese Thin Tail and Fat Tail (Mason 1978, 1980; Obst et al. 1980; Bradford et al. 1986) and the Chinese Hu breed (Cheng 1984a, b) may be suitable sheep breeds. Among goats, the Bengal (Acharya 1982), Leizhou (Cheng 1984b), and Barbari (Sahni and Roy 1967; Gall 1981; Acharya 1982) show above-average prolificacy.

Breeds with larger mature size and higher growth potential include, for sheep, the Javanese Fat Tail (Mason 1978, 1980; George 1982), the Nellore (Littlewood 1936; Acharya 1982), and Red Madras and Ganjam (Acharya 1982), and, for goats, the Jamnapari and Ganjam of India (Gall 1981; Acharya 1982), the Etawah of Indonesia (Devendra and McElroy 1982), and Matou and Leizhou of China (Cheng 1984b). The Jamnapari (from which the Etawah is almost certainly derived) is also above average in milk-production potential.

THE PLACE OF IMPROVED GENOTYPES

An improved genotype usually refers to a population that has been selected for performance traits and, thus, has a higher potential than an unselected breed for one or more components of performance. Many improved breeds are from temperate climates, where improvement programs have been in place longer than in the tropics. Crossbred animals produced by mating breeds with unselected, local stocks may also be classified as improved genotypes. In addition, animals carrying specific genes for high production potential, such as the Booroola gene, would also be classified as improved, regardless of the source of the gene.

Deciding on the best genotype for a particular production system is an important step. In general, one wants the highest prolificacy, growth rate, or milk yield compatible with satisfactory adaptation to the environment. Adaptability is determined primarily by fertility and by viability of young and of adults. While there are no absolute rules, the following are suggested indicators of lack of adaptation:

° Fertility from a 2-month mating season either less than 80% or more than 10% below that of adapted local stocks;

° Mortality of lambs or kids from birth to weaning exceeding 20% of all young born (a frequent contributor to high mortality is multiple births; in an environment in which mortality of single, twin, and triplet (or more) young is 12, 25, and 60%, respectively, a stock with a significant (e.g., $\geq$10%) incidence of triplets is not adapted);

° Lambing or kidding intervals exceeding 12 months;

° Growth rates or milk yields of introduced breeds less than 50% those typical of these breeds in their home environment; and

° Annual mortality of animals aged 1-6 years exceeding 5%.

For effective exploitation of improved genotypes, feeding, management, and disease control should be sufficient to permit animals to equal or preferably exceed these standards. A larger mature size of an improved breed will rarely compensate for a lower fertility of that breed compared with a (usually smaller) locally adapted breed. Illustrations of this point are given by Fletcher et al. (1982) and Alderson et al. (1983). If feeding and management are sufficient for good viability of young born as multiples and for good growth rates and milk production, however, resources will be wasted if the animals used do not have the genetic potential for these levels of performance. This is often a particularly important issue for milk production; the difference between improved dairy breeds and most indigenous breeds of sheep and goats in milk production potential is sufficient that milking is often not justified for animals that do not carry some improved dairy breed inheritance.

BREEDING STRATEGIES

Strategies for improving the genetic potential of animals include

- Selection within local breeds and types;
- Breed replacement (partial or complete); and
- Systematic crossbreeding.

The amount and kind of effort required for success and the time scale for response differ considerably among these three strategies.

Selection Within Local Stocks

This strategy is indicated where adaptability is particularly important, which is often the case where tropical diseases and parasites result in an extremely poor performance of imported temperate breeds. This approach avoids the often high cost of importation, the risk of introducing new diseases, and has the additional advantage of maintaining animals and products familiar to local producers and consumers. The principal disadvantage is a relatively slow rate of change: often an annual rate of only 1-2% for well-designed, well-executed selection programs. Program officers, whether representing local or international agencies, like to see rapid change and rapid return on investment. Unfortunately, the return on investment from inappropriate importation is likely to be negative.

An approach to utilizing locally adapted germ plasm, not yet widely used but of high potential, is screening local populations for superior animals. Some traits for which screening of large numbers of local populations could be very useful include

- Selection of wool-free animals from mixed wool-hair sheep populations where the fibre crop produced is not utilized;

- Selection of twin-producing ewes or does from populations where twinning rate is low and it is desired to increase it (it is important in this situation to select females raising twins);

- Selection of fibre-producing animals with the desired fibre diameter and density, and freedom from defects such as kemp, where fibre is an important source of income; and

- Selection on a combination of traits, e.g., large rams free of wool and with desired phenotype with regard to horns, colour, etc., and large females with the phenotypic criteria listed for rams and that are capable of rearing multiple young to good weights.

The cost of picking the best 100 animals out of a local population of 5,000-10,000 animals (best 1-2%) may be less than the cost of importing a new breed. Such selection could result in a one-step increase in productivity or profitability of 10-15%, while maintaining a well-adapted stock; the annual increases of 1-2% from continued selection can then be added.

Breed Replacement

A need for a substantial one-step increase in genetic potential, e.g., in milk-producing ability, to initiate a dairy production system, may justify the importation of improved germ plasm. The need to compare the new genotypes with local stocks in all aspects of performance, including fertility, parturition interval, and viability of both young and adults, cannot be overstressed.

Where feeding, management, and disease control can be improved sufficiently to permit the improved breed to express its full genetic potential, then complete breed replacement could be indicated; this is unlikely in most environments for small ruminants in Southeast Asia. A more common situation is that the F_1 or backcrosses involving the improved and local breeds are significantly superior to both of the local breeds. In this situation, repeat crossing or development of a new "synthetic" based on a crossbred foundation is indicated. The procedure is to establish by careful evaluation what level of improved breed inheritance gives the best performance in the management situation likely to hold in the future and to devise a strategy to maintain that level.

Systematic repeat-crossing programs are difficult to maintain under the best of conditions and often impossible to maintain in existing production environments in developed or developing countries. The system of choice may, therefore, be the development of a new breed based on the crossbred. Having decided on an optimum level of improved breed inheritance (e.g., 25, 50, 62.5%), animals carrying this percentage are intermated with selection toward defined performance goals. The principal disadvantage of this approach is that half (or more) of the heterosis realized in the F_1 may be lost and, thus, a substantial decline in performance may occur. However, if additive merit of the F_1 is much higher than that of the local breed for production traits and of the imported breed for adaptability, the synthetic may be the best genotype available. It may also be possible to reduce the loss in heterosis by use of more than two breeds in the synthetic. For example, two dairy breeds such as Anglo-Nubian and Alpine and two local breeds such as Etawah and Kacang might be used to produce a four-way cross to be used as the base for a new dual-purpose (milk and meat) goat breed. In theory, 75% of the F_1 heterosis should be retained in the synthetic. The difference in retained heterosis must be evaluated against the possible loss in additive merit from the use of more than the two best breeds.

Systematic Crossbreeding

Repeat crossing to produce F_1's between local and improved breeds requires maintenance of the pure local breed and either the pure imported breed or a source of semen as well as continuously following a specific mating plan.

Production of three- or four-way crosses adds more requirements. Two- or three-breed rotational crossing schemes require, at the least, a continued availability of purebred semen and a knowledge of the breed makeup of all females. If these steps can be followed, the benefits of heterosis may be substantial. These steps, however, may be quite out of the question in a village or pastoral system; for this reason, we do not feel these are practical breeding strategies in most situations for the species and production environments under consideration here. The use of a selected local breed or established synthetic, where all males and females are of the same population (or converging towards the same population), is usually much more feasible.

PROBLEMS OF USING IMPROVED GENOTYPES AT THE SMALL FARM LEVEL

There are two particular difficulties in effecting genetic improvement at the small farm level. First, small ruminants are used as a cash reserve and are often sold or purchased depending on whether the owner needs or has money. The resulting lack of continuity of animals within a flock makes performance recording, selection, or evaluation of a new genotype very difficult.

Second, many smallholders do not keep enough breeding females to justify keeping a breeding male, but are dependent on a neighbour's male(s), matings under common grazing conditions, etc. This makes such things as parentage recording or carrying out a specific mating plan difficult to impossible. The lack of regularly available males and the difficulties of estrus detection result in long intervals between parturitions (Bell et al. 1983). This has more serious implications for productivity of the flock than for genetic improvement, but also slows the rate of progress from selection or introduction of improved males.

PRACTICAL ASPECTS: OPTIONS FOR THE USE OF IMPROVED GENOTYPES AT THE SMALL FARM LEVEL

There are several ways of using improved genotypes at the small farm level. One option is the distribution to smallholders of males from a selected stock of the local breed (e.g., improved by intense screening and within flock selection), males of an imported breed, or imported x local males, depending on whether the desired smallholder animal carries 50 or 25% improved breed inheritance. The improved males will often come from a government-operated multiplication centre. There are two requirements for this approach to have a favourable impact: first, the males distributed should be clearly superior to the smallholder's own animals and, second, the producers must use the distributed males rather than their own. Distribution schemes sometimes fail on both counts, and if the distributed males are in fact not superior, the farmers may be exercising sound judgment in not using them.

A second option, which may be combined with the first, is for a group of village producers to organize cooperative use of males. Eight farmers with, say, a total of 30-40 females might select two superior males for use in their flocks. These males might come from a government research or multiplication station or might be selected from their own or a neighbouring village. Each farmer would run a male with his females 1 out of 4 months on a regular rotation. Assuming good fertility of females 60-90 days postpartum, all females should have lambing or kidding intervals of approximately 8 months. Parturition would occur during only 3 months of the year, facilitating management; all sires would be selected by the farmers and, hence, should meet their standards; sires of all animals would be known and males could be changed on a schedule to avoid inbreeding. Extension workers or village officers could assist with sire selection and could keep a record of all sire use, which could facilitate the exchange of males between groups of farmers.

Assuming estrus-detection techniques used by farmers are adequate, females can be bred to a male maintained by one farmer in the village, who would be paid a fee for this service. The males so used could be obtained from one of the sources described in the first two options, with the extension service, where operational, assisting with selection of males and possibly with coordination and monitoring of the program.

As can be seen, there are different ways of introducing animals of improved genetic potential into smallholder flocks. The important consideration is identification and use of males superior in performance traits for that production system. Artificial insemination is another method of introducing superior germ plasm; however, because of the costs and requirements for technical expertise and precise timing associated with artificial insemination, systems using natural service are more appropriate in most situations involving small ruminants.

POTENTIAL IMPACT OF GENETIC IMPROVEMENT

Increases in production from using animals of improved genetic potential can be substantial. F_1 dairy x local breed females may produce 50-100% more milk than the local breed (Garcia 1982); crossing with a prolific breed can increase numbers born by more than 50% and offtake rates by 25-50% (Dickerson 1977); Dorper ewes with little wool (cover score, 2) weaned lambs 17% heavier than fully woolled ewes in the same flock (coat score, 6) (Odenya 1982). These are only a few of many examples. The increases in productivity cited will normally require some improvement in feeding and management, but a much smaller increase than the increase in outputs, where the animals involved have good fertility and viability. Thus, efficiency is increased, often substantially. We emphasize again, however, the importance of matching genetic potential to level of feeding and management. A high genetic potential without commensurate inputs and a high level of feeding and management for animals lacking the ability to respond represent a waste of resources. Only when these two factors are appropriately matched can animals make the expected and needed contribution to human welfare.

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