New Technologies for Improving Goat Production in Vietnam

Barry W. Norton,
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Report of the activities of the Vietnam-Australia Goat Improvement Project (2006-2009)

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Barry W. Norton,
The University of Queensland, Australia

Nguyen Thi Mui
National Institute of Animal Husbandry, Vietnam

and

Dinh Van Binh
Goat and Rabbit Research Centre, Vietnam

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Collaboration in Agricultural Research and Development (CARD) Project (009/05VIE)
between
Goat and Rabbit Research Centre (Vietnam) and
The University of Queensland (Australia)

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The photo on the front cover is of Nong Tun Manh, son of farmer Mr Nong Quoc Hung, holding a young Saanen x Bachthao kid (June 2007).

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Foreword

The goat is a truly remarkable animal, being one of the earliest ruminants domesticated by humans, and providing, through history, an amazing array of products for their use. The rare fibres, cashmere and mohair, are the preferred cloth of royalty and goats milk has the reputation for being the healthy alternative to cows milk for infants. Goat meat is also a delicacy in all parts of the world, and is prized for its low fat content and juicy tenderness when taken from young animals. Goats are also the saviour of the poor in many developing economies, being easy to manage and feed, producing many offspring and surviving under the most difficult environmental conditions. Despite these stirling qualities, goats are not ranked highly by all, and many farmers measure wealth by the number of cattle they have, and will trade their goats to gain this status. The Vietnamese government, like many other bureaucracies, has only lately come to realize the value of goats in their economy, and since 1993 have been activitely promoting goats as a way to alleviate poverty in their rural populations. It has been my great pleasure to be associated with one of these schemes, and to have met so many Vietnamese scientists, extension workers and farmers who are as enthusiastic as I am about the potential of these animals to make a real difference in people's lives. We have shared the joy of learning new knowledge about the goats in Vietnam, and I am hoping that this small start is the beginning of a longer term relationship that will develop between farmers and research workers interested in promoting goats in south-east Asia. The following study provides many insights into the biology and adaptive characteristics of goats to their environment. However, the key to the success of this program will be the conversion of this knowledge into practical applications which will benefit the rural community. I would like to encourage all who are continuing with this mission, and wish them every success with their work, and hope that they will, as I have, cherish the joy and challenge that comes from working with goats.

Barry Norton
October 2009

About the Authors

Barry W. Norton

Barry is an Agricultural Science graduate from the University of Melbourne, and following PhD studies at Sydney University and post-doctoral research at the University of New England, he spent 33 years as a lecturer at the University of Queensland until his retirement in 2006. During this time, he worked as an animal scientist in both Australia and south-east Asia, pursuing interests in ruminant nutrition and goat production. He has more than 190 publications in scholarly journals, and was awarded the Crown of Thailand in 1993 for his contribution to agricultural development in Thailand. He also received a Doctor of Agricultural Science from the University of Melbourne in 2004 in recognition of his research in goat biology. He currently holds an honorary position at the University of Queensland, while pursuing interests in developing post-graduate education in Papua-New Guinea and improving goat productivity in Vietnam.

Nguyen Thi Mui

Nguyen Thi Mui was born in Hai Duong province, Vietnam and graduated BSc (Pasture Research and Roughage for Animals) from the National Institute of Animal Husbandry in Hanoi in 1979. She has been employed by NIAH since that time. Her professional interests have been the development of forages and pastures from local feed resources for sustaining livestock production in Vietnam. Mui completed an MSc (Tropical Livestock Production Systems) and a PhD in Animal Nutrition at the Swedish University of Agriculture, Uppsala, Sweden in 2000. Throughout her distinguished research career, she has been retained as a consultant and technical advisor to both national and international agencies (FAO, World Bank, SAREC, DANIDA, CARD) on wide variety of projects associated with improving quality and yield of local and introduced forage varieties. She has more than 80 publications in Vietnamese and English on the topics of pasture improvment for animal production.

Dinh Van Binh

Dinh Van Binh was born in Ninh Binh province, Vietnam and graduated as BSc (Animal Husbandry) from Hanoi Agricultural University in 1972. He gained a PhD from the Vietnam Science and Technology Institute in 1995, and he currently holds the title of Associate Professor in NIAH. Dr Binh was appointed Director of the Goat and Rabbit Research Centre at Sontay in 1993, and has actively promoted the development of both goat and rabbit research as means of improving the economic returns to poor farmers throughout Vietnam. He has more than 40 publications in English and Vietnamese in the areas of goat, sheep and rabbit husbandry, breeding and management. His distinguished contribution to agricultural development in Vietnam was recognised by award of The Golden Kapok for his pioneering studies on Vietnamese goats. He also won the FAO Edouard Saouma Award in 2001 for his leadership in developing a goat milk production system for poor farmers in Vietnam.

Table of Contents

Chapter 1

Introduction

The Green Revolution in Asia introduced small-holder farmers to a concept of holistic application of technologies to the improvement of crop productivity, using combinations of fertilizers, pesticides, new adapted varieties of plants and mechanization to increase food productivity from traditional farming systems. While it now recognized that this revolution may have created other problems (social, demographic), there is no doubt that the increased productivity has brought greater wealth and food security to the rapidly increasing populations of these regions. As a consequence of increased wealth, the demand for animal products has also increased, with an increase in price, which has the effect of not only improving the quality of human nutrition but also alleviating poverty amongst poor farmers with animals to sell. However, less attention has been paid to applying this holistic concept to improvements in animal productivity, with most accent being given to the control of endemic diseases, such a foot and mouth disease and rinderpest, and to the introduction exotic breeds of livestock to replace indigenous and local breeds whose low productivity is attributed to their genetic backgrounds. While there is no doubt that controlling disease must be the first priority for action, there is an increasing belief that the productivity of local animal breeds should first be improved by providing by better management (housing, nutrition, controlled breeding, selection), and that cross-breeding with exotic breeds should only be considered after the potential of the local breeds has been maximized. These issues must be carefully considered when planning the introduction of new management technologies to small-holder farms in all developing economies.

Geography and Climate

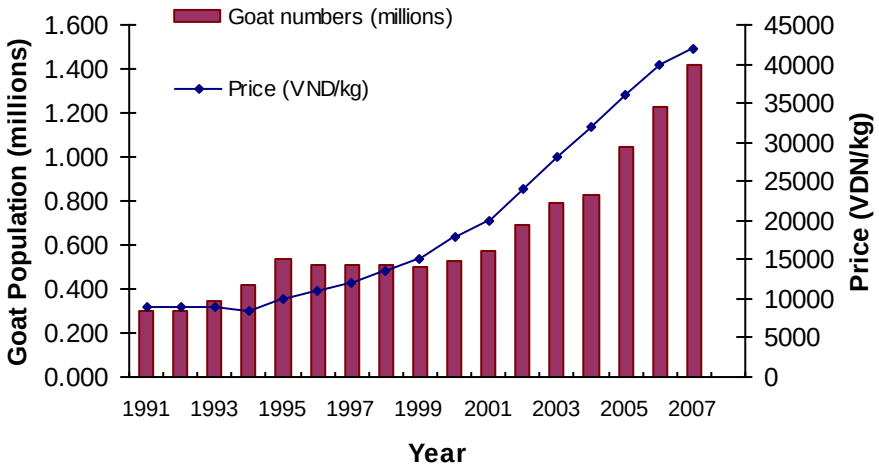
The recent troubled history of Vietnam has limited progress in industrial and agricultural development when compared with some other south-east Asian countries. However, significant development has taken place in the past 20 years, such that, Vietnam is now a net exporter of rice, and a major producer of coffee, rubber, cotton, tea and minor food crops. There are only limited opportunities to export animal products due to declarable endemic diseases, which also limit animal productivity internally. Vietnam is located between 9 and 23 degrees north and occupies about 331,000 square kilometers from the gulf of Tonkin in the North to the South China Sea in the south. Vietnam is a country of tropical lowland, hills, and densely forested highlands with level land covering no more than 20% of the area. The Red River (Song Hong) delta (15,000 square kilometers) in the north and the Mekong River delta (40,000 square kilometers) in the south are the most important intensively cropped areas. The narrow flat coastal lowlands joining the north and south are also fertile rice fields, while the central

highlands represent about 22% of the arable land, and is now planted to large areas of coffee and other cool season crops. There are few places in Vietnam that have less than 1000mm rainfall annually, with an average range of 2000-2500mm. The monsoonal rains arrive in Vietnam usually in May, lasting until September (in the north) and October (in the south). Temperatures are relatively high all year round, although north Vietnam has a definite cooler season than the south. Average monthly temperatures in Hanoi vary 12-20^{0}C (minimum–maximum) in January to 25-32^{0}C in June, compared with temperatures in the south (Ho Cho Minh city) which range from 21-32^{0}C in January to 24-32^{0}C in June. The Vietnamese government has developed extensive irrigation areas from highland dams used for hydro-electricity generation, and the potential of Vietnam to significantly expand its agricultural production in the future is guaranteed by these developments.

The state of agriculture

In 2007, it was estimated that the total labour force in Vietnam was about 46.4 million, with about 55.6% being employed in agriculture, 18.9% in industry and 25.5% in service sectors. However, as a proportion of GDP (Gross Domestic Product), industry earned 42.3%, services 38.2 and agriculture represented only 19.5% of total GDP. This shows that the large agricultural labour force contributes only a small proportion to national GDP, and are among the poorest citizens in the country. It was also stated at this time that average GDP per capita was also very low ($2600) and that 14.8% of the population were considered to be below the poverty line set by FAO. While it is government policy to encourage farmers to move into industrial employment, it is also important to promote improvements in agricultural productivity to achieve national food security, to earn export income and to increase the income of the rural poor. The objective of the project which will be described later is to provide the expertise, materials and funding to assist small-holder goat producers in south-eastern Vietnam to improve the productivity of their goat herds. It is expected that this increased productivity will lead to more goats for sale, which will then increase farmer income, and thereby contributing to the alleviation of poverty in these areas.

Figure 1.1. Changes in goat numbers and price from 1994 to 2007



Animal production in Vietnam is primarily focused on pig, poultry and fish production to cater for the majority demand for these meats. It is only in recent times that some emphasis

has been placed on increasing the output of beef meat and dairy products to meet the increasing demand for these commodities as general affluence grows in the country. Goats have been an important but minor component of Vietnamese extensive agricultural production systems for many centuries. According to the Vietnamese Ministry of Agriculture and Rural Development (MARD) (2003), there were 850,000 goats in Vietnam (Figure 1.1), of which 73% are found in the north and 27% in southern Vietnam. In northern Vietnam 48% of all goats are found in the mountainous areas of the country, and account for 67% of the total number of goats in Vietnam.

Figure 1.1 also shows that while the total numbers increased by about 270%, price increased by over 300%, indicating that with increasing numbers there was an increased demand which is reflected in the higher price. There seems little doubt that goat production could be a profitable enterprise for small-holder farmers in Vietnam.

Prior to 1993, little attention was paid to goat husbandry in Vietnam. Farmers raised goats on natural pastures using traditional techniques and generally lacked experience in the application of modern technologies to goat production. There are two breeds of indigenous goats in Vietnam, Co (or grass) and Bachthao (BT). Co goats are the minority breed, brown in colour, small in body size and are thought to be low in productivity. These goats are most often found in remote and mountainous areas, and are well adapted to these environments. The more common larger black and white Bachthao goat has the characteristics of some European breeds (French Alpine) and was possibly introduced by European colonists in the 17^{th} century. However, until recently, little was known about the breeding, feeding or management of these breeds of goats.

In 1993, the Vietnamese government realized that goats were an important part of the rural economy, particularly for poor farmers, and that improvement in their productivity would directly benefit these farmers. MARD (Ministry of Agricultural and Rural Development) was given national responsibility for research and development of goat production, and the Goat and Rabbit Research Centre (GRRC) was established at Sontay near Hanoi under the management of the National Institute of Animal Husbandry (NIAH) to achieve this goal. At this time, goats in Vietnam were being raised mostly for meat, which attracted a high price in the market compared with other meat. Research at GRRC was focused on developing dairy and dual-purpose goats by cross-breeding with selected Bachthao goats. In 1994, some exotic goat breeds were imported from India (Jumnapari, Beetal, Barbari) and in 2002, further imports of high-producing Alpine and Saanen goats and Boer goats for meat were made from USA. These breeds have since been maintained at GRRC by selection as pure breeds for cross-breeding with local Co goats. In the period 1994-2004, the progeny of Indian and Bachthao bucks crossed with local Co does (F1: 50% exotic) had significantly increased milk yields (25-50%). Yields were further increased (40-55%) in F2 generation (75% exotic). Since then, herds of F1 and F2 crossbreds have been distributed to many farmers, and with the development of local fresh milk and cheese processing plants, this initiative has contributed in a major way to overall economic development, poverty and hunger alleviation, especially for those living at the rural and remote areas. An important part of this development was the recognition by farmers that increased productivity could only be achieved by improved management of animal health, nutrition and reproduction.

However, these improvements in productivity have been mostly restricted to the northern provinces of Vietnam, and in 2004, a need was seen to extend this knowledge to goat farmers in the mountainous areas of north-west Vietnam, and to the southern provinces. In these

areas, goat productivity has remained low due to reproductive failure and high mortality caused by endemic diseases, poor nutrition and a lack of reproductive management. The cycles of low prices which follow diseases outbreaks also leads to instability in these goat production systems. In these areas, the first priority for research is identification diseases impairing productivity, followed by strategies to control and prevent these diseases in the future. The second priority will be identification and correction of management practices which are limiting productivity, issues such as inbreeding caused by over-use of bucks, poor nutrition and reproductive management. These new practices need to be applied in wholistic fashion to gain most effect. The area chosen for intervention by the Vietnam-Australia Goat Improvement team was the south-east provinces of Ninh Thuan, Binh Thuan and Lam Dong. This area was chosen because the Vietnamese government was planning to establish a Sheep and Goat Research Centre in Ninh Thuan to service the development needs for sheep and goat production in this region, and the activities of the project will provide a baseline from which extension programs can be developed by the new Centre. It is also expected that many of the recommendations developed for goats may also be applied to sheep. The following chapter describes the methodology applied to improving goat productivity and reports the results of surveys of small-holder goat farms in the south-east provinces of Vietnam which to determined the nature and extent of the problems faced by farmers raising goats in these areas.

Chapter 2

Characterisation of Goat Production Systems in Vietnam

Goat production in Vietnam has rapidly expanded in the north with the advent of new knowledge for disease control, feeding management and the introduction of both local (Co, Bachthao) and exotic (Jumnapari, Anglo-nubian, Saanen, Boer) breeds of goats to village live-stock systems. These initiatives have been led by the Goat and Rabbit Research Centre (GRRC) at Sontay, from which an expanding milking and meat goat industry is being developed. While goat meat is not a common commodity in the markets of Vietnam, economic returns to goat farming are high and are attracting many farmers to add goats to their farming enterprises. Goats are particularly important for poor farmers, usually providing good returns for little investment. The Vietnam-Australia Goat Improvement Project was jointly funded by the Vietnamese and Australian governments with the specific aim of developing and implementing new appropriate technologies for improving goat production and increasing small-holder income in the south-east region of Vietnam.

The south-east region contains those parts of lowland southern Vietnam which are north of the Mekong River Delta, and in which there are seven provinces (Tay Ninh, Binh Duong, Binh Phuoc, Dong Nai, Ba Ria-Vung Tau, Binh Thuan, Ninh Thuan) and the independent municipality of Ho Chi Minh City (formerly Saigon). The provinces of Ninh Thuan and Binh Thuan, together with the adjoining Central Highlands province of Lam Dong, were chosen as the focus for these studies. The fertile coastal plains of Ninh Thuan and Binh Thuan support rice, fruit growing and fishing industries, with hilly and mountainous areas extending to Lam Dong province have coffee, horticulture and upland cropping as their main enterprises. The goat population in these areas is generally small, sharing with sheep, a place on many poor small-holder farms. Little is known about the potential for or limitations to improving goat or sheep production in this region.

The local people in these areas are mainly Vietnamese, Kinh, Cham, Ra Glai, Co Ha and Hoa with Ma and Nung minorities in Lam Dong, and are amongst some of the poorest in Vietnam (U$50 income per annum). The traditional farming systems vary from rice cropping in the river deltas in Ninh Thuan to upland farming systems based on cassava, root crops, fruit and forest trees and livestock. In 2006, goat numbers in Ninh Thuan, Binh Thuan and Lam Dong provinces were estimated to be 107,420, 53,540 and 11,581 respectively. Goats are largely managed by women and children. Income from livestock has been estimated to be 22-25% of the total income from agricultural production in the region.

The aim of this project was to develop strategies for improving goat productivity in these regions, and included elements of farm survey to identify the problems and realised outcomes, training of key farmers and provincial Department of Agriculture and Rural Development (DARD) staff in the application of the new technologies needed, and strategic planning to improve the health, nutrition and reproductive rates of local goats. The specific objectives and expected outputs from the project over a 3 year period were:

1. Identification and characterisation of target farms
2. Training and information dissemination
3. Provision of improved health care and housing for goats
4. Improve the availability and quality of feeds and forages for goats
5. Provide local and introduced Bachthao bucks of proven genetic merit for breeding
6. Economic evaluation of the impact of new technologies on goat productivity

The implementation and outcomes from each of these objectives will be reported and discussed later in this book, but the first activity undertaken was to select and characterise the farms and farming systems in which new technologies were to be applied.

Table 2.1 List of location and numbers of farms surveyed to establish base line data for goat farming systems in south-east provinces of Vietnam

Province	**District**	**Farms inside Project**		**Farms outside Project**		**Total Farms**
		Number Farms	**Goats/ Farm**	**Number Farms**	**Goats/ Farm**	
Ninh Thuan	**Ninh Hai**	3	71	8	41	11
	Thuan Bac	6	49	0		6
	Ninh Phuoc	6	78	7	139	13
subtotal		***15***	***65#***	***15***	***92#***	***30***
Binh Thuan	**Tuy Phong**	3	92	3	41	6
	Bac Binh	3	62	3	65	6
	Ham Thuan Bac	3	92	3	46	6
subtotal		***9***	***82#***	***9***	***52#***	***18***
Lam Dong	**Duc Trong**	**3**	**70#**	**5**	**25#**	**8**
Total		***27***	***1926****	***29***	***1972****	***56***

Average goats/farm for each province *Total number of goats recorded

Identification and selection of farms for survey

The diversity of the farming systems in these three provinces made it difficult to decide how best to select a representative group of farmers to include in this project. Three broad categories of farming environments were identified, lowland - high rainfall, upland - low rainfall and highland - high rainfall. It was also deemed necessary to work with poor farmers who had some potential to improve the productivity of their goat herds, and this condition constrained selection to farmers who lived on farms that were owned or leased, they were required to own approximately 30-50 goats and to have some experience with goat raising. DARD officers in each province were then asked to find suitable candidates by negotiation with district and commune officials in selected districts in each province. The number of

farms finally selected was 30 for Ninh Thuan (districts Ninh hai, Thuan Bac, Ninh Phuoc), 18 for Binh Thuan (Bac Binh, Ham Thuan Bac, Tuy Phong) and 8 for Lam Dong in only one district Duc Trong. These numbers were chosen to reflect the relative numbers of goats in each province and were the maximum number that could be accommodated within the budget and labour available. Each farm was inspected by senior staff before official inclusion in the project. All farms were then surveyed, and approximately half of the farms in each district were chosen for the application of the new technologies (Farms inside Project), while the remaining farms were left without further support (Farms outside Project). The data from latter group was used as a baseline against which changes in farming system productivity in the selected farms were measured. It can be seen from Table 2.1 that while similar numbers of farms were surveyed for inclusion inside and outside the project, goat herd sizes varied considerably within and between districts, such that, some very large goat farms (>200 goats) and very small farms (<20) goats were included in the survey.

Question and answer session with farmer

Survey methodology

The project team developed a questionnaire from discussion with GRRC and DARD staff and from other surveys that have been made of farming systems in Vietnam. The purpose of the survey was to collect back-ground information on the nature and activities of small-holder farmers in the above provinces, and this information will be subsequently used to determine the extent to which the planned intervention with new technologies affects the qualitative and quantitative activities on each farm. The selection of farms for interview was described above and was not random. Many constraints were placed on this selection process, for example, pre-selection by DARD and Commune staff, willingness of the farmer to participate and ease of access during all seasons. As a consequence, farms chosen inside and outside the project, while raising goats, are sometimes quite different in other attributes, meaning that these farms may not be easily compared.

Two types of survey were conducted, the first survey was aimed at describing the Livestock-Farming system at the beginning (June 2006) and end (June 2008) of the project, and the second survey recorded details of goat productivity and management at 3 monthly intervals on those farms selected for longitudinal study. The Livestock-Farming System survey collected information on the farmer's household circumstances (family and farm size, labour, land tenure), crops grown and animal raised, crop and animal management including disease incidence and severity, sources of income and sinks of expenditure and marketing and

processing of goat products. Key informants, usually Commune leaders and local DARD officers, were used to learn about local history, commune (village) and local authorities (Womens Union, Farmers Union etc) were encouraged to participate where interested. Secondary data on climate, soils and agricultural policy was collected from the DARD agencies in each province, and Vietnamese government sites on the internet. Primary interviews were conducted at pre-arranged times with each farmer and their family at their farm, with one experienced (trained) staff member being responsible for conducting each interview. Each interview usually took about 2 hours, and the completed interview sheets were then stored for later translation into English and interpretation. A copy of the questionnaire is available from the authors on request. It should be remembered that all data collected comes from farmer's views and estimates, and there is really no way that this data can be externally verified. It is for this reason that no measures of statistical variance have been applied nor significance of differences claimed. The Goat Productivity and Management survey recorded herd statistics at the start (numbers, breed, sex, age, reproductive traits, past mortality, etc) and at 3 monthly recorded intervals health measures applied (vaccines, anthelminthics, etc), live-weights, births, deaths, sales, purchases at each time. The results from this survey will be reported in Chapters 6 and 7 where the outcomes of the application of the new technologies are reviewed and assessed.

One of the participating Vietnamese families with Project staff

Characterisation of Livestock-Farming Systems

A large amount of information was collected during the surveys of these 56 farms, and this data was summarised as mean values for each record and compared between farms inside and outside the project, and within each group, between Provinces. While it is recognised that this treatment may over simplify the significance of similarities and differences, the presentation of any greater detail (ie ranges) would possibly confuse and complicate the interpretation of this data. Where further explanation of some data is required, more detailed analyses may be conducted. The following section divides the data into separate categories for ease of presentation and discussion.

Table 2.2 Description of Vietnamese goat farmer family circumstances and socio-economic characteristics

Characteristic	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	**Binh Thuan**	**Lam Dong**	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**
Gender of owner %						
Male	93	100	33	100	100	100
Female	7	0	67	0	0	0
Family structure						
Adult males	1.46	1.22	1.0	1.8	1.78	1.2
Adult females	1.33	1.55	1.33	1.6	1.22	1.0
Male children (<18)	1.2	1.0	0.6	1.86	0.88	1.8
Female children (<18)	0.8	0.55	0.67	1.47	0.55	0.8
Average family size	4.79	4.31	3.60	6.73	4.43	4.8
Religion of owner						
None	93	100	33	100	100	100
Has religious beliefs	7	0	67	0	0	0
Education of owner (%)						
Cannot read or write	7	16.5	0	0	0	20
Can read and write	13	0	33	27	22	20
Finished primary school	67	55	33	53	44	20
Finished secondary school	13	22	34	20	34	40
Finished Tech/University	0	16.5	0	0	0	0
Wealth rank (% poor)	27	11	0	0	0	66
Family labour (person/years)	2.1	1.66	3.0	2.7	2.33	2.2
Hired labour (% farms having)						
No hired labour	26.7	11.1	66.7	100	22.2	60
One persons/year	40.0	22.2	0	0	55.6	40
Two persons/year	13.4	11.1	0	0	22.2	0
3-4 persons/year	13.2	0	0	0	0	0
5-7 persons/year	0	22.2	33.3	0	0	0
Only at harvest	6.7	22.2	0	0	0	0
Farm Size (ha)	1.831	6.819	2.501	4.738	3.236	2.194
Range	0.1-5.0	1.1-17.1	0.9-4.0	0.4-11.1	0.8-6.6	1.5-3.5

Family circumstances and socio-economic characteristics

Table 2.2. shows that men, who were mostly the farm owners, had families varying in size from 4 to 7 members, being supported on areas of land varying from 0.11 to 17.1 ha, and that the adult members of these families were the major source of labour for farm work. It is not known what proportion of farmers owned or leased their land. The overall proportion of households judged to be poor was low (14%) representing only 8 of the 56 farms surveyed. Poor households were mainly from ethnic minority groups or families with only old people for labour. However, it was clear from this data that family labour was not sufficient to run the farm effectively, and most farms needed to employ at least one additional person at some time in the year to help with farm operations. The farms hiring labour are mainly those raising large herds of goats which are taken daily for grazing away from the farm. Farms growing grapes, coffee and other fruit trees also hire labour but only in the harvesting season. Small family sizes and the relative shortage of labour are probably related, with school

attendance by children exacerbating the problem. It seems likely that labour shortage does limit the potential to increase agricultural and animal production even from these small farms.

Table 2.3 Family food security and consumption patterns

Measurement	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	**Binh Thuan**	**Lam Dong**	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**
Food security (% of farms)						
Surplus over one year	60	22	67	53	67	40
Sufficient for one year	13	44	0	41	22	60
Sufficient for 9 months	*27*	*24*	*23*	*6*	*11*	*0*
Food consumption (kg/year)						
Milk (cows)	84	36	84	48	24	36
Beef	24	24	48	24	24	60
Goat meat	0	0	0	12	12	0
Lamb	0	0	0	12	0	0
Pork	84	144	84	108	180	108
Chicken	48	48	72	60	36	36
Eggs (50g)	4.4	7.3	10.0	7.9	4.7	5.4
Fish	228	228	120	96	204	108
Money spent on food (millions VND/year)	11.76	11.93	14.68	17.24	13.07	8.42

Family food security and consumption patterns

Table 2.3 shows that, on average, 51% of farmers surveyed were able to either grow or purchase more food than their family needs each year, presumably by selling or trading surplus food for goods and/or services. However the remaining 49%, could only produce either just sufficient, or not enough food, each year to feed their families, and where less than the years requirement, would need to purchase extra food from other sources. It is clear that about one half of this population could be considered at threat from malnutrition or starvation in some years, and highlights the need for these poor farmers to find new ways to increase their food production and/or income from their agricultural enterprises. Consumption patterns of the traditional animal protein sources, pork, chicken and fish, represent about 79% of all animal sources consumed, As might be expected, families from the Lam Dong highlands, consumed less fish and more beef than did families from the coastal lowlands. Very few families consumed their own goat meat, which probably reflects the high market price that could be obtained from selling goats, and the preference of farmers to reserve their goats for sale rather than for home consumption. The amount of money spent on food was generally similar across farms, although Ninh Thuan farmers outside the project seemed to spend more and Lam Dong farmers outside the project seemed to spend less on food than all other farmers. These trends correlate well with the wealth rankings shown in Table 2.2 where this latter group were judged the poorest farmers in the survey.

Land, Crop and Forage production

The diversity of agricultural produce grown on the farms was large, and only the major crops were recorded for analysis. In addition to those shown below in Table 2.4, and allocated to the "other crops" group were crops such as coffee (in highland areas), sugar cane, fruit trees (papaya, dragon fruit, cashew nut, durian, etc) and a wide range of vegetables grown mostly for home consumption. While rice is the staple food crop grown in Vietnam, in

the present study, only 60% of farms grew rice. The areas of rice grown were generally small (0.25-0.6 ha) with the exception of farms on Binh Thuan inside the project that planted larger areas (<>2 ha). Yields varied greatly across farms (5.1-19.8 tonnes/ha) due largely to varying environmental conditions (rainfall) and whether there were two crops per year. Farms which had excess food tended to be those that double cropped and had access to irrigation or reliable rainfall.

Table 2.4 Land use and crop, fruit and forage production

Measurements	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	**Binh Thuan**	**Lam Dong**	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**
Rice						
% farmers growing:	60	44	67	40	78	60
Area sown (m^2)	5611	20250	6000	2458	3271	3667
Yield/area (kg)	4000	29500	6250	4887	1928	1900
Yield (tonnes/ha)	7.138	14.467	10.42	19.82	5.894	5.181
Grapes						
% farmers growing:	0	44	0	13	0	0
Area sown (m^2)		1940		2250		
Yield/area (kg)		4175		4400		
Yield (tonnes/ha)		21.52		19.56		
Maize						
% farmers growing	20	56	67	0	0	0
Area sown (m^2)	3693	15000	6500			
Yield/area (kg)	550	7484	3000			
Yield (kg/ha)	1489	4989	4615			
Mung beans						
% farmers growing	20	11	33	0	0	0
Area sown (m^2)	3500	5000	10000			
Yield/area (kg)						
Yield (kg/ha)	na	na	na			
Fresh Forage						
% farmers growing	67	67	67	87	100	20
Area sown (m^2)	1125	2963	1360	3519	2156	2000
Yield / area (kg)	12930	34650	13000	37754	19266	20000
Yield (tonnes/ha)	114.9	116.9	95.6	107.3	83.4	100.00
Other crops						
% farmers with:	47	100	100	33	34	100
Area (m^2)	5292	23755	27933	20820	10166	14200

While some farmers consumed all the rice they grew, most farmers, sold about 70% of their rice, using the remainder for home consumption and animal feeding. The by-products of rice processing (broken rice, rice bran) were used for raising pigs, while rice straw was conserved as hay mostly for cattle. Some farms inside the project had planted maize and/or mung beans as annual crops, although this practise was not recorded for farms outside the project. With the exception of Lam Dong farms outside the project, more than 67% of all farms were growing forages to feed their animals. The area of improved pasture, mostly King (Elephant) Grass (*Pennisetum purpureum*), planted for feeding animals did not seem to depend on the number of stock (cattle, goats, sheep) owned, but on the availability of irrigation water in the

dry season. It was also noted that where farmers had planted improved grasses, they were already receiving significant income from their livestock enterprise. The sources and types of feeds used for livestock will be presented and discussed in a later section.

Table 2.5. Ownership and herd structures of cattle, sheep and goats populations

Ruminant species	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Cattle						
% farmers owning cattle	47	67	67	0	78	17
Herd size	13.5	27.1	28.5		15.1	12.0
Bulls	0.3	0.5	1.0		0	0
Dry and pregnant cows	6.6	12.0	14.0		9.9	6.0
Lactating cows	1.9	2.2	7.0		0.3	3.0
Female calves	1.7	5.2	3.5		2.9	0
Male calves	0.9	3.2	2.0		1.1	1.0
No. sold in previous year	1.1	3.5	1.0		1.6	2.0
Mortality in previous year	1.0	0.5	0		0	0
Sheep						
% farmers owning sheep	7	0	0	47	0	0
Flock size	55			67.2		
Rams	1			1.0		
Dry and pregnant ewes	18			33.7		
Lactating ewes	7			9.9		
Female lambs	7			7.7		
Male lambs	6			4.7		
No. sold in previous year	10			7.9		
Mortality in previous year	6			2.3		
Goats						
% farmers owning goats	100	100	100	100	100	100
% Bachthao*	93	100	67	87	100	0
Herd size	73.8	108.7	80.5	93.8	51.6	29.6
Bucks	0.9	2.1	1.0	1.3	1.1	1.0
Dry and pregnant does	31.9	43.0	17.3	49.7	34.7	12.8
Lactating does	9.1	12.1	21.3	13.7	1.8	0.8
Female kids	9.7	14.7	6.0	10.4	3.9	1.2
Male kids	3.1	7.9	4.3	5.6	1.3	3.4
No. sold in previous year	11.0	21.3	20.3	11.3	7.9	9.2
Mortality in previous year	8.1	7.6	10.3	1.8	1.9	1.2

* All other goats were Co or Co x Bachthao

Ownership and herd structures of cattle, sheep and goat populations

Cattle and sheep were being raised with goats on many of the farms surveyed. Table 2.5 shows the level of ownership of cattle, sheep and goats by farms inside and outside the study, as well as, herd size and structure, for each species. The female breeding herd for each species was broadly divided into those that were either dry (non-pregnant, non-lactating) or pregnant and those that were lactating (with young), the suckling and weaned progeny were categorised as "young" females and males, ie non-breeding animals. Mature males were

listed separately. Animals sold or that had died in the previous year were also recorded, and herd/flock size calculated as the sum of all categories.

Cattle were being raised by about 60% of the farmers interviewed (with the exception of those in Ninh Thuan outside the project), with herd sizes varying from 10-70 animals. The main breeds found in Binh Thuan and Lam Dong households were Vang (70%) and Laisind (30%), with a predominance of females in the herd. Male cattle are traditionally sold for meat at about 2 years of age. Sheep are often raised with goats, but this situation was found only for farmers outside the project in Ninh Thuan and for one other farmer inside in Ninh Thuan. The breed of sheep most commonly found was the indigenous wool/hair Phan Rang sheep. When initially selecting farms for survey, goat enterprises with significant numbers of sheep were excluded because it was thought that sheep would compete for the resources supplied to goats, and confound the interpretation of any responses by goats to the application of new technologies. It was notable that annual mortalities were low (5-15%) for both sheep and cattle.

Typical dry season in Binh Thuan

As planned, all farms had some goats with herd sizes varying from about 10 to 400 on one farm in Ninh Thuan outside the project (Mrs Nguyen Thi Lieu). The majority of goats were Bachthao breed, but some farms had significant numbers of Co and Bachthao x Co goats, for example, most goats in Lam Dong province were these cross-breeds. All farmers were upgrading their small Co goats with the larger Bachthao breed. Table 2.5 shows that, on average, there appeared to be no more than one breeding buck per farm, and at the time of survey, some farms did not have a buck for breeding. It has been common practice for farmers to sell bucks when they reach about 25 kg, keeping only one buck for breeding, and using this buck for perhaps 3-4 years. In this case, this practice may result in inbreeding in these small herds, and evidence of hermaphrodism and abnormal genitalia was found in some herds. Often, the breeding buck being used is also the slowest growing male, and is only kept because it did not reach saleable weight in the required time. Where this is the case, there is a selection pressure being applied against live-weight, and small progeny are to be expected. While it is difficult to separate the effects of inbreeding from those of malnutrition and ill-health, it will be recommended that new bucks be provided to all farms to avoid any future

inbreeding. Most farms are building their herds, and usually retain all females, selling only young males.

The average mortality recorded for the goats from all provinces inside the project was not unusually high, 10% per annum on average. However, this figure obscures the fact that much higher mortalities were recorded on some farms, and 14 of the 27 farms surveyed inside the project had mortalities higher than 15%, the highest mortality being 40% recorded for one farm in Lam Dong. These high mortalities warrant further study. Table 2.6 shows information collected from farmers on ages and live-weights of goats from birth to first kidding. The range in birth weights covers both single and multiple birth kids, and was recognisably lower for Co and Co x Bachthao kids. The values shown come directly from farmer's knowledge and were not actually measured. Kid mortality was generally low, since mortalities of upto 20% are usually found in most grazing herds. It is not clear why estimates of kid mortalities from farms outside the project (3-7%) are much lower than those from farms inside the project (7-15%). It is suggested that these values may all under-estimate the significance of this problem in these goat herds. Kids are naturally weaned in these systems, that is, when milk production from their does ceases. The average time to weaning (100 days) also reflects the length of doe lactation in this environment. Although the proportion of twins in these kids is not known, the weaning weights would be judged generally low for Bachthao goats with mature body weights of 45 and 60 for females and males respectively. There are clearly opportunities to increase weaning weights with these goats so that they reach market or conception weights quicker than now reported. The males will be sold for meat in the live-weight range of 25-30 kg, which will take at least another 12 months before marketable. Again, there are opportunities here to increase growth rates by better nutrition and management.

Table 2.6. Farmer estimates of ages and weight of kids from birth to first kidding.

Measurement	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	**Binh Thuan**	**Lam Dong**	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**
Birth weight (kg)						
Mean	1.95	2.16	1.53*	2.32	1.99	2.00
Range	(1.5-3.0)	(1.5-2.5)	(1-1.8)	(1.5-2.5)	(1.5-2.5)	(1.5-2.5)
Kid mortality % (0-3 mths)						
Males	3.9	4.7	2.0	1.3	2.1	3.4
Females	7.5	10.7	4.7	1.9	2.4	2.6
Weaning						
Mean weight (kg)	12.2	12.7	10.0*	10.8	9.8	10.2
Range	(8*-16)	(10-16)	(8-12)	(7.5-12)	(9-11)	(9-11)
Mean age (days)	101	109	110	92	96	95
Range	(60*-120)	(90-120)	(90-120)	(80-120)	(90-105)	(90-105)
Age at first mating#						
Mean age (months)	8.7	7.4	10.0*	9.4	4.67	6.4
Range	(5-13)	(5-11)	(7-13)	(7-11)	(4-6)	(5-8)
First kidding						
Mean weight (kg)	22.9	24.0	20.3*	25.9	22.4	24.0
Range	(16*-26)	(12*-30)	(18-23)	(23-29)	(21-25)	(23-25)
Mean age (months)	13.7	12.4	15.0*	14.4	9.67	11.4
Range	(10-18)	(10-16)	(12-18)	(12-16)	(9-11)	(10-13)

* Co x Bt goats # Estimated as 5 months earlier than first kidding

Mean age of first conception was estimated by subtracting 150 days (average gestation period for goats) from the recorded mean ages of first kidding. These observations suggest that in an uncontrolled mating system, doe kids will, on average, conceive about 6 months after weaning (9.2 months old), and kid at 14 months of age. However some doe kids may mate earlier than this, with possibly both short and longer term effects on their reproductive capability.

The conception and kidding patterns found here suggest that under natural mating, kidding could possibly take place at any time of the year. It may therefore be expected that if kidding takes place in the middle of the wet season or at the end of the dry season when feed is scarce, abortion and doe and kid mortalities will be common. It is not yet known whether farmers manage this aspect of reproduction, ie by restricting doe access to bucks, but such management practices may be useful in these goat livestock systems.

Feeds and feeding systems for goats

The feeds used for goats are heavily reliant on the sources of natural forages, and where available, goats are taken out daily to graze these common areas of pasture, forest margins and roadsides. The herd is returned to a goat house each night for security, and depending on the season, may or may not be offered additional feed or water. Young suckling kids are often left in the goat house each day while their does are away grazing, and may be offered some grass or rice bran at this time. Does with very young kids (< 2 weeks old) are usually kept in pens and fed supplements until old enough to survive the day without suckling.

Table 2.7 Feeds and feeding systems for goats in survey groups

Feeds and grazing data	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
% feeding supplements	100	100	67	100	89	20
Supplements fed						
King grass						
Water spinach	87*	78	67	93	89	20
Sweet potato vine	60	44	33	0	0	0
Cassava foliage	13	33	67	0	0	0
Maize stover	13	44	0	0	0	0
Grape leaf	53	55	67	40	55	40
Rice bran	27	0	0	27	0	0
Molasses	33	44	67	40	0	60
Other (by-products)	13	0	0	20	22	0
	80	78	67	0	11	11
Grazing management						
Forest	60 (7.4)#	78 (6.7)	100 (8.0)	100 (7.4)	100 (7.7)	100 (8.2)
Garden	0	11 (10)	0	0	0	0
Rice fields	40 (2.8)	11 (1)	0	0	0	0

* % of farmers feeding this supplement # Values in brackets are hours grazing/day

Table 2.7 shows that the herd will often spend 7-8 hours grazing away from the farm, but are only allowed much shorter times if grazing gardens or rices paddies. Fresh feeds, such as King grass, were used by most farmers where available, as were crop residues. However, with perhaps the exception of rice bran, these supplements were mostly high in fibre and low in protein, and must be considered generally as low in quality. The amounts given were usually small, with allowances per goat, varying from 300 g/d to *ad libitum* intakes. Generally the demand for feed is greater than the supply, with feed deficits occurring in the wet season when access to grazing is limited, and in the dry season, when feed quantity and quality is limiting in all grazing areas. At the time of survey, there were no improved forages available or being promoted for use, nor were farmers aware of or practising fodder conservation. The exception was the storage of rice straw, but this was exclusively for the feeding of cattle. Traditional views consider that goats will not eat rice straw. There is clearly a need to introduce new forages to these areas, particularly, high producing grasses which could be irrigated and fertilised with goat manure throughout the dry season, and also forage and tree legumes to provide strategic supplements of protein for pregnant and lactating does. The forage needs of a herd of 50 goats with an average live-weight of 25 kg is about 100 kg fresh forage (30% legume:70% grass) per day to meet all requirements. This allowance could be easily produced from small plots of land dedicated to forage production.

Typical symptoms of Goat Pox

Kid with broken leg from bad flooring

Goat health and incidence of disease in surveyed farms

The effective management of animal health has two components, the first is disease prevention by providing a safe and hygienic environment in which the goats live, and the second is disease control in which medication, quarantine and veterinary advice are applied to alleviate animal distress and to prevent the spread of disease to other animals. The traditional grazing systems used in Vietnam, where goats from many different farms graze together each day, makes disease prevention and control more difficult than where individual goat herds graze in isolation. These circumstances require that disease control become a community issue, not just the problem of each farmer, and in this case, the control of infectious diseases such as foot and mouth and goat pox, need to be managed by local government authorities. Such management will require controlling the movement of all stock in "infected" areas, the compulsory slaughter of diseased stock and implementation of measures (eg vaccination) to control the problem. These are clear issues that the Vietnamese government needs to address if animal industries are to thrive in this environment.

However, each farmer can exercise control over all these aspects on his farm, and should be able to ensure that his goats return each night to a clean and disease-free environment, and be monitored daily for any signs of disease or ill-health. It is common practice in Vietnam for

goats to be held in goat houses overnight to protect from animal and human predators. Poorly constructed and managed goat houses may be a significant source of disease and injury, and the survey team made a point of carefully inspecting each goat house before recommending any action on disease control and prevention.

Housing and veterinary services

The status of some of the goat houses found during the survey of farms in the three provinces is shown in the following photos. Generally the goat houses were of poor design and construction, due mainly to the use of cheap local materials. House areas were often small in relation to the number of goats held, and few had separate internal pens that could be used to hold recently kidded does and their kids, isolated sick animals or for bucks to prevent indiscriminate breeding. The walls were made of local materials such as small tree branches, bamboo, waste wood, plastic sheeting or fertiliser bags, and many houses did not afford much protection from wind or driving rain. Floors were often in the worst condition when made from round bamboo poles with gaps big enough for the goat's legs to become caught and damaged. Most houses were raised above the ground by about one metre providing ventilation which decreased humidity during the wet season and spaces through which urine and faeces can pass. When poorly constructed, manure was collecting on the floor creating smell and a potential source of infection. The manure that fell through the slatted floor accumulated underneath the building, and unless removed also, constituted a health hazard for both goats and humans. It is important that these areas be fenced to deny easy access, and frequent removal should be encouraged as a matter of course. There were no differences between farms inside or outside the project in the standard of housing, and it was decided that the simplest intervention with greatest effect would be to provide a concrete collecting floor for manure underneath each goat house. It was expected that this flooring would retain the manure in one dry area and could be collected by hosing into a sump for later use as fertiliser or for sale. A herd of 50 goats weighing 25kg and consuming 500 g dry mater per day excretes about 40 kg fresh manure per day containing significant amount of nitrogen, phosphorus and other nutrients needed for plant growth. This manure could be used on crops, gardens or as we would recommend, to fertilise plots of improved pastures (grasses and legumes) as supplements for feeding. Most farms had small fenced areas where goats could be held during the day if not away grazing, and these areas should also be considered when planting forages as supplementary feeds.

Typical goat house in Binh Thuan

A large and well-designed goat house in Ninh Thuan

Veterinary knowledge and expertise is essential for the prevention and treatment of disease. In Vietnam, community veterinary workers have responsibility for monitoring the incidence and severity of disease of livestock in each commune/village, administration of drugs and

vaccines, and for reporting to local district veterinary authorities on these matters. These "veterinarians" are required to have, at least, an intermediate certificate, in addition to practical experience with goat managment or training in animal health management. They are paid according to their qualifications and not for their experience, by district and subsidy from the Province. There is a shortage of veterinary workers in Vietnam, and generally most villages do not have access to such services. There is an urgent need to train more of these workers to meet the challenges of disease prevention and control in the rural areas of Vietnam. In the absence of experienced veterinary workers, community veterinary health is managed by a commune veterinary board which is responsible for disease detection, diagnosis and control, recording and reporting contagious animal diseases of public concern, supervision and enforcement of slaughter and meat hygiene regulations and the regulation of the sale and use of all drugs and vaccines. However, differences in education levels of these workers between villages makes these services not very effective. It is clear that there is a need for the training of local veterinary workers by the Project if the disease control measures suggested are to be effective and sustained into the future.

Incidence and control of disease in surveyed farms

Disease prevention and treatment were a major problem with all livestock farmers, since there are no government or community programs dedicated to the prevention or control of epidemic disease in this part of Vietnam. Even though it is claimed that all cattle have been vaccinated against foot and mouth disease, local knowledge suggests that no more than 30-35% have been vaccinated. Goat pox is a good example, it has occurred in epidemic proportions over the past few years without any action to quarantine or manage this disease. The response of farmers to news of an epidemic is to sell all goats for fear that their goats will be unsaleable if contracting the disease. This action floods the goat market reducing the price, and return to farmers. Control of this disease is imperative if sustainable goat production is to develop in south-east Vietnam. When interviewing farmers about the diseases affecting their goats, the survey team had some difficulty relating the symptoms described to a recognisable disease, even though veterinary workers were present. As a consequence, symptoms such as bloating, diarrhoea and malnutrition, may be caused by one or more organisms or circumstances, and the design of treatments requires a more detailed and specific diagnosis than could be provided at this time. For example, the symptoms of scabby mouth and Goat Pox are similar when first contracted by the goat, but most goats will self-cure from scabby mouth, but may die from Goat Pox.

The symptoms of bloating are likely to be secondary to another causative agent(s), such as malnutrition, starvation or blockages of the digestive tract. While these symptoms were observed on most farms, it was young animals that mostly died from these symptoms. This problem appeared to be particularly important in Lam Dong, where young goats were dying on 30-40% of the farms surveyed. Table 2.8 shows that diarrhoea was a common symptom for mature goats on a few farms, but there were few deaths following these symptoms. However, almost all farms recorded a high incidence of these symptoms in young goats, amongst which there were high mortalities. There are possibly two major causes of this symptom, intestinal parasites and/or enterotoxemia. Enterotoxemia (*Clostridium perfringens* infection) is most often found in young goats, and is easily controlled by vaccination at an early age. Intestinal parasites can also be controlled with strategic drenching or injection with anhelminthics (eg ivermectin) at times of the year when animals are most prone to infection. Ivermectin will also control external parasites eg lice.

Pasteurellosis was also recognised as a serious disease in goats across all areas, with about a third of all farms recording an incidence in both mature and young goats, with significant number of deaths also occurring. A vaccine is available in Vietnam, and will be recommended for use. Scabby mouth is a common disease in young goats which normally cures itself by the time of weaning. It is highly contagious, and while simple, home-made vaccines can be used to cure this disease, it does not usually cause death, and topical treatment with astringents as done by farmers will relieve the symptoms in severe cases. However it was noticed that there was a high incidence of this disease in Ninh Thuan amongst farms which were not going to be included in the project, and some deaths of goats occurred there.

Table 2.8. Incidence of common goat diseases and local treatments

Disease/Symptoms	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Bloating						
% farms affected	20	78	67	30	67	60
Treatment	leave to self-cure, dose with plant oil, doe with ginger extract					
Diarrhoea						
% farms affected	67	56	67	40	67	33
Treatment	streptomycin, penicillin, dose with coconut milk, veterinary help					
Pasteurellosis						
% farms affected	33	33	33	20	78	20
Treatment	vaccination, streptomycin, veterinary help					
Scabby mouth						
% farms affected	27	22	33	40	21	40
Treatment	streptomycin + penicillin, cleaning with lemon, salt or permanganate					
Pneumonia						
% farms affected	33	44	33	40	44	40
Treatment	Streptomycin, penicillin, Tylogen, Dovenic, veterinary help					
Pink eye						
% farms affected	27	44	67	27	34	40
Treatment	eye drops (for humans), bathing with salt water,					
Fascioliasis						
% farms affected	40	11	0	27	33	40
Treatment	vaccination?, ivermectin, veterinary help					
Goat Pox						
% farms affected	27	0	0	33	56	20
Treatment	veterinary help, clean with Carambola or lemon juice					
Undernutrition						
% farms affected	7	0	0	13	33	0
Treatment	feed mash, glucose injection					

Pneumonia commonly occurs as a result of exposure to rain and cold, exacerbated by crowded housing with other animals. As recommended by farmers, treatment with antibiotic and removal from stressful conditions is effective for curing this disease, but prevention is the easiest solution. Proper housing during the cold and rainy season will be the most effective control measure needed. Pink eye takes various forms, but most commonly associated with damage and subsequent infection in the eye, which is easily cured by topical treatment with

antibiotics. This disease is not life-threatening and can be avoided by appropriate management and proper housing. Fascioliasis (Liver fluke infection) is a serious and debilitating disease commonly associated with sheep and goats grazing wet areas such as swamps or rice fields. Specific drugs (Dovenic) have been developed to treat infected animals, and ivermectin has also proved effective. It is well known that the liver fluke larvae need a snail as an intermediate host, and the most common form of control is to avoid grazing animals in wet and swampy areas. Where an incidence was found in this survey, significant numbers of goats had died.

Goat Pox (*Caprovirus*) has been recently recognised as a serious disease of goats in Vietnam, first being diagnosed by staff of GRRC in the north, which prompted the commercial manufacture of an effective vaccine for use in sheep and goats. In the current survey, goat pox was detected on farms in all provinces, all at a relatively low level (20-30% farms infected). The disease is highly contagious and where present will kill or debilitate all animals on a farm. Isolation and quarantine is the only effective way to control its spread. The vaccine which is now available is a valuable preventative measure in limiting the spread of the disease, and will be used on all project farms under study.

Income and expenditure from farming enterprises

The main sources of income for farmers surveyed were directly from the sale of crop and animal produce, with few declaring any other sources of earnings. Table 2.10 shows some estimates of the incomes and expenditures of farmers on their cropping and livestock enterprises. The diversity of agriculture on each farm made it difficult to record all the details of their activities, and the calculations made in the table are only first approximations to an understanding of the complexities of these farming economies. The values presented are averages for 15, 9 and 3 farms in Ninh Thuan, Binh Thuan and Lam Dong provinces respectively for farms inside and outside the project. The most noticeable feature of this table is that there was little similarity between farms or provinces in their economic activities, with cultivation and livestock enterprises on average providing about equal proportions of their income (45%), with the remaining 10% coming from external (non-agricultural) sources. In all cases, goats provided the largest proportion of income from livestock.

The average overall net income (difference between income and expenditure) for farms inside and outside the project in each province varied from a profit of 48.4 million VND/year for farms inside the Project in Lam Dong to an annual loss of 12.9 million VND/year for farms outside the project in Binh Thuan province. Detailed consideration of each enterprise shows for some farms, annual expenditure greater than income which possibly indicates that not all income for year had been received. The data also rely on the accuracy of the farmers recall of his income and expenditure, which may be in error, and closer scrutiny of this data is probably not warranted. The returns to the farmers investment (net income as percentage of expenditure) has been calculated for the cultivation and livestock enterprises, and cultivation consistently showed much higher returns than livestock which in two provinces (Binh Thuan and Lam Dong) were found to be negative (less return than invested). It is difficult to speculate further on these observations without more detailed information on the nature of the expenditure. The largest category of expenditure was for "off-farm activities" which included the purchase of food, fuel, clothing and household goods and the costs of education, health and rent where their land is not owned. The cost of purchasing food was estimated previously to be, on average, about 12.85 mVND/year (Table 2.3), which represents about 70% of the average annual expenditure in "off-farm activities". It is clear from these calculations that most families surveyed would classed as poor, spending most of their labour and meagre incomes on providing the essentials for living, food, clothing and shelter.

Table 2.9 Enterprise income and expenditure and returns to investment.

Criterion		Farmers inside Project			Farmers outside Project		
		Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
		Millions Vietnamese Dong (VND/year					
Crops	Income	6.93	16.60	33.86	17.50	6.81	3.80
	Expenditure	3.17	10.89	8.95	4.64	5.87	2.80
	Balance	3.76	5.71	24.91	12.86	0.94	1.00
Garden	Income	10.3	19.97	28.0	1.5	0	11.4
	Expenditure	0	0	0	0		0
	Balance	10.3	19.97	28.0	1.5		11.4
Fruit trees	Income	2.340	6.88	12.67	0	3	0
	Expenditure	5.067	4.95	11.00	0.65	4.5	8.2
	Balance	-2.727	1.93	1.67	-0.65	-1.5	-8.2
Cattle	Income	1.96	13.0	0	0	3.5	0
	Expenditure	9.98	9.5			1.7	1.0
	Balance	-8.02	3.5			1.8	-1.0
Sheep	Income	0.33	0	0	21.0	0	0
	Expenditure	3.0			1.75		
	Balance	-2.67			19.25		
Goats	Income	14.8	16.92	22.0	17.90	5.5	6.0
	Expenditure	21.8	16.1	19.0	6.21	4.5	6.0
	Balance	-7.0	0.82	3.0	11.69	1.0	0
Pigs	Income	7.1	0.22	0	0	0	9.0
	Expenditure	0.2	0.26	0.83			7.0
	Balance	6.9	-0.04	-0.83			2.0
Poultry	Income	0.013	0.056	0	0	0	0
	Expenditure	0	0				
	Balance	0.013	0.056				
Manure	Income	1.19	1.71	0	0.47	0	0
	Expenditure	0	0		0		
	Balance	1.19	1.71		0.47		
Other farm activities	Income	4.53	7.88	5.0	1.06	3.0	0
	Expenditure	0.2	1.93	2.3	3.91	0	0.2
	Balance	4.33	5.95	2.7	-1.85	3.0	-0.2
Off-farm Activities	Income	6.22	0.078	0	0	2.03	7.32
	Expenditure	20.96	19.38	11.0	23.07	20.0	14.20
	Balance	-14.74	-19.30	-11.0	-23.07	-17.97	-6.88
Total	Income	55.71	83.66	101.53	59.55	23.84	38.52
	Expenditure	64.38	64.10	53.10	40.00	36.60	39.40
	Balance	-8.67	19.52	48.41	19.55	-12.84	-0.88
	% Return	-13.5	30.4	91.2	48.9	-35.0	-2.20
% Income from:							
	Cultivation	34.9	51.9	73.4	31.9	41.1	39.5
	Livestock	45.6	38.1	21.7	66.1	50.3	38.9
% Returns to Investment*							
	Cultivation	138	174	274	259	5.4	38.1
	Animals	-27.4	23.4	15.8	395	45.2	-57.3

* % Return to investment calculated as Balance (Net Income)/Expenditure*100

Since the project was focussed on goat enterprises, more information on the nature of expenditure on this enterprise was collected, allowing a more detailed interpretation of these activities (Table 2.10). The effects of herd size on the profitability of this enterprise was explored in this table, with somewhat equivocal results.

Table 2.10 Effects of herd size on profitability of goat enterprises

Parameter	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
	Millions of Vietnam Dong (VND)/year					
Small herd (< 50 goats)						
Income from:						
Selling breeders	0	2.0	0	4.0	0	4.4
Selling for meat	0.8	6.0	5.8	5.9	2.7	12.0
Selling manure	0.5	1.3	1.1	1.1	0.8	1.6
Total income	**1.3**	**9.3**	**6.9**	**11.0**	**3.5**	**18.0**
Expenditure on:						
Buying breeders	0	12.0	6.0	0.9	0	9.2
Feed	0.3	3.8	1.2	0.5	0.5	1.8
Labour	1.8	7.5	4.5	2.8	2.0	4.3
Veterinary costs	0.3	0.5	0.6	0.5	0.2	0.2
Facilities	0.3	1.5	1.0	0.3	0.2	2.5
Total expenditure	**2.7**	**25.2**	**13.3**	**5.0**	**2.9**	**18.0**
Balance (Net Income)	-1.4	-16.0	-6.4	6.0	0.6	0
% Return to Investment	-51.9	-63.4	-48.1	120	21	0
Large herd (>80 goats)						
Income from:						
Selling breeders	10.0	17.0	30.0	10.0	0	na
Selling for meat	14.0	22.0	25.6	15.0	3.5	na
Selling manure	1.8	2.5	3.5	2.1	2.1	na
Total income	25.8	41.5	59.1	27.1	5.6	na
Expenditure on:						
Buying breeders	30.8	9.5	25.0	0	0	na
Feed	5.0	3.7	4.5	1.8	0.5	na
Labour	8.6	8.5	10.5	5.2	4.5	na
Veterinary costs	1.4	0.9	1.1	0.7	0.2	na
Facilities	2.2	0.5	2.7	0.5	0.3	na
Total expenditure	48.1	23.1	43.8	8.2	5.5	na
Balance (Net Income)	-22.3	18.4	15.4	18.9	0.1	
% Return to Investment	-46.4	79.7	35.1	230	1.8	

na – Data not available, no farms of this size in sample

Herd size did have an indirect effect on the profitability of these goat farms by constraining how many goats could be sold in any one year. The high prices for goats encourages farmers to retain all their females for breeding, and where possible, buy more breeding stock to improve the long term productivity of their herds. It can be seen from the above table that annual profits are determined by how many goats (for breeding and meat) were sold and how many new breeders were purchased in that year. Breeding does are expensive (2-2.5 mVND)

and represent a major investment for farmers with small herds. At the time of survey, there was significant mortality in all herds, and farmers with small herds were probably most affected because they had few meat goats for sale and needed to buy new breeders to replace those that had died. It is expected that control of disease will decrease mortality and provide all farmers with more goats for sale and with replacement breeding does removing the need to purchase new and expensive breeding does. The control of disease will also increase veterinary costs, but as shown in the above table, these costs are relatively small in relation to all other costs, and could be easily met by the sale of the extra goats saved from dying of disease and malnutrition. There is little doubt that investment in effective disease control will have major effects on the profitability of all goat enterprises, but particularly for farmers with small herds.

Marketing and processing of goats

Goats in Vietnam may be sold as breeders (males and females) to other farmers to build up their herds or as meat goats for consumption. The main market for goat meat is in the large cities where there are restaurants specialising in goat dishes, where both meat and offal are valued for consumption. Goat traders travel the provinces purchasing goats which may then be taken to a feedlot for finishing to market weight or taken directly to the restaurants where they are sold and slaughtered on premises for consumption. It was estimated that there if there were 100 goat restaurants in Ho Chi Minh city slaughtering 20 goats/day all year, this would make a total of 730,000 goats being slaughtered annually in Ho Chi Minh city alone. When one compares this figure with the estimated numbers of goats in the surrounding provinces (eg 93,000 in Ninh Thuan) it is difficult to understand how these small populations can sustain such numbers for the restaurant trade. It was previously shown that local goat took 18 months to reach slaughter weight, which means that it would need a population of about 400,000 breeding does producing 2 kids per year to meet this annual demand. While this output is possible, natural disasters, disease and remoteness of location causes supply to be variable, and the high prices relative to other meats, reflects a continuing high demand for not only goat meat but also breeding stock by small farmers who wish to take advantage of these high prices.

Breeding female Bachthao goats cost 2.0 - 2.5 mVND (U$125 – U$150) to buy, and proven bucks often cost more than 3 mVND each. Many farmers are now interested to upgrade their small Co goat herds by crossing with Bachthao, further driving up the price of breeding stock. Both males and females are being sold for meat, and there is a strict live-weight range (28-30 kg) specified as optimal by the "market". In 2007, live goats were being sold for 25,000 – 30,000 VND/kg live-weight , that is, 0.62 – 0.90 mVND (U$40 – 50) for one 30 kg male goat. Premiums were paid for Boer crossbred goats, and penalties apply to goats that are smaller than specification. Normally the price given at the farm gate is less (50-75%) than the price charged to the consumer. Traders will also take advantage of farmers selling goats by offering reduced prices if large numbers are available for sale or if the farmers are desperate to sell. There is a need for a more accountable marketing system, and it should be possible for farmers to organise their own co-operative marketing system, where one trader is employed by the co-operative to secure a market, and exclusively sell goats from the farmer co-operative which guarantees a continuous supply. There is also a need for alternative markets for goat products, and it should be possible for the same farmer cooperative to supply goats to a local abbatoir which could slaughter and package (frozen, vacuum packs) for distribution in supermarkets.

However the problem with this plan is that there are currently no commercial slaughter and processing facilities for goats in the south of Vietnam, although the technologies for

developing such facilities are already available in abbatoirs for pigs and rabbits. There is an urgent need to develop such facilities if the marketing of goats is to be expanded to make goat meat available to all through super-markets outlets.

Conclusions and recommendation for action

The survey conducted in south east Vietnam in June 2006 collected information from 30 farms in Ninh Thaun, 18 farms in Binh Thuan and 8 farms in Lam Dong province. Data on family structure, crop and animal productivity, animal disease and income and expenditure were collected, tabulated and analysed to describe the nature of these farming systems with goats as a major enterprise. The limitations to improving productivity were broadly identified, and one half of these farms was selected for the application of new technologies to the goat production component of these farms. In retrospect, there seems to be no good reason for surveying twice the number of farms needed for the study, other than to confirm that despite being in the same provinces, these farms were individually diverse in their farming activities. In other words, comparisons between farms in the same (or different) provinces provides no more information than to confirm this diversity. However, it was important to have a baseline from which the effects of the application of the new technologies can be judged, and the data collected here for the farms inside the project will be compared with that collected on the same farms at the end of the project (June 2007). At this time, another group of farms "outside the project" will be surveyed, and a three-way comparison may made between farm profiles and activities at the beginning (June 2006 inside) and end of the project (June 2008 inside), and between the "improved" farms (June 2008 inside) and other farms in the same locality (June 2008 outside) on which there has been no application of new technologies. This latter group will be different to that used for the first survey in 2006.

The objectives of the Vietnam-Australia Goat Improvement Project

Develop herds of high producing Bachthao goats

Improve housing and manure management

Provide productive legume and grass forages and

Selected Bachthao bucks to avoid inbreeding

The survey identified some major components of the goat production systems that could be improved by the application of some new technologies applied in a holistic manner. The high incidence of morbidity and mortality from disease must be the first aspect of the system needing correction, focussing particularly on the contagious diseases observed. In this case, it is proposed that all goats should be vaccinated to control Pasteurellosis and Goat Pox, and vaccination against Enterotoxemia (*C. perfringens*) is also indicated for young animals on all farms. The availability, vaccination schedules and costs will be reviewed in the following chapter. It will also be recommended that all goats be strategically drenched or injected with an ivermectin based drug to control internal (worms, liver fluke) and external (lice, ticks etc) parasites, and these options will also be discussed in Chapter 3. All goats will then be monitored to determine whether this package is sufficient to control the major diseases expected. As noted earlier, goat housing has an important role in maintaining healthy goats, and in the survey the aspect needing most improvement was an effective separation of goats from the manure they create. It is proposed that the project will provide the cost of the materials to construct a concrete apron under each goat house to collect manure for subsequent use on gardens and forage plots. Details of this activity will be developed further in Chapter 3.

The second limitation to improved production is the quantities and quality of feed available to feed goats at critical stages of their productivity cycle (conception, pregnancy, lactation) and during the dry season when the only feed available is from communal grazing areas. It was recommended that small areas (0.2 ha) of pastures be established on each farm, situated close to the goat houses and irrigable throughout the year. A focus should be placed on promoting legumes in these forage banks to supply high protein forage as supplements to high producing but often low quality grasses. The appropriate choice of forages (grasses, forage and tree legumes) will be discussed in Chapter 4 together with requirements for fertiliser and management. It will be suggested here that in the first year, part of the area should be reserved for seed production to allow expanded plantings of the best plants. An important aspect of forage feed production is to plan for the cutting and storage of high quality forage as hay or silage for feeding in the dry season. It will also be proposed that both silage and hay making be included in the package of technologies recommended for implementation on the selected farms.

Well grown Bachthao does with kids

Cross-bred Bachthao and Co (grass) goats in Lam Dong

The third limitation noted during the survey was inbreeding associated with the over use of single bucks in herds of his progeny and the availability of genetically proven breeding bucks. However, there is little point in providing "improved" bucks until all diseases are controlled and where there is sufficient quality feed available to meet the needs of does

pregnant from "improved" bucks. It is therefore recommended that all farms be provided with a new Bachthao buck of proven genetic merit in the second year of the project. If possible, these bucks should be selected from local populations on the basis of "productive" merit not on size or conformation. In some cases, where herd management standards are high, other breeds could be introduced (Boer, Saanen), although it is likely that the gains made in production by disease control and improved nutrition will allow Bachthao goats to produce as well as exotic cross-bred goats.

A further limit to improved productivity, once disease is controlled and nutrition improved, is the farmers poor understanding of management practices which would maintain the longer term productivity of his goat herd. It is suspected that there are high kid mortalities associated with does mating too young (< 5 months old) or does kidding at inappropriate times (middle-end dry season, wet season). There is a need to better manage reproduction to match conditions most favourable to doe and kid survival. Optimal kidding times are when there is sufficient feed for the pregnant does in the last month of pregnancy and for two months following kidding. In southeast Vietnam, the monsoon season usually starts in May-June, suggesting kidding should occur in the late wet season (October-November) with mating again the following May (early wet season). In this system, bucks would need to be held separately from does between February and May to prevent uncontrolled mating. However, each farm may have its own preferences for kidding times, but should consider that once a year mating is likely to provide greater returns than the current system of random mating.

The last limitation to improved profitability from goats is the inability of farmers to control the price they get for their goats. This problem is partly related to goat traders being the only marketing avenue available and the fact that farmers could not easily predict how many goats they might have for sale in any year. However with the introduction of disease control and better management farmers should be in a better position to know how many goats they will have for sale, and use this certainty to bargain for better prices from the traders. Alternatively, they should be encouraged to form co-operatives and develop other marketing channels, such as packaged product into super markets. The project proposes to provide funding for the purchase of slaughtering and processing equipment to be installed in a pilot abattoir to be set up at the new Sheep and Goat Research Centre at Ninh Hai in Ninh Thuan province. These facilities will be used to experiment with packaging, processing and distribution of goat meat to promote better returns to goat producers in the southeast of Vietnam.

Chapter 3

The management of goat health and disease

Introduction

The maintenance of animal health is central to all effective and efficient animal management systems, whether intensively housed or extensively grazed. In a review of goat productivity in the south-eastern provinces of Vietnam (Chapter 2), a low incidence but a wide range of different diseases were implicated in the low productivity of goats in these areas. It should be noted here that the diseases present were listed from the farmers knowledge, and since detailed veterinary diagnosis was not possible at this time, only a superficial assessment of the specific diseases present could be made. It was recognised at the time that symptoms such as diarrhoea, bloat and "pneumonia" may be caused by many different organisms, and that any treatment recommended would require a more specific diagnosis to be effective. The Vietnam-Australia Goat Improvement Project was initiated to investigate the limitations affecting goat productivity in Vietnam, and to improve productivity by developing and applying holistic solutions to the solution of these problems. Poor husbandry and a lack of hygiene are probably the most important factors affecting goat health in Vietnam, indicating that a two-pronged approach to disease control is required, improve hygiene and living conditions by providing good housing, animal care, nutrition and appropriate treatment (vaccines, drugs) to decrease the incidence and severity of disease. The project team needed to review the husbandry practices of the surveyed farmers, and make recommendations on how these practices should be changed to improve goat productivity on these farms. These recommendations must include changes to housing and general management, as well as strategies to control the diseases causing poor productivity in surveyed goat herds. The following chapter reviews some of the many factors that affect the health of goats in Vietnam, and offers selected strategies for improving health on small-holder goat farms.

General signs of health and sickness in goats

The early recognition of sickness in goats is essential for diagnosis of health problems and the application of effective treatment. Table 3.1 shows some common observations of signs of health and sickness in goats. There are also more specific signs which indicate the part of the body affected, eg diarrhoea, constipation and bloating suggest diseases of the digestive tract, coughing and nasal discharge of the respiratory system, stiff gait and abnormal behaviour are signs of diseases affecting the nervous system. Wounds and lameness are related to injury which is common in goats.

Table 3.1 Recognition of symptoms of health and disease in goats

Healthy goats	Signs of illness in sick goats
Active and alert, good appetite	Dull, stands alone, hangs it head, stops eating
Chewing cud, rumen peristalsis active,	Stops chewing cud, bloating
Smooth and shiny coat	Rough coat
Normal body temperature: 38-39.5 ^{o}C	Fever, hot or cold ears, wet and cold skin, body temperature over 40^{o}C
Breaths/minute rest: Adults & Weaners 12-15, Kids 15-30	Difficulty with breathing, panting, coughing, wheezing
Pink coloured mucus membranes, conjuctiva of eye, mouth, dry nose	Colour of mucus membranes, pale (anaemia), yellow (jaundice), dark red (infection, fever, poisoning)
Firm pelleted faeces, round and hard	Diarrhoea: watery faeces, some blood, foetid smell

It is good husbandry practice to inspect animals once a day for symptoms of disease, external and internal parasites or injury, and when detected, they should be immediately isolated from other animals. When disease is found, goats should be held for treatment in separate house some distance from the main goat house. All pens must be disinfected after having been occupied by diseased goats, and gloves should be worn while treating sick goats. Goats with contagious diseases should be held in isolation until at least two weeks after recovery. Goats with diarrhoea must be allowed access to drinking water and a mineral supplement/lick to replace the large amount of body fluid and minerals lost.

Herd management and animal health

The rules of good management are few, but simple, goats need comfortable and secure housing, free access to clean water, supplements of dry, good quality feed when feed available from grazing is of low quality, trim hooves regularly to prevent joint disorders and minimise infections (foot abscess,etc), and routinely de-worm all goats before and after the wet season. Where possible, manage animals, pastures and grazing areas to minimise re-infection from intestinal parasites. Special attention needs to be paid to management during mating (bucks and does), at kidding (does and kids) and kid growth to weaning. Where mating takes place all year as in Vietnam, there is little opportunity to promote fertility by improved nutrition, and conception rates will vary with the time of year of mating. This random system of mating means that small numbers of does will be kidding at different times of the year, again, making it difficult to manage as a herd. However, the survival of the doe and her kids at kidding depends on the care taken of her at this time.

Does should be isolated and fed protein and energy supplements in the two weeks before kidding, this feeding promotes colostrum production and easy induction of lactation. Does should be provided with a clean, spacious and separated pen in which to deliver her kids, and doe and kids should not be separated for the first 10 days to ensure that her kids consume sufficient colostrum to gain immunity. During this time, does should be offered good quality hay, and when kids are strong enough, their does should re-join the herd grazing away from the farm. Kids should be allowed to suckle every 4-6 hours, but where their does are away grazing, suckling is usually restricted to only overnight. It is possible that the engorgement of kids that follows suckling after 8 hours of starvation may be responsible for the diarrhoea observed in young kids and the suggestion that enterotoxemia is the cause. Kids do not usually join the grazing herd until weaning at about 3 months. In this case, pre-weaning kids will need sources of good quality feed as well as grain supplements to promote the rapid growth to weaning.

In the survey conducted (Chapter 2), the weaning weights of Bachthao kids were low (10-16 kg) with growth rates ranging from 75-130g/d. Improved nutrition would greatly improve these gains, and decrease the time to sale. In the first month after weaning, the young goats are very susceptible to infection from both external and internal parasites. Weaners should first be de-wormed a month after weaning, this timing allows the young animals to gain some immunity against intestinal parasites before treatment with anthelminthics. Good quality feed and supplements (concentrates, molasses-rice bran blocks, leucaena leaf) should also be offered to weaners between 3-6 months of age. If possible, weaners should be run separately from the main herd, and grazed on pastures which have not grazed for at least 6 weeks by adult goats. Alternatively, weaners should be grazed first on new pastures and followed by the adult animals. This strategy minimises the danger of disease transfer from old to young stock.

Dangerous bamboo flooring

Unhygenic accumulation of manure around house

Housing and animal health

In Vietnam, goats are grazed outside during the day and held in goat houses over night to protect from the weather, predators and theft. The types of goat houses have been described earlier, and in many cases, were found to be inadequate. It is essential that the houses be kept clean and dry, and protected from rain and wind. Although it is important to provide good ventilation, draughts need to be avoided, particularly in winter when temperatures are low and there is high humidity. It is at this time that pneumonia and other respiratory diseases are most easily contracted. However, good ventilation is essential when temperatures are high to keep goats cool and avoid heat stress. For these reasons, opened sided goat houses with retractable blinds are a good idea, rolling the blinds down in cold weather, and up in hot weather. Most goat houses should be built with a high clearance (one metre) from the ground, this will allow good ventilation, decrease humidity and allow for the collection of manure from beneath the house. Many goat houses had poor flooring, often with gap in the floor boards which represented a danger of injury to all goats.

The size of the animal house is also important, and should allow approximately 0.5 m^2 of floor space for each goat, together with separate pens for kidding and suckling does. An optimal shed design for 50 goats would be a 5 x 5 m floor area with 5 one-metre square pens along the back wall. The house should be walled on 3 sides and the front facing opposite to the direction of the prevailing weather. Feeding troughs should be placed on the outside of front face on either side of a door, so that goats can be fed from outside and no feed residues remain inside the house. Clean, fresh water should be provided both inside and outside the goat house, and should be easily accessible to both small (kids) and large goats. The roof of the house should be good enough to prevent raining entering, and high enough for humans to enter and work with their goats. Details of construction have been presented in GRRC workshop training manuals.

The accumulation of manure underneath each goat house was a problem on many farms surveyed, often uncontained and spreading beyond the boundaries of the house, and created not only unhygienic and smelly conditions for both goats and humans, but also represented a continuing source of infection for goats. Goats are usually confined in the house for 10-12 hours per day, resulting on about half of all manure excreted being under the house. Goat manure is a valuable source of fertiliser for gardens and crops, and as an additional source of income. It was decided by the team that funding will be provided to construct a sloping concrete apron under each shed to allow for the easy collection and removal of manure, and to ensure that these areas were fenced to exclude all animals. It was hoped that, in this way, the hygiene of the goat shed would be improved and that the manure would provide a source

of income/fertiliser for the farmer. Farmers were expected to provide the labour to help with this construction and were encouraged to improve their goat houses to the above standards at their own expense.


Well designed manure collection system


Clean, spacious, well constructed goat house

Diagnosis and treatment of common diseases of goats

The following list of common diseases is not meant to be comprehensive, but provides information on the aetiology, symptoms and treatment of the diseases observed in the survey of goat farms in southeast Vietnam. The intention is to develop a series of strategies which may be applied to the prevention and control of diseases found in these goats. A reliable and modern Veterinary text, such as The Merck Veterinary Manual (http://www.merckvetmanual.com/), should be consulted for a more comprehensive description of diseases found in goats and for more detail on those listed below.

Bacterial and Viral Diseases

1. Neonatal diarrhoea

Diarrhoea in kids is usually caused by bacterial (*Escherichia coli*, *Clostridium perfringens*, Salmonella etc), coccidial and some viral (rotavirus, corona virus) infections. Gastrointestinal parasites are the main cause of diarrhoea in weaned kids, with different species causing characteristic symptoms. Because diarrhoea may be caused by many different agents, it is important to prescribe the correct treatments. Diarrhoea is commonly found when kids are being reared intensively under crowded and unhygienic conditions, or when the kidding season coincides with hot or cold weather and heavy rain. Overfeeding with grain, excessive consumption of milk or wet and mouldy food may also induce diarrhoea. It is important that all kids consume sufficient colostrum in the two days after birth to provide them with some protection from infection while the gut adapts to the new environment. There are mild and severe forms of infection causing diarrhoea, mild forms are normally transient, and associated with increased gut motility and soft to fluid faeces, and lasts for only a short time. Severe forms last longer and can result in dehydration, depressed intakes, weakness, decrease in body temperature, abdominal distension and extreme motility of the gut. The faeces vary in type from pasty white to watery brown or greenish yellow frothy foetid excretions.

Sick goats should be isolated from others in a warm dry place, and depending on severity, fluid therapy should be applied in the form of electrolyte solutions, either orally or intravenously. Only dry feeds should be offered, and then in small portions to prevent overeating. In Vietnam, goats with diarrhoea are offered tannin-rich leaves or fruits as a curative, but in severe cases, antibiotics are indicated. In kids, 4-8 tablets of trimethoprim

sulphonamide are given twice a day, and for adult goats, intramuscular injections of Genta-Tylan, Norflox or Coliston may be used. However, it is important to diagnose the causal organism before antibiotics are prescribed. Prevention is the best management practice, making sure that pens are clean and dry, that clean feed and water are continuously available and that any diseased goats are removed from the main herd as soon as any illness is detected.

2. Goat Pox (Capripoxvirus, GPV)

Goat Pox (Goat poxvirus ICTV) is listed among the Group A diseases by the World Organisation of Animal Health (OIE), and is a highly contagious viral disease of goats, characterised by fever and discharge from the nose and eyes. Pox lesions appear on the skin and on the gastric and gastrointestinal mucosae. GPV is the most important pox virus disease of all domestic animals, and causes high mortality in kids and significant economic losses (AGA-Disease Cards.htm, OIE, FAO). GPV is currently prevalent in the Indian sub-continent, Asia and north Africa. Where strict quarantine measures can be applied, it may be eradicated from most areas. GPV is highly host specific infecting only goats, but host specificity may vary with some isolates also infecting sheep. GPV observed in Vietnam is specific for goats, since sheep grazing with infected goats do not appear to contract the disease.

Epidemiology

The distribution of goat pox in enzootic areas is often a reflection of the distribution of traditional forms of husbandry. Diseases in herds are usually only seen following the introduction of new animals, typically from a market, and generally affects animals of all ages The disease usually spreads through the herd within 3-6 months, then disappears in the absence of any further susceptible animals. Generally an epidemic in a susceptible herd can affect over 75% of goats, with mortality as high as 50%, in young goats fatality rates may reach 100%. The virus commonly infects its host's respiratory tract and transmission is most often through direct or intimate contact between animals. Insects do not seem to be an important epidemiological agents. Animals are most infectious soon after the appearance of papules, during the 10 day period before the development of significant levels of protective antibody. Virus particles are found in high concentrations in the papules, particularly those in the mucus membranes which release virus into nasal, oral and lachrymal secretions, and into milk, urine and semen. The virus is very resistant, and may persist off the animal host for up to 6 months in shaded animal pens, for 3 months in dried scabs on the fleece, skin and hair. There is no evidence that some animals are persistently infected with GPV, that is, there is no carrier state.

Disease course and Pathology

Pathogenicity of various strains of GPV varies considerably, and usually has an incubation period of 2 weeks before symptoms appear. The fever lasts for 4-7 days post-infection. Macules (2-3 cm diameter areas of congested skin) can usually be seen on the white skin of goats 24 hours after the onset of fever (pyrexia). These macules swell to become hardened papules which are concentrated on the head and neck, axilla, groin, perineum and external mucus membranes of the eyes, prepuce, vulva, anus and nose. The papules then ulcerate, and in some strains, there is a vesicular stage producing fluid exudates. The papules then become necrotic, and if the animal survives, scabs, which persist for up to a month, are formed over a 5-10 day period. The course of the disease from first signs to healing of scabs may take 1-2 months. The lesions are not restricted to the skin, but may also affect the gastrointestinal tract from the mouth and tongue to the anus. Post-mortem lesions usually include tracheal congestion, nodules and white patches on the lungs, with inflamed spleen and lymph nodes.

Goat pox macules on mouth and eyes

Characteristic lesions on ear

Diagnosis

Goat pox is usually identified by the clinical signs that constitute the skin lesions, gross pathology of the disease and the host species affected. Clinical diagnosis for mild to severe cases of GPV includes symptoms of fever, depression, inappetence and arched back. These symptoms are then followed by cutaneous eruption beginning with erythematous areas (macules) especially noticeable in the hair and hair-free parts of the body, these macules later evolve into papules. The papules may then dessicate and forms crusts, or may transform into vesicles, which rupture, leaving a thick crust over the lesion. Alternatively, the papules may give rise to nodules involving all layers of the skin and subcutaneous tissue (stone pox), with subsequent necrosis and sloughing leaving a hairless scar. Ear lesions distinguish the goat pox virus from scabby mouth.

Treatment and Prevention

In enzootic areas, like Vietnam, both live attenuated and inactivated vaccines are useful in the prevention and control of GPV, but inactivated vaccines give only short term immunity. Live attenuated vaccines are highly immunogenic but may result in mortalities. Vaccines incorporating locally prevalent strains of GPV are usually successful in protecting goats against GPV. Annual vaccination of susceptible goats with a live vaccine will control the disease, while 6 monthly vaccinations with inactivated vaccines are required for the same effect. It is advisable to vaccinate all goats over 10 days old, although maternal antibodies (through colostrum) will inactivate the vaccine.

Infected goats should be placed in clean, well ventilated housing and fed a balanced diet. Animals who are not feeding should be given 10% glucose saline parenterally. All diseased animals should be given antibiotics to prevent bacterial infections. Respiratory distress can be relieved by washing nostrils with weak permanganate solution (1:10,000) and application of eucalyptus oil. Antibiotic ointment or powder should be applied to skins lesions. Infected goats must be kept in isolation for 45 days after all symptoms have disappeared. Prevention of infection requires quarantine of all goats before introduction to the herd, strict control over animal and vehicle movements in infected areas, proper disposal of dead animals and products, and in serious outbreaks, slaughtering of infected herds. While there are no reports of human health hazards caused by eating meat and meat products from infected goats, there have been reports that handling infected goats can result in mild skin reactions in humans.

Recommendation for action in Vietnam

An inactivated vaccine against GPV was developed by the Vietnamese Institute of

Veterinary Science in 2005 in response to the detection of GPV in the Ninh Binh area of north Vietnam. This vaccine is now commercially available, and has been authorised for use in Ninh Thuan, Binh Thaun and Lam Dong provinces. All goats over 10 days old should be vaccinated initially, and then at 6 monthly intervals until experience determines optimum intervals for re-vaccination. A regional control strategy is required and where many herds are grazing in common, a ring vaccination and quarantine program is recommended. Until such strategies are implemented, each farmer should continue to vaccinate his herd.

3. Mycoplasma pneumonia

Pneumonia is a wide spread disease of goats caused by many different agents. Several species of Mycoplasma produce non-specific pneumonias in goats (*Mycoplasma ovipneumonia, M capricolum, M. agalactia*). The disease is spread via respiratory secretions. In addition to respiratory disease, there are other conditions associated with mycolplasmas including polyarthritis, mastitis, conjunctivitis and keratisis. Tylosin (10-20 mg/kg once daily) and tiamulin (20mg/kg once daily) are more effective than oxytetracycline (15 mg/kg daily) for the treatment of pulmonary mycoplasmas.

Contagious Caprine Pleuropneumonia (CCCP)

CCPP is caused by the F38 biotype of Mycoplasma. It has an incubation period of typically 6 to 10 days and affects all ages of goats. Clinical signs include fever, coughing, laboured respiration with grunting and front legs spread wide apart. The head may be held low, with a frothy nasal discharge and salivation, and the goat is unwilling to move. Typically morbidity rate is 100% and mortality rates vary from 50 to 100%. Death usually occurs within 2 – 10 days of the onset of clinical symptoms. Treatment is similar to that of other mycoplasmas, tylosin (11 mg/kg), tetracycline (15 mg/kg) or streptomycin (30 mg/kg). The prognosis for recovery with prompt treatment is good (70-80% recovery).

Pleuropneumonia

This pneumonia is caused by *Mycoplasma mycoides capri* and *M. mycoides mycoides*, and depending on virulence, has an incubation period of 10 to 20 days. Affected animals have a high fever, coughing, painful dyspnea and anorexia. Morbidity rates are near 100% but mortality varies with organism, less that 40% for *M. mycoides mycoides* and near 100% for *M. mycoides capri*. Kids are often infected by the ingestion of contaminated milk. Tylosin (11 mg/kg intramuscularly for 5-14 days) has been reported to be more effective that oxytetracycline treatment.

4. Pasteurellosis

Pasteurellosis is also a type of pneumonia caused by *Mannheimia (Pasteurella) haemolytica* and *Pasteurella trehalosi* (formerly *P. haemolytica biotype T*). These organisms are the primary agents involved in respiratory disease, septicemia, arthritis, meningitis, and mastitis and may be important secondary invaders in respiratory diseases of ruminants. *M. haemolytica* is most commonly associated with pneumonic pasteurellosis, while *P. trehalose* mainly causes septicemia and systemic pasteurellosis in young weaned sheep. Pneumonic pasteurellosis can also be caused primarily or secondarily by *P. multocida* in sheep and goats, and outbreaks world-wide lead to high mortality and significant economic loss. All above species are common commensal organisms of the tonsils and nasopharynx of healthy sheep and goats. The transition from infection to disease seems to be facilitated by various stressors, including concurrent infections, changes in climate, pasture or feed, and other management factors. The virulence of the Pasteurella organism is either initially very high or increases during an outbreak, so that the disease may be spread to unstressed herd members.

Clinical symptoms and treatment

In acute cases, there is typically a fever of 40.0 to 41.5^{o} C and a muco-prurulent nasal and ocular discharge. The animals are lethargic, lose weight, have dyspnea and painfull coughing. Mortality rates may be greater than 50%, and commonly one goat is found dead suddenly before any others are observed to be ill. Antibiotics are effective against these organisms, and may be administered intra-muscularly or sub-cutaneously. Penicillin (20,000-40,000 IU/kg twice daily), ampicillin (5-10 mg/kg twice daily), genta-tylan (0.1-0.2 ml/kg twicw daily) and tylosin (10 – 20 mg/kg twice daily) have all been used to treat this disease. A definite response to treatment should be obtained after 48 hours (ie decreased fever, improved appetite, etc), if this has not occurred, another antibiotic should be chosen and used for a further 48 hours. A minimum of 4-5 days of therapy are usually required to return the goat to normal health.

Prevention and recommended action

Good ventilation and adequate floor space per goat in the animal house is important to reduce infection, and newly introduced goats should be kept isolated for at least 3-4 weeks before introduction to the herd. Young kids are particularly susceptible to outbreaks of this disease, and it is important for neo-natal kids to have sufficient colostrum to protect against infection at this early stage of life. Where a high incidence of Pasteurellosis is found, vaccination is an important strategy for overcoming this disease. Vaccination of the whole herd twice a year is recommended, particularly at the start and end of the wet season when goats many be closely housed under humid conditions for some days at a time.

5. Enterotoxemia

Enterotoxemia is one of the most important diseases of goats and in some areas, the most prevalent. The disease is caused by the toxin produced by the bacterium *Clostridium perfringens* type C or type D. The type D infection (epsilon toxin) is probably far more common than the type C (beta toxin), the latter infection resulting in intestinal hemorrage and necrosis. The type D toxin causes vascular damage and increases the permeability of the intestinal wall to toxin absorption. This organism is normally found in soil and the intestinal tract and under favourable conditions, will proliferate in the gut producing toxins in lethal quantities. The conditions which favour proliferation are when the rate of passage through the gut slows as a result of excessive intakes of cereal grains, young lush pasture or an over consumption of milk. In Vietnam, young kids are often left at home when their dams are taken each day for grazing. Under these circumstances, kids may engorge on milk when their does return each night, and single kids may be particularly prone to excessive consumption at these times. Where twins are suckling one doe, engorgement is less likely, as may be their chance of suffering enterotoxemia. Similarly, the overnight starvation of does, and rapid feeding when taken to pasture may also dispose these goats to enterotoxemia.

Clinical symptoms and treatment

There are three distinct forms of enterotoxemia per-acute, acute and chronic. The per-acute form occurs most frequently in young goats, with larger kids being most affected. Symptoms are a sudden loss of appetite, depression, abdominal pain (arching back, kicking at belly), bleating with pain, a fever upto 41.5^{o} C and watery and foetid diarrhoea containing blood and mucus. Finding one or more dead animals is often the first indication of infection, and recovery is rare even with treatment. The acute form is similar but less severe, and most often affects mature goats. Faeces may turn soft and pasty, but later become watery. The symptoms last for 3-4 days, often inducing severe dehydration and acidosis. Recovery may occur, but most die before treatment can be applied. The chronic form is indicated by intermittent, recurring period of illness over several weeks during which time the goats are

dull and listless, with a reduced appetite. Progressive weight loss occurs with episodes of pasty or loose faeces. This form is difficult to diagnose as enterotoxemia.

Intravenous fluid therapy with isotonic electrolytes plus bicarbonate may be used to counter shock, dehydration and acidosis. Antibiotics (penicillin, streptomycin, trimethoprim-sulphonamides) are often used to limit further bacterial infections. Goats may also be dosed with activated charcoal, magnesium sulphate or hydroxide or kaolin-pectin to limit uptake of toxin from the digestive tract. However, recovery from per-acute and acute infections is rare, the animal usually dying before treatment can be applied.

Prevention and recommendations for action

Careful management of feeding is important for the prevention of enterotoxemia, and allowing unrestricted access to grain or any readily fermentable carbohydrate sources should be avoided. Similarly careful management of kids may be needed to avoid excessive consumption of milk at a very young age. It is routine practice on many farms to vaccine young goats and sheep against a number of different clostridial infections, and most vaccines will include *C. perfringens* Type D toxoid. Young kids should be vaccinated at 4-6 weeks of age and again at weaning (12 weeks). Does should also be vaccinated during the last month of pregnancy to boost her immunity for transfer through colostrum to her newborn kids.

6. Infectious keratoconjunctivitis

This disease may be caused by several different micro-organisms, such as *Mycoplasma spp* (as discussed earlier) and *Chlamydia psittaci.* No infective forms are associated with the lodging of foreign bodies (eg grass seeds) or injury to the eye. Early or mild forms of keratoconjunctivitis results in excessive lacrimation, resulting in wet patches on side of face below eyes. The conjuctiva of the eye becomes woollen and red, and over several days, hyperemia of the conjuctiva increases and the cornea may become hazy or completely opaque. Some animals develop a corneal ulcer, which may perforate. The eye is held closed, and blinking is frequent. The loss of sight will cause the animal to lose weight because unable to forage, and total blind animals often die. Where there are no complications (ie ulceration), most goats heal within 1-2 weeks.

Treatment

The eye should be irrigated with physiological saline (0.9% NacCl in sterile water) or cleaned with cooled boiled salt water to remove exudates, dust and foreign matter. Antibiotic ointments (tetramycin, kanamycine, gentamycine) should be applied 3-4 times a day until healed. In severe cases (cornea completely opaque), a solution of 10% Zinc sulphate in water should be applied 2-3 times daily. Intramuscular antibiotic injections may be indicated where whole herd infected.

7. *Scabby mouth or contagious ecthyma (Orf)*

Contagious ecthyma (CE) is an infectious dermatitis of sheep and goats that primarily affects the lips of young animals. The disease is usually more severe in goats than sheep. Humans can also be affected, and dogs that eat infected carcasses. Infection occurs by contact, and the causal poxvirus (a parapoxvirus) is highly resistant to desiccation, persisting in dried scabs for many years. CE is found worldwide and is most commonly found in young goats although mature goats may contract the disease if they had not previously gained

immunity as a young animal. The primary lesion develops on the skin of the lips and often extends to the mucosa of the mouth. Where this occurs, a secondary necrobacillosis frequently develops. Does nursing infected kids can develop lesions on the udder, which can lead to mastitis when not treated. The course of the disease is 1-4 weeks during which time the scabs fall off and the tissues heal without scarring. The lesion is characteristic and easily differentiated from ulcerative dermatosis and goat pox. Morbidity in kids is usually 100% while mortality is low, although malnutrition through restricted suckling and secondary infections may lead to deaths where not treated. Some goats are persistent carriers of CE and should be culled from the herd as a continuing source of infection.

Treatment and control

Antibiotic treatment is not indicated unless secondary bacterial infections occur. A disinfecting fluid (methylene blue-iodine suspension) is recommended to treat lips and mouth, with Iodo-Tetran solution (15-20 applications) having the best results for treatment of this disease. Local treatments include the use of astringents such as lemon or star-fruit juice. Where possible, infected animals should be isolated from the herd. However, the symptoms disappear when the animal gains immunity, and this process may be hastened by using a single strain vaccine or by preparing and administering a home-made live-vaccine.

This may be done by collecting recently discarded scabs from infected kids, mix with 0.9% saline or water, and apply to either a scarified section of skin inside the back leg or directly to the mucosa of the mouth. It is suggested that kid should be vaccinated in this way at about 3 weeks of age, and then again at 8 weeks. This technique will be applied where indicated in the goat herds surveyed in south-eastern Vietnam.

8. ***Other infectious diseases***

There are many other infectious diseases which may be contracted by goats which have not been considered in the chapter because they were not recognised amongst the diseases found in the survey of Vietnamese goat farms. It is possible that as the goat production systems intensify, some of these diseases may become more evident. In particular, there are number of clostridial diseases found in goats in other parts of the world but not recorded in Vietnam (eg *C. tetani* (tetanus), *C. novyi* (Black Disease), associated with liver fluke infections, *C chauvoei* (Black Leg) and *C. septicum* (malignant oedema). Caseous lymphadenitis or cheesy gland (*Corynebacterium pseudotuberculosis*) may also be found in closely confined goats, and vaccines are now commonly available for use against this organism.

Parasitic diseases

Goats, like other ruminants, are infested by both internal and external parasites which have effects varying from minor annoyance and morbidity to mortality. The following description does not attempt to list all that are found, but only those that a most likely to affect the productivity of goats in Vietnam. Intestinal parasites are probably the most widespread and important parasites, followed by liver fluke in wet areas then external parasites such as ticks and mites that infest the skin and hair.

1. Nematodiasis

Nematodes (roundworms) are the most common parasites found in the gastrointestinal tract of goats. They may be categorised by the anatomical region they infest and the severity of their effect on the well-being of the host. Some nematodes are visible imbedded in the mucosa and sub-mucosa of the oesophagus and rumen, but these are all non-pathogenic and of little clinical significance. *Haemonchus contortus* (Barbers pole worm) is a voracious blood-sucking parasite that infests the abomasum, and is consistently associated with morbidity and significant production losses in all environments. Other important worms of the abomasum are *Ostertagia spp* and *Trichostrongylus axei,* with all parasites causing blood loss and anemia. The hookworm *Bunostomum trigoncephalum* and *Gaigeria pachyselis* are also blood-suckers but live in the small intestines. *Cooperia curticei, Nematodirus spp, Trichostrongylus spp* (Black Scours worm) and *Strongyloides papillosis* are also found in the small intestine, and feed on epithelial detritus. Amongst these, only the latter two species are considered to be pathogenic. Whipworm (*Trichuris ovis)* and the caecal worm (*Skrjiabinema ovis* are found in the caecum, and both are generally non-pathogenic. *Oesophagostomum columbianum)* resides in the colon, but the nodular lesions produced by their infective stage are found throughout the intestines. *Charbertia ovina* is another nematode of the colon that can contribute to clinical parasitism worldwide.

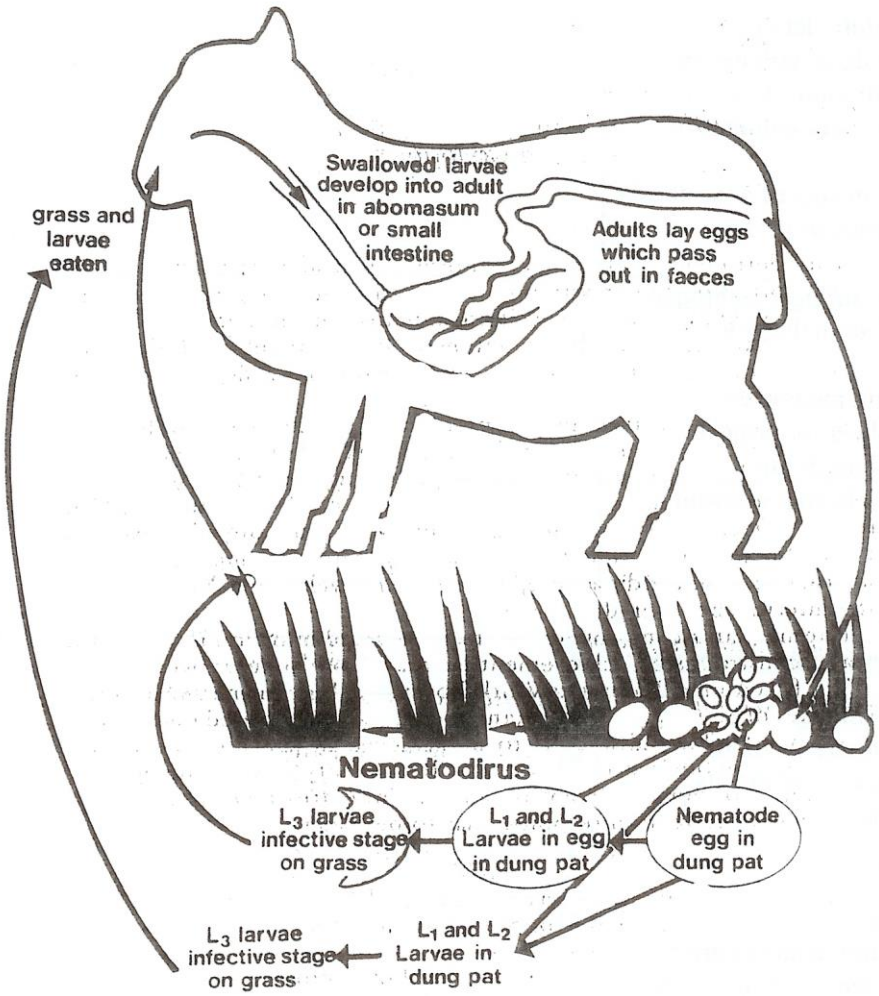
The larval forms of the gastrointestinal nematodes mature to adults attached to the epithelia of the intestine, and have high rates of egg production which pass through the intestines to faeces where they are excreted onto pastures. Larvae develop from these eggs and pass through a number of larval stages before finally becoming infective and re-enter the host to again undergo maturation. The blood sucking species have their effect by producing a progressive anemia in their host. *Haemonchus spp* is the most common pathogen species found in wet warm conditions, and in tropical areas, are probably always present and infective on pastures where goats are grazed continuously. The blood loss leads to depression in appetite, listlessness, morbidity and sometimes mortality. The other nematodes that do not feed on blood cause erosion of the mucosal epithelium, inflammation, hyperemia, edema and diarrhoea. Severe gastritis and intestinal colitis with profuse mucus secretion can also be caused by these nematodes.

Clinical symptoms Most intestinal parasite infections are mixed, and the clinical signs are seldom representative of only one organism. One group of nematodes (*Trichostrongylus, Ostertagia, Cooperia, Nematodirus*) produce a gradual but progressive loss of condition, poor growth and decreased feed intakes. In severe infections, a dark green to black diarrhoea is evident, with staining of the hind region. Chronically infected animals also develop a pot-bellied appearance, a rough dry coat and flaky skin. There is no anaemia associated with these symptoms. Infection by *Oesophagostomum* may result in signs of abdominal pain such as hunched back and reluctance to move, with affected animals often developing a fever. Diarrhoea in young kids and soft mucoid faeces in adults mat also been found. When blood feeding parasites are present (eg *Haemonchus*), anemia is the most obvious clinical sign, and where massive infections occur, animals may die of gastric haemorrhage. The acute, chronic form is most common, showing pale mucous membranes and conjuctiva, with increased heart and respiratory rate and inter-mandibular edema (bottle jaw) a common symptom. Weakness and reluctance to move are clear indications of infection, these animals are often at the back of the herd when being driven. Constipation is more common than diarrhoea in these animals, and weight loss is also likely to occur.

Treatment and Prevention

Where goats are grazed intensively, routine treatment with anthelmintics (AH) are often needed to control heavy infestations of the major pathogenic nematodes. The AH used may be broadly divided into 2 groups, single dose oral doses (drenching) which act to either

kill all resident parasites immediately or to have a sustained action of killing parasites over a 4-6 week period. The most effective AH sold under a variety of different commercial labels are Levamisole (8 mg/kg BW), Albendazole (10 m/kg BW) and Ivermectin (5 mg/kg BW). The persistent and over-use of these drugs will result in an increasing resistance of the worms to AH, and a decreasing effectiveness of control. Strategic use of these drugs in therefore indicated, routinely changing drug type and timing of application to ensure that resistance does not occur. In tropical environments, there is a continuous source of infective larva present on grazed pastures. Under these conditions, goats need to be rotated around different pastures which have not been grazed by other goats for at least 3 months. Where pastures are spelled in this way, the infective larva present on the pasture cannot find a host, and will die from dessication. This is the natural control mechanism for intestinal parasites in the dry season where water limits their development.



The recommended strategy for control is to treat (oral drench or intramuscular injection) with AH at the beginning of the wet season when goats are first being grazed on new early growth pastures and again when goats are moved to new pastures. Long acting and broad spectrum drugs such Ivermectin are recommended here. Young kids still suckling their does should not be treated with AH because milk from the does appears to offer some protection against these parasites. It is further suggested that these kids be treated with AH about one month after weaning, this strategy allows parasite infections to establish in the kid, and for the kids to gain some immunity to these parasites before dosing with AH. It is also recognised that there some goats may be more resistant or resilient to intestinal parasites than others, and such

genetic characteristics are worth selecting for. In Vietnam, where goats are usually grazing in common with goats from other farms, it may be difficult to avoid continuous re-infection with parasite larvae. In this case, some special management strategies may need to be developed, such as rotating goats around the grazing range, avoiding contact with other goats where possible. It would also be good management practise to not allow goats to graze intensively managed pasture plots, so that all cut-and-carry feed can be maintained free of intestinal parasites. In this way, holding goats in the animal house in the wet season and feeding only harvested forage, provides another way of controlling intestinal parasites in these small goat herds.

Recommendation

All adult goats should be routinely treated with injectable Invermectin at the beginning of the wet season when they are introduced to new areas of pasture. Weaner goats should be injected one month after weaning, then routinely with the rest of the herd. Fodder banks should be managed (fenced) to avoid being a source of parasite infection in cut-and-carry feeding systems. A second Invermectin treatment should be applied 12 weeks after the first to kill all parasites which have been acquired during wet season grazing. It should be noted that these treatments will also be effective in controlling some external parasites which are also most infective in the wet season.

2. Cestodiasis (Tapeworm)

When compared with gastrointestinal nematodiasis, cestodiasis (infection with tapeworm) is of little clinical or economic significance. *Monezia expansa* is the major intestinal tapeworm found in sheep and goats, and in Vietnam, *M. benedi* is also common. Monezia uses ruminants as a definitive host and various species of mites as intermediate hosts. Adult tapeworms in the intestines may grow to several metres long, and consist of a head (scolex) and a short neck followed by a long segmented body composed of proglottids The most posterior proglottids are packed with eggs and break off and passed in the faeces, These egg "packets" are white, 1-1.5 cm long and easily detected by the eye in faeces. Mites in soil and on herbage ingest these eggs in which they develop into infective larvae (cysticercoids). Goats consume these mites during feeding, and the larvae then develop into adult tapeworms in the small intestines. Tapeworms do not feed destructively, but absorb nutrients through their skin, and at least 50 tapeworms are needed in the intestine before any clinical damage is caused to the host. Clinical symptoms are usually found in goats younger than 6 months. Severe infections produce a distended, pot-bellied appearance in young goats which have poor growth rates. Faeces appear normal, but may be soft and unpelleted. Constipation may also occur as a result of a massive blocking of the intestines by the tapeworm population.

Treatment and Prevention

There are a wide range of AH are available for removing adult tapeworm in goats. While some effective and specific drugs are available (Niclosamide (50m/kg orally), Praquantel (5 mg/kg orally), Febantel (5 mg/kg orally), tapeworms are also controlled by AH used for gastrointestinal nematodes. For example, the newer benzimidazoles such as mebendazone (915 mg/kg orally), fenbendazole (10-15 mg/kg orally) and oxfendazole (10 mg/kg orally) are effective against both tapeworms and nematodes, while Albendazole (910 mg/kg orally) is effective against tapeworm, nematodes and Fasciola hepatica (liver fluke). There is little practical benefit in a preventative program for tapeworm control, and the use of as broad spectrum AH in goats post-weaning is usually sufficient to control these infections. There is little possibility that mites as the intermediate host can be controlled because they are widely distributed through the ecosystem.

3. Coccidiosis

Coccidiosis in goats can cause ill-thrift, severe diarrhoea and sometimes death. It is most often found in kids and stressed animals, and is caused by the coccidia of a protozoan parasite Eimeria which invades the cells of the intestinal wall. Coccidia are highly host specific, but sheep and goats share some common species. Goats appear to develop resistance with age, but stressful conditions (poor nutrition, lack of shelter, overcrowding, excessive handling) can cause resistance to break down. Goats become infected by ingesting mature oocysts of coccidia, with each oocyst having the potential to destroy thousands of host intestinal cells. Once in the intestine, the infective coccidia emerge from the oocysts and penetrate the intestinal cell walls where they multiply rapidly, rupture the host cell, and invade new cells. This process is repeated several times before new oocysts are formed and passed in faeces onto pasture. Kids, particularly newly weaned, are the major source of oocyst infection, and other kids can readily pick up infection from pasture or from the udder of the doe. Moist temperate or cool conditions favour the maturing process which varies from as short as one day in summer to several weeks in winter. Once mature, oocysts are very resistant to environmental fluctuations, but cannot survive direct sunlight or hot dry conditions. The most common sign of infection is diarrhoea, which may be severe and contain blood. If the infection is acute, goats may die within 24 hours after contracting the infection. Affected goats show a rough coat, weakness and weight loss. Scarring of the intestinal lining sometimes causes goats to continue to show ill-thrift, with decreased growth and milk production.

Control and Prevention

Denying young goats access to oocyst infection is the first rule of control, which means using feed and water troughs in which goats cannot defecate (ie cannot walk in), ensuring that water troughs do not overflow to provide wet environment for oocyst development and avoid grazing goats at high density on damp pastures. Stress is the second most important factor to avoid, and all goats should be provided with good, well drained and ventilated shelter, prolonged periods of close confinement should be avoided and keep young and older goats separated where possible. Anti-protozoal agents such as monensin have been found to be effective controlling coccidiosis in goats. While it is likely that such infections may be the cause of diarrhoea observed in the previous survey of goat farmers in south-east Vietnam, the only strategy recommended for action is the maintenance of hygienic conditions in goat houses and its surrounds.

4. Fasioliasis (Liver Fluke)

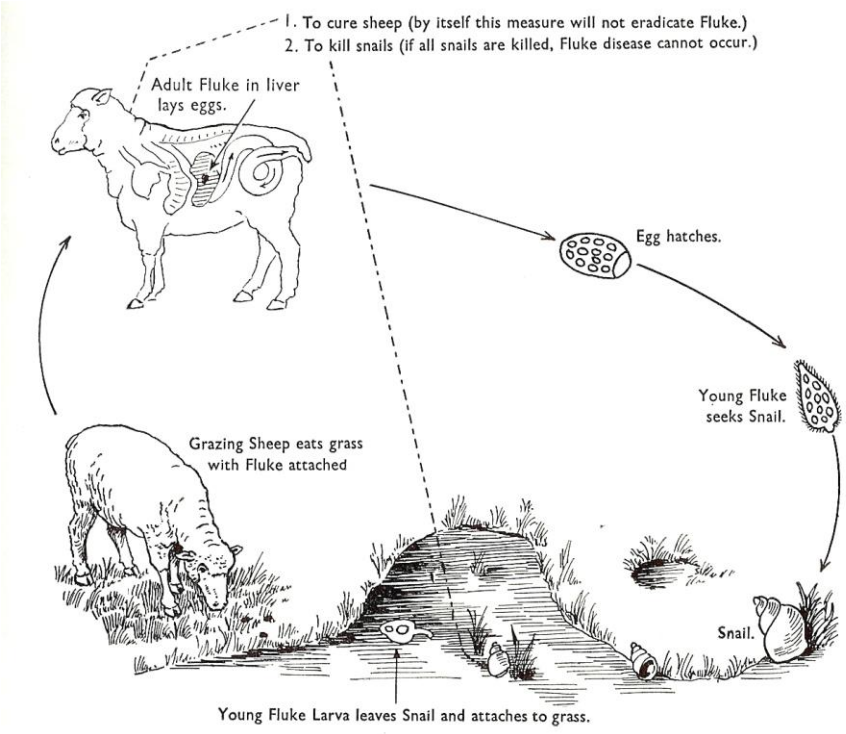
Liver fluke is a common parasite of sheep and goats grazing swampy or wet pastures. Two species of trematodes (flukes) exist that will infect goats, *Fasciola hepatica* (18-32 mm long by 7-14 mm wide) and *Fasciola gigantica* (24076 mm long by 5-13 mm wide). *Fasciola spp* have a two-stage life cycle, with water snails (*Galba trunculata,* Lymnaeidae) acting as an intermediate host. Adult flukes live in the biliary tract of the definitive host (goat or sheep) and lay eggs that are passed via the bile duct into faeces. On wet pastures, eggs develop to the first stage miricidia which invade water snails. In the snail, miricidia develop through different stages to cercariae which leave the snail and attach to plants and develop into the infective stage (metacercaria). Grazing goats ingest these metacercaria which invade the abdominal cavity through the intestines, thereby entering the liver, where they invade the bile duct and undergo further development to the egg laying stage. Flukes may also be found in the kidneys and lungs. The conditions that favour infection are a combination of suitable moisture and temperature conditions that allow persistence of infective larvae, the presence of the intermediate snail host and grazing by the primary ruminant hosts.

Pathogenesis and clinical symptoms

Damage is caused when large numbers of metcercariae invade the liver simultaneously causing a traumatic hepatitis (acute fascioliasis). *Fasciola gigantica* is more pathogenic to goats that *Fasciola hepatica.* In acute fascioliasis, there is a marked disruption of liver tissue, extensive hemorrhage, severe internal bleeding and death may occur. Even without severe hemorrhage, goats may die within a few days from liver failure. Acute fascioliasis, though uncommon in goats, may present as sudden death or as progressive weakness, depression, anorexia and pallor (pale skin, conjunctivae and mucous membranes) lasting as long as 3 days before death. Chronic fascioliasis is the most common form found, with affected animals showing similar symptoms to those described for the acute phase, with weight loss occurring for a prolonged period, and some animals will have diarrhoea. The body condition will be poor, the hair coat rough, mucus membranes pale and heart rate increased. The most easily recognised symptom is the intermandibular oedema occurring in long standing cases.

Treatment and control

Acute and sub-acute fascioliasis should treated with diamphenitide or triclabendazole, although the prognoses are poor. The chronic form should be treated with anthelmintics which can kill and remove adult flukes (eg Albendazole, Fascinex, Tozlan). However, avoidance of risk areas where there are large snail populations is still the best management strategy. These areas include rice paddies, drainage ditches, swampy areas, stagnant ponds etc. Animals which have to graze in such areas should be treated with effective drugs every 4-5 months.



5. Sarcoptic mange (Scabies)

Three different species of mites cause the main type of skin irritation or scabies in goats. Scabies of the head (and sometimes over other parts of the body) is caused by *Sarcoptes rubicaprae* (Sarcoptic mange). This mite tunnels through the epidermis and feeds on tissue fluids. It begins with the appearance of small pruritic nodules, especially on the head, which develops into a severe dermatitis around the eyes and ears, on the neck and

thorax, extending to the inner sides of the legs and udder. Scabies of the lower limbs, udder, scrotum, perineal region and sometimes the neck is caused by *Choriotes caprae* (Chorioptic mange), this mite lives on the surface of the skin and feeds on epidermal debris. The lesions here are like non-follicular papules, crusts, erythrema and ulceration are most commonly found on the areas described above, with pruritis usually obvious. Goats will chew these limb lesions to relieve the irritation. Scabies of the ear is caused by *Psoroptes cuniculi* (Psorotic mange), this mite does not burrow either but feeds on tissue fluids. Affected goats shake their heads and scratch their ears, and occasionally external lesions are visible. An examination of the ear canal will commonly find a large plug of yellowish-white wax.

Treatment and control

Treatment of lactating goats with repeated bathing (once per day for 7 days) with lime-sulphur solutions (2%) has proved effective for the control of Sarcoptic and Chorioptic mange. The crusts should be removed by washing with soap. Amitraz (0.05% twice, 7-10 days apart is also recommended. Acaricides such as Crotoxyphos (0.25%), coumaphos (0.25%), trichlorfon (0.2%), lindane (0.03%) and fenvalerate (0.05%) are alos effective when applied at least twice at 10-14 day intervals. These treatments are also effective for Psorioptic mange. In non-lactating goats, Ivermectin has been found to be effective when administered as two injections one week apart). Since this is an occasional problem, it is best treated on a case by case basis, although the above recommendation to use ivermectin for nematode control will also have an effect in controlling these mange infections.

Integrated management approaches for the control of internal parasites in goats

The widespread presence of intestinal parasites in the environment of the grazing goat in Vietnam makes the continuous of drugs alone for control both ineffective and uneconomic. It is imperative that the environment also be managed to minimise the risks of infection, and drugs will have their greatest effect when applied strategically within this management framework. Some of these strategies have been mentioned when discussing particular diseases, but the principles need reviewed again to re-inforce the significance of an holistic approach to both disease and animal management.

Housing

Proper goat housing is essential for managing the health and well being of goats. The principles outlined earlier suggested that protection from the weather was the first consideration, the house providing good ventilation, hygiene, drainage and the sanitary collection of manure underneath the slatted floor. Frequent removal of manure also creates a better environment for both the goats and the humans working closely with them.

Water and feed supplies

Continuous access to clean water, both inside and outside the animal house is also important, ensuring that all watering points are placed to avoid faecal and urine contamination. Feeders for forage and concentrates should be designed so that goats cannot walk over feed, and clean nutritious sources of feed should be readily available near the house to allow feeding at times when grazing is denied because of wet weather or simply a lack of feed in the dry season. Supplements of high quality feeds (rice by-products, molasses, sugar-cane, Leucaena, Jack Fruit leaves, etc) should also be fed to meet the needs of pregnant and lactating does, and young kids before weaning.

Herd management

Kids under 3 months of age (before weaning) should be grazed close to the house during the day, and separately from adult goats where possible. Any new goats being introduced to the herd should be vaccinated, treated for internal and external parasites, and kept separate from the herd for at least a month to allow the symptoms of any disease to appear. A routine vaccination program for all goats should be implemented, taking note of the

strategic times when such treatments are most effective. Where possible, kidding times should be managed to match available feed resources and climatic conditions.

Vaccination program

A minimum vaccination program will be conducted to control goat pox, pasteurellosis and enterotoxemia using commercially available vaccines. Injectable ivermectin will be used to control intestinal and external parasites. The following details apply to the administration of this program. No goats under one month of age were vaccinated, nor were does on the last month of pregnancy or first month of lactation vaccinated. All goats had been reportedly vaccinated against Foot and Mouth disease before the project began, but no new goats were vaccinated after that time. Vaccinations were undertaken in relation to the scheduled visits by technical staff and depending on the age of goats at the time. Goats were vaccinated against Enterotoxemia (2ml intra-muscular injection) and Pasteurellosis (1 ml intra-muscular injection) in March and September, and against Goat Pox (1 ml intra-muscular injection) in April and October.

Chapter 4

Training and information dissemination supporting improved goat productivity in Vietnam

Introduction

Training was an integral part of the Vietnam-Australia Goat Improvement Project, and all activities had some component of training. Planned training courses and workshops were held through the 3 year period of the project, and provided instruction in goat production technologies and techniques to all involved with the farming communities of these provinces. All levels of the provincial administrative hierarchy were involved, senior management (Director of DARD, Directors and Vice-Directors of livestock and extension Departments), DARD livestock and extension officers, district and commune extension and Veterinary officers and commune leaders. These trainees were to become the trainers of goat farmers directly involved in project activities and also were the leaders of the workshops held during the project to teach local farmers the principles and practice of the use of new technologies and techniques being promoted by the Project. Training is simply one of many different ways to disseminate information, with the conduct of surveys, workshops, seminars, discussion groups and on farm instruction being other important avenues of information dissemination. In the following sections, training and information dissemination will be considered as components of the same activity, and no further distinction will be made between them.

Scope of training

The broad objectives of the project required a comprehensive approach to be taken to training, the expectation was the Vietnamese staff would be able to conduct, record and interpret survey information collected from goat farmers, to instruct goat farmers in the application of new technologies and techniques to improve the productivity of their goats. These activities involved the application eartags for identification, weighing of goats, interpretation of instructions and application of vaccines to control disease, advising farmers on disease diagnosis, record collection (kidding, sales, deaths) and pasture establishment and maintenance. These staff also needed to develop accurate methods of collecting, recording and interpreting this data from farmers, and be able to write reports describing the progress being made by project farmers. The expectation for project farmers was that their training would provide them with knowledge of the major limits to the productivity of their goats and the techniques to overcome the problems associated with raising goats in these environments. It was hoped that the expertise gained by project technical staff would be passed to local DARD staff who would then be the primary focus for solving problems in these areas when the project finished.

Training facilities and information dissemination

The broad scope of training planned required a wide range of facilities and media for instruction. It was important to expose DARD staff, with little experience of modern animal husbandry techniques, to both traditional and modern goat farms, so that they might relate better to any theoretical instruction (in lectures/books) given. This need was met by holding the first workshop for DARD and GRRC staff at the Goat and Rabbit Research Centre at Sontay (Bavi) in north Vietnam. This facility provided the opportunity to demonstrate modern techniques in breeding, feeding and disease management in a Vietnamese context. The other facilities used were the individual farms of participating farmers, detailed information on each farm was first obtained during the intital survey, and then GRRC

technical staff and DARD officers visited these farms every three months over a 2 year period. These farms became the "field laboratories" for learning by technical and DARD staff, and the more progressive of these farms were then selected as "demonstration" farms for practical demonstrations of the successful application of new technologies, and for instruction during workshops with other local farmers outside the project interested in applying these technologies to their own farms.

The Goat and Rabbit Research Centre, Son Tay

Demonstration of feeding techniques

Training for senior management

The need for training of senior staff in Project management is not often recognised as a legitimate activity, since the training is often informal and the acquisition of knowledge is simply part of the management activities. Informal training takes place when the Project Directors discuss the requirements of the project with senior Government staff, with learning occurring for both parties about how best to bring the required plans to fruition. For example, before any provincial staff or farmers can be involved in the project, agreement needs to be reached between Project Directors and the Directors of DARD and Extension services in each province. Rules and regulations regarding the provision of services or application of drugs vary between provinces and approval must be gained before any collaboration can take place. In this case, both proponents are being educated or trained, provincial administrators learning about the potential of new technologies to improve goat production, and the Project Directors learn about the sociological and political considerations which might limit the potential success of the project.

Advisory Board meeting at Binh Thuan 2007

Farmers Forum at Binh Thuan 2007

The trust built between senior participants in the project is an important element for assuring a successful outcome for the project, and in the case of this project, a highly successful outcome was only possible with the strong support given by all senior provincial administrators in Ninh Thuan, Binh Thuan and Lam Dong.

Advisory Board and Farmers Forums - It was also considered necessary to have a formal connection between senior CARD project staff and senior Provincial government Directors, and an Advisory Board, consisting of the Director of DARD (or his nominee) of each of the three provinces, was set up in the first year of the project and held annual meetings each year from 2006 to 2008. The objective here was to inform Provincial government of the progress made in Project activities over the past year and plans for the coming year. These meetings were conducted in Vietnamese with English translations, and all Directors were invited to comment on any aspect of project activity. This advice was then incorporated into future plans where appropriate. The presentations made on progress and future plans were then reported to another meeting of DARD Veterinary and extension advisors and project farmers who were also invited to comment on the progress being made and on any problems which they were having in implementing the strategies being promoted by the project. This "Farmers Forum" provided the opportunity for all project participants to contribute to the planning and future outcomes of the project.

Regional Conference on Goat Production The final results from last two years of project activity were presented at a Conference in Phan Rang in November 2008. The conference was titled "New Technologies for Improving Goat Production in southeast Vietnam" and involved both Project and Provincial senior staff presenting papaers ion the impact of the project on overall goat productivity in each province, and specific improvements associated with the control of disease, the development of pastures and improvements in reproductive rates and economic returns from improved productivity. As for Advisory Board meeting GRRC and DARD technical officers were invited to give papers, as were other goat workers from other parts of Vietnam. Some project farmers also gave presentations, and the conference was followed by a visit to one of the local demonstration farms which had been promoted by the project. This conference served the purpose of not only presenting the final outcomes of the project to all participants and the general public but also provided some training of senior and other staff in conference organisation, research paper preparation and presentation.

Vietnamese scientists discussing goat management practices with Australian farmers

Tour of goat production systems in Australia Although the farming and management of goats in Vietnam and Australia are very different enterprises, many of the principles of management are similar, the effective control of disease, the provision of adequate nutrition from pastures and the need to understand and develop marketing strategies for the product, goat meat. Senior Project and DARD managers undertook a short visit to Australia to inspect goat and sheep enterprises with a view to understanding how goats are managed under extensive grazing conditions in Australia. It was expected that exposure to these different enterprises would encourage the Vietnamese staff to see alternative low-cost ways of managing goats in large herds, and prompt them to extract techniques and technologies from the Australian systems which might be useful to the future goat and sheep industries of Vietnam.

Technical staff weighing and measuring girth on goats in Ninh Thuan

Training a team of technical staff for project management

The conduct of the project depended on training a team of technicians who could interpret and apply the project plan to the improvement of goat productivity on small-holder farms. Two teams were required, one that was employed directly by the Project and who were responsible for applying the planned technologies to the participating farms. The second team was of provincial DARD veterinary and extension workers who would establish contact with the participating farms, facilitiate access by project technicians and who would learn from and eventually take over the responsibilities of project staff when the project ended.

Training Project technical staff

At the beginning of the project, experienced technical staff from GRRC were co-opted to undertake specific project tasks, these tasks being broadly, survey conduct (interview, recording, documentation), application of new technologies to each farm (pasture establishment, goat house modification, vaccination etc) and recording of all data collected about the productivity of goats (live-weights, kids born, goats bought, sold and deaths). This data was then presented to senior management for analysis, interpretation and publication. Senior staff provided instruction and guidance in all these matters, and were finally responsible for the veracity of the data collected. However, a workshop was held in April June 2006 before the project actually started. This workshop had the following objectives, to upgrade their knowledge on goat production technologies, to describe the purpose of the project and to develop a questionnaire to provide some baseline information on the small-holder livestock systems being targeted.

The following lectures and activities were presented over 6 days at this workshop to meet these objectives. Eight GRRC staff attended the course:

Introduction to GRRC research and its transfer to farmers
Strategies for developing programs of goat breeding in Vietnam
Goat breeding and selection technologies
Goat production systems in Australia
Goat and sheep nutrition – Some principles
Feed resources and feeding systems in Vietnam
Goat and sheep health management
Goat meat and milk processing
Introduction ot the Vietnam-Australia Goat Improvement Project
Methodology of questionnaire preparation and survey conduct

Visits were made to the facilities at GRRC, the Bavi milk processing plant and local goat farms to inspect the effects of new technologies on goat productivity. Attendance records were kept and a certificate awarded to all who completed the course.

The training of these staff continued on the selected farms in Ninh Thuan, Binh Thuan and Lam Dong provinces, where further instruction in recording and vaccination techniques was given by senior project staff. Three GRRC staff visited all project farms in each province every 3 months to collect the data, and a further staff member remained at GRRC in Bavi to assist with the data collation and storage. The competency achieved through this training may be judged from the successful implementation of all project objectives and the availability of data which has now been analysed and interpreted in these proceedings.



Training veterinary and extension staff on demonstration farms

Training provincial extension and veterinary staff There was also an urgent need to train technical staff from the provinces in which the project was to be conducted, since these staff would be responsible for selecting and interacting with goat farmers and overseeing the daily management of project initiatives while GRRC staff were undertaking other duties. A total of fourteen provincial staff came to GRRC for the inaugural workshop mentioned above, and completed the course of lectures and demonstrations with the eight GRRC staff. The compositions of these groups were Ninh Thuan 5 staff (Vice-leader Agriculture department, Leader, Phan Rang Thap Cham Veterinary Centre and three Livestock officers from the two different extension centres), Binh Thuan 4 staff (Veterinary and Livestock specialists four different extension centres), and Lam Dong 5 staff (Vice Director Veterinary Services (Lam Dong), Director Veterinary Services (Duc Trong) and 3 livestock technicians). Following this training, there was a good record of continuing participation in project activities in each province, with all 4 DARD officers from Binh Thuan, 3 officers from Lam Dong and 2 officers from Ninh Thuan maintaining contact with

the project until the end of the project (ie 64% of trained staff active). As part of their continuing training, it was expected that these officers would also participate in the training workshops for farmers which were held in all provinces. This participation was not as active as expected, and it is not clear how these training workshops can continue without the active input from these staff.

Explaining the principles of pasture establishment

New Bachthao buck to overcome inbreeding

Training participating farmers in application of new technologies

The project selected 27 farms on which to apply a package of new technologies designed to improve goat productivity. Pastures were established on all farms in the first year and involved Project staff working closely with each farmer to ensure effective establishment. Weed control and watering were the highest priorities, and farmers quickly learned how to maintain these pastures. Instruction was also provided for cutting management and the storage of dried hays. Special instructions were required for legume management, with higher cutting heights and less frequent harvests. The modification of the goat house allowed for easy collection of manure, and all farmers were encouraged to collect and use this manure on their pastures on a regular basis. All farmers were required to keep records of their management of goats, listing births, deaths and sales, as well the routine monitoring of animal health. Project staff were available continuously for advice, and also visited each farm every 3 months to ensure that all required vaccinations were administered and to discuss with farmers any on-going problems. Farmers were also supported to attend the annual 'Farmers Forum" which was held each year in conjunction with the Advisory Board meeting. These meetings and subsequent inspections of "demonstration" farms stimulated discussion among farmers and encouraged the sharing of mutual experiences to solve any current problems in their goat production enterprises. While considerable gains in knowledge have been made by project farmers over the past two years, there still remains much to improve in some systems.

Training other local farmers in the application and management of new technologies

A total of 11 training workshops for local farmers not included in project activities have been conducted in 2007 and 2008. A key component of this training was the selection of appropriate farms for demonstration purposes, and it was not until June 2007, that such farms were ready for such use. Table 4.1 shows the locations and dates when these workshops were held. At each of these workshops, lectures were given at first by senior GRRC and NIAH staff on the following topics.

Technologies for improving goat housing and hygiene in the central provinces of Vietnam

Goat selection, breeding and management in the central provinces.

Technologies for preventing and treating goat diseases in the central provinces
Technology for establishing and using pastures as feeds for goats in the central region of Vietnam

The details of these lectures were provided in workshop training manuals (Vietnamese) which were given to each participant at the time of instruction. Discussion sessions were encouraged after each presentation to emphasise the relationship between theory and practise and allowed farmers to present problems and solutions as they saw them. In 2008, younger members of the GRRC technical teams presented the lectures, and there is a need to develop further the training of new trainers to take over this responsibility when the project ends.

Table 4.1 Locations, dates when held and numbers of participants for training workshops in goat management techniques in Ninh Thuan, Binh Thuan and Lam Dong provinces in 2007 and 2008

Year	Province	District	Commune	Date held	No farmers	Demonstration Farm
2007	Ninh Thuan	Ninh Phuoc	Phuoc Huu	May 31	23	Long
		Ninh Hai	Xuan Hai	June 2	27	Duc
		Thuan Bac	Cong Hai	June 6	26	Hoa
	Binh Thuan	Bac Binh	Binh Tan	June 10	28	Lang
		Ham Thuan Bac	-	-	-	-
		Tuy Phong	Vinh Hao	June 8	27	Lang
	Lam Dong	Duc Trong	Ta Nang	June 12	29	Lung
2008	Ninh Thuan	Ninh Phuoc	-	-	-	-
		Ninh Hai	Xuan Hai	June 3	32	Thanh, Duc
		Thuan Bac	Cong Hai	June 5	29	Hoa, Hung
	Binh Thuan	Bac Binh	Binh Tan	June 9	28	Lang
		Ham Thuan Bac	-		-	
		Tuy Phong	Vinh Hao	June 7	32	Lang
	Lam Dong	Duc Trong	Da Loan	June 11	28	Lung

Assessment of competency

An evaluation was made of the effectiveness of the training provided by the project for the different groups. The most important criteria of the efficacy of training is the extent to which the original project aims have been achieved, and subsequent chapters provide this evaluation, ie identification and characterisation of target farms (Chapter 2), provision of improved housing and health care for goats (Chapters 3 and 6), improve the availability and quality of feeds and forages for goats (Chapter 5), provide local and introduced Bachthao bucks of proven genetic merit for breeding (Chapter 6 and 7) and economic evaluation of the impact of new technologies on goat productivity (Chapter 6). In all cases, project objectives were not only achieved but in many cases, exceeded expectation. The competency of senior staff may be judged from the fact that this project has been brought to a satisfactory conclusion, and without competent management, this could not have been achieved. The competency of the technical staff as a result of the training provided can also be assessed by reviewing the effectiveness with which they transferred the new technologies to farmers and recorded the outcomes. Again the successful development of 19 small-holder farms across three provinces of southeast Vietnam is testament to a successful transfer of information, and is sufficient evidence to claim that their training was most effective. A further assessment of these farmers was made at the end of 2008 to determine whether the techniques provided were being permanently adopted into their routine management practices. The extent to

which the training workshops for farmers outside the project were effective would be best determined by counting the number of these farmers who have adopted new techniques to improve their goat production system. However these evaluations would take more time than was available before the end of the current project.

It may be concluded that the provision of strategic training at all levels of project activity has provided a highly successful outcome for all concerned, senior management have initiated a successful program which has significantly improved both goat production and farmer wealth in their respective provinces, technical staff have gained many new skills and experience of goat production enterprises in southeast Vietnam and goat farmers have improved the productivity of their goats and have increased the profitability of their goat enterprise.

Chapter 5

Pasture development for goat production systems in southeast Vietnam

Introduction

The Vietnam-Australia Goat Improvement Project (The Project) aims to improve goat production in southeast Vietnam by improving animal health and providing adequate nutrition to meet the needs of a productive and healthy herd. The nutrition of goats in Vietnam is provided mainly by grazing and from cut-and-carry forages opportunistically harvested from roadsides and other off-farm locations. The pastures grazed are usually low quality native or natural pastures, with decreasing quality and availability as the dry season progresses. The daily movement of stock to and from the grazing range and the manual harvesting of forages for home feeding are labour intensive activities. The project aims to provide small on-farm plots of improved forages as sources of high quality feed to supplement or replace cut-and-carry the forages, thereby decreasing the labour requirements for animal management as well providing year round sources of good quality feed. The following Chapter describes, firstly, the climate and soils of southeast Vietnam as a pre-requisite for selecting and establishing suitable pasture grasses and legumes for use in these areas. The methodology of establishment and maintenance of these pastures is then presented, together with measures of productivity and recommendations for the most suitable pasture species for each area.

The climate of Vietnam

Vietnam is located between 9 and 23 degrees north, with a long eastern coast line on the Gulf of Tonkin and the South China sea. It has a tropical monsoon climate, from May to September, the south monsoon when winds are predominantly from the southeast. From October to April, the north monsoon dominates bring cold north-easterly winds to northern Vietnam. There is a transition period between each monsoon season when winds are light and variable.

In the south of Vietnam, there is a single rainy season during the south monsoon, during which high rainfalls are recorded (>1000mm). Annual rainfall is higher in the hills facing the sea where 2000-2500 mm/year has been recorded. For coastal areas and parts of the central highlands facing northeast, the season of maximum rainfall is during the south monsoon, from September to January. These regions receive torrential rain from typhoons which move in from the South China sea at this time of year.

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Temperatures are high all year round for both southern and central Vietnam, with the lowlands being sheltered from the colder northerly air and the dry season is warm to hot with much sunshine. However, the climate is highly variable, frequently bringing floods and droughts to this part of Vietnam, causing crop failure and great human hardship.

The weather patterns in the project areas are similar to those found in Ho Chi Minh city, although more often drier than for the Mekong delta. Table 5.1 shows the average temperatures and rainfall in Ho Chi Minh city. The wet season usually starts in May and ends in November, during which about 90% of the annual rain falls. The long dry season begins in December and lasts until April. These data show that plant growth is at no time limited by temperature and that the principle limitation to growth is availability of water. Where irrigation water is available, crops may be produced year round in this part of Vietnam.

Table 5.1 Average monthly rainfall and temperatures for Ho Chi Minh city (Source Embassy of Vietnam, London UK www.vietnamembassy.org.uk/)

Month	Rainfall		Temperature	
	Average Monthly (mm)	Average rainy days	Minimum	Maximum
January	14	3	21 (13)	32 (37)
February	4	2	22 (15)	33 (38)
March	12	2	23 (19)	34 (39)
April	42	5	24 (20)	34 (40)
May	220	15	25 (21)	33 (39)
June	331	22	24 (22)	32 (38)
July	313	23	25 (20)	31 (35)
August	267	20	24 (19)	32 (34)
September	334	21	23 (21)	31 (35)
October	268	20	23 (20)	31 (34)
November	115	12	22 (18)	30 (35)
December	56	8	22 (15)	31 (36)
Total	**1976**			

* Figures in brackets are lowest minimum and highest maximum for month

Only limited climatic data was available for the provinces of Ninh Thuan, Binh Thuan and Lam Dong, and as with the data in Table 5.1, the dominant influence is the southern monsoon from May to November, with lower average rainfalls than found for Ho Chi Minh city (Table 5.2). Lam Dong also tended to have lower temperatures than the other provinces.

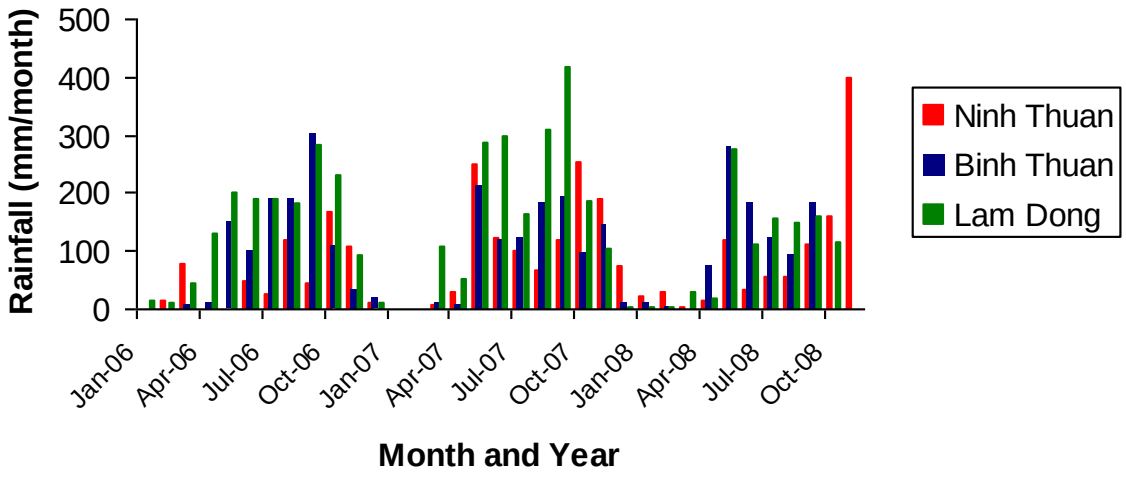
Table 5.2 Mean annual rainfall (mm) for Ninh Thuan, Binh Thuan and Lam Dong provinces (2006-2008)

Measurement	Ninh Thuan	Binh Thuan	Lam Dong
2006	623	1111	1594
2007	1216	1107	1935
2008*	1007	948	1018

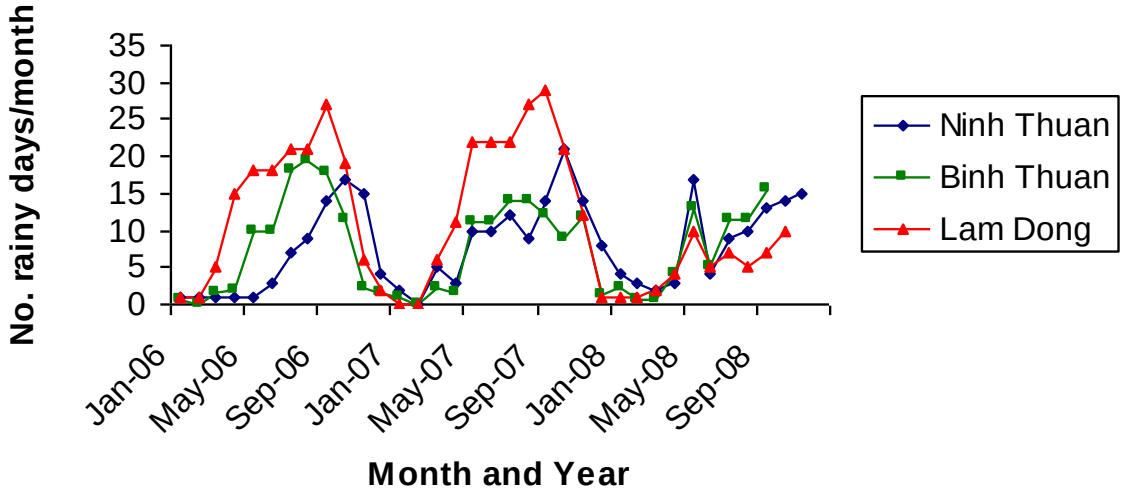
* January to September only

The following charts show the mean monthly rainfall (mm) and mean monthly rainy days (number) for the years over which the project ran (2006-2008). Mean maximum and mean temperatures varied little throughout the year, with a range around the mean of about 5^{o}C. Mean monthly temperatures averaged annually were 27.1, 26.9 and 21.3^{o}C for Ninh Thuan, Binh Thuan and Lam Dong provinces respectively.

Mean Monthly Rainfall (Ninh Thuan, Binh Thuan & Lam Dong)

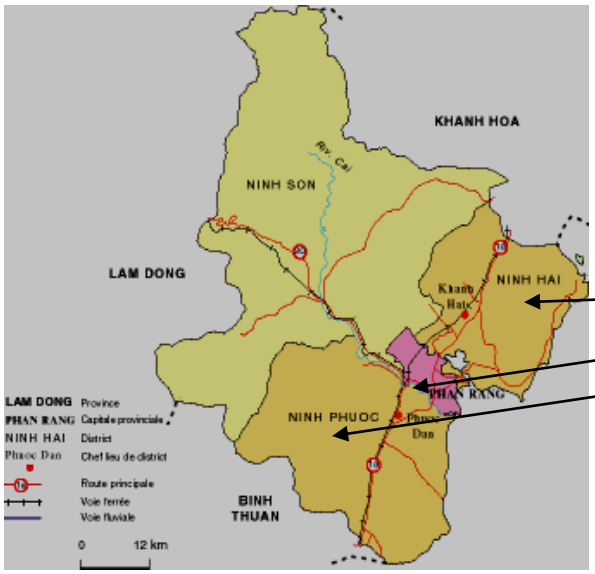


Rainy days for Ninh Thuan, Binh Thuan and Lam Dong (2006-2008)



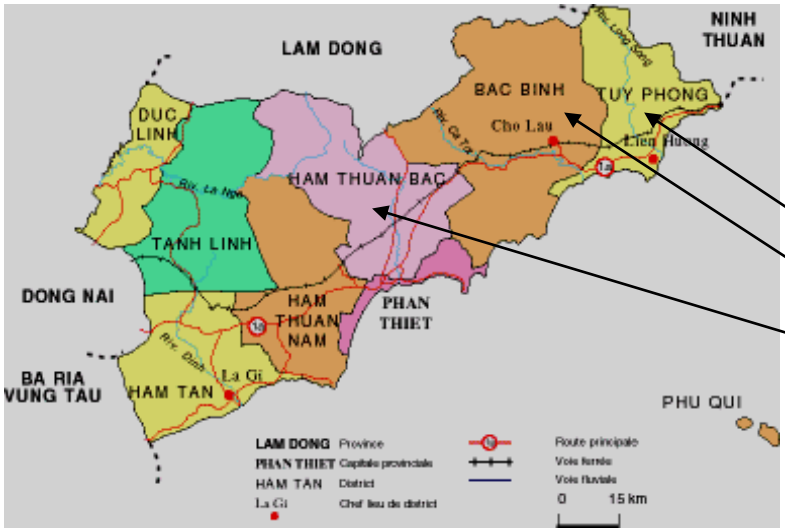
In 2006, the monsoon came late to Ninh Thuan, resulting in a prolonged dry season and low annual rainfall for that year. A "normal" wet season occurred in 2007 in all provinces, with Lam Dong receiving the most rain over that year. The dry season commenced in December and lasted for 6 months until about May in both 2007 and 2008. In 2008, the wet season started slowly, and did not deliver the rain expected.

Locations of Project activities in Ninh Thuan, Binh Thuan and Lam Dong provinces



Ninh Thuan Province Project Districts

Ninh Hai
Thuan Bac
Ninh Phuoc



Binh Thuan Province Project Districts

Tuy Phong
Bac Binh
Ham Thuan Bac

Lam Dong Province Project District

Duc Trong

The soils of Vietnam

At the time of writing, there is little quantitative information available on the soils of Vietnam. Soils of the coastal lowland provinces of Ninh Thuan and Binh Thuan are commonly shallow, poor in organic matter and low in clay content. The three main types are disintegrated detrital soils (Utisols), Xerosols and Yermosols or alkaline sialite soils. They are predominantly low fertility sandy clay loams with variable pH ranging from 7.5 to 8 in those derived from limestone (coastal soils) to 5-5 to 6.5 for those derived from granite or laterite (inland soils). In the hilly regions of Lam Dong province the soils are Acrisols or Ferrosols ranging in pH from 6.5 to 7.0. The sandy coastal soils generally have low water holding capacity, which limits their use for irrigation.

Pastures and the nutritional requirements of goats

The purpose of providing improved pasture species on the farms of participating farmers was to provide an easily accessible and continuous source of feed for goats throughout the year. These feeds are meant to supplement grazing intakes of goats at times when feed quality is low and quantity scarce, or where good quality feed is needed to meet the special needs of pregnant does and growing kids. It was important to estimate how much feed would be required to meet the annual needs of a typical goat herd in southeast Vietnam, and these estimates would determine how much pasture should to be produced each year to meet these needs. There are already some excellent publications of how best to select and use forages in smallholder systems*, and the following principles have been extracted from these sources to make predictions of the forage needs of goat farms in southeast Vietnam.

Table 5.3 Estimation of area of legume grass pastures required to fully feed a herd of 50 goats for 120 days each year

Herd Composition	No.	Mean Wt (kg)	Intake (DM* as % BW)	Legume			Grass			Total Area (m^2)
				Kg DM	Kg GM#	Area planted m^2	Kg DM	Kg GM	Area planted m^2	
Bucks	1	60	2	29	96	12	115	384	32	44
Mature does	15	45	2.5	608	2025	253	1418	4725	394	647
Weaner bucks	11	20	3	238	792	99	554	1848	154	253
Weaner does	11	20	3	238	792	99	554	1848	154	253
Kids	12	6	1	35	115	14	52	173	14	29
Total	**50**		**2.3**	**1146**	**3820**	**478**	**2693**	**8978**	**748**	**1226**

* DM = dry matter, # GM = green or fresh matter

Table 5.3 shows an estimation of the area of legume and grass pastures needed to support a herd of goats for one year in southeast Vietnam. The assumptions made were as follows, that all goats will obtain their nutrient requirements from grazing off-farm pastures for 245 days of the year, ie length of wet season during which time quality pasture is available. All goats will need to be fed for at least 120 days each year (length of dry season), and that the diet fed should contain 30% legume/70% grass in dry matter as high quality diet.

* Developing Forage Technologies with Smallholder farmers: how to select the best varieties to offer farmers in southeast Asia. ACIAR/CIAT PublicationMN062 P.M. Horne and W.W. Stur (1999)
Developing Forage Technologies with Smallholder Farmers: how to grow, manage and use forages. ACIAR/ CIAT Publication W.W. Stur and P.M. Horne (2001)

Different goats have different requirements which are reflected in different intakes as % body weight eg 2% for bucks, 2.5% does, 3% for growing weaners and 1% for pre-weaning kids (since only consume feed near weaning).

It was assumed that average yields of legume would be 80 tonnes edible green matter (GM)/ha/year and 120 tonnes grass edible green matter (GM)/ha/year and that this green material contains on average 30% dry matter (DM). These calculations suggest that 1200 m^2 will be needed to produce the required forage, and that about 40% of this area needs to be planted to legume and 60% to grass. It is also anticipated that variability in production at different sites may decrease yields, and it is recommend that at least 1500 m^2 be planted to allow for such variability. The above calculation assumes that legumes will contain on average 12-22% crude protein (CP) and that grasses contain 6-16% CP. The digestibility of grasses is directly related to the stage of growth, the older the regrowth the higher the fibre (NDF) content and the lower digestibility and CP content. Legumes are less variable in quality, and their value is related to the fact that quality does not decrease with maturity. It does need to be stressed that leaves are higher quality than stems in both grasses and legumes, and that young plants are of higher quality than old plants. The management of forages for greatest utility depends on balancing optimum quality (high protein content, high digestibility) with maximum yield.

Hilled rows are best for establishing pastures in the wet season

Pasture establishment on Project farms (2006)

The Project selected 27 farms in Ninh Thuan, Binh Thuan and Lam Dong provinces which were to be used to demonstrate the impact of improved technologies on goat productivity. The characteristics of these farms have been described previously (Chapter 2). Table 5.4 shows the numbers and average size of farms in each provincial district as well as herd size and the area of pasture defined for planting. The average area planted was 1817 m^2 (range 500-2500) with priority given to the choice of land near the goat house. This decision was made to ensure that daily care could be taken of these pastures, and also provided easy access for cut-and-carry activities and grazing when needed.

Table 5.4 The numbers and size of project farms in each province with values for goat herd size and average areas of pasture planted (2006).

Province	District	No. Farms 2006	Farm Size (ha)	Herd Size	Pasture area planted
Ninh Thuan	Ninh Phuoc	6	2.065	52	1850
	Ninh Hai	3	1.060	56	1700
	Thuan Bac	6	1.016	40	1567
Binh Thuan	Bac Binh	3	9.813	29	2033
	Ham Thuan Bac	3	9.200	64	1833
	Tuy Phong	3	6.520	71	2000
Lam Dong	Duc Trong	3	5.980	49	2000

A range of grasses and legumes with known adaptation to the project areas was chosen from seed or vegetative material held by the National Institute of Animal Husbandry. The grasses were chosen for their capacity to produce high yields of good quality forage, and for their ability to persist through a dry season with minimum maintenance. *Stylosanthes guianensis* and *Flemingia macrophylla* were chosen as forage legumes and Leucaena and Calliandra were selected as tree legumes. The details of the species used are as follows:

Green Panic (Guinea grass) *Panicum maximum* cv Revedale Thailand TD58
Ruzi grass *Brachiaria ruzuziensis*
Signal grass *Brachiaria decumbens* cv Baselisk
Maxmillet (Hybrid between Sorghum bicolor and Pennisetum purpureum)
CIAT Stylo *Stylosanthes guianensis* cv CIAT184
Plus Stylo *Stylosanthes guianensis* cv Plus
K636 Leucaena *Leucaena leucocephala* cv K636 (UQ)
Ipil Ipil *Leucaena leucocephala* cv K280 (Philippines)
Bavi K8 *Leucaena leucocephala* cv K8 (UQ)
Calliandra *Calliandra calothyrsus*
Flemingia *Flemingia macrophylla*

Some of the problems of establishment

Poor Stylo stand because of flooding

Poor grass yields from salt intrusion from over-watering

The areas for sowing were prepared as seed beds in June and July 2006, and since the wet season had already started, seedling establishment was variable. However, delaying planting until the following year would have meant that forages would not be available until the final year of the project which was too late for any effective evaluation. Each plot was divided into 12 equal sections and each species planted by the farmers into raised rows with 50 cm spacing between them. Fertiliser and irrigation was applied as required, and replanting done where germination failed. An inspection and evaluation of the effectiveness of establishment was made in November 2006 (end of wet season) and the results are summarised in Table 5.5 below.

Table 5.5 Evaluation of success of grass and legume establishment 4 months after planting

		% success in establishing species						
Province	**District**	**Green Panic**	**Ruzi Grass**	**Signal Grass**	**Stylo**	**Leucaena**	**Calliandra**	**Flemingia**
Ninh Thuan	Ninh Phuoc	83	83	50	50	50	50	34
	Ninh Hai	100	67	34	34	34	34	0
	Thuan Bac	50	34	34	50	34	17	17
	Mean	**78**	**61**	**39**	**45**	**39**	**34**	**17**
Binh Thuan	Bac Binh	100	100	100	100	67	67	67
	H.Thuan Bac	33	33	33	33	33	33	33
	Tuy Phong	67	67	67	67	33	0	33
	Mean	**67**	**67**	**67**	**67**	**44**	**33**	**44**
Lam Dong	Duc Trong	67	34	34	34	33	33	33

Green Panic (Guinea grass) proved to be the most easily established grass with, on average, 78% of farms in Ninh Thuan, and 67% of farms in Binh Thuan and Lam Dong, have productive stands by November 2006. Ruzi grass and signal grass were most easily established in Ninh Phuoc (Ninh Thuan) and Bac Binh (Binh Thuan), but less easily established in other districts. In Lam Dong, only one of the three farmers was able to establish and maintain a productive pasture plot, and failure here was due to flooding, grazing by cattle, and a general lack of interest in managing these pastures. However, grasses were more easily established than legumes on these farms, with Stylo being easier than the other species. With the exception of farms in Bac Binh district, less than 50% of farms were able to successfully establish Stylo at first planting, and this failure was most associated with the death of young seedlings from flooding during the wet season. As will be shown later, replanting at a more favourable time resulted in productive stands of CIAT Stylo particularly. Much less success was found for the establishment of the Flemingia and the tree legumes, Leucaena and Calliandra, in these cases, only a third of farms were able to successfully grow these plants during the wet season. All species are intolerant of flooding at an early stage of growth.

During this period, two farms withdrew from the project, and of the remaining 25 farms, only 16 farms were able to establish effective pastures. The reasons for failure were many, including inappropriate areas for planting (salted soils, flood prone areas), uncontrolled grazing by animals and a lack of attention to the advice given by visiting

technical staff. All failed pasture plots were replanted at the end of the wet season (November) or next year in March (early wet season). The recommended cutting height for mature erect grasses such as Green Panic and Elephant grass was 30-35 cm, while 15-20 cm was recommended for the more prostrate grasses like Ruzi and Signal grass. Stylo should not be cut any lower than 25 cm, and tree legumes should be cut at 50 cm or higher. The latter species take longer to grow to harvestable height than other legumes.

Demonstrating desired cutting heights

Good stands of Flemingia in Binh Thuan

Evaluation of establishment (March 2007)

All project farm pastures were inspected in March 2007 to evaluate the effectiveness of establishment and survival through the dry season (December 2006 – March 2007). The following conclusions were drawn from the observations made during this inspection.

Ninh Thuan Leucaena K636 was more productive and showing greater resistance to psyllids than Ipil Upil and Bavi K8, and was the preferred variety for planting in these areas. However, Leucaena did not perform well in poorly drained soils, and should be planted on borders, paddy bunds and other elevated areas on the farm. Some farmers had used Leucaena plantings around the boundary of goat houses or pasture plots to good effect. The alkaline pH of the soils in this area favours the growth of Leucaena. On most farms, there were effective stands of CIAT Stylo 184 which appeared better adapted than Plus Stylo. Some stands of Stylo were first harvested 60 days after sowing with subsequent harvests following at 40 day intervals. One farmer noted that his goats preferred Stylo and Green panic to Ruzi and Elephant grasses. The same farmer made the observation that it is better to feed goats individual grass species rather than mixtures, the reason being that less selection and wastage occurred. However it remains preferable to feed mixtures of grasses and legumes (3:1) to provide the appropriate balance of nutrients. Calliandra establishment was uniformly poor, and leaf productivity low when compared Leucaena growing in the same location. Flemingia establishment was generally satisfactory, but variable in some locations where flooding had occurred. Under these water-logged conditions, it was suggested that species such as *Paspalum atratum* cv HiGane and American Joint Vetch (*Aeschynomene americana*) might prove more productive. Where pasture plots failed in the dry season, it was usually due to poor establishment in the wet season followed by poor management (no irrigation, fertiliser or weeding) during the dry season. Forage blocks need to be irrigated at least once a week during the dry season to maintain productivity. On one farm, establishment failed completely because of saline soils, although a productive sugar cane crop was growing nearby. Another farm showed evidence of soils with surface salt-crusting. Rhodes grass (*Chloris gayana* cv Callide) and American Joint Vetch should be tested on these soils.

Pasture establishment failed in the upland area of Ninh Thuan (Loi Hai, Thuan Bac) because of the long dry season and farmers had no access to water for irrigation. In this case,

the short growing season would be better suited to annual or weakly perennial species such as *Stylosanthes hamata* cv Verano and *S. scabra* cv Seca, undersown into maize crop, and harvested after cob removal. Leucaena would also perform well here if carefully nurtured through the first dry season. The failure of the pastures planted on these farms was exacerbated by uncontrolled grazing by cattle, and fencing is essential if effective pastures are to be developed on any farm. At this time (March 2007), 10 of the 15 farms in Ninh Thuan had well established pastures, 2 farmers had withdrawn due to personal reasons, and pasture establishment has failed on 3 farms.

Ruzi grass in Ninh Hai, Ninh Thuan

Mrs Tam Stylo and Flemingia in Ninh Thuan

Binh Thuan The proportion of farmers successfully establishing pastures plots (67%) in this province was similar to that for Ninh Thuan. One farmer had over-planted the pasture area with ground-nut, and two farmers had withdrawn from the project. However, establishment was variable, and difficulties were mostly associated with the availability of water for irrigation during the dry season. Where water was available, all species established well, and one farmer with only a few goats had decided to allow Stylo, Flemingia and the tree legumes to mature and seed before harvesting, and this farm proved to be a significant source of seed for other farmers interested in growing improved pastures for their goats. However it was noticeable that farmers here did not value legumes as highly as grass with many Leucaena plots going un-watered throughout the dry season. Farmers in this area also planted vigorous grasses such as Elephant grass under their fruit trees not realising that fruit yields may be compromised by such practises. A better practice would be to plant Stylo under these trees so that there would be less competition and the possible contribution of nitrogen to the soil as an added benefit.

While these farmers recognised the value of additional feed from these pastures, there was less appreciation about how best to manage and use these pastures for strategic feeding and conservation. Frequent cutting during the wet season will produce large amounts of feed which could be stored as either silage or hay for use in the dry season. The more frequently grasses and legumes are cut, the younger and more nutritious is the forage available. Some farmers have been collecting and drying Leucaena leaf as supplements for goats giving low quality hays, and there is a growing appreciation that both legumes and grasses are needed to provide high quality diets for growing and reproducing goats. As with other areas, uncontrolled grazing by cattle of particularly legume pastures has resulted in the loss of these pastures, and fencing and control of grazing must be practised if sustainable pastures are be developed. It is also important to maintain fertiliser inputs to these pastures with goat manure (or inorganic fertilisers) because continued harvesting will eventually exhaust soil nutrients

and result in plant mortality. It was noted that some farmers were selling their goat manure rather than returning to the pastures that had generated it.

Guinea grass on Farm 13 in Binh Thuan

Liberal application of manure ensures good growth

Lam Dong Only one of three project farmers in this province had established productive pastures by the time of this evaluation, and all species were performing well on this farm. CIAT Stylo was particularly productive here, and was being used as a source of quality feed by young kids. However, at this time, the area was unfenced and being indiscriminately grazed by livestock. There was no evidence of planted forages on one of the other farms, and only as small area of grass planted under coffee trees on the other farm. There seems to be little commitment by these farmers to the project, while willingly accepting free vaccines and drugs to cure their goats of disease.

Leucaena K636 very successful in backyard pastures in Ninh Thuan

Evaluation of effects of pasture development on grazing management (November 2007)
At this time, pastures have been successfully established on 16 of the 19 farms still remaining in the Project, with attempts to re-establish pastures on those farms that had failed in the 2007 season. After two wet seasons, the pastures now established are likely to be sustainable into the future, and some farmers were actively expanding the areas of pastures on their farms. In general, Ruzi and Signal grass have been found to be more productive than Green Panic, although not producing as much dry matter as newly introduced Elephant grass species. Stylo has proved to be best early and consistent legume performer, with Leucaena K636 now growing well following its usual slow establishment phase. Flemingia is also persisting on some farms, but has lower yields than Leucaena. Farmers inside and outside the project were surveyed at this time about their feeding practices for goats, and the results of this survey are shown in Table 5.6.

Table 5.6 Survey of grazing management and feeding practices of farmers inside and outside the project in Ninh Thuan, Binh Thaun and Lam Dong provinces (November 2007)

Parameter	Farm inside Project			Farms outside Project		
	Ninh Thuan	**Binh Thuan**	**Lam Dong**	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**
Forage production						
Area (m^2)	1800	2100	1500	500	700	0
Yield (kg edible green matter/m^2)	2.3	2.8	1.25	3.1	2.1	0
Supplementation (% of farms using)						
King grass/sweet jumbo sorghum	0	0	0	12	10	0
Water spinach	17	20	0	0	0	0
Sweet potato vine	8	0	0	18	0	0
Cassava foliage	0	0	0	0	0	0
By-product feeds	58	40	33	17	30	29
Use new improved forages	83	80	67	12	20	0
No supplements used	17	10	33	59	60	71
Grazing Management						
% farmers grazing goats in forest	92	90	100	100	100	100
% farmers grazing goats in rice field	8	10	0	0	0	0
% Farms allowing all day grazing	83	100.0	67	100	100	100
% Farms allowing half day grazing	17	0	33	0	0	0
Average time grazing (h/day)	4.0	4.4	5.5	8.0	8.2	8.5
Fodder conservation						
% farms making legume hay	83	50	67	0	0	0
% farms making grass hay	75	63	0	0	0	0

The impact of the Project on forage production and use is clearly demonstrated in this table. Project farms were producing and feeding more forage to their goats than were other farms outside the project. A higher proportion (67-80%) of farms inside the project were using improved forages for feeding when compared with those from outside the project (0-20%). As a consequence of having more available forage on farm, fewer Project farmers used supplements than farms outside the project. The impact of increased forage production is also evident in the grazing management of the goats, farmers inside the project grazed their goats for shorter times on off-farm pastures (4-5.5h) than did other farmers (8-8.5 h). Clearly the local production of improved pastures has decreased the labour costs associated with

grazing management as well as saving money on the purchase of supplements. At this time, most Project farmers were being encouraged to make hay from legume and grass forages, and the adoption of this practice is reflected in the high proportion of farmers making hay from these sources.

Evaluation of productivity (June 2008)

At the final survey conducted in June 2008, there were 19 farms remaining of which 16 had good records of pasture production. Edible biomass yields of each species were measured by cutting and weighing fresh material from defined areas of each plot on these farms at frequent intervals throughout the two and half year experimental period. Among introduced grasses, *Panicum maximum* TD58 was the most promising, producing between 128-142 tonnes edible fresh matter/ha/year for cutting intervals of 25-35 days. Table 5.7 shows mean values with SE for frequency of cutting (times/year) and edible biomass yields (tonnes/ha/year) for each of the species planted.

Table 5.7 Mean values with SE for the frequency of cutting and edible biomass yields of grasses and legumes grown on project farms in Ninh Thuan, Binh Thuan and Lam Dong provinces between 2006 and 2008.

Species	Ninh Thuan			Binh Thuan			Lam Dong	SE
	Ninh Phuoc	Ninh Hai	Thuan Bac	Bac Binh	Ham Thuan Bac	Tuy Phong	Duc Trong	
Cutting frequency (times per year)								
Panicum maximumTD58	10.2	10.0	10.0	10.3	9.0	9.5	7.0	0.93
Brachiaria decumbens	6.3	7.0	7.2	8.3	7.0	6.1	6.8	0.71
Brachiaria ruziziensis	8.2	8.0	8.0	9.0	8.4	8.5	6.0	0.89
L. leucocephala (K636)	6.0	6.0	6.5	6.3	6.0	6.0	4.0	0.35
L. leucocephala(IpilIpil)	4.7	5.0	5.5	4.9	4.8	5.0	4.0	0.54
S. guianensis CIAT 184	6.5	-	6.0	6.5	6.5	6.0	6.0	0.43
S. guianensis Plus	6.0	-	6.0	6.5	6.0	6.0	6.0	0.36
Flemingia macrophylla	4.0	-	5.0	6.0	6.0	5.0	5.0	0.69
Calliandra calothyrsus	-	5.0	-	-	-	-	-	-
Edible Biomass Yield (tonnes/ha/year)								
Panicum maximumTD58	140	136	143	142	129	127	128	17.8
Brachiaria decumbens	109	122	115	123	122	114	114	12.5
Brachiaria ruziziensis	113	126	129	117	115	108	108	13.7
L. leucocephala (K636)	80	90	84	83	88	88	50	10.9
L. leucocephala(IpilIpil)	62	73	67	72	72	71	31	7.6
S. guianensis CIAT 184	86	-	81	82	87	77	81	6.9
S. guianensis Plus	81	-	76	80	82	74	78	7.2
Flemingia macrophylla	86	-	105	80	74	79	69	11.8
Calliandra calothyrsus	-	66	-	-	-	-	-	-

The productivity rankings of the grasses for Ninh Thuan and Binh Thuan were Green Panic first, with Ruzi and Signal grass coming a close second. However, grass productivity was lower in Lam Dong than in other provinces probably due to the cooler growing conditions in these mountainous areas. High grass growth rates were promoted by the addition of 50kg NPK after cutting and with irrigation. Stylo CIAT 184 was consistently the most productive

legume across all environments, with Leucaena K636 and Flemingia being the next most productive. Calliandra only persisted in Ninh Hai and was of only moderate productivity. The average yields found for grasses and legumes agree closely with the yields needed to provide dry season feed for a 50 goat herd (see Table 5.3). Pasture samples were collected from 3 farms in Binh Thuan (farms 3) and Ninh Thuan (farms 12 and 21) for determination dry matter and chemical composition of the most productive species (Table 5.8)

Table 5.8 Mean values with SE for the dry matter (DM) content and chemical composition of selected pasture species.

Pasture species	DM %	% in DM			
		Crude protein	Ash	Neutral detergent Fibre	Acid Detergent fibre
Panicum maximum TD58	20.6±0.7	11.7 ± 0.5	8.5 ± 1.7	52.3 ± 0.8	32.3 ± 0.7
Brachiaria ruziziensis	22.5±1.1	10.9 ± 0.7	7.3 ± 1.8	55.8 ± 0.7	33.7 ± 1.2
L. leucocephala K636	25.4±2.2	23.8 + 0.6	5.4 ± 1.1	43.6 ± 1.2	37.6 ± 0.5
S. guianensis CIAT 184	21.2±1.6	18.2 ± 0.3	7.4 ± 2.5	47.8 ± 1.3	34.8 ± 0.7
Flemingia macrophylla	28.2±2.3	17.2 ± 1.4	6.7 ± 1.3	61.2 ± 2.5	51.4 ± 1.2

As expected, the legumes (Leucaena and Stylo) had higher protein and lower NDF (fibre) contents than did the grasses thereby confirming their higher nutritive value. Flemingia also had a high protein content but its very high NDF and ADF contents indicates that this forage will be of low nutritive value for goats. The conclusions that may be drawn from these results are that, once established, and irrigated in the dry season, all species were able to provide significant sources of cut and carry fodder for goats in the three provinces studied. Three grass species (Green Panic, Ruzi grass, Signal grass) and two legume species (Leucaena K636, Stylo CIAT 184) may be recommended as easily established, high quality and productive pastures for use by small-holder goat farmers in southeast Vietnam.


Kid goats grazing Stylo in Lam Dong


Panicum maximum (PD58) in Ninh Thuan

Initiatives in forage conservation

The successful establishment of small plots of productive grass and legume pastures on each farm has meant that farmers have a potentially continuous supply of quality feed depending on water availability. The grasses and legumes recommended above are able to survive the dry season by strategic watering. Where year round irrigation is available, and temperature

not limiting (> 12^{o}C), high yields of forage may be harvested throughout the year. However, a more appropriate strategy would be to take advantage of high growth rates throughout the wet season, by harvesting frequently and storing as hay or silage for use in the dry season. The maintenance of productive pastures depends not only on water but also on the addition of fertiliser to replace soil nutrients taken up by the plants. While commercial fertilisers are a valuable source of plant nutrients, they are often too expensive for use on pasture. Where available, it has been suggested that 50 kg/ha NPK should be used after each harvest (cutting). NPK fertilisers vary in composition, but commonly contain 24% N, 6% P and 6% K plus another 64% inert material. Goat manure is the preferred source of fertiliser for these pastures, and the construction of a manure collection pad and drainage pit under each goat house was aimed at providing easily collectable sources of manure for fertilising forages. However, the composition of manure varies with feed being consumed, with the extent of urine contamination and also temperature and degree of decomposition. It is important to understand the extent to which manure can replace commercial fertilisers in small holder systems. Table 5.9 shows a theoretical calculation based on the data shown previously in Table 5.3 in which a herd of 50 goats fed for 120 days required 3839 kg DM (12.8 tonnes GM) containing 30% legume and 70% grass DM. If DM digestibility of this mixture was 60%, then 1536 kg dry faeces would have been excreted by these goats. Estimated values for the N, P, K and S contents of grass, legume and faecal DM were obtained from the literature and applied to these calculations to estimate the extent to which nutrients in faeces can replace those lost in the harvested forage.

Table 5.9 Calculation of the extent to which goat manure (30% DM) applied to grass and legume pastures (70% grass, 30% legume) can replace the nutrients consumed by a herd of 50 goats

Component	Feed Removed					Faecal excretion		% Requirement met by manure
	Grass		Legume		Total			
	% in DM	kg	% in DM	kg	kg	% in DM	kg	
Fresh matter		8978		3820	12798		5119	
Dry Matter	30	2693	30	1146	3839	30	1536	
Nitrogen	1.82	49.1	3.20	36.7	85.8	1.76	27.0	32
Phosphorus	0.11	3.0	0.26	3.0	5.9	0.23	3.5	59
Potassium	1.17	31.5	1.17	13.4	44.9	0.43	6.6	15
Sulphur	0.18	4.9	0.32	3.7	8.6	0.18	2.8	32

This table shows that by applying all the manure excreted by 50 goats back onto the pastures that provided the feed, only 32% of the N and S could be replaced by fertilising with manure. Fertiliser application should at least replace the nutrients removed at harvest if sustainable pasture yields are to be attained. To meet just the needs for N, three times the amount of manure shown above needs to be applied (ie 15 tonnes fresh manure/ha) for optimum growth, this is equivalent to 86 kg urea N or 185 kg urea/ha. Alternatively 100 kg urea supplies the same amount of N as 2650 kg manure. While potassium was found to be the most limiting nutrient found for pasture growth, soils reserves are likely to support growth for some years before additional K is required. NPK (24%N, 6%N, 6%N) would need to be applied at a rate of 638 kg/ha/year to meet deficit in K or 748 kg/ha/year to meet the total need for K. Where the aim is to only meet the N deficit, then 245 kg/ha would be required or 358 kg/ha/year to meet the total need. Manure was found to be a good source of P for plant growth, and maybe better applied to legumes than grasses. However, it is clear from these calculations that much

larger amounts of manure than previously thought need to applied to soils to maximise plant growth, supporting the view that inorganic fertilisers (urea, triple super phosphate, NPK) are needed to achieve high yields of pasture from these intensive cropping systems.

Dried Leucaena leaves (farm 21)

Ruzi grass hay for storage in plastic bags (farm 2)

Seed production and collection

As mentioned earlier, some farmers decided to allow their legume forages, Stylo, Flemingia and Leucaena, to grow to maturity in the first year of growth, and to harvest seed from them for sale or for expanding their planted areas of forage in the future. The climate in Binh Thuan proved most suitable for this harvest, and yielded large amounts of viable seed from these legumes. Grass seed is more difficult to harvest and generally has only a short storage life, and most farmers were propagating grasses by direct planting of cuttings.

Flemingia seeds well in Binh Thuan

Excellent yields of Style CIAT86 from farm 3

There were no accurate measures taken of yields of seed on these farms, but clearly seed production is both profitable and easily integrated with forage production systems. However the residue remaining after threshing for seed is of very low quality, and not useful as animal feed. The appropriate management of these pastures is to set aside a portion of the pasture plots (10%) dedicated to seed production, and use the remainder for frequent harvesting and either storage or direct feeding to animals.

Conclusions

Farmers who have been interested to conserve forage have mostly used either leucaena leaf stored in drums or sun-dried hay stored in large plastic bags. There is however only limited opportunities to dry hay in this climate, the best time is usually at the end of the wet season (November and December) when pastures should be allowed to grow on stored moisture or irrigation and be harvested at a relatively young stage of growth. During the rainy season

when pastures are growing best, there is little opportunity to harvest and dry forages. The project has been encouraging GRRC staff to experiment with the making of silage at these times, but to date this has not become a popular activity with farmers. The major focus now for project activities in pasture development will be creating awareness of the need to conserve forages, and to investigate practical ways of preparing and storing both grass and legume forage for use particularly in the mid- and late dry season.

Chapter 6

The impact of new technologies on the productivity and economic returns to goat farming systems in southeast Vietnam

Introduction

The limitations to goat productivity in Vietnam have been broadly categorised as a high incidence of disease causing morbidity and mortality, a shortage of cheap sources of quality feed (eg forages) to supplement goats during times of nutritional stress (dry and wet seasons) and a general lack of understanding by farmers of the principles of goat management. An initial survey identifying these limitations has been presented in Chapter 2, and a series of specific strategies proposed to alleviate these problems have been developed in Chapters 3 (disease control and prevention), Chapter 4 (pasture development using improved grass and legume species) and Chapter 5 (training programs to improve farmer management of goats). Goat farms in Ninh Thuan (15), Binh Thuan (9) and Lam Dong (3) provinces were identified in this initial survey (June 2006) for the application of a recommended package of technologies needed to improve goat productivity.

In brief, it was recommended that all goats be vaccinated against Goat Pox, Pasteurellosis and Enterotoxemia and that Ivermectin (injectable) be administered every 6 months to control internal and external parasites. All goat houses were inspected and a concrete apron built underneath each house to collect urine and manure for subsequent use on pastures and for sale. Between June and December 2006, pasture plots (~1000m^2) containing grasses and legumes were established on each farm. Each farm was visited at three monthly intervals to administer vaccines and invermectin, to review overall disease and management status of farm, to inspect pastures and to record live-weights and changes in herd numbers through births, deaths and sales.

Table 6.1 Schedule of activities on selected goat farms in Ninh Thuan, Binh Thuan and Lam Dong provinces between June 2006 (inception) and June 2008 (completion).

Time of Event	Ninh Thuan			Binh Thuan			Lam Dong
	Ninh Hai	Thuan Bac	Ninh Phuoc	Tuy Phong	Bac Binh	Ham Thuan Bac	Duc Trong
2006							
June[ACD]	3*	6	6	3	3	3	3
December[ABC]	3	6	6	3	3	3	3
2007							
March[ABC]	2	6	3	2	3	2	3
June[ABC]	2	6	3	2	3	2	3
September[AB]	2	6	3	2	3	2	3
December[ABD]	2	5	3	2	3	1	3
2008							
March[AB]	2	5	3	2	3	1	3
June[ABD]	2	5	3	2	3	1	3
November[D]	2	5	3	2	3	1	3

***** Number of farms in project **A** vaccination/injectable Ivermectin, **B** record productivity, **C** establish pastures, **D** conduct survey

During this two year period, seven farmers withdrew from the project for a variety of reasons, leaving a total of 19 farmers still participating at the end of the experimental period (June 2008). Table 6.1 shows the schedule of events for the project, including interventions and changing numbers of farms involved over this time.

Methodology for application of new technologies to goat farming systems

Teams of GRRC and DARD extension personnel worked to provide the technical support and advice to each farmer in the Project. Starting in December 2006, each farm was visited every three months (until June 2008) to administer vaccines and drugs, review goat health, inspect pastures, collect records of births, deaths and sales from the farmer and to weigh all goats. In June 2006, November 2007 and June 2008 a survey was also conducted for each farm. The 2006 survey provided the base data reported in Chapter 2, the 2007 survey recorded progress to date and the results of the final 2008 will be reported now. Each farmer was provided with a notebook to record the dates of birth, deaths and sales, and weights of kids at birth and other goats at sale. Prior to initiation of the vaccination schedule, approval was sought from the Provincial DARD authorities for the use of new Goat Pox vaccine. The other vaccines had already been officially approved for use in each Province. The vaccination schedule required that after the first vaccinations against Goat Pox, Pasteurellosis and Enterotoxemia, a booster vaccination was needed after 3 months to ensure a good response to the vaccines. Thereafter, each goat was vaccinated every 6 months to maintain a high level of immunity. Kids were first treated with injectable ivermectin at weaning (3 months) and thereafter at six monthly intervals (March and September). Inbreeding was recognised early in the project as a significant problem for all farmers, and all existing bucks were replaced with locally selected Bachthao or GRRC Saanen or Boer bucks (3 farms only) in June 2007. The impact of this intervention will only be seen in the last year of the productivity data, but is not easy to isolate since all farmers were given new bucks (no control where farmers retained old bucks).

In the first six months of the project, pasture establishment was poor or failed on some farms due to the flooding of plots in the wet season. At later times, pastures failed because they were not watered through the late dry season. On each occasion, the project provided more seed and advice to help re-establish these pastures. The final outcome of these efforts has been reported in Chapter 5 which deals specifically with the technologies needed to establish effective pastures in these environments. The records of goat productivity (growth, reproductive rate) were collated, translated into English and entered into a database for analysis and interpretation. This data will be reported later in Chapter 7. The technical inputs, data collection and surveys undertaken every 3 month usually required a team of 5-6 persons working continuously for 3 weeks, and a further 3 weeks to translate, collate and enter into databases.

As shown in Table 6.1, there were initially 27 farms selected for project activity, but 8 farmers had left the program by December 2007. There were a variety of reasons for leaving the project, some withdrew because of labour shortages caused by sickness in the family, some sold their goat herd when an epidemic of goat pox broke out in 2007 and others were not sufficiently interested in the activities to undertake the tasks required of them by the project. However, the 19 remaining farms in December 2007 continued their participation until the end of the project in June 2008, and all had, by then, recognised the significant benefits of the new technologies and improved management for the productivity and profitability of their farming enterprises. The project provided all the costs associated with goat house improvement, vaccines, seed and new bucks for breeding, in some cases, extra costs for labour and materials to support their farming enterprise. The sustainability of these

improvements in productivity will be judged by the continuing application of these new technologies by farmers after project has finished. A final survey of all farmers was conducted in November 2008 to determine the extent to which these new techniques have been incorporated into traditional management practices. The key lesson learnt here was that investment in disease control and pasture development will return greater benefits than the cost of the material purchased. These results are reported later in this Chapter.

Survey of farms in June 2008

A final survey was conducted on the 19 farms remaining in the project (Farms Inside) and a further 38 nearby farms in each district, these farms having no previous involvement in project activity (Farms Outside). These latter farms were meant to represent the current state of traditional goat farming each district, and were used to measure the impact of project activities on goat production in these areas. Table 6.2 shows mean values for numbers of farms surveyed in June 2008 in each district, as well as, average farm sizes and goat herd numbers.

Table 6.2 Average farm and goat herd size and numbers of farms surveyed in Ninh Thuan, Binh Thuan and Lam Dong provinces in June 2006.

Province	District	Farms inside			Farms outside		
		No. Farms	*Farm Size (ha)*	*Goats /farm*	*No. Farms*	*Farm Size (ha)*	*Goats/ farm*
Ninh Thuan	**Ninh Hai**	2	0.385	39	9	0.365	41
	Thuan Bac	5	0.636	45	10	0.451	56
	Ninh Phuoc	3	1.398	45	3	1.733	36
Bin Thuan	**Tuy Phong**	2	6.520	83	4	0.980	68
	Bac Binh	3	4.813	47	5	4.974	87
	Ham Thuan Bac	1	8.600	12	1	6.500	187
Lam Dong	**Duc Trong**	3	5.547	49	6	3.655	19

In general, farms sizes inside and outside the project were similar, with the exception of farms in Tuy Phong inside the project which were larger than those outside the project. However, average farm sizes were clearly smaller in Ninh Thuan than for the other Provinces. These smaller farms are a reflection of location, farms in Ninh Thuan being found on more fertile, well watered and productive soils than those in Binh Thuan and Lam Dong. It was clear that the average numbers of goats found on each farm bears little relation to farm size or even district. The small herd size on farms inside the project in Ham Thuan Bac cannot be reasonably compared with the very large herd size of those on Ham Thuan Bac farms outside the project. Most farmers in these areas graze their goats on communal or forestry areas distant from their farms, and are therefore not necessarily limited by the land area available on their farms. Herd size is more often related to the net reproductive rate, and on many farms, was low due to a high incidence of kid mortality. This aspect of productivity will be discussed further later in this report.

Table 6.3 shows values for average family size and composition, as well as other socio-economic characteristics of the family including sources and availability of labour. Farm ownership was predominantly male, of the Kinh ethnic group, with the average age of the family head being over 45 years. Most farmers interviewed had more than 20 years of experience farming locally, and generally considered that they were able to earn a better than subsistence living from their farm. Each farm was supporting on average 3 to 7 family members, with usually the parents of the family head also being supported.

Table 6.3 Family structure, characteristics and activities on the farm

Characteristic	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	**Binh Thuan**	**Lam Dong**	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**
Gender of owner %						
Male	90	100	100	77	90	90
Female	10	0	0	23	10	10
Average Age of Head	47.7	47.5	54.0	47.5	51.9	47.2
Family structure						
Adult males	1.7	1.8	1.7	0.2	2.0	2.3
Adult females	2.0	2.0	1.0	1.9	3.0	1.7
Male children (<18)	1.2	1.0	0.3	1.0	0.9	1.8
Female children (<18)	0.9	0.5	0	0.6	0.9	1.2
Average family size	5.8	5.3	3.0	3.7	6.8	7.0
Ethnic Group						
% Kinh	90	100	100	73	100	67
% Dan Toc	10	0	0	27	0	33
Farming Experience (Years)	36	22	40	30	31	20
% farmers considered poor	0	0	34	0	0	34
Family labour (person/years)						
Full-time	2.0	2.5	4.7	2.4	3.1	3.5
Part-time (0.3 full time)	0.7	0.5	1.0	0.5	0.6	1.3
Total	2.2	2.7	5.0	2.5	3.3	3.9
Hired labour						
% farms hiring males	80	50	100	64	60	34
Jobs for males	Work in gardens, pick fruit, cut sugar cane, look after goats and cattle, general farm work					
% farms hiring females	60	16	0	18	30	17
Jobs for females	General farm work, plant crops, look after goats					

*(1= Poor, 2=subsisting, 3=wealthy)

The family unit on these farms was the primary source of labour, for cropping, gardens and animal husbandry. If part-time labour represents 30% of a full time labour (one person year = 2600 hr/year) unit, then, on average, each farm had between 2.2 and 5.0 person years of labour available. However, this amount of labour was clearly not sufficient, and most farms hired additional male labour, with few farms hiring female labour. Extra labour was hired at critical times of the year, usually at planting and harvesting of crops. This aspect of farming activities will be discussed further later.

Table 6.4 Land utilization on goat farms in Ninh Thuan, Binh Thuan and Lam Dong Provinces of Vietnam

Land Category	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
House land area						
% Farm area	4.8	0.8	1.1	5.7	1.7	1.6
% farmers with access	*100*	*100*	*100*	*100*	*100*	*100*
Cropping Land						
% Farm area	48.9	30.2	7.2	32.8	19.1	15.9
% farmers with access	*80*	*67*	*67*	*77*	*70*	*83*
Forages						
% Farm area	9.0	2.8	2.0	6.3	3.6	0.2
% farmers with access	*90*	*100*	*100*	*41*	*40*	*17*
Garden						
% Farm area	17.8	32.9	80.8	45.9	45.9	59.0
% farmers with access	*60*	*100*	*67*	*59*	*50*	*83*
Forestry						
% Farm area	3.0	23.2	5.6	9.3	16.0	0.0
% farmers with access	*20*	*50*	*34*	*9*	*20*	*0*
Lakes/Ponds						
% Farm area	0.7	0.1	3.3	0.0	0.8	0.2
% farmers with access	*10*	*17*	*67*	*0*	*10*	*17*
Other						
% Farm area	15.8	10.1	0.0	0.0	12.8	23.0
% farmers with access	*30*	*67*	*0*	*0*	*20*	*34*
Average total farm size (ha)	1.340	8.613	5.980	0.879	4.364	4.364

Land ownership and utilisation

The categories of land use on each farm and the relative access by each farmer are shown in Table 6.4. In general, all farmers owned (with title) the land on which their house was built. However only 67 to 83% of farmers had access to cropping land, which varied in size from 7-16% farm area in Lam Dong to 33-49% of farm area in Ninh Thuan. By contrast, more than

90% farmers inside the project had access for land for growing forages, while farmers outside the project had much lower accessibilities (17-41%). This is not surprising because all farmers in the project had established pastures as part of their involvement, while those outside the project, had no such commitment. On all farms, the area of garden occupied the largest portion of farm land, being highest in Lam Dong where coffee growing was a major garden activity of all farms involved. However, again, not all farmers had access to lands for gardens. On average, 9 to 33% of farm area was as forest, lakes/ponds and "other", and few farmers had continuing access to these areas. The forest is an important resource for grazing, lakes and ponds for stock and irrigation water as well as fish. The significance of these "other" resources for farmers in the project was not assessed.

Land use for cropping

Although the farmers interviewed were mainly goat farmers, they also grew crops, particularly rice and maize, where suitable land was available. Rice was the preferred crop, and with the exception of project farms in Binh Thuan, most farmers planted 67-100% of available cropping land to rice. In Binh Thuan, most farmers preferred to plant maize, possibly because these areas have lower rainfall and shorter growing seasons. The differences in growing environments are also reflected in crop yields, with significantly higher rice yields in Ninh Thuan than in other provinces. On average, 28% of the rice grown was consumed by the household, with the majority (71%) being sold. Only small amount of rice were retained for feeding to livestock. In contrast, little maize was consumed, with the exception of farmers in Lam Dong, all maize was sold. Farmers outside the project in Lam Dong used a major proportion of the maize crop as animal feed.

Table 6.5 Data on the yields and utilization of the major crops, rice, maize and specialist crops (sugar cane, grapes, coffee) from farms on Ninh Thuan, Binh Thuan and Lam Dong provinces of southeast Vietnam

Crop Produced	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Rice						
% Cropping area planted	70.7	28.8	100.0	95.1	67.1	77.1
Yield (kg/ha)	**11469**	**5667**	**5231**	**14644**	**14031**	**4500**
% consumed	22.6	19.6	41.2	29.1	17.8	35.4
% sold	77.4	78.4	58.8	70.9	79.5	62.5
% fed to animals	0.0	2.0	0.0	0.0	2.7	0.0
Maize						
Yield (kg/farm)	475	15333	0	0	6883	1150
% consumed	0.0	0.0	0	0	0.0	13.0
% sold	100.0	96.7	0	0	100.0	13.0
% fed to animals	0.0	3.3	0	0	0.0	73.9
Other crops						
Yield/farm	2740	2740	16667	800	8450	3875
% sold	100	100	100	100	100	100

The "other" crops grown included sugar cane, cashew nuts, coffee, fruit (guava) and "industry plants". These crops were raised principally for sale, and the yields recorded are meaningless without some detailed description of the particular crops grown.

Animal ownership and herd sizes on project farms

As planned, all farms had goats, with herd sizes varying from 19 to 90, with no clear differences between farms inside and outside the project. Most farms (71%) also had small numbers of cattle (4-9). Although sheep are commonly farmed with goats in many areas of Vietnam, there were no sheep on the farms surveyed in Lam Dong, but a small number of farmers (10%) in Ninh Thuan and Binh Thuan (14%) had small sheep flocks (5-15 animals). This is not surprising because the initial selection of farms in these areas excluded those with large numbers of both goats and sheep for fear of cross-utilisation of resources for sheep and goats. Poultry was also owned by most farmers, although ownership was much higher amongst the farms inside the project.

Table 6.6 Animal ownership and herd sizes for farms in Ninh Thuan, Binh Thuan and Lam Dong provinces of southeast Vietnam

Animal Ownership	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Goats						
% farmers owning	100.0	100.0	100.0	100.0	100.0	100.0
Herd size	43.8	53.2	49.3	47.0	89.2	18.8
Cattle/Buffalo						
% farmers owning	60	100	67	45	50	83
Herd size	5.3	8.8	9.0	3.5	9.0	8.3
Sheep						
% farmers owning	10.0	0.0	0.0	13.6	10.0	0.0
Herd size	5.0	0.0	0.0	14.5	15.0	0.0
Poultry						
% farmers owning	70.0	100.0	100.0	31.8	40.0	83.0
Flock size	16.7	57.7	100.3	9.2	26.5	36.0

Boer and Saanen bucks provided for some project farms in 2007

Herd structure and productivity of goats on surveyed farms

The data collected here was by interrogation of farmers about the events that occurred in the previous year, eg births, sales and deaths. This data is subjective and susceptible to error, and more precise information was collected every 3 months by weighing and counting goats in the particular classes. The values shown in Table 6.7 are useful for comparison with farms inside and outside the project, and more accurate information will be presented in the following chapter on productivity.

Table 6.7 Herd structure and weights of goats at selected times during growth to maturity on farms in Ninh Thuan, Binh Thuan and Lam Dong Provinces.

Class of Animal	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Herd Structure						
Mature Bucks	0.8	0.8	1.1	2.1	1.2	1.4
Mature does	15.3	12.8	11.0	11.3	26.4	4.8
Weaner bucks	14.8	12.4	10.9	9.4	26.2	4.1
Weaner does	7.2	11.5	14.3	14.3	17.3	4.8
Kids	5.7	15.7	12.0	9.9	18.1	3.7
Goats sold	14.3	10.7	23.7	8.4	11.6	3.0
Goats died	3.9	3.0	3.3	6.6	8.9	1.8
Herd size	62.0	66.8	76.3	62.0	109.7	23.7
% sold annually	23.1	16.0	31.0	13.6	10.6	12.7
% annual mortality	6.3	4.5	4.4	10.6	8.1	7.7
Estimated weights (kg) at selected times						
Birth wt	2.4	2.3	2.0	1.8	1.9	1.6
Weight at 3 months	12.7	11.9	11.3	11.3	11.4	10.4
Weight at 6 months	18.9	19.1	16.8	17.2	17.6	16.7
Weight at sale	23.4	23.3	21.4	21.4	22.0	20.9
First conception (age in mths)	8.4	8.2	8.0	7.6	7.6	6.5
First kidding (age in mths)	13.4	13.2	13.0	12.6	12.6	11.5

Two important comparisons can be made between farms on which the new technologies were applied or denied. The net annual turnoff rate (goats sold or died per year) is a definitive measurement of overall farm productivity, and it can be seen from Table 6.7, that farms applying the new technologies had higher sales and lower mortalities over the year studied. Inside farms sold, on average, 23% of the herd each year, equal to about 16 goats, while farms outside the project sold only 12% of their herd, or 8 goats per year. While lower mortality through better disease control did contribute to this improved productivity, there

was also a general improvement in overall reproductive rate, leading to farms inside the project being twice a productive as those outside the project. The economic implications of these improvements will be explored later in this chapter. These differences were also seen in the weights of goats, kids, weaners (3 months) and goats at 6 months were always heavier on farms inside the project compared with those outside. The differences increased as the goats became older, 0.5k at kidding, 1.0 kg at weaning and 1.3 kg at 6 months and 1.2 kg at sale. These results indicate that a better price (~5%) would be obtained for these goats which are usually sold on a live-weight basis. The weight differences would suggest that farmers applying the recommended technologies not only sold more goats but also received a better price per goat.

The survey also revealed that under traditional systems of management where bucks have continuing access to does, young does on farms inside the project were conceiving at about 8.2 months of age, and kidding 5 months later, at 13.2 months of age. Young does from farms outside the project appeared to be conceiving and kidding earlier (12.3 months of age) than those on farms inside the project. While there appears to be no immediate negative effects of this early kidding on young does' life-time productivity, a more important determinant of effective reproductive performance is the time of kidding. For optimal reproductive performance, kidding should occur when there is low seasonal incidence of disease and good sources of nutrition to support doe lactation and kid growth. Where kidding occurs in the dry season, disease incidence is low, but so also is the availability of high quality feed. In the mid wet season, there is usually a good supply of feed available, but a high incidence of disease exists. The matching of kidding times to optimise reproductive rate will require some control of the time of breeding, that is, bucks will need to be removed from the herd for a time. The optimum time for kidding will depend on the environment and the farmer's willingness to restrict mating times. This theme will be explored in more detail later in the chapter when reviewing the productivity of goats on the different farms.


Preparing feed for silage making


Guinea grass hay stored in plastic bags

Sources of feed for goats

The information presented in Table 6.8 was collected from farmers during interview, and represents only approximate estimates of the quantity and quality of feeds offered to goat on the different farms. All farms had access to local grazing areas such as communal pastures, forest margins and roadsides. Mature goats were usually taken for grazing early in the morning, and returned to the goat house in the early afternoon. While the time spent away from the house was about 7 hours, grazing time might be less than this depending on the distance walked to the grazing areas. Most grazing ruminants will have intensive periods of grazing in the morning, with resting in the heat of the day, and a further grazing period in the

late afternoon. While no observations of grazing patterns have been made with Vietnamese goats, it is possible that the grazing management practised denies goats a second grazing period in the afternoon, and when feed is limiting, may represent a significant limit to their nutritional well-being. This deficit in intake may be corrected by providing additional feed in the afternoon when goats return from grazing, and this practice was found to be common amongst farmers in the survey.

Cut-and-carry systems are the usual way of providing additional feed, with forages and tree leaves being harvested each day from the most convenient sources, usually the roadsides, forest margins or government land. Where cultivated forages are available on the farmers land, these are the preferred source of feed. Table 8 shows that where cultivated forages were available on farms inside the project, almost all farmers harvested forages for feeding to their goats, the amounts harvested often being greater than those for farmers outside the project growing cultivated forages on their land. It was also noted that where forages were easily accessible close to the farmers house, only 30% of farmers inside the project continued to collect natural forages while more farmers (53-75%) in Ninh Thuan and Binh Thuan collected natural forages as sources of feed for their goats. Only farmers inside the project in Ninh Thuan provided hay as a supplementary feed for their goats. While supplements of grain or cassava were used by farmers in both Ninh Thuan and Binh Thuan provinces, more farmers (25-42%) used these supplements in Binh Thuan than in Ninh Thuan (3-13%). The amounts of supplement used was usually small, 56-125 g/head/d. Information was collected from each farmer on when these supplements were fed, and peak use was towards the end of the dry season (July and August).

Table 6.8 Sources of feed for goats on farms inside and outside the Project in Ninh Thuan, Binh Thuan and Lam Dong Provinces.

Source of Feed	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Grazing (hr/d)	6.9	7.0	6.3	7.0	6.6	6.7
Feeds offered						
Cultivated forages						
% farmers using	90	100	100	50	40	17
kg/goat/d (fresh wt)	2.5	2.0	0.6	0.7	0.8	0.6
Native forages						
% farmers using	30	33	0	75	53	29
kg/goat/d (fresh wt)	0.8	0.4	0.0	0.7	0.4	2.5
Hay						
% farmers using	21	0	0	0	0	0
kg/goat/d (fresh wt)	0.2	0.0	0.0	0.0	0.0	0.0
Total Forage						
% farmers using	100	100	100	81	68	41
kg/goat/d (fresh wt)	3.5	2.4	0.6	1.4	1.2	3.1
Supplements						
% farmers using	13	42	0	3	25	0
g/goat/d	122	67	0	56	85	0

There were no farmers in Lam Dong that used grain/cassava supplements, probably because of the distance from cheap supplies of these supplement sources. While the above data is interesting, there is no definitive evidence supporting the effectiveness of these supplements for improving goat performance, and more discerning studies will be needed to determine the types (energy, protein), amounts and timing of supplements needed to optimise goat productivity in these areas. It was expected that the additional forage sources provided by planting pastures would be conserved as hay or silage for feeding in the late dry season.

Table 6.9 Labour required (hrs/day and sources) for the management of cropping and animal husbandry activities on goat farms in southeastern Vietnam.

Labour Requirements	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Supervision of grazing						
Labour (hrs/d)	6.9	7.0	6.3	7.0	6.6	6.7
Source of labour	Children, family members, hired labour					
Harvesting forages						
Labour (hrs/day)	2.1	1.5	1.3	1.4	1.4	2.0
Source of labour	Children, family members, hired labour					
General animal care						
Labour (hr/d)	1.6	1.0	1.0	1.1	1.4	0.8
Source of labour	Children, family members, hired labour					
Total Labour for Animals (person/yr)	1.1	0.9	0.9	1.0	0.9	0.9
As % total labour available	48	36	17	38	29	24
Assessment of labour availability						
Cropping						
% farmers with labour shortage in						
January-March	37	28	11	51	0	0
April – June	60	67	67	51	60	94
July – September	53	61	45	33	27	33
October - December	50	72	78	33	20	33
Animal Management						
% farmers with labour shortage in						
January-March	10	17	0	33	0	6
April – June	47	56	23	77	0	23
July – September	17	6	0	0	0	0
October - December	20	0	0	0	0	0

Availability of labour for cropping and animal husbandry

In an earlier section of this report, family labour was found to be less than that required for all farm jobs, and additional labour was hired at critical times of the year (Table 6.3). The survey of farmers further investigated these requirements for labour to gain a better understanding of the extent to which labour was limiting productivity. Table 6.9 shows the

average time taken to complete tasks associated with the raising of goats, namely, the shepherding of goats while at pasture, the harvesting of forages and the general care and maintenance of goats in the household.

When the daily tasks are added, it was taking between 10 and 11 hours per day to manage the goat herd, representing 1.0-1.1 person years. One person year is calculated as one person working for 10 h each day for 5 days in a week, totalling 2600 h/year. When this labour is sourced from family members, it represented between 29 and 480% of the labour available on Ninh Thuan and Binh Thuan farms, but only 17-24% of labour available on Lam Dong farms. The reasons for this difference are not clear. The requirements for labour are seasonal, and farmers were asked to nominate the months of the year when demand was greatest. Table 6.9 provides a summary of this information, recording % of farmers with a labour shortage in each quarterly period. For cropping activities, the greatest shortage of labour was in the April to June quarter which is when the rice crop is being harvested and dried. Despite similar availabilities of family labour, farmers inside the project appeared to have greater shortages of labour for cropping (50% of farmers) than did those from outside the project (36% of farmers). The labour requirements for animal management were much lower than for cropping, and the only time when shortages were recognised was again in the April-June period when most farmers registered a shortage of labour. Farmers inside the project appeared to have greater demands (greater shortages) of labour than did farmers outside the project. It was also noted that farmers outside the project generally had sufficient labour for animal management, with the exception of those in Ninh Thuan. It is proposed that for much of the year there was sufficient family labour to manage animals, but labour shortages occur at harvest times when additional labour is hired.

Incidence and severity of disease in goats in Ninh Thuan, Binh Thuan and Lam Dong

Disease was recognised as a possible major limit to the productivity of goats in southeast Vietnam, and part of the strategy for improving productivity was to introduce a strategic vaccination and a health awareness program to all farms inside the project. When questioned, few farmers recognised specific diseases, such as Goat Pox, Pasteurellosis, Enteroxemia, Pneumonia or Intestinal parasites, more often describing symptoms (scabby mouth, pink eye, rumen bloat, dermatitis, diarrhoea) or outcomes of disease (abortion, nutritional deficiency). There were no opportunities to confirm the diagnosis of the diseases described or to determine the causal agents involved. However some conclusions can be drawn from the observations made, and the following tables have been divided into recognisable diseases with known causative organisms (Table 6.10), diseases for which there are suspected organisms (Table 6.11), and the last table (Table 6.12) shows the incidence of symptoms associated with unknown causes.

Table 6.10 shows results for the observed incidence and severity of the major diseases affecting goats in southeast Vietnam. Goat Pox was diagnosed as a serious disease during the first survey of diseases conducted by the project. At the time of the current survey, vaccination against Goat Pox was proving to be effective, with no goats on any of the project farms showing evidence of the disease. However, the disease was still present in this environment as shown by 40% of farms outside the project being infected in Ninh Thuan, and on these farms, on average 44% of herd was infected, and of these 60% died. There was lower incidence of Goat Pox in Binh Thuan, with about 20% of each herd being infected, but again about 60% of these goats died from Goat Pox. There were no recorded cases of Goat Pox in Lam Dong, possibly because the farms are more isolated from each other than in the other provinces.

Table 6.10 Survey findings for the incidence and severity of Goat Pox, Pasteurellosis, Enterotoxemia, Pneumonia and infections with intestinal parasites in goats from farms inside and outside the project in Ninh Thuan, Binh Thuan and Lam Dong provinces

Disease Condition	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Goat Pox						
% farms affected	0	0	0	41	20	0
% goats infected	0	0	0	43.5	21.3	0
% infected goats died	0	0	0	60.3	57.9	0
Age when affected	All goats					
Month when affected	All months except May, June and October					
Treatment applied	Goat Pox vaccine where zero incidence, isolation, other treatments not effective					
Pasteurellosis						
% farms affected	0	0	0	4.5	0*	0*
% goats infected	0	0	0	8.5	0	0
% infected goats died	0	0	0	22.2	0	0
Age when affected	Does					
Month when affected	May and June					
Treatment applied	Pasteurellosis vaccine applied, *no recorded incidence					
Enterotoxemia						
% farms affected	0	0	0	32	20	17
% goats infected	0	0	0	11.6	3.9	10.6
% infected goats died	0	0	0	92.1	100.0	0.0
Age when affected	Does, weaned kids					
Month when affected	April, May, June					
Treatment applied	Vaccination effective, applying antibiotics not effective					
Pneumonia						
% farms affected	50	50	0	50	40	67
% goats infected	5.5	5.0	0	10.4	3.1	10.6
% infected goats died	62.5	75.0	0	57.4	54.5	50.0
Age when affected	All goats					
Month when affected	July to December only					
Treatment applied	Inject genta, biovitamin, Sulfanilamide					
Intestinal Parasites						
% farms affected	0*	0*	0*	54.5	0	17
% goats infected	0	0	0	55.9	0	31.9
% infected goats died	0	0	0	14.9	0	16.7
Age when affected	All goats					
Month when affected	March & April, August to December					
Treatment applied	*Ivermectin applied 6 monthly effective,					

There were no cases of Pasteurellosis recorded on farms participating in the project vaccination program, nor were any cases recorded in either Binh Thuan or Lam Dong. Less than 5% of farms in Ninh Thuan recorded symptoms of Pasteurellosis, with about 12% of each herd being infected. Despite earlier predictions, it seems that Pasteurellosis may not be as serious a disease of goats as previously thought, and vaccination may only need to be applied when outbreaks of the disease occur. Vaccination against Enterotoxemia proved to be highly effective with no cases being recorded over the past year on farms inside the project. However, 17 – 32% of farms outside the project were affected by Enterotoxemia, with 4 to 12% goats in each herd being affected. It is likely that any infected goats will be kids or weaners, and amongst these goats, there was a high mortality (92-100%).

It is strongly recommended that vaccinations against Enterotoxemia be continued as a routine practice for all goat herds, vaccinating kids at 6 weeks and again at weaning. It should be noted here that the use of antibiotics was not effective in decreasing mortality in these herds. Pneumonia affected 40-67% farms in the survey, and while only a few goats in each herd (3-10%) were affected, once infected there was a high probability of mortality, ie 50-75% of infected goats died. It is likely that these deaths occurred during the wet season and were related to overcrowded housing or exposure to rain and wind. Isolation and antibiotic treatment were effective in controlling this disease which was found on farms both inside and outside the Project. Intestinal parasites have long been recognised to cause morbidity and mortality in goats in Vietnam. The 6-monthly treatment of all goats with ivermectin on farms inside the project proved highly effective, there were no recorded symptoms in any herds. However, intestinal parasites were a major problem for goats on farms outside the project in Ninh Thuan, with more that 50% of goats on half of all farms showing symptoms and suffering mortality. While there was a lower incidence of intestinal parasites in Lam Dong (17% farms), mortality was still associated with infections on these farms. There is a continuing need to develop management practices to decrease the incidence of recurring parasite infections, and strategic treatment with ivermectin is an important part of this overall management package.

A typical healthy large-framed Bachthao doe capable of both good milk production
and high reproductive rate and will be the basis of a profitable goat industry in sotheast Vietnam

Scabby mouth (Contagious ecthyma (ORF)) was a common infection found in young kids. Table 6.11 shows that goats on most farms were infected with this disease, and that mortality from the disease was usually low (4-6%). However, farms outside the project were more severely affected than those inside the project, with much higher proportions of the herd being infected (8-19%), with higher mortalities amongst those infected.

Table 6.11 Survey findings for the incidence and severity of Scabby Mouth, Pink Eye, Dermatitis and symptoms of other diseases in goats from farms inside and outside the project in Ninh Thuan, Binh Thuan and Lam Dong provinces

Disease Condition	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Scabby Mouth						
% farms affected	60	0	100	81.8	70	34
% goats infected	6.1	0	3.7	18.7	7.8	15.9
% infected goats died	6.3	0	0	10.1	4.1	16.7
Age when affected	Young kids					
Month when affected	At kidding times					
Treatment applied	Use alum, salt or Methylene Blue					
Pink Eye						
% farms affected	60	0	0	59	40	0
% goats infected	9.5	0	0	16.0	40.0	0
% infected goats died	0	0	0	0	0	0
Age when affected	Does, weaners, kids					
Month when affected	March to December					
Treatment applied	Kanamycin, bathe eyes in 0.9% saline					
Dermatitis						
% farms affected	40	0	0	27	10	0
% goats infected	12.6	0.0	0.0	13.8	11.2	0.0
% infected goats died	0.0	0.0	0.0	5.1	0.0	0.0
Age when affected	Does and weaned kids					
Month when affected	February to July, September to November					
Treatment applied	Ivermectin (external parasites), alum or coconut oil to relieve Irritation					
Other undiagnosed diseases						
% farms affected	30	67	67	27.2	30	0
% goats infected	4.6	7.5	7.1	7.1	7.8	0
% infected goats died	100.0	87.5	28.6	100.0	19.0	0
Age when affected	All goats					
Month when affected	All months except December, January and February					
Treatment applied	Disease not specified, no treatments applied					

In Lam Dong, 17% of infected kids died, indicating that this disease needs to be treated at an early stage to control infections. While it is possible to vaccinate against this disease, topical treatment with astringents to prevent spreading is probably the best solution. Pink eye is a common infection of the eye, which is highly infectious and treatment is required as soon as evident. This condition was most common in Ninh Thuan, affecting about 60% of farms and 10-16% of each herd being infected. While there were no mortalities associated with this disease, blindness may result if left untreated. Dermatitis was also found in a few goats (13-14% of herd) from Ninh Thuan (27-40% farms affected). However mortalities were low. While the causative agent is not known, the high incidence in this province was probably related to the humid environment in which these goats were found. Similar conclusions could be drawn for pink eye. Since all goats on farms inside the project were treated with ivermectin, the dermatitis observed was not related to the activities of external parasites (lice, scabies) but was probably mycotic in origin. Other undiagnosed diseases of goats were recorded during this survey, and were more serious for farms inside the project (30-67% farms affected) than for farms outside the project (27-30% farms affected). The significance of these observations was that, while only small proportions of the herd were affected (5-8%), high mortalities (87-100%) resulted from these diseases. There is an urgent need to investigate further the causes of these diseases to prevent further mortalities from these causes.

The final table (6.12) shows the incidence of symptoms or outcomes of undiagnosed diseases in goats, and it is realized that some of these observations may contradict previous conclusions about the incidence and severity of diseases described previously. For example, a high incidence of diarrhoea was observed on most farms (80-96%) in Ninh Thuan and Lam Dong, but with a relatively low incidence in each herd (5-12% of herd). These symptoms may simply represent undiagnosed cases of intestinal parasites, entertoxemia or other diseases causing diarrhoea. The difference between these and earlier observations is that despite treatment with ivermectins, the incidence of diarrhoea was similar between farms inside and outside the project. It was also noted that there was a high mortality associated with this diarrhoea (25-80%), and it is possible that the goats observed here missed the 6 monthly routine treatment with vaccines and ivermectin, dying before treatments could be applied. While there appeared to be a lower incidence of diarrhoea in Lam Dong (34% of farms), similar proportions of goats in the herd were affected, with a very high mortality (80%) in goats on Lam Dong farms inside the project. It was also noted that treatment with antibiotics was seldom effective, further suggesting intestinal parasite infections, particularly Tristrongylid (Black Scour worm), in these goats. Many farmers reported a high incidence of rumen bloat in their goats, with 16-67% of farms inside the project finding a low incidence in the herd (2-4%) but high mortalities (50-100%). Similar numbers of farms outside the project recorded bloat which affected higher proportions of the herd (7-20%) than found for farms inside the project. Again high mortalities were associated with bloat. The causes of bloat may be many, from ingestion of poisonous plants, impaction of the rumen, starvation or too rapid ingestion of fermentable carbohydrate feeds. The treatments applied were usually aimed at breaking the stable foam in the rumen by ruminal dosing with vinegar (acetic acid) or plant oils. The low incidence and high mortalities makes this an important “disease” which should be treated quickly as soon as it is detected.

All farms both inside and outside the project recorded similar levels of abortion in their does (5-10%). Doe mortality following abortion was low for farms inside the project (0-3%), but much higher for farms outside the project (12-20%). Abortions occurred between February and October, and this high incidence was probably associated with nutritional stress at at the

end of the dry season. Lower mortalities on project farms were possibly related to a higher availability of feed throughout the year. Some farmers considered that nutritional deficiency was a significant cause of morbidity and mortality in their goats, although it was not clear whether the deficiencies were of feed (energy), protein or specific nutrients. It is important to note that high mortalities were associated with the relatively low incidence of these conditions. It is likely that these observations apply to particular farms under specific conditions eg local effect of drought, poor quality feed etc. The solution to these problems will be from an appropriate on-farm diagnosis of annual production activities.

Table 6.12 Survey findings for the incidence and severity of diarrhoea, rumen Bloat, abortion and nutritional deficiency in goats from farms inside and outside the project in Ninh Thuan, Binh Thuan and Lam Dong provinces

Disease Condition	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Diarrhoea						
% farms affected	70	83	34	95.5	80	34
% goats affected	10.1	5.3	20.3	12.4	12.4	10.6
% affected goats died	51.6	35.7	80.0	25.4	44.2	25.0
Age when affected	All goats					
Month when affected	July to October, December, February					
Treatment applied	Use streptomycin, sulfathiazon, genta? and tetracyclines alum, little success					
Rumen Bloat						
% farms affected	30	16.7	67	50	20	50
% goats affected	3.0	1.9	4.1	6.6	20.0	12.4
% affected goats died	50.0	100.0	100.0	52.9	100.0	42.9
Age when affected	Mature does and weaners					
Month when affected	May to September only					
Treatment applied	Drench with garlic, vinegar or ginger solutions					
Abortion						
% farms affected	70	50	67	59	40	50
% goats affected	9.8	5.0	8.1	10.0	7.8	8.8
% affected goats died	3.3	0.0	0.0	11.5	0.0	20.0
Age when affected	Young and mature does					
Month when affected	February to October, no record of stage of pregnancy collected					
Treatment applied	Inject with Biovitamins?, feed grass, often no treatment					
Nutritional Deficiency						
% farms affected	10	0	0	18.2	30	0
% goats affected	9.1	0.0	0.0	17.0	12.7	0.0
% affected goats died	100.0	0.0	0.0	56.3	100.0	0.0
Age when affected	Young kids, does at kidding					
Month when affected	February to May					
Treatment applied	Offer milk to kids, give grass from forest					

Income and expenditure on cropping

While goat farming was the primary focus of these studies, all farmers surveyed were involved in mixed farming, that is, cropping, fruit trees and other cash crops were being grown as well as the raising of animals. Table 6.12 shows that between 50 and 75% of all farms were growing rice, which generated a major proportion of income (47 – 81%) from cropping for farmers in Ninh Thuan province. While rice was still a significant source of income for farmers in Binh Thuan (20-41% crop income), it was only a minor crop in Lam Dong province. The major crop here was coffee which accounted for 73-92% of cropping income in this province,

Table 6.13 Income and expenditures (millionsVDN) for cropping enterprises on goat farms surveyed in Ninh Thuan, Binh Thuan and Lam Dong provinces of Vietnam

Crop grown	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Rice						
% farms growing	60	67	67	77	50	67
Income (mVDN)	14.100	15.500	6.667	15.000	13.560	12.133
% total cropping income	47.3	20.1	2.2	80.6	41.4	12.8
Cassava & Maize						
% farms growing	40	83	67	23	30	100
Income (mVDN)	1.690	11.500	5.333	1.918	4.750	13.967
% total cropping income	5.7	14.9	1.8	10.3	14.5	14.7
Short day crops?						
% farms growing	20	50	100	9	40	67
Income (mVND)	9..750	5.333	29.2000	0.682	5.820	68.667
% total cropping income	32.7	6.9	.96.1	3.7	17.8	72.5
Other crops						
% farms growing	30	67	0	14	30	0
Income (mVDN)	4300	44833	0	1000	8640	0
% total cropping income	14.4	58.1	0.0	5.4	26.4	0.0
Total Average cropping income	29840	77167	304000	18600	32770	94767
Average expenses						
Seed (varieties)	1.427	6.892	8.750	1.314	3.529	2.600
Fertilizer	4.810	13.817	75.800	2.982	9.417	25.667
Pesticides and Herbicides	0.700	2.617	5.733	0.661	1.283	0.967
Fuel and oil	2.500	5.100	21.333	0.055	0.300	6.783
Labour	5.410	13.500	89.333	5.138	8.550	19.667
Total Average expenses	13.890	41.158	20.0950	9.325	15.590	55.683
Profit from cropping (mVND)	15.950	36.008	103.050	9.275	17.180	39.083
% Return to Investment (Profit./Expenses*100)	114.8	87.5	51.3	99.5	110.2	70.2

Maize and cassava were grown by a high proportion of farmers both inside and outside the project, but accounted for only small fraction of cropping income (2-15%). In Binh Thuan, a wide variety of income-earning crops were grown, eg sugar cane, cashew nut, grapes, guava and other minor cash crops, and diversity of cropping was the usual practice here. It was not possible to separate the individual costs of growing these crops, but expenditure on the major resources used in crop production was collected. As might be expected, expenditures varied widely between farms and provinces, but all farms recorded high returns to investment in crop production. Rice proved to be the most profitable investment where it could be grown (Ninh Thuan), returning 100-115% of the investment. In Lam Dong where coffee was the major crop grown, there was a lower but still very profitable return to investment of 50-70%. It is likely that these vales are over-estimates of profitability, because no costing has been made for the family labour involved or infrastructure depreciation.

Table 6.14 Income and expenditures for animal production on goat farms surveyed in Ninh Thuan, Binh Thuan and Lam Dong provinces of southeastern Vietnam

Animal	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Goats						
% farmers raising	100	100	100	100	100	100
Income (mVDN)	19.460	18.183	37.667	11.909	18.700	7.700
% total animal income	68.7	53.3	77.1	50.8	53.4	50.8
Sheep						
% farmers raising	30	34	67	77	20	34
Income (mVDN)	3.890	1.867	6.500	3.455	0.220	2.333
% total animal income	13.7	5.5	13.3	14.7	0.6	15.4
Cattle/Buffalo						
% farmers raising	10	83	34	82	50	67
Income (mVDN)	1.400	8.833	4.667	2.000	12.860	4.917
% total animal income	4.9	25.9	9.6	8.5	36.7	32.5
Other animals						
% farmers raising	90	100	0	9	70	10
Income (mVDN)	3.580	5.250	0	6.673	3.270	0.200
% total animal income	12.6	15.4	0.0	28.5	9.3	1.3
Total Average income from animals	28.330	34.133	48.833	23.430	35.050	15.150
Average expenses						
Animal costs	0.190	0.250	0	0	0.360	0
Veterinary care	1.290	1.683	1.500	1.470	1.535	0.805
Feeds and supplements	0.525	0.983	1.667	0.423	0.350	0
Labour	4.710	1.667	4.000	3.245	5.100	3.233
Total Average expenses	6.715	4.583	7.167	5.139	7.345	4.038
Profit from animals (mVND)	21.615	29.550	41.667	18.291	27.705	11.112
% Return to Investment	321.9	644.7	581.4	355.9	377.2	275.2

Income and expenditure on animal management

Similar data were collected for the animal enterprise on each farm, and the results are shown in Table 6.13. Farmers inside the project had higher incomes in VDN (~25.0 mVDN) and as a % of all income from animals (66%), when compared with farmers outside the project (~13.0 mVDN) and 52% of all animal income. As discussed in earlier sections farmers who applied the recommended technologies had increased numbers of goats for sale which lead to the higher returns noted above. Where sheep were raised, they contributed only small amounts to income, while cattle provide between 26-37% income in some provinces (Binh Thuan, Lam Dong). As expected the greatest expense in raising animals was the cost of labour, and to a lesser extent, the cost of veterinary chemicals. However, expenses formed a relatively small fraction of the total income received from animals, and overall, the return to investments in animal production was very high, 516% for farms inside the project and 336% for farms outside the project. From such high levels of profitability, it would seem that further investment in vaccines and drugs to improve animal health can be easily justified in the budgets of these farmers.

A greater availability of high quality forages increased reproductive rates on small-holder goat farms

Marketing and sources of veterinary advice

The marketing of goats is an important aspect of goat production and profitability in Vietnam, but there is little definitive information available on this activity. There are few slaughter houses dedicated to goats in Vietnam, with only one government supported slaughter house near Phan Rang in Ninh Thuan province. Results of the survey (Table 6.14) showed that about half of the farmers sold their goats directly to this slaughter house in Ninh Thuan while the other half sold their goats to traders who travelled from farm to farm buying goats. In Binh Thuan and Lam Dong, all goats were sold to traders, who then may grow goats to accepted marketable weights of 28-30 kg, or sell directly to restaurants in the large cities (eg Ho Chi Minh city). Farmers were asked where they purchased breeding goats and to whom did they sell breeding stock. No farmers brought breeding stock locally, all went to more distant localities to purchase breeding bucks and does. This practice was clearly aimed at avoiding inbreeding that may arise from the use of only a few bucks in each farm. All farms participated in both purchase and sale of breeding stock, but farmers inside to project were generally more active than those outside the project. Veterinary services in Vietnam operate on a number of levels from partly trained village para-veterinarians to those who qualified through tertiary education. All farmers surveyed relied on advice from private veterinarians rather than government officers, and with the exception of farms in Lam Dong, the majority of farms (60-83%) purchased their veterinary medicines from these same private sources. In Lam Dong, all medicines were purchased through government agencies.

Table 6.15 Destinations and sources of goats sold for slaughter and breeding and sources of veterinary advice for farmers in Ninh Thuan, Binh Thuan and Lam Dong provinces in Vietnam

Sources and sinks for animal	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Animal Sales						
% farmers selling to:						
Traders	40	100	100	46	100	100
Direct to slaughter house	60	0	0	55	0	0
Source of breeding stock	All farmers purchased from and sold breeding stock to outside local areas					
% farmers selling	50	17	100	9	30	34
% farmers buying	60	17	67	27	20	50
Source of Veterinary advice	All farmers used a private Veterinarians rather than Government services for advice, but varying numbers purchased medicines for government sources					
% farmers buying veterinary medicines from Government	40	17	100	41	0	100

The impact of Project activities on overall farm profitability

The information collected on the income and expenditure for cropping and animal production enterprises allow estimates to be made of the overall impact of the introduction of new technologies on farm profitability and farmer wealth. Table 6.15 show summarised data from which some outcomes may be calculated. In addition to earning income from farming enterprises, many farmers (and their wives) worked off-farm (34-67%) to generate additional income. Off-farm earnings varied with Province, Ninh Thuan 23-27%, Binh Thuan 7-10% and Lam Dong 3-8%. Expenses for running the farms includes not only expenditure against cropping and animal production, but also for interest paid on loans, living expenses for the family and savings where possible. Many farmers had taken out loans to help with improving infrastructure on their farms, including housing, and to pay for their childrens education. Loans varied from 7.5 to 66.0 mVDN, while farms being supported by the project had taken out much larger loans (39.0 mVDN) than did farms from outside the project (9.9 mVDN). Although information on interest rates was not collected, for the purposes of calculation, it has been estimated that a maximum of 10% interest would be charged against each loan. The difference between total income and the expenses from the cropping and animal enterprises plus interest was assumed to be the money used for living expenses, rent and savings. The assumption here is that no farmers were in debt, that is, their annual income equalled their annual expenditure.

A 'wealth' index was calculated as (cost of living + savings + rent) as a percentage of gross income. When calculated this way, there were no clear differences between farms inside and outside the project, but a definite trend for Province. Farms in Ninh Thuan had a higher wealth index (70-71) than did farms in Binh Thuan (61-69) with farms in Lam Dong being the poorest, that is, had the lowest wealth index (41-49). When expressed in this way, the introduction of new technologies to improve goat productivity had no significant effect on the overall 'wealth' of farmers.

Table 6.16 Average values for the income from and expenditure (mVDN) on cropping, animal husbandry and external sources of farms inside and outside the project in Ninh Thuan, Binh Thuan and Lam Dong provinces in southeast Vietnam

Income and Expenditures	Farmers inside Project			Farmers outside Project		
	Ninh Thuan	Binh Thuan	Lam Dong	Ninh Thuan	Binh Thuan	Lam Dong
Source of Income						
Cropping	29.8	77.2	304.0	18.6	32.8	94.8
Animal raising	28.3	34.1	48.8	23.4	35.1	15.2
Other (external)						
% farmers with other income	60	34	67	55	67	50
Other income (mVND)	21.6	9.0	10.7	12.5	7.4	9.5
Total Income	79.7	120.3	363.5	54.5	75.3	119.5
Expenditure						
Crop production	13.9	41.2	201.0	9.3	155.9	55.7
Animal Production	6.7	4.6	7.2	5.1	7.3	4.0
Interest on loans (10%)	3.6	1.4	6.7	1.2	0.8	1.0
Cost of living + savings + rent#	55.6	73.1	148.8	38.8	51.6	58.7
Total Expenditure	79.7	120.3	363.5	54.5	75.3	119.4
Wealth Index*	70	61	41	71	69	49
Loan						
% farmers with loan	60	100	34	55	30	83
Average Loan (mVND)	35.700	14.2	66.7	12.2	7.5	10.0
Purpose of Loan	For sending children to school (27%), house construction (24%), improving farming (breeds and seeds) 49%)					

Difference between total income and (expenses for crop production, animal production and interest paid). * (Cost of living + savings + rent) as a percentage of total income

Conclusions

An initial survey of goat farmers in Ninh Thuan, Binh Thuan and Lam Dong provinces was undertaken in June 2006 to establish a baseline from which changes in productivity in response to the application of new technologies could be evaluated (Chapter 2). This survey also identified the major problems facing goat farmers in these areas, and provided priorities for action. The specific objectives and expected output from the project's activities were listed as follows:

1. Identification and characterisation of target farms
2. Training and information dissemination
3. Provision of improved health care and housing for goats
4. Improve the availability and quality of feeds and forages for goats
5. Provide local Bachthao goats of proven genetic merit for breeding
6. Economic evaluation of the impact of new technologies on goat productivity

Objective 1 has now been completed with the survey of farms "inside" and "outside" the project in June 2006 and June 2008, providing a comparison for changes in goat productivity over a two year period. Objective 2 has also been completed, where GRRC and DARD staff have been trained in goat production technologies, where individual farmers have been

trained in the application of techniques in animal health care and pasture management and where other local farmers have been trained in goat production technology at 14 two-day workshops in each province. Details of this training have been presented in Chapter 5. In the second year of the project, Objective 5 was completed with all farmers being provided with new Bachthao bucks to avoid the possibility of inbreeding occurring. The impact of this introduction will be assessed in Chapter 7 in which the growth and reproduction of goats is presented in more detail. It is however expected that because of the short time since introduction, only limited conclusions can be drawn about the impact of this initiative. The results from the 2008 survey provided information and conclusions about objectives 3, 4 and 6, and a detailed discussion of each issue has been completed in each relevant section.

Impact of improved health care

The construction of manure collection pads under each goat house permitted the easy removal of manure, and the maintenance of more hygienic conditions around house. The manure provided a source of income from sale and as fertiliser for garden, pasture and crops. The vaccination program effectively controlled goat pox, pasteurellosis, enterotoxemia and intestinal parasites, such that no incidence of these diseases was detected on any of the farms participating in the project. The control of disease decreased kid mortality, increased the number (annual turn-off) and weight of goats sold, thereby significantly increasing income from goats on these farms. Annual income from goats on project farms was nearly double that on farms outside the project (25.1 vs 12.8 mVDN) making a substantial contribution to the income of these poor farmers. However, there remained on some farms, diseases which require further efforts to control, amongst these were scabby mouth, pneumonia and other minor but unknown and fatal diseases.

Improved availability and quality of feed for goats

While this aspect has already been discussed in greater detail in Chapter 4, the survey provided some additional conclusions about the use of forage for goat feeding. Few farmers fed their goats either hay or supplements, and relied on cut-and-carry grasses/forages to feed in times of nutritional stress. It was noted that when on-farm pastures were provided, farmers cut less forage from other sources, presumably saving time in travel and effort. It was also shown that these farmers offered more forage/goat per day to their goats than farmers outside the project with less easy access to cut-and-carry pastures. It is difficult to separate the effects of better disease control and improved nutrition on the overall growth and productivity of the goats surveyed, but there is no doubt that the greater availability of easily harvested forages made some contribution to this improved productivity on project farms. Both grasses and legumes were sown in the pasture plots established, with the intention of educating farmers about the need to provide high protein leguminous feed to meet the needs of lactating does amd growing kids. However, the high productivity of the grasses lead farmers to believe that the slower establishing and growing legumes were not useful, and many died out because farmers did not continue watering during the dry season. There is a need to maintain a good balance of grasses and legumes to provide the highest quality feed for goats in these environments.

Economic evaluation of impact of new technologies

Goat farmers implementing project recommendations had not only much higher incomes from their goat herds, but the average return to investment from goats was also much higher (516%) than that on farms outside the project (336%). These advantages were gained not from larger herd sizes but by having more goats available for sale each year. Not all farmers have the land or inclination to increase their herd sizes because this would usually

involve a greater investment in capital (larger goat house) and labour, which is already in short supply. However, this greater earning capacity was associated with farmers inside the project having larger loans (38 mVDN) than did farmers outside the project (10 mVDN). These indicators clearly suggest that the project has had a significant impact on the profitability of the goat enterprise on the mixed farming enterprises in Ninh Thuan, Binh Thuan and Lam Dong Provinces of southeast Vietnam.

Chapter 7

The impact of new technologies on the productivity of goats in southeast Vietnam

Introduction

Goat production is a minor but significant enterprise for many small holder farmers in Vietnam, providing readily available sources of income for family and household purposes such as education and clothing of children, purchase of food and feed and of household goods and services. In previous chapters, it was shown from a survey of farm and farmer activities that goat productivity could be improved by the strategic application of vaccines against diseases, by better nutrition through improved pasture production and by the introduction and rotation of new breeding stock to overcome the limited genetic potential of local stock. While these observations confirmed that the application of holistic management packages to goat production in Vietnam effectively improves productivity, little information was gained from these studies on the potential productivity of goats in these improved management systems. Some information on herd structures, live-weights and reproductive performance of goats under improved and traditional management was obtained in the survey, but this data was collated from farmer's responses to questions and while valuable, can only be considered as qualitative and in need of quantitative verification.

An important aspect of the Vietnam-Australia Goat Improvement Project was to train extension workers and farmers in improved management techniques for raising goats. An essential part of this training was to develop an identification system for goats so that records could be kept of individual performance from which selection could be made on the basis of superior performance (eg live-weight, reproduction, milk yield). The following study was conducted in conjunction with the survey carried out on all farms "inside" the project (Chapter 6) with the aim of producing quantitative data on goat productivity on each farm. All goats were uniquely ear-tagged at the beginning of the study (June 2006) and their individual performance (live-weight, kids born, mortality, sale) recorded every 3 months until survey completion in June 2008. It was expected that this study would provide definitive data on seasonal changes in live-weights, the timing and frequency of kidding and on changes in herd structure over the two year period. This information is considered essential for the development of more effective and efficient management systems for goats in south-eastern Vietnam.

Materials and Methods

Selection of farms for project activity

In June 2006, project teams visited Ninh Thuan, Binh Thuan and Lam Dong provinces of south-eastern Vietnam to select farmers and farms willing to participate in the Project. The plan was to apply vaccines and anthelmintics to control common diseases, to provide training and assistance to establish small plots (1500 m^2) of improved pasture and quarterly visits to advise on management techniques for improving goat productivity. In the second year, each farm was provided with a new Bachthao bucks to overcome the inbreeding observed on some farms. A total of 27 farms were selected at this time, 15 in Ninh Thuan, 9 in Binh Thuan and 3 in Lam Dong provinces. The farms were chosen on the basis of, firstly, willingness to participate, then on the nature of the goat enterprise, ie small goat herds (20-60 head), no or few sheep and cattle and owner operated. The presence of other ruminant animals on the farm was considered as a possible complicating factor when trying to assess the specific

impact of new technologies on the productivity of goats. Details of the characteristics and activities of these farms and farmers have been presented in Chapters 2 and 6.

Collection of productivity data

At the beginning of the Project in June 2006, all goats on each farm were to be fitted with ear-tags to allow life-long measurement of productivity. This practice is not commonly used in Vietnam, and both a lack of experience by project technical staff and resistance from some farmers, made this operation difficult with less than satisfactory outcomes. This failure to appreciate the crucial importance of individual animal identification subsequently compromised the collection of data from many farms, and limited the interpretation of the results collected. At the time of the initial application of ear-tags, all farmers were provided with books in which they were asked to record kidding data (doe number, sire, date of birth, number, weight and sex of kids born), vaccinations, mortalities and sales. Each farmer was given a set of bath-room scales on which he could weigh his goats at these times.

Weighing goats on bathroom scales

Measuring girth circumference

Estimation of age in goats

It was important to determine the date of birth and/or age of each goat at the start of the survey, since both the season of birth and age are related to the advent of reproductive activity in both males and females. Farmers were asked to estimate the age of each goat on their farm, and on some farms (12,19,20,21,22,23,24), dental records of each goat were recorded to provide an alternative estimate of age. An approximate estimate of age from dentition was calculated from the following formula:

$$\mathbf{A = 4 \times T + 6}$$ where A = age in months and T = number of permanent teeth.

This empirical formula assumes that the first two permanent teeth erupt at about 14 months of age, and that a further 2 teeth erupt every 6 months until a full mouth (8 teeth) is found at about 38 months of age. While this formula accurately predicts the age of mature goats (14 months and older), it is not very accurate in estimating the age of young goats. Where farmer estimates appeared in error, the age of young goats was predicted from their live-weight using the following formula. This equation was developed from a set of data from Bachthao goats of known age (1 – 12 months) and weight (3 – 30).

$$\mathbf{A = 0.6721 \times W - 1.60 \quad r^2 = 0.8145}$$ where W = live-weight (kg) and A = age in months

This formula predicts that, on average, birth weights of kids were 2.2 kg, and that at weaning (3 months) they weighed on average only 6.8 kg, increasing to about 20 kg at 12 months of

age. Again, this estimate of age can only be approximate, and further information on this relationship is presented later in this chapter. Fortunately, this correction did not need to be made on many farms.

Project staff visited each farm every 3 months at which time they weighed all goats to nearest kg, vaccinated all goats as prescribed by the experimental schedule, and recorded and collated all data collected by the farmer in the previous 3 month period. All new kid goats were ear-tagged and vaccinated as required at this time. Girth circumference (cm) was also measured on all goats from December 2006 to December 2007. These measurements were made to investigate the relationship between girth circumference (G) and live-weight with a view to providing an alternative way of estimating live-weight that could be used routinely by farmers to measure performance of their stock. This data was entered into an XL spreadsheet for subsequent analysis and interpretation.

The following information on goat productivity was planned to be calculated for presentation, sex, birth weight, birth type and dates of kidding and conception of all kids born in each quarter, kid, weaner and mature doe weights and weight gains throughout each season, kidding intervals for does and the changes in herd size as a consequence of consumption, mortality and sale.

Table 7.1 Number of farms in districts of Ninh Thuan, Binh Thuan and Lam Dong provinces participating in the survey and productivity measurements in each quarter.

Month of Survey	Ninh Thuan			Binh Thuan			Lam Dong
	Ninh Hai	Thuan Bac	Ninh Phuoc	Tuy Phong	Bac Binh	Ham Thuan Bac	Duc Trong
June 2006	2*	6	3	3	3	2	3
December 2006	2	6	3	3	3	2	3
March 2007	2	6	3	3	3	2	3
June 2007	2	6	3	2	3	2	3
September 2007	2	6	2	2	3	2	3
December 2007	2	5	2	2	3	1	2
March 2008	2	5	2	2	3	1	2
June 2008	2	5	2	2	3	1	2

* Number of farms participating in productivity measurements

Results and Discussion

Table 7.1 shows the numbers of farms in each district that were participating in each quarter. At the start of the survey, 27 farms were chosen but by the end of the first year (June 2007), only 22 farms remained which were providing useful data. In the second year, a further 5 farms withdrew from the project, leaving only 17 farms, from which basic productivity data was being collected. It was also found during this time that animal identification was proving to be a problem, with ear-tags being lost and not replaced, duplicate numbers for different goats on the same farm, but mostly poor planning in allocation and administration of ear-tag numbers over the experimental period. The recording of reproductive information required the accurate identification of does with their kids, and records of birth dates for all kids was

essential. The records kept by the farmers were generally poor, with no information being kept on weights and dates of animal sales or mortalities. There were even problems with the technique for weighing goats which required a man to hold a goat while standing on bath-room scales. When the goats were small, the errors were large, and where the goats were large, they were often too heavy or awkward for a man to hold while standing on scales. An alternative method of weighing was suggested at the start of the survey, but rejected by the technical staff in favour of the method used. Consequently, there were no weights recorded for any breeding bucks, either local or introduced, because they were generally too heavy to weigh by this method. As will be mentioned later, there appeared to be a disproportionate number of female kids born to goats in these herds, suggesting that either some form of post-natal selection and culling of male kids was being made ie male kids were being killed after birth and not recorded.

Typical small-holder farming family with their goats

Selection of farms for analysis of productivity

It was expected that following identification by ear-tagging, all goats born from December 2006 onwards would be recorded. Table 7.2 below shows that dates at which new kid goats and their does were first recorded on project farms in each district, and for those shown, records continued to be collected until the end of the survey in June 2008. This table shows that, with one exception (farm 10 in Ninh Phuoc), there were no kids born which were identified with their does in the period between June 2006 and mid-December 2006 on any farms. Records of does and their kids were first collected on most farms (11/17 or 65%) between January and June 2007, with 3 farms in Binh Thuan only starting records in November 2007, 15 months after the survey started. These kiddings followed the introduction of new Bachthao bucks to each of these farms on 2nd June 2007, resulting in 24 kids from 17 does for farm 2, 4 kids from 3 does from farm 4 and 67 kids from 51 does for farm 9 from November 2007 to June 2008. Poor kidding performance of does on these farms prior to the introduction of the new buck was attributed to the following reasons.

Farm 2. (Bac Binh) This farm had only one mature buck in June 2006, and 19 kids from unidentified does were produced up until February 28 2007. This pattern indicates that no further conceptions from this buck occurred after late September 2006. This buck was sold before the introduction of the new Project buck, as were 7 of the 12 kid bucks from previous kidding. Doe fertility was high (93%) after introduction of the new Bachthao buck, with 16 does kidding from herd of 14 (3 does apparently kidded twice in this period) producing 18 kids (1.1 kids/doe). This data shows an average kidding interval for the does that kidded

twice was 177 days, suggesting that the second conception occurred only 4 weeks after kidding. This aspect of reproduction will also be explored further in data presented later.

Farm 9 (Tuy Phong) There was only one young buck (10 months old) available on this farm for mating at the time of the first survey (June 2006), and was possibly the sire of 11 kids born between June and November 2006, although he would have been only 5 months old when he sired his first kids. A further 4 kids were born to this sire between 5th March and 4th June 2007, after which, this buck was sold and replaced by a new Bachthao buck provided by the Project. However, there can be no certainty from these records that the new buck was the only sire of all kids born after this time (June 2007), because a younger Bachthao buck (born June 2006) was also maintained with the herd and could also have been a sire to some kids. Between June 2006 and June 2007, only 8 of the 34 mature does kidded, producing 11 kids. This is a very low reproductive rate (23%), which was probably caused by poor performance by the local buck. After the introduction of the new Bachthao buck in June 2007, 51 of the 60 mature does (85%) produced 67 kids (1.3 kids/doe), indicating that doe fertility was high and was probably not limiting reproductive performance of goats on this farm. It is interesting that during this 12 month period, no does kidded more than once, and because the first kids in this group were born on 1st November 2007, kidding interval (time between successive kiddings) for these does was at least 7 months. Kidding intervals will be explored in more detail on other farms where kidding data had been recorded for longer periods.

Table 7.2 Dates when newly born kids were first and last recorded on farms in the districts of Ninh Thuan, Binh Thuan and Lam Dong provinces of southeast Vietnam.

Month of Survey	Ninh Thuan			Binh Thuan			Lam Dong
	Ninh Hai	Thuan Bac	Ninh Phuoc	Tuy Phong	Bac Binh	Ham Thuan Bac	Duc Trong
October 2006			3rd, (10)				
November 2006							
December 2006							
January 2007	15th, (17)*	5th, (23)					
February 2007		10th, (19)					
March 2007		15th, (24)					
April 2007		11th, (22)		2nd, (8)	5th, (1)		
May 2007	2nd (16)						20th, (27)
June 2007			10th, (12)		25th, (3)		
July 2007							1st, (25)
August 2007		29th, (21)					
September 2007							
October 2007							
November 2007							
December 2007							
January 2008							
February 2008				4th, (9)	25th, (2)	15th, (4)	
March 2008							
April 2008							
May 2008							
June 2008	4th June	3rd June	6th June	6th June	7th June	8th June	11th June

* Figures in parentheses are the number of the farm involved

Farm 4 (Ham Thuan Bac) When first surveyed in June 2006, there were two mature Bachthao bucks (50 and 28 months old) and 4 weaner bucks (3-6 months old) available as sires. Over the next 12 months, only 3 of the 18 mature does kidded (17%) producing 6 kids (2.0 kids/doe). The new Bachthao buck was introduced in June 2007 by which time both mature bucks and 2 of the 4 weaner bucks had died, but over the next 12 month period, mature doe numbers fell from 14 to 5 due to mortalities from Goat Pox. These mortalities arose because the Goat Pox vaccines had not been kept refrigerated and were subsequently ineffective. In this time, only 4 does kidded producing 4 kids, and little useful data was collected from these records.

Consequently, the above three farms were excluded from further analysis, leaving only 14 farms (9 in Ninh Thuan, 3 in Binh Thuan, 2 in Lam Dong) from which meaningful data was obtained. It was also noted that there was considerable variability between farms within and between districts of each province, and that there seemed to be little merit in attempting to make comparisons between farms in the different districts. The results for farms in each province were therefore combined to give provincial averages, and this data formed the base for discussion and interpretation of the results obtained on herd productivity in each year.

Herd structure and productivity

Table 7.3 shows mean values for the different classes of goats found on farms in Ninh Thuan, Binh Thuan and Lam Dong provinces in 2006/2007 and 2007/2008. These means are derived from the quarterly data collected, and therefore are averages of 4 values in each year. The classes of stock were defined as follows, kids 0-3 months, weaners 3-12 months and any goats older that this were considered mature goats eg females were capable of kidding (conception at 7 months) and males older than 12 months were considered sexually mature and capable of siring kids.. In the first year, only estimates of age were obtained, but during the second year, all birth dates were known, and accurate records of class could be applied.

Table 7.3 Mean values for different classes of goats found on farms in Ninh Thuan, Binh Thuan and Lam Dong provinces in 2006/2007 and 2007/2008.

Class	2006-2007			2007-2008		
	Ninh Thuan	**Binh Thuan**	**Lam Dong**	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**
Herd Structure	*Average number of goats per quarter over each year*					
Mature Bucks	1.4*	0.6	3.7	1.5	1.4	6.1
Mature does	27.6	16.3	24.3	26.7	18.9	27.0
Weaner bucks	1.9	2.3	7.8	3.3	3.0	3.3
Weaner does	11.6	11.2	12.8	6.4	7.9	8.3
Kid Bucks	1.4	2.4	6.2	3.2	2.7	2.8
Kid Does	2.9	5.4	10.2	3.8	3.0	3.3
Goats Sold	1.6	1.2	3.5	3.6	4.0	6.1
Goats dead	1.3	0.8	1.7	2.2	0.8	2.6
Herd Size	49.8	40.3	70.2	50.7	41.8	59.4
% sold annually	9.6	8.9	15.0	28.4	38.2	41.1
% annual mortality	7.8	6.0	7.3	17.4	7.7	17.5

Herd size and composition

Herd sizes varied from 12 (Farm 17, Ninh Thuan) to 117 (Farm 12, Ninh Thuan) goats, with provincial average sizes varying from 42 to 70. Herd size did not change significantly with time, with farmers electing to maintain herd size by selling goats in excess of requirements. Annual sales increased from about 12% of the herd in 2006/2007 to over 38% of the herd in the following year, while average herd size remained about constant. Both male and female goats were being sold, usually young males for meat and older females as breeding stock. Mature does represented, on average, 38-53% of the herd, with weaner does, as replacement stock, representing a further 24% in 2006/2007 and 15% in 2007/2008. Farmers retained only small numbers of weaner bucks in their herds, presumably to grow them to suitable weights for sale as meat. In 2006/2007, there appeared to be disproportionate numbers of male and female kids, that is, less than the expected 50:50 ratio for males and females. Since there is no evidence that these male kids were sold or eaten, it may be assumed that there was greater than usual mortality of male kids from disease, or from either accidental or intentional deaths. It may be usual practice in times of food scarcity to kill male kids in excess of needs, but this conjecture requires confirmation. In the next year (2007/2008), the ratio of male to female kids on most farms was closer to expectation, 53% female, 47% male.

The introduction of disease control programs resulted in low annual mortality rates in the first year (7-9%), and in the second year for farms in Binh Thuan. However, average annual mortalities were much higher in Ninh Thuan and Lam Dong in 2007/2008 due to disease outbreaks on 4 farms in these provinces in this year (Farms 12, 22, 23 in Ninh Thuan, Farm 25 in Lam Dong). In these cases, upto 40% of these herds died because of a lack of vaccine availability, ineffective vaccines or inappropriate administration.

Some examples of hermaphrodism in Vietnamese goats

This increased mortality on all these farms was mainly attributable to goat pox. However it should be noted that mortality rates were lower that the rates of sale indicating that despite some disasters, the profitability of the goat enterprise remained high. The improved productivity also provided not only enough replacement does but also additional does, allowing the expansion of the herds if required.

Incidence of horned and polled (hornless) goats in Bachthao goats

Vietnamese farmers prefer to have polled goats in their herds to avoid injury to other goats and humans. There appears to be some selection pressure applied by farmers to increase the number of polled goats in their herds, and it was of some interest to determine what

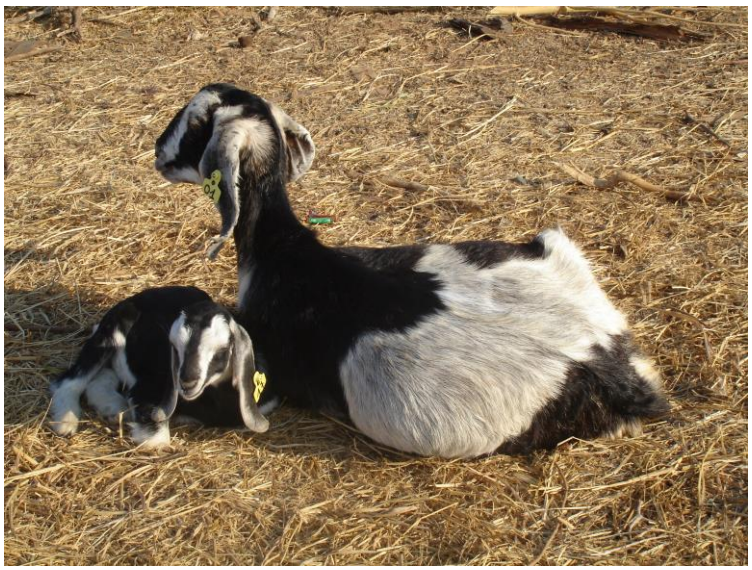
proportion of these herds were polled. Table 7.4 shows the average incidence of hornedness in male and female Bachthao goats found during the study. Unfortunately, records of the presence of horns were only taken at one time at the beginning of the study, and there were few males and no young kids in these samples, and only 25 goats recorded in Lam Dong province. In Ninh Thuan and Binh Thuan, similar proportions of the doe herds were polled (43%), although the limited data from males suggests that this conclusion cannot be also drawn for males. All bucks surveyed in Lam Dong had horns which is possibly related to the fact that here, the predominant breed being used, was the smaller Co native goat, which does not develop the large horns often found in Bachthao goats.

Table 7.4 Incidence of polledness in Bachthao goats in Ninh Thuan, Binh Thuan and Lam Dong Provinces in southeast Vietnam

Province	Males		Females		Total	
	Number	% Horned	Number	% Horned	Number	% Horned
Ninh Thuan (8)*	9	66.7	269	56.9	278	57.2
Binh Thuan (3)	13	46.2	74	56.8	87	55.2
Lam Dong (1)	7	100.0	18	88.9	25	92.0
Totals	29		361		390	
Average		65.5		58.4		59.0

* Number of farms

Polledness in goats has been correlated with infertility in females, and if this were also the case for Bachthao goats, then farmers selecting does (and possibly bucks) for polledness may be also be selecting against fertility.



Polled Bachthao does are preferred to horned goats

Table 7.5 shows that, on average, 44% of all does were polled, which is a high incidence when compared with that found in other goat herds. On most farms, fewer polled does kidded (46%) than horned does (58%), suggesting that polledness may be negatively related to doe fertility. The differences found were larger on some farms than others. For the polled does that did kid, they had fewer kiddings over the 18 month period of observations, with the

Table 7.5 Mean values for the incidence of polledness in Bachthao goats and relationship with doe fertility on 10 farms in Ninh Thuan and Binh Thuan provinces of southeast Vietnam

Province	No. Does	% Horned	% Kidding		Kiddings/period		Kids/doe	
			Horned	Polled	Horned	Polled	Horned	Polled
Ninh Thuan (6)*	230	54.3	57.6	40.0	1.42	1.21	1.33	1.37
Binh Thuan (4)	104	57.7	58.3	52.3	1.43	1.30	1.44	1.40
Average		**55.7**	**57.8**	**46.3**	**1.42**	**1.27**	**1.39**	**1.39**

* Number of farms

figures indicating that while 42% of horned does kidded at least twice in this period, only 27% of polled does kidded more than once in this period. However, there were no significant differences between does in their capacity to produce multiple births, and again, the results show that, on average, 39% of all does kidding produced twins or triplets irrespective of whether they were horned or polled. While it is recognised that the limited data set makes it difficult to draw clear conclusions on this important issue, there is sufficient indication to suggest that this problem needs to be studied in more detail under controlled conditions in these goats. If selecting for polledness is selecting against fertility, farmers need to know the practical significance of this selection, so that do not compromise herd productivity by these practises. Other aspects of female reproduction in these goats will be discussed later in this chapter.

Management and Productivity of males

In June of the first year of the study, most farms had at least one mature breeding buck running with their herd, although there were some significant exceptions to this practice. In Ninh Thuan, 3 of the 9 farms had a breeding buck available in June 2006, while in Binh Thuan, only 1 of the 3 farms had a buck. In Lam Dong, all farms had breeding bucks. In June of the second year, the Project provided a mature Bachthao buck for breeding, on the condition that farmers sold their current breeding bucks. While it is difficult to ascribe any direct benefits from the provision of these new bucks, the continuing presence of a buck in each herd at least ensured that the maximum reproductive potential of the does could be achieved. In the first year of the project, many hermaphrodite and/or intersexes were noted (and culled) suggesting that there was a significant level of inbreeding occurring in some herds. No cases of genital abnormalities were observed in kids sired by introduced bucks.

Age of puberty in males

The usual practice on Vietnamese goat farms is to run bucks continuously with does, or if kept in separate accommodation, to at least allow daily contact with the doe herd. Even if mature bucks are not owned by farmers, the practice of common grazing ensures that does are continually exposed to males, and will conceive when receptive and/or in oestrus. Weaner males as usually maintained in the herd until sale or slaughter which usually occurs when they reach live-weights of 25-30 kg at about 18 months of age. During this time, indiscriminate mating may take place, leading to inbreeding and a general lack of control of either the age at which does conceive or the time at which they kid. This issue will be discussed in more detail later, but it is important to know the age when young bucks reach puberty and are capable of effective mating. Some evidence is presented above for Farm 9 on which one buck appeared reach puberty at 5 months of age, but this observation needs confirmation. Unfortunately, there were no specific studies made of puberty in males in this survey. However, where mature males were continuously available on farms in the first year

of this survey, it is possible to compare the fertility of these local bucks with that of the new Bachthao bucks introduced at the beginning of the second year (June 2007).

Fertility of Bachthao bucks

Information on buck reproductive competence and fertility was difficult to collect in this study. In the first year, most farms had one mature buck, and in some cases, only for part of the year. Clearly, where there is no buck available, there should be no conceptions and kiddings for the does in that herd. However, does often grazed away from the farms each day and had contact with bucks from other herds, or were mated with young weaner bucks which were being grazed with these herds. In some cases, no buck presence was recorded, and yet kids were born on these farms during this first year. Table 7.6 shows kidding data from each province in each year of the study. While no clear general conclusions can be drawn from this data, some trends worthy of further study may be noted. The most comprehensive set of data was collected from farms in Ninh Thuan (194-207 does recorded), and the introduction of a new buck to each farm in June 2007 had a significant effect on doe performance. The table below shows that there was a significant increase in the proportion of does kidding, in the number of kids born and in kids born per doe, when the new buck was introduced to farms in Ninh Thuan. However, there appeared to be no significant effect on reproductive outcome in Binh Thuan and an apparent decreased productivity in Lam Dong when the new bucks were introduced. All farmers were required to sell their breeding bucks before receiving new bucks in June 2007. This situation resulted in no kiddings occurring between June and November, and a peak of kidding 5 months after the introduction of the new buck. This peak of kidding then determined when the next kidding would occur and the monthly patterns of kidding seen in the first year now became more synchronised. In Lam Dong, the decreased number of does kidding was caused by one farmer selling about 20% of his breeding herd and losing another 20% to an outbreak of disease. On this farm, the introduced buck did not appear to be active in January 2008, 6 months after introduction, and no kids were born between June and December 2008.

Table 7.6 Mean values for the kidding performance of Bachthao does between June 2006 to June 2008 in Ninh Thuan, Binh Thuan and Lam Dong provinces

Year of record	Ninh Thuan (9)*		Binh Thuan (3)		Lam Dong (2)		Overall
	Mean	±SE	Mean	±SE	Mean	±SE	Mean
2006/2007							
No. Does Kidding	9.4	2.07	16.3	1.20	31.5	18.50	**14.1**
As % of all Does	43.6	8.66	99.4	2.37	123.3	11.85	**66.9**
No. Kids born	12.8	2.80	23.7	2.60	49.0	33.00	**20.3**
Kids/doe	1.19	0.17	1.44	0.059	1.44	0.205	**1.28**
2007/2008							
No. Does Kidding	19.7	3.48	15.7	2.08	16.5	8.50	**18.4**
As % of all Does	85.5	6.82	82.6	5.41	58.7	5.38	**81.1**
No. Kids born	26.1	4.41	22.7	1.45	24.0	5.77	**25.1**
Kids/doe	1.33	0.039	1.46	0.184	1.56	0.195	**1.39**

***** Number of farms

It may be concluded, with some reservations, that the introduction of new Bachthao bucks improved the kidding performance of does in their herds, and that a high level of fertility was able to be expressed by Bachthao and Co x Bachthao does in these areas.

Management and productivity of females

The effective management of the doe herd is essential for the development of productive and sustainable goat production systems. Health care and disease control are only one part of this management system, it is also important to manage the reproductive capability of the herd. Traditional systems of goat raising in Vietnam encourage continuous mating and kidding in does from an early age, with the apparent intention of maximising the number of kids produced per doe lifetime. One consequence of this practice is that does will conceive as soon as they reach puberty, kid at a very young age and will usually have difficulty or fail to rear this kid. A second consequence will be that kidding will be spread across all months of the year, and often at times when either low feed availability (late dry season) or high rainfall (wet season) limits the survival of the doe and her kids. There are clear advantages for better managing kidding in these environments, but some information is needed on basic data for Bachthao goats in this environment eg age of puberty, existing patterns of kidding and the usual intervals between kiddings.

Bachthao does are capable of high reproductive rates

Table 7.7 Mean, maximum and minimum ages of first kidding for Bachthao does in Ninh Thuan, Binh Thuan and Lam Dong provinces in southeast Vietnam

Measurement	Ninh Thuan (9)*	Binh Thuan (5)	Lam Dong (3)	Mean
	Mean	Mean	Mean	
Mean Age (months)	19.5 ± 0.95	19.5 ± 0.20	18.7 ± 0.23	**19.2**
No. Does recorded	51	58	17	**126**
Maximum Age	24.3 ± 1.24	26.4 ± 0.64	23.8 ± 2.09	**24.9**
Minimum Age	14.8 ± 1.62	12.1 ± 0.40	14.1 ± 2.03	**13.7**
Start Date for records	16/01/2006	15/02/2006	18/02/2006	**6/02/2006**
Date of First Kidding	1/02/2007	7/06/2007	18/03/2007	**30/03/2007**

***** Number of farms

Age at puberty

The ages of all does were recorded during the first interviews with farmers in June 2006, and after that, birth dates of all goats were recorded until the end of the study in June 2008. Only does born in 2006 were considered for the calculation of age of puberty because

these 126 does were directly observed to kid during the study. Older does may have had kids before the study began, but age at first kidding could not be easily discerned. As shown in Table 7.2, the times when does were first clearly identified (by ear-tag) varied between farms, these average times are also shown in the above table. The mean age at first kidding was 19.2 months, with the earliest age being 12-14 months. Since the gestation period in goats is about 5 months (150 days), it may be calculated that these early kidding does must have conceived first at 7-9 months of age. The earliest recorded age found was 11.0 months, or first conception at 6 months of age. There was a significant number of does that did not conceive until 18-20 months of age, that is, kidded first when 24-26 months old. These observations show that young does will generally kid either one or two years after their birth, depending on the availability of a buck. This result suggests that it may be possible to better synchronise kidding on these farms by only allowing bucks access to does for a short period (6-8 weeks) during the year. Under this system, 90% does will conceive in this period, and will kid 5 months later. These kids will then reach sexual maturity 7 months later, and be ready for mating in the next year when all does are mated again. It may be preferable to delay conception in these young does until they are 17 months old, when they are more mature and better able to raise kids. This is the usual practice on modern goat farms in Australia and Europe.

Kidding interval

The frequency of kidding in does will be determined by how long it takes before oestrus recommences and conception occurs after kidding. It is commonly thought that oestrus only commences when milk yields in lactation start to decline, which may be upto 8 weeks in well fed does, or shorter periods in does with shorter lactation periods caused by the loss of a kid or poor nutrition. In the former case, does could theoretically kid again 206 days after their last kidding, or 5 times in 3 years. However, this intensity of kidding is seldom achieved under natural conditions, mainly because environmental and nutritional factors limit the ability of does to meet this potential. Under Vietnamese conditions, bucks are not usually continuously available for mating, adding a further limitation to the achievement of a high

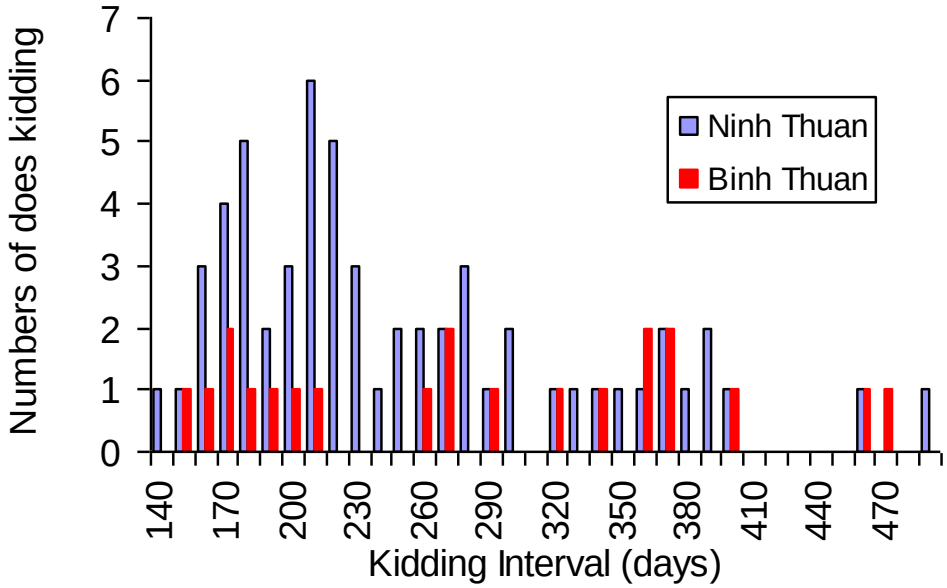
Table 7.8 Mean values for kidding intervals in Bachthao does in Ninh Thuan, Binh Thuan and Lam Dong provinces of southeast Vietnam.

Measurement	Ninh Thuan (9)		Binh Thuan (5)		Lam Dong (2)		Mean
	Mean	SE	Mean	SE	Mean	SE	
Mean Interval (days)	276	18.0	287	38.2	367	17.9	**310**
No. Does	6	0.8	5	1.4	13	4.7	**8**
Maximum	370	26.3	383	69.4	403	5.5	**385**
Minimum	212	15.8	202	24.6	294	22.0	**236**
No. Does kidding	26	3.6	21	1.9	25	13.0	**24**
Period	493	25.0	475	13.9	433	26.0	**467**
% does kidding	25.9	3.4	22.0	6.1	31.4	10.3	**26.4**
Date First Kidding	12/03/2007		18/02/2007		5/04/2007		

frequency of kidding. Table 7.8 shows results from a limited collection of data from the two year study of goat productivity in southeast Vietnam, and while the period of this survey was short, on average, 15 months, and involved measurements on 384 does, longer periods with more animals are required to obtain definitive data on this subject. It was estimated that, on average, only 26% of the does kidding kidded twice in the period of observation, indicating that 74% kidded once or not at all in this period. The significance of this observation will be discussed later. The mean kidding interval was found to be 310 days, but had a wide range.

The kidding intervals for does in Lam Dong were significantly longer (367 days) than those for does in the other two provinces (280 days). However, maximum and minimum kidding intervals were perhaps more interesting than mean values, with an average minimum interval of 207 days for does in Ninh Thuan and Binh Thuan provinces. Figure 7.1 shows the distribution of kidding intervals for these does, with a clear peak of around 210-220 days, and kidding frequencies varying thereafter upto 400 days (13.1 months). On average, 64% of all does kidding twice kidded within 280 days of their last kidding, and were therefore capable of achieving at least 4 kiddings in 3 years.

Figure 7.1 Distribution of kidding frequencies in Bachthao does in Ninh Thuan and Binh Thuan provinces in southeast Vietnam



Fertility in does

Doe fertility is determined by many physiological, environmental and nutritional factors, some of which have been presented previously eg buck presence and fertility (Table 7.6), time of conception after kidding (Table 7.8) and polledness (Table 7.5).

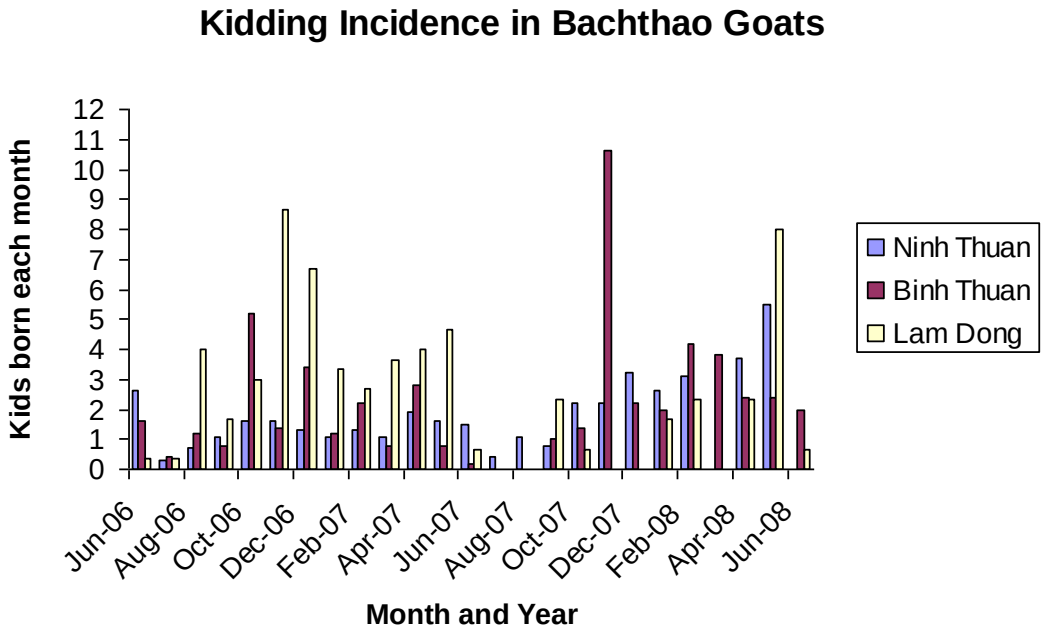
Table 7.9 Mean values for kidding rates in Bachthao does from Ninh Thuan, Binh Thuan and Lam Dong provinces in southeast Vietnam

Measurements	Ninh Thuan	Binh Thuan	Lam Dong	Mean
No. does kidding	216	45	25	286
% Does kidding	85.5	90.4	89.5	88.5
Kids/doe	1.36	1.51	1.36	1.38
% does with singles	65.3	53.3	68.0	63.6
% does with twins	33.3	42.2	28.0	34.3
% does with triplets	1.4	4.4	4.0	2.1

Table 7.9 summarises some of this data, and shows that Bachthao doe fertility is usually high (85-90% of all does conceiving), with approximately 64% of does kidding producing singles,

34% twins and 2% with triplets. This incidence of multiple births is lower that expected, in other goat breeds, single kids are usually born to does at their first kidding, and thereafter these does produce twins or triplets. Where breeding does are kept for 6 years and kid once a year for 5 years, at least 9 kids should be born, giving an expected average output of 1.8 kids/doe. While kidding rates are good for this environment, there is clearly further potential to increase the number of kids born per doe. Multiple births in these goats are not always desirable, and their survival depends on improved levels of management providing disease control and better nutrition for the herd as a whole.

Figure 7.2 The monthly incidence of kidding in Bachthao does over a two year period in Ninh Thuan, Binh Thuan and Lam Dong provinces of southeastern Vietnam



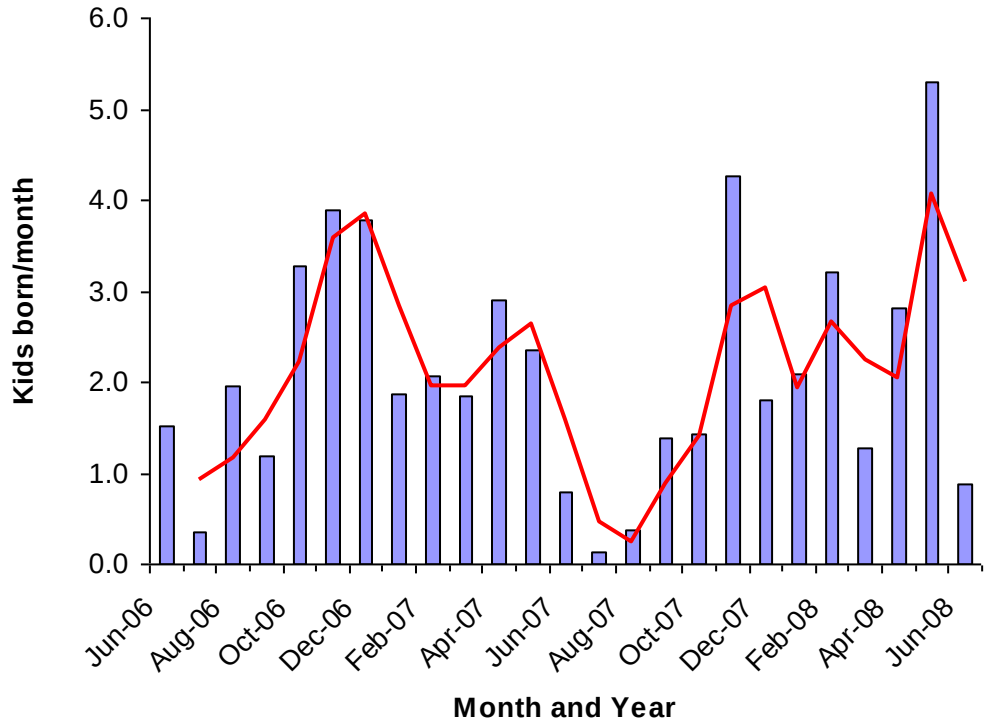
Patterns and frequency of kidding

The timing of conception and kidding in does is often determined by the environment in which they are found. Photoperiod is known to significantly affect fertility in both males and female goats in temperate and sub-tropical regions (greater than 25^{o} latitude north or south), goats in these regions having distinct breeding and non-breeding seasons. Vietnam is located between 9 and 23 ^{o} latitude north, and while the breeding season of goats here is unlikely to be affected by photoperiod, the distinct wet and dry seasons are likely to be related to breeding/non-breeding seasons in these goats. Reproductive activity may be synchronised with season when oestrus activity and ovulation is initiated/stimulated by the onset of the rainy season, ensuring that does will receive good nutrition during pregnancy and early lactation, depending on the length of the wet season. In the south of Vietnam, the monsoon season begins in April-May and lasts until September, when the long dry season sets in. This is an ideal climate for reproduction in goats, with conception in April resulting in kidding in September at the end of the rainy season. Kids born at this time would have at least 3 months of good feed available until December when the dry season begins.

However, inspection of the kidding patterns of does in the present study (Figure 7.2 and 7.3) shows does kidding throughout the year, and even when all data were combined, clear patterns of kidding were difficult to detect. The decline in kidding rates between June and October 2007 is largely the result of farmers selling all their mature bucks prior to the

introduction of new bucks provided by the Project. Similarly, the peak of kidding found in December 2007 (Binh Thuan) is also the outcome of this introduction, although these bucks were not immediately active on all farms, as seen by sporadic kidding patterns over the next six months. The first year is therefore the most representative of the natural kidding patterns found, and there are clear peaks of kidding in October, November and December, with a further minor peak six months later in May. The interpretation of this data is confounded by some does kidding twice in the one year, which, as was described earlier, could theoretically take place 7 months after their last kidding. While it is difficult to determine from the present data whether does kidding in the late dry season (January and February) had difficulty raising their kids, it would be prudent for farmers to ensure that peak kidding occurs at the end of the wet season in October when sufficient feed will be available for the lactating does and their kids.

Figure 7.3 Mean values for combined monthly kiddings of Bachthao does from Ninh Thuan, Binh Thuan and Lam Dong provinces



Live-weight and growth

The mature live-weights of Bachthao bucks and does raised under intensive management at the Goat and Rabbit Research Center have been found to be 60-70 kg and 45-50 kg respectively. A major objective of the current study was to measure the live-weights and live-weight change for all classes of Bachthao goats being raised under improved management conditions on-farm in southeast Vietnam.

Birth weights of single and multiple born kids

All farmers were provided with bathroom scales at the start of the Project, and were required to record the dates of birth, sex and birth type of kid, as well as their weights immediately after birth. The proportions of kids born as singles, twins and triplets was presented earlier (Table 7.9). As expected, single born kids weighed more than twin born, and twins weighed more than triplets. Single and twins were generally heavier in Ninh Thuan and

Binh Thuan than in Lam Dong, the lower kids weights here was related to a higher proportion of the smaller Co goat in these herds. Overall, the ratios of males to females for singles and triplets were as expected, 50:50, but in all provinces, the ratio was 60:40 for females:males. It is suspected that either male kid mortality was higher than female mortality but was not reported by the farmer or that there was an unrecorded culling of males shortly after birth.

Table 7.10 Mean values for the birth weights of single, twin and triplet born kids from does in Ninh Thuan, Binh Thuan and Lam Dong provinces in southeast Vietnam.

		Ninh Thuan	Binh Thuan	Lam Dong	Overall	
Sex	**Parity**	**Birth Weight (kg)**	**Birth weight (kg)**	**Birth Weight (kg)**	**Total**	**Mean Wt**
Male	**Single**	2.19 (74)*	2.25 (8)	1.92 (8)	90	2.12
	Twin	1.88 (56)	2.16 (15)	1.24 (6)	77	1.76
	Triplet	1.48 (5)	1.67 (3)	1.50 (1)	9	1.55
Female	**Single**	2.20 (67)	2.24 (16)	1.76 (9)	92	2.07
	Twin	1.96 (88)	1.96 (23)	1.86 (8)	119	1.93
	Triplet	1.60 (4)	1.73 (3)	1.80 (2)	9	1.71
% Females	**Single**	47.5	66.7	52.9	50.5	
	Twin	61.1	60.5	57.1	60.7	
	Triplet	44.4	50.0	66.7	50.0	

* Values in brackets are number of kids in group

Herd live-weight–age relationships

Live-weights and ages of all goats on all farms were recorded every 3 months, as well as the birth weights of kids born in that quarter. For reporting purposes, all goats younger than 3 months were counted as kids, those aged from 3 to 12 months were counted as weaners and those older than 12 months as mature goats.

There was little information available on the live-weights of mature bucks (older than 12 months) on these farms. As indicated earlier, most farms at the start of the study had either one or no breeding bucks, and young bucks were being sold usually before they reached maturity. Prior to the introduction of new Bachthao bucks in June 2007, all farmers sold any mature bucks they had, as well as, all weaner bucks so that subsequent kiddings could be attributed solely to the activity of the new buck. New Bachthao bucks were introduced to 19 farms in early June 2007. These bucks were estimated to be about 30 months old at the time, and weighed from 57 to 70 kg (61.7 $\pm$ 0.71 kg). It is unfortunate that these bucks were not weighed again during the next 12 months (2007/2008), and it is not known how large they might have grown under local conditions. Table 7.11 shows the mean ages and live-weights of does and their kids in the first two years of the study. The varying ages of goats at each sampling time makes it difficult to describe the normal patterns of growth during these times.

Table 7.11 Mean values for the ages and live-weights of different classes of goats recorded in Ninh Thuan, Binh Thuan and Lam Dong provinces in 2006/2007 and 2007/2008.

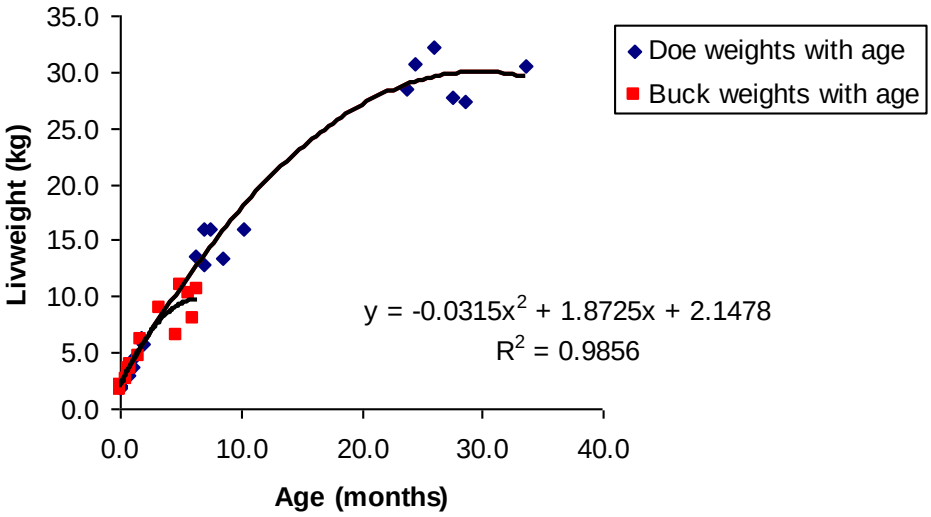
	2006/2007			2007/2008			Overall Means	
Class of Stock	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**	**Ninh Thuan**	**Binh Thuan**	**Lam Dong**	**2006/2007**	**2007/2008**
Does								
Live-weight (kg)	27.4	30.8	28.6	30.6	32.1	27.8	28.9	30.2
Age (months)	28.6	24.4	23.7	33.5	25.9	27.6	25.6	29.0
Weaner Bucks								
Live-weight (kg)	6.5	8.9	10.7	10.2	11.1	8.1	8.7	9.8
Age (months)	4.7	3.3	6.3	5.7	5.1	6.1	4.8	5.6
Weaner Does								
Live-weight (kg)	12.9	16.0	16.1	13.6	15.9	13.4	15.0	14.3
Age (months)	6.8	7.0	10.2	6.3	7.5	8.5	8.0	7.4
Kid Bucks								
Live-weight (kg)	3.6	4.6	6.2	4.0	3.5	2.5	4.8	3.3
Age (months)	0.9	1.5	1.7	0.9	0.6	0.5	1.4	0.7
Kid Does								
Live-weight (kg)	3.7	5.7	6.4	4.7	3.3	3.1	5.3	3.7
Age (months)	1.1	1.9	1.8	1.2	0.7	0.6	1.6	0.8
At birth								
Bucks	2.0	2.1	1.6	2.0	2.1	1.6	1.9	1.9
Does	2.1	2.0	1.8	2.1	2.0	1.8	2.0	2.0

Figure 7.4 shows a plot of the average live-weights and ages of does (birth to 30 months old) and bucks (birth to 6 months). A polynomial equation best fitted this relationship ($r^2 = 0.98$), and is shown in the body of the graph. There were too few accurate data on bucks older that about 6 months (see above), but the relationship for younger bucks closely fitted that found for does. Some estimates of live-weights at different ages predicted from this equation are shown below:

Age months)	**0**	**3**	**6**	**12**	**18**	**24**	**30**
Liveweight (kg)	2.15	7.48	12.25	20.08	25.65	28.94	29.97
Gain (g/d)		54.1	48.3	39.7	28.2	22.5	5.2

It maybe concluded from this table that, firstly, kid growth rates to weaning (3 months) were low, as were the mean live-weights attained at that time (7.5 kg). This data suggests that significant gains in productivity could be made by improving these growth rates, eg better feeding of does, good quality feed for young kids, etc.

Figure 7.4 The relationship between live-weight and age for Bachthao goats raised in Ninh Thuan, Binh Thuan and Lam Dong provinces over the year.



This calculation also shows that Bachthao goats reached marketable weights (27 kg) at about 18 months of age, which agrees with observed practice. The graph above also suggests that does are approaching mature weight at 30 months of age, and that on average, these live-weights are only about 30 kg. However, a larger set of observations, including older and heavier goats, is required to decide this matter more conclusively.

Figure 7.5 Live-weight-age relationship for Bachthao goats from three different farms in Binh Thuan province, southeast Vietnam

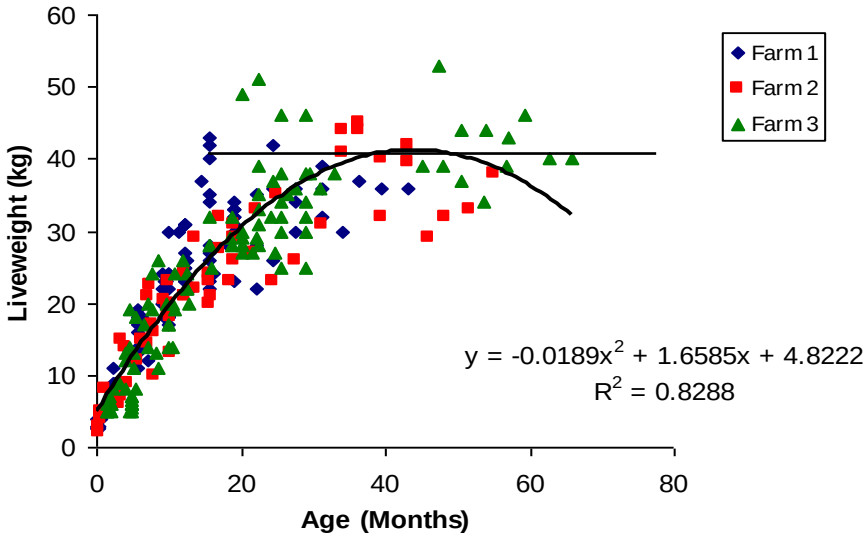


Figure 7.5 shows a comprehensive set of data on the relationship between age and live-weight from three different farms in Binh Thuan province. Goats in this study varied from new born to does over 5 years old, and for goats over 50 kg live-weight. The variability in the data is probably associated with inaccurate estimates of goat ages from farmers. This graph allows some extension of the conclusions from Figure 7.4, it would seem that the goats (mostly does) continue to grow for 3.5 years reaching mature weights of approximately 40 kg. However, on some farms, there were some goats with mature weights of 50 kg, and some

that reached 40 kg at earlier than 3 years of age. These values agree well with the estimates of mature weights Bachthao does at GRRC of 45-50 kg. However, there does appear to be a significant reserve of genetic potential in these Bachthao goats which would allow them to achieve high growth rates, and reach marketable weights earlier than 18 months.

Boer buck introduced to farm 22

Saanen buck given to farm 21

The effects of cross-breeding on live-weights and growth

The major objective of the present study was to characterise and improve the productivity of Bachthao goats on the 27 participating farms. There was a belief that the genetic potential of these locally adapted goats should be fully developed and exploited before introducing any other breeds of goat for cross-breeding. However, it was agreed with three farmers with good management skills that a limited introduction of a new breed could be undertaken. One farmer in Binh Thuan was interested to introduce a Boer buck to his Bachthao herd, and two other farmers wanted to improve milk production by introducing improved Saanen bucks. The Boer buck was selected from the GRRC stud animals and introduced to the farm in May 2006. This buck weighed 54 kg on 8th December 2006, and following its death in June 2006, was replaced by another buck in September 2007. The Saanen bucks were also sourced from GRRC, and were introduced to Farm 21 (Thuan Bac) on 8th December 2006 (54 kg) and to Farm 12 (Ninh Phuoc) on 28th February 2007 (50 kg). Unfortunately these bucks were not weighed again, and it is not know how well they grew under local conditions. While this is a limited sample, the following comparisons were made between 3 farms in Ninh Thuan, Farm 12 (Saanen buck), Farm 22 (Boer buck) and Farm 18 (Bachthao buck). Since all other bucks had been removed, all kids born were only from the introduced bucks. Two aspects of productivity can be examined, firstly the effects of breed of sire on the birth weights and types of kids born, and secondly, effects on the growth rates of these kids until the end of the study in June 2008.

Effects of cross-breeding on kid birth weights and type. Table 7.12 shows mean values for the birth type and weights of kids born from Boer, Saanen and Bachthao sires and Bachthao dams. The only significant differences that seem to exist were that single male Boer x Bachthao kids were significantly heavier at birth that were single male kids from the other breeds. There appeared to be no significant differences between twins from the different cross-breeds. However, larger sample sizes are needed for more meaningful comparisons before any clear conclusions should be drawn.

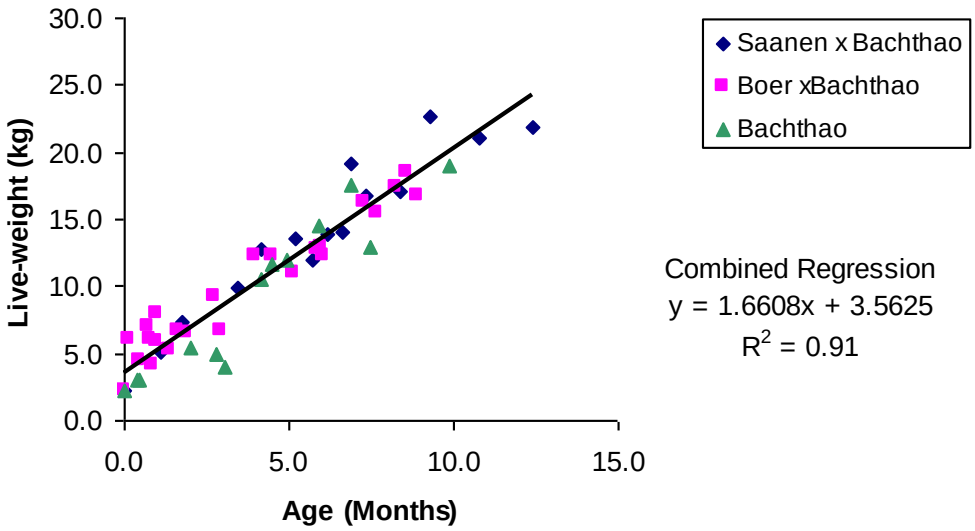
Table 7.12 Mean values for the birth type and weights (kg) of kids from Boer, Saanen and Bachthao sires on farms in Ninh Thuan province in southeast Vietnam

Sex	Parity	Boer		Saanen		Bachthao	
		No.	Birth weight	No.	Birth weight	No.	Birth weight
Male	Single	12	2.78	19	2.16	14	2.18
	Twin	14	2.04	9	2.00	17	1.99
	Triplet	3	1.45	0	0.00	0	0.00
Female	Single	6	2.45	17	2.45	16	2.30
	Twin	20	2.00	9	2.00	23	1.91
	Triplet	3	1.70	0	0.00	0	0.00
% Females	Single	33.3		47.2		53.3	
	Twin	58.8		50.0		57.5	
	Triplet	50.0		0.0		0.0	

Local Bachthao bucks were replaced in June 2007

New Bachthao bucks were given to all farmers

Figure 7.6 Liveweight changes with age in Boer x Bachthao, Saanen x Bachthao and Bachthao goats from 3 different farms in Ninh Thuan province in southeast Vietnam



Effects of cross-breeding on growth rates The kids born from the Boer (58), Saanen (54) and Bachthao (35) sires were weighed at birth and every three months thereafter for a period of about 12 months. Figure 7.6 shows the relation between live-weights and age for kids from the different sires. There were no significant differences between the cross-bred and Bachthao kids in their patterns or extent of growth over this period. In the combined regression shown above, age accounted for 91% of the variation in live-weight, and there was no evidence that the cross-breds from Boer or Saanen sires grew any better (or worse) than those from Bachthao sires. The live-weights of cross-bred kids at different ages was calculated from the individual regressions relating age and live-weight, and are shown below.

Age (months)	Saanen x	Boer x	Bachthao	Combined
0	2.23	2.17	2.16	2.19
3	9.10	8.84	7.39	8.54
6	14.04	13.38	12.94	13.53
12	23.94	22.47	24.03	23.49

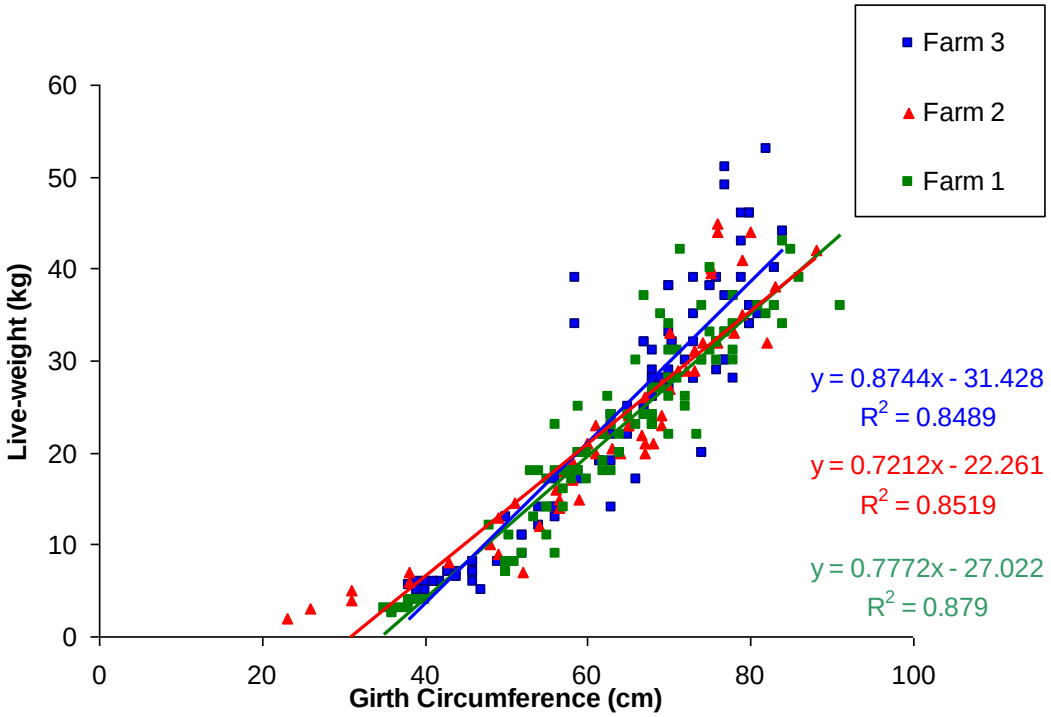
While there does appear to be small differences in live-weights at weaning (3 months), these differences have largely disappeared by the time the kids reach one year old. It was expected that cross-breds would grow at a higher rate than local Bachthao kids because of the high growth potential of the sire, and as a consequence of hybrid vigour. It seems that the high growth potential may be limited by maternal effects, that is, low milk production and poor post-natal nutrition. This result does suggest that there may be little justification for the introduction of new breeds of goats to southeastern Vietnam, since Bachthao goats appear to have sufficient potential to respond in productivity to improved management in this environment.

Relationship between girth circumference and live-weight

Weighing animals is central to all management programs, providing information on not only the well-being of the stock, but also provides quantitative information necessary for the selection and sale of animals. When the current program began, there were no farmers weighing or objectively identifying their goats, and project staff immediately applied ear-tags for identification and bath-room scales for weighing goats at different times in their production life. At this time, it was suggested that perhaps an easier and more rapid estimate of live-weight could be obtained from measuring girth circumference. This technique has proven to be an accurate predictor of live-weight for young growing goats, but less useful for predicting live-weight in mature goats or pregnant does. Measurements of girth, live-weight and age were taken on all goats in December 2006, March, June, September and December 2007. This data has been made available to Vietnamese technical staff to develop measurement techniques for the rapid estimation of live-weight, with the expectation that this technique might be useful for farmers in their management.

Figure 7.7 shows live-weight plotted against girth circumference (girth) for each of three farms, and the individual linear regressions are shown in the text. Girth accounted for from 85 to 88% of the variation in live-weight, but there was still a large amount of variability associated with this relationship, particularly for goats weighing more than about 30 kg. Above this weight, girth was a very poor predictor of live-weight as might be expected, for example, pregnant does will increase in weight without changing girth circumference, horn and fleece growth increase weight without girth as will fat deposits increase weight without frame size.

Figure 7.7 Relationship between live-weight and girth circumference for Bachthao goats of mixed sex and age on three farms in Ninh Thuan province in southeast Vietnam.



When the data used in the above graph are combined, the overall regression is highly significant, but still only accounts for 85% of the variation in live-weight.

$W = 0.802G - 27.7$ RSD $\pm$ 4.601 $R^2 = 0.849$ n=272

where W = Live-weight (kg) and G = girth circumference (cm)

The above observations suggest that girth measurement as a predictor of live-weight will be most useful for use in young goats upto about 25 kg live-weight, and from the variability seen in the measurements taken on three different farms above, it may be relevant to develop equations for each farm. A tape-measure calibrated to read live-weight directly can be developed from the relationships developed between girth and live-weight.

Conclusions

The information collected and presented above is the first comprehansive quantitative study of the biology of the Bachthao goat being raised under traditional management in the southeast provinces of Vietnam. The results of this study need to read in conjunction with the more qualitative information presented in the previous chapters, and then synthesised into a modern management plan for the improvement of goat productivity in Vietnam. It is unfortunate that this study has been only for two years, and that there has been no real opportunity to develop this information into a plan for the future. New information has been found on the reproductive biology of these goats, on kidding patterns in relation to overall herd productivity, birth weights, twinning rates, the effects of polledness on reproduction, outcomes for cross-breeding and the general patterns of live-weight growth from birth to maturity. It is also recognised that many of the conclusions drawn from this data still need confirmation.

There are clear indications that the Bachthao goats in Vietnam are not only well-adapted to the tropical environments in which they are found, but also have a capacity to respond to

improved management conditions, such as better disease control and nutritional management. There is however a need to change the traditional management system to allow these goats the opportunity to fully express their biological potential. For example, uncontrolled breeding leads to does conceiving and kidding at too young an age, and compromises their longer term productivity. It does seem that Bachthao does are able to breed all year in this environment, which leads to kids being born at all times of year, from in the middle of the wet season when disease incidence is high to in the middle of the dry season when feed availability is low and heat stress high. Under these conditions, morbidity and mortality are likely to be high, and productivity compromised. These problems will be discussed and solutions offered in the last chapter of this report.

Chapter 8.

Conclusions and recommendations for future research

Introduction

The Vietnam-Australia Goat Improvement Project set out to, firstly, survey and describe the goat production systems in Ninh Thuan, Binh Thuan provinces of southeast Vietnam, and from this understanding, recommend and apply new and appropriate technologies to overcome the major constraints to goat production in these areas. This process of review, recommendation, application and recording of outcomes has been described in detail in the previous chapters, and where appropriate, conclusions and recommendations have been made on specific issues. Although this project has been judged a resounding success by Vietnamese collaborators, farmers and administrators at the Hoan Cau Conference (November 2008), the time frame of 2 years was really too short to claim any long-term sustainable improvement to goat productivity in these areas. For example, farmer confidence in goat raising is annually tested by rapid changes in the price of goats, and despite improvements in productivity, many farmers will sell all their goats when the prices fall. It is hoped that this response to low prices will change as farmers learn how to prevent or avoid the diseases that cause these violent market fluctuations. It is also recognised that there is no single technology responsible for improved productivity, it is the holistic application of training for farmers and extension staff, strategic control of disease, provision of additional feed resources to improve dry season nutrition and the development of alternative markets for goat products that is the key to success. Project activities in each of these areas have produced some results, taught lessons and provided insights into what needs to be planned for the future. The Vietnamese government is planning for a future expansion of the goat and sheep industries, and have committed funding for the establishment of a Goat and Sheep Research Centre in Ninh Thuan, which will foster this development in the south of Vietnam. The following presentation summarises again the progress made in particular areas of project activity, and makes recommendations for future action which might help ensure a productive and sustainable future for the goat industries of Vietnam. These recommendations may also be helpful for developing policy for and activities of the new research centre in Ninh Thuan province.

Training

The Project has been responsible for training at many different levels, senior management (Advisory Board, visit to Australia), DARD and GRRC extension and technical staff (orientation workshop at GRRC, Advisory Boards, on-farm surveys), participating farmers (on-farm instruction, workshops, Farmers Forum) and non-participant goat farmers (workshops). The final conference at Hoan Cau Resort in Phan Rang, Ninh Thuan in November 2008 provided an opportunity for all above participants as well as senior government officials to learn about the objectives and outcomes of project activities. While the training of DARD staff by the project has proved to be very successful, as demonstrated by their continuing active participation in project implementation, there are too few to effectively service the needs of all farmers interested in improving the productivity of their goat herds. There is an urgent need to train more provincial DARD officers to service these needs, and it is recommended that each Provincial DARD office develop a plan to train more officers in goat and sheep production. The level of this training needs to be higher than that provided to farmers, and it is expected that trained officers will be responsible for developing plans for improving productivity and take-over the conduct of farmer workshops. It is also

important that the model of DARD trainers be developed in other Provincial offices, so that improvements in goat productivity can be extended to farmers in the whole of Vietnam.

Advisory Board and Farmers Forum meeting, Lam Dong 2007

There is also a need to continually review the materials being used for training, and I believe that the emphasis should move away from the promotion of cross-breeding with exotic breeds and concentrate more on strategic management of Bachthao goats which have been shown to respond readily to improved management. The workshops should perhaps focus on firstly, nutrition, reproduction and health, describing the relationship between the biology and practical management of these traits, and secondly on the resources needed to optimise performance and decrease environmental stress under Vietnamese farming conditions. Training should be directed towards providing the farmer with an annual management program which optimises resource use, including the construction of appropriate housing and pasture establishment and conservation. It is expected that the new Centre for Sheep and Goat research in conjunction with local Veterinary Institutes will provide expertise and guidance in developing new programs of training and promoting improved productivity from small ruminants in the south of Vietnam.

Since the first training course, there has been an accumulation of new knowledge on goat production in Vietnam, and this information now needs to be made available to a wider audience of research workers, veterinary officers, extension workers and farmers in Vietnam. This “Goat Farming Technical Manual “ should include information on goat house design and construction, identification, diagnosis and treatment of diseases, nutrition, feeds and feeding systems for goats, including conservation techniques, pasture and pasture establishment for goat farmers, reproduction and breeding in goats, including opportunities for cross-breeding and lastly information on the economics of goat production, marketing and opportunities for product diversification in Vietnamese markets. The current document may form the basis for this book, but it must be compiled in Vietnamese by Vietnamese staff who know best how to focus on those matters of greatest interest and relevance to Vietnamese farmers. This manual should be set at a higher level than the manuals used for farmer workshops, and would be the basis for training the “trainers”.

Disease management and control

There is no doubt that a high incidence of contagious and endemic diseases has severely limited the growth of the goat and sheep industries in Vietnam. Apart from the morbidity and mortality that these diseases cause, the industry is seriously de-stabilised by disease outbreaks which cause farmers to sell their stock at low prices in anticipation that their goats will not be saleable if they are diseased. At the beginning of the Project in 2006, there was a need to decide which diseases were of greatest need of control in the three provinces chosen for project activities. This decision was made more difficult because there was no official records of the occurrence, distribution and significance of any diseases of goats and sheep in these provinces. A survey of farmers in June 2006 attempted to find out what were the most important diseases of goats in selected areas of Ninh Thuan, Binh Thuan and Lam Dong provinces, but the outcome of this survey proved to be less than satisfactory. The problem was that neither the farmers nor local DARD officers could adequately describe in scientific terms the diseases that were affecting their stock. At best, general symptoms were described, and diseases matched to these symptoms by GRRC staff and others. It was for this reason that Project staff decided to provide a broad coverage of the diseases suspected, although goat pox was definitely diagnosed as probably the most serious disease encountered.

Bachthao goats are well adapted to Vietnam and highly productive when managed well.

There remains an urgent need for training both farmers and DARD staff in the detection, diagnosis and treatment of diseases of goats in the south of Vietnam. Even when goats are diagnosed with a contagious disease, there appears to be no official reporting or regulation of animal movement to control it spread to other goats. The usual practice of herds from many different farms grazing the same communal areas also encourages the spread of disease, and discourages farmers from taking responsibility for the health of their own stock. There is also a need for a local diagnostic Veterinary laboratory in each Province which can rapidly analyse and identify animal disease for farmers and DARD officers. There are many diagnostic kits now available which allow the rapid diagnosis of most important animal diseases.

Project staff developed a program of vaccination and treatment based on their 3 monthly visits to each farm, and promoted a fixed routine to control the diseases being treated. In some cases, this routine was not the most appropriate plan for treatment, but in the short time available, was the most expedient technique to ensure complete control. Now that the Project is finished, there is a need to re-evaluate some of these strategies. For example, the goat pox vaccine was not administered to kids (less than 3 months old), and vaccination began at 3 months and thereafter at 6 monthly intervals. This vaccination schedule is likely to be too frequent, and it is suggested that after 2 vaccinations, goats should have sufficient antibodies to last for the remainder of their life. It is also relevant to note that once goat pox is controlled in a herd, and there are no new goats entering the herd, there should be no need to continue to vaccinate adult animals. It is recommended that further research be done on this problem by farmers and DARD staff, specifically investigating the residual effects of a vaccination and how to reduce the number of vaccinations to the minimum required to control the disease in both the individual herd and in the local area. It is also recommended that a program of strategic vaccination against goat pox (and other notifiable diseases) be initiated by Provincial officers creating goat pox free zones where the disease has been eradicated. Goats must be certified disease free before they can move into or through these areas.

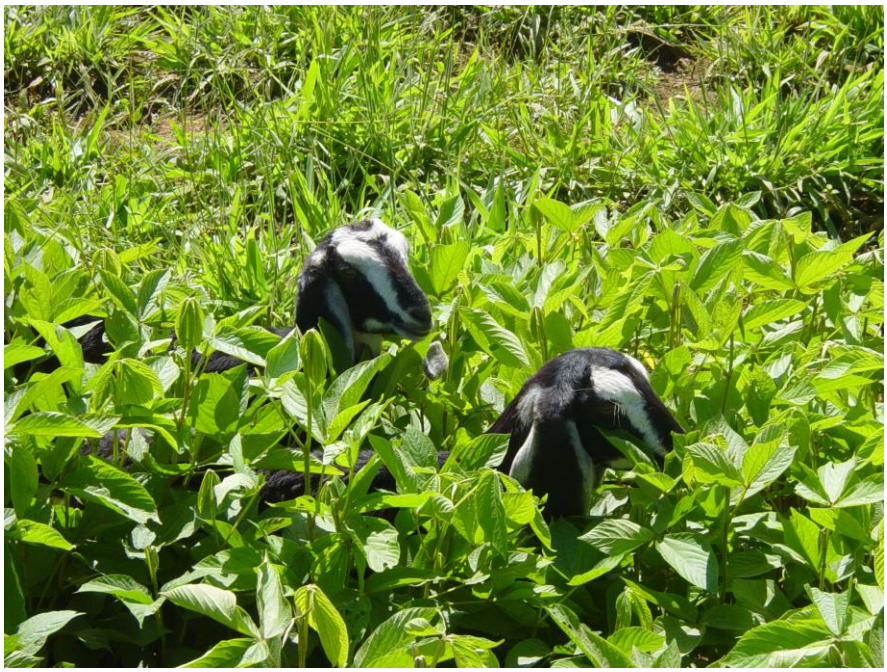
In a similar way, vaccination schedules against Pasteurellosis and Enterotoxemia may also need to be re-evaluated, for example, the area may be free of Pasteurellosis (none diagnosed during the project) and thus vaccination unnecessary. Enterotoxemia usually affects young goats, and vaccination is recommended at 6 weeks of age and again at weaning. There should be no further need to vaccinate these goats for the rest of their lives. Six monthly vaccinations are probably not necessary and uneconomic, but again this practice also needs more research to develop the most effective schedule for each farm.

Intestinal parasites and liver fluke are probably the most common parasites associated with morbidity and mortality of goats in tropical climates like Vietnam. The strategy used by Project staff to control intestinal parasites was to administer Ivermectin to all goats every six months. While this was very effective in most cases, ivermectin treatment alone is not a useful long-term economic strategy. It is well known that the excessive use of ivermectin may lead to resistance in the parasites being treated, and a better technique is to use ivermectin in conjunction with a herd management program to avoid exposure to intestinal parasites. Intestinal parasites thrive in wet environments and can cause significant losses of production if left unchecked. However the strategic use of ivermectin can effectively control these parasites, all should be treated three weeks before the end of the dry season, and again 6 after the wet season begins. This schedule will initially kill all resident parasites in each goat, then kill any new larvae which had developed on the pasture following the start of the rainy season. Again, there is a need for further on-farm research to develop methods of intestinal control appropriate to each area. There is a belief amongst some farmers that traditional medicines are effective in controlling many different diseases of goats, and while it is realised that these treatments are cheap, there is little evidence that any are effective. Farmers should be encouraged to examine these beliefs and to make comparisons for themselves by experimenting and critically testing the efficacy of traditional and proven veterinary medicines for disease control in goats.

Pasture establishment and management

A major focus of the Project was to provide additional feed resources for goats during the long dry season found in these areas, and to this end, small plots of pasture were established

and grown under irrigation during the dry season. Eleven species of grasses and legumes were tested, and included fodder trees, such as Leucaena and Calliandra. The results of these trials have been reported in detail earlier and elsewhere, and do not need to be summarised again here. The success of these plantings depended on the location chosen, farmers attention to weeding during establishment and the management of water. Seedling inundation in the wet season and failure to water in the dry season were the major causes of failures at establishment. In some areas, irrigation was not available throughout the dry season, and and all pastures failed under these circumstances. Where irrigation was available, Leucaena, Stylosanthes sp, and grasses survived well, and formed the basis of productive forage banks. There is a continuing need to develop pastures for the drier areas of Vietnam, some of which have very short growing seasons. Under these conditions, heavily seeding annual grasses and legumes would be a better option that the tropical perennial species chosen for the wetter environments. Annual legume crops, such as Lablab and Pigeon pea, would contribute to soil fertility and provide a crop for both human consumption and forage for animal use. Deep rooted forage trees such as Leucaena would also perform well here once they are well established. One of the problems of establishing pastures in Vietnam was the general lack of appreciation by the farmers of the long term benefits of growing their own animal feed. There are also opportunities to grow forages in rice paddies in the dry season, under tree crops such as coffee and on grazing commons. It is recommended that future research on pastures be extended to the drier areas of Vietnam where the annual forage deficit for grazing ruminants is greatest.



Matching high quality feeds (Flemingia) with greatest need

The most important contribution that the project attempted to make was the introduction of legumes as forages for goats. Most farmers knew about growing grasses, and valued the high productivity of the introduced species and varieties that were being promoted by agricultural officers. Farmers knew less about growing legumes, and it was noticeable that legumes were more often failing at establishment, and even when established had much slower growth rates than grasses. Despite good productivity of Stylo and Leucaena after establishment, farmers still favoured the grasses. Toward the end of the project, new varieties of grasses were introduced to and enthusiastically adopted by farmers, often neglecting the legumes which

were struggling to survive in their pasture plots. The idea that high protein low fibre legumes were being grown to use a supplements to low protein high fibre grasses was not fully developed by project staff or understood by farmers. This concept needs to be better promoted so that farmers will gain a better understanding of the value of their legume forages.

The short term nature of the project did not allow the development of plans for the strategic use of pastures on the project farms surveyed. It was expected that once established, the high quality forages produced would be used for, perhaps grazing with pregnant does in their last month of pregnancy and/or with does with kids in the first 4 weeks after kidding. An ideal use of these pastures would have been to allow young kids held at home to graze these forages when their does are taken out for grazing, and this practice was adopted by one farmer with great success. During the wet season, there is usually sufficient native forage available for grazing off-farm, and it is during this time that pasture forage should be harvested, and either fed directly to does or young kids as described above or conserved as hay or silage for the dry season. Few farmers used their grown forages in this way.

As shown in Chapter 5 on pastures, the wet season in these areas of Vietnam is intense with more than 15 rainy days/month and high humidity for at least 6 months. There is no opportunity to sun dry forages for storages as hay during these times, but it would be possible to cut and store fresh forages as silage during this period. The development of this technology was proposed for action at the beginning of the project (2006), but it was only late in the project that silage making and storage was attempted. In most cases, silage quality was poor because the materials were not chopped fine enough and the conditions of fermentation were not anaerobic. These silages were made from low quality grasses to which was added some fermentable substrate (rice bran, molasses) and were sour-smelling and unpalatable. It had been recommended that green grass (immature) be mixed with young legume leaves (30% by weight) and allowed to ferment anaerobically in plastic bags. There is an urgent need to further develop this technology so that the value of the pastures grown in the wet season can be realised. There are better opportunities for making good quality hay late in the wet season, and the recommendation here is to harvest grass and legume plots about 6 weeks before the wet season ends, and make into silage. These plots should then be harvested at 4-6 weekly intervals until water starts to limit growth. Irrigation could be applied to extend this growing season if needed. The harvested grasses and legumes should be mixed (30% legume), sun-dried and stored in large plastic bags until needed for feeding during the middle and late dry season. Some farmers did make hay during the project, but again this hay was of low quality because the grass was harvested at a mature stage, and no legumes were added. Some farmers also successful harvested dried legume leaf (leucaena, stylo) for feeding as supplements to low quality hay and straw.

Herd management for improved productivity

The traditional way of managing goats in southeast Vietnam has been to run all classes of animals together until individuals are sold or die. The herds are usually taken from their home base each day for grazing, and in the dry season, these grazing areas may be a long distance away. At these times, young kids are kept at home, and graze around the house. Bucks and sick goats may also be kept home in separate house. All goats are housed at night to protect from theft and predators. Supplements and forages harvested from the roadsides are also fed in times of feed shortage during the dry season. Women and children are largely responsible for the day-to-day management of the herd, while breeding and sale is the man's responsibility. Some veterinary medicines are used, but they mostly rely on traditional

medicines of varying efficacy. Does kid all year, and kid mortality rates are often high, particularly during the wet season and at times when the doe is suffering nutritional stress.

The Project identified some strategies which would have an immediate effect on productivity, these being the improvement of housing, the control of disease and the provision of home-grown forages (grasses and legumes) to alleviate nutritional stress. While these strategies were most effective in decreasing mortality and increasing the reproductive rate (kids surviving to weaning), more comprehensive changes need to be made to herd management if these gains in productivity are to be sustained. The changes needed may conflict with some traditional ways of goat management, but are essential if high levels of productivity are to be realized in the longer term.

Individual goats must be uniquely identified to allow a detailed recording of their productivity (inheritance, growth, reproduction) to be made. At the beginning of the Project, it was decided that ear-tags were the best way to identify individual, and a range of sizes was selected for use in kids and larger goats. This exercise proved to be difficult for the technical assistance and some farmers did not want their goats marked in any way. As a consequence, animal identification became a problem every time staff visited a farm, tags often fell out or were chewed, and most farmers were unable re-identify these goats. These problems lead to unreliable data being collected, and is a major problem that must be addressed in any future field studies with goats in Vietnam. If ear-tags are not acceptable, then perhaps neck-tags or sub-cutaneous electronic tags could be used. Livestock identification is a very important way to control animal movement and control disease in many countries, and electronic tagging is now the preferred method of identification. It is strongly recommended that the system of identification be explored for future use in Vietnam, initially in experimental and stud animals, and later in all animals in Vietnam.

Cross-breeding Bachthao with Saanen to improve milk production

Preliminary studies in the Project have suggested that there is little benefit arising from cross-breeding Bachthao does with Boer or Saanen bucks, suggesting that maternal traits (milk

production) are probably limiting any potential improvement that have might come from these exotic bucks. There is evidence that crossing Co goats with Bachthao does have significant advantages, mostly as increases in live-weight and weight gains. However, there have been significant improvements in the productivity of local Bachthao goats by simply controlling disease and preventing in-breeding. Consolidation of this improved productivity should be the first objective of any future activities, and only when maximum productivity by Bachthao goats in this environment has been reached should there be any consideration of introducing exotic breeds.

Does kidding year round are more likely to abort and/or lose their kids if they kid in the middle of the wet season (July) or in the late dry season (March/April). In the first case, high humidity encourages disease and respiratory illness, and in the latter case, low feed availability and nutritional stress will decrease milk production and kid growth. It is a simple matter to manipulate kidding to occur at times when conditions are optimal for doe lactation and kid growth, and the predictable and distinct wet and dry seasons in Vietnam make it easy to decide to best time for does to kid. Mature bucks should be introduced to does for only 6-8 weeks in May and June, at all other times they should be sold or held off-farm A fertile and active buck will inseminate more than 90% of does over a 4-6 week period. When the does kid in October and November (beginning of the dry season), high quality feed would still be available to support good milk production for at least 6 weeks, and for the growth of kid goats until about 3 months of age (weaning February). As the dry season progresses, the requirements of both does and weaner goats will decline, making it easier to match requirements (demand) with supply. Weaner does and kids can be held with the herd until about 7 months of age (puberty May), after which time, the weaner bucks should be held separate to avoid any unwanted pregnancies. A choice needs to be made here about whether weaner does should be mated at the same time as the mature does, if not, they must be isolated from herd when buck is introduced. The schematic plan shown below will focus kidding at one time of the year allowing the accurate planning of annual labour requirements.

Table 8.1 Schedule of events for management of Bachthao goat breeding herd in Binh Thuan

Event	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
		Dry Season					**Wet Season**				**Dry Season**	
Rainy Days	1	0	2	3	11	9	14	15	15	10	7	2
Weaning	☺	☺										
Weaners out*					☺							
Buck in					☺							
Buck out						☺						
Does kid										☺	☺	
Sell goats	☺				☺					☺		

***Doe and buck weaners

This plan requires the removal of all mature breeding bucks, including weaners over 7 months, for most of the year, and the rotational use of selected breeding bucks would suit this plan well. However, once the does are pregnant, there is a period of about 6 months in which they will not conceive again unless they abort. In this case, all doe weaners could again be admitted to the herd after removing the breeder buck, although weaner bucks still pose a threat to weaner does at this time, and still must be kept separate from the herd. Since it is the weaner bucks which are usually sold for meat when they reach about 25 kg, there is a good

case for farmers to build a separate goat house next to fenced pastures where these goats can be exclusively held until sold.

The marketing of goat meat in supermarkets is a significant opportunity for the future

Economics and marketing of goat products

Goats and goat products are in high demand in Vietnam, and contrary to accepted economic theory, as the numbers increase so does the price. However the price does fall when disease epidemics threaten the goat industry, and as described earlier, farmers will sell all their goats at these times, flooding the market, and depressing the prices paid. It should also be noted that price fluctuations at the farm gate are seldom reflected in the high prices paid in restaurants in the large cities. The simple economic fact is that where management is improved, more does raise kids to weaning, and there are more goats for sale. A major impact of the Project has been to allow farmers to both sell more goats and increase their herd size. In a wider context, if this trend flows through to all goat farmers, then perhaps supply and demand market forces will start to act as expected ie increased production will drive down prices. However, in the short term, this greater productivity means better returns to farmers and more profitable enterprises.

There is a need for more information on the marketing of goats. Goat traders seem to visit farmers a various times throughout the year, but we were unable to determine exactly how these traders do their business. Some traders buy goats at about 25 kg, and then have special farms where they feed them to market weight (28 kg). Other traders take the goats directly to restaurants when they are held and slaughtered on demand. There appears to be are no 'wet' markets for goats, that is, places where the public can purchase carcasses and other goat products. Similarly, there are few slaughter houses devoted to goats, so little goat meat appears in supermarkets for sale. However, there is a new slaughter house opening outside Phan Rang in Ninh Thuan province, and the project has supported the purchase of meat processing equipment to help with the development of alternative markets for goat meat. There is an urgent need for more research into the current marketing infrastructure through which goat meat is sold, and on the potential for marketing processed goat products through supermarket chains.

The development and operation of a slaughter house will require a constant source of goats for slaughter and a dedicated outlet and clientele through which to sell. This situation creates the need for co-operative buying schemes from local goat farmers, that is, a guaranteed and continuous source of goats for slaughter. The initiation of such a scheme would have a stabilising effect on the industry, providing a definite market paying a fair price for goats, over a period of time sufficient for profits from goat farming to be re-invested in the industry.
It is hoped that the recommendations made above will stimulate further research and interest in the goat and sheep industries of Vietnam, and that the Vietnam-Australia Goat Improvement Project will be remembered for the impetus it has provided in encouraging the development of the goat and sheep industries in Vietnam.