Dynamics of small ruminant development in Central Java-Indonesia

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Abstract

Small ruminants are an important but neglected resource in developing countries. Small ruminant production systems are complex. The multiple goals related to small ruminants, combined with the complexity of their management, and the resources and social arrangements involved, make small ruminants keeping an enterprise that is inherently difficult to study and to understand. This study analysed the behaviour of small ruminant production systems in order to understand their development prospects in different agro-ecological zones in Central Java, Indonesia. Three districts of Yogyakarta Province, Central Java-Indonesia, were selected to be the research sites, namely Bantul (lowlands), Sleman (middle zone) and Kulon Progo (uplands) districts. The data were gathered by studying literature to obtain primary and secondary data on small ruminant development, interviewing farmers and key persons, group meetings, field observations and monitoring feeding practices, animal performances and marketing strategies, and laboratory analyses on air and water qualities inside and around small ruminant houses. During about one century of small ruminant development in Indonesia, the role of small ruminants has remained more or less the same, whereas major changes occurred in the types of animals kept, in animal numbers and in farmer's management. Driving forces for changes in small ruminant systems have acted at different aggregation levels. The intensification of land use has resulted in major changes in management. In the middle zone and uplands the majority of small ruminants are kept in confinement, whereas in the lowlands small ruminants are mainly kept in a combination of grazing and confinement. Farmers referred to their small ruminants as a saving (tabungan in Javanese) that provides security and helps to accumulate capital, which in turn helps to reduce hunger and buffers against periodic drought. Manure was the second main reason for keeping small ruminants. The supply and demand of sheep and goats fluctuated throughout the year. The demand for and price of small ruminants increased dramatically during the weeks before Idul Adha, the feast of sacrifice. Farmers do not seem to profit from this increased demand. Farmers rarely sell their animals directly on the small ruminant market or to the consumers. The housing of small ruminants close to the family quarters resulted in very high levels of faecal coliform bacteria and total coliform bacteria, two groups of bacteria used as indicators for water contamination caused by manure. It is unlikely that small ruminants will become a main income earner in rural households. If households have sufficient family labour for the management of small ruminants, small ruminants are an appreciated secondary activity. Efforts to improve small ruminant production need to be facilitated by stronger institutions, local empowerment and regulation of access to resources. The local government, scientists, extension workers, and farmers themselves have to work together, because improving small ruminant production means that farmers have access to reliable and affordable support services, offering them access to knowledge and inputs, including credit and marketing information.

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Chapter 1

Introduction

1.1. The role of small ruminants

Small ruminants are an important but neglected resource in developing countries. They are closely linked with the poorest people in pastoral systems and complex crop-livestock systems, and convert low-quality resources to high quality protein (El Aich and Waterhouse, 1999). Small ruminant production is frequently associated with crop production, mainly because of its buffer function for crop failure and crop surpluses (Slingerland, 2000) and as provider of manure (Johnson, 1984). Special advantages of small ruminants over large ruminants include higher production efficiency, easier marketability and lower risks (Soedjana et al., 1988), broader adaptability to different environments, and smaller absolute feed requirements per animal (Peters, 1988). Small ruminants have not benefited from aid programs and development services (Morand-Fehr and Boyazoglu, 1999) and have not influenced policy and decision making (Valdivia, 1999). Government policies are mainly geared to crop and cattle production (Dubeuf et al., 2004; Devendra, 2002). Lack of information on the contribution of small ruminants to rural households is assumed to be one principal reason for the non-recognition of their importance by policy makers and relevant institutions.

Often it is claimed that the potential of small ruminants to reduce poverty is enormous. If the poor can acquire animals, their livestock can help them along a pathway out of poverty (Dossa et al., 2003; Kristjanson et al., 2004; Peacock 2005; Holmann et al., 2005; Saadullah et al., 2005). Other authors, however, stated that this potential capacity of small ruminants to improve livelihoods of the rural poor is not realised (Morand-Fehr and Boyazoglu, 1999; Devendra, 2001).

In Indonesia, small ruminants play an important role for small farmers to increase the economic value of the resources in farmers' hands such as forages and family labour (Satari, 1987). They act as live savings in case farmers have urgent cash requirements (Sarwono et al., 1993; Djoharjani, 1996; Subandriyo, 1998; Budisatria, 2000), have socio-economic relevance and socio-cultural roles (Devendra, 1992), and they produce manure to fertilise the land. Nearly 99% of small ruminants in Indonesia are found with smallholder farmers (Knipscheer et al., 1984; Soedjana, 1993) and the contribution of small ruminants to the total farm income is relatively higher on small farms than on larger farms (Paris, 1992; Soehaji, 1994; Valdivia, 1999). The capability to convert into cash at any time also makes livestock more attractive, this in contrast with crop production which can only be used or sold on or after a fixed point in time (Ifar, 1996). Since 95% of the Indonesians are Moslem, small ruminants play an important role in religious festivities, mainly in *Idul Adha* celebration. This is because each Moslem's family with a higher living standard is obliged to slaughter a sheep or a goat. The farmers also use small

ruminants in undertaking religious pilgrimages, the observance of birth, deaths, marriages and other rituals. For the poor farmers, it is hard if not impossible to slaughter large ruminants for religious celebrations; therefore the availability of small ruminants during that period is important.

Because 70% of the people depend on agriculture for its living, the Indonesian government highly values development of agriculture. In spite of the popularity of small ruminants and all the suggested advantages of small ruminants, little attention has been paid to small ruminant development in Indonesia, either by government or non-government institutions (Knipscheer et al., 1987).

In order to exploit the potential of small ruminants in rural development it is necessary to understand the constraints to, and opportunities for, small ruminant production. This research was conducted in Yogyakarta Province, Central Java-Indonesia. This province is known for the quality of its small ruminants and has different small ruminant management systems.

1.2. Yogyakarta Province

1.2.1. Location

Yogyakarta Province is one of 30 provinces in Indonesia; it lies in Central Java, bordered by the Indonesian ocean to the south and Central Java Province to the northeast, west and northwest (Figure 1). Yogyakarta Province lies between 7.33° - 8.12° south latitude and 110° – 110.50° east longitude and 100 m to 499 m above sea level. Hilly areas can be found in the south, so called Pegunungan Seribu (a thousand mountains) which mostly consist of limestone and therefore are unfertile, while lowlands are situated in the middle of the province. There is only one mountain in Yogyakarta Province, mountain Merapi (2920 meters above sea level), a live volcano, located in the northern part of Yogyakarta Province. The region of Yogyakarta has a unique natural character, i.e. geographically, Yogyakarta lies between Merapi mountain at the north and Indonesian ocean at the south, and topographically, Yogyakarta region declines to the south (Kamulyan, 2005).

1.2.2. Climate

Yogyakarta Province has a tropical climate. The average temperature is 26.1 °C, the maximum is 33.1 °C and the minimum is 21.6 °C. Recorded humidities vary between 22 and 98% (Badan Pusat Statistik, 2000). There are two seasons in the year, the wet and dry season. Usually the wet season begins in October and lasts until April. Average annual rainfall is about 1900 mm. The monthly rainfall is between 3 mm and 496 mm in which those above 300 mm take place during the period January up to April. The heaviest

rainfall usually occurs in February. Generally there is no rainfall from May to August and therefore the atmosphere during these months feels hot during the day and cool in the night and early morning.

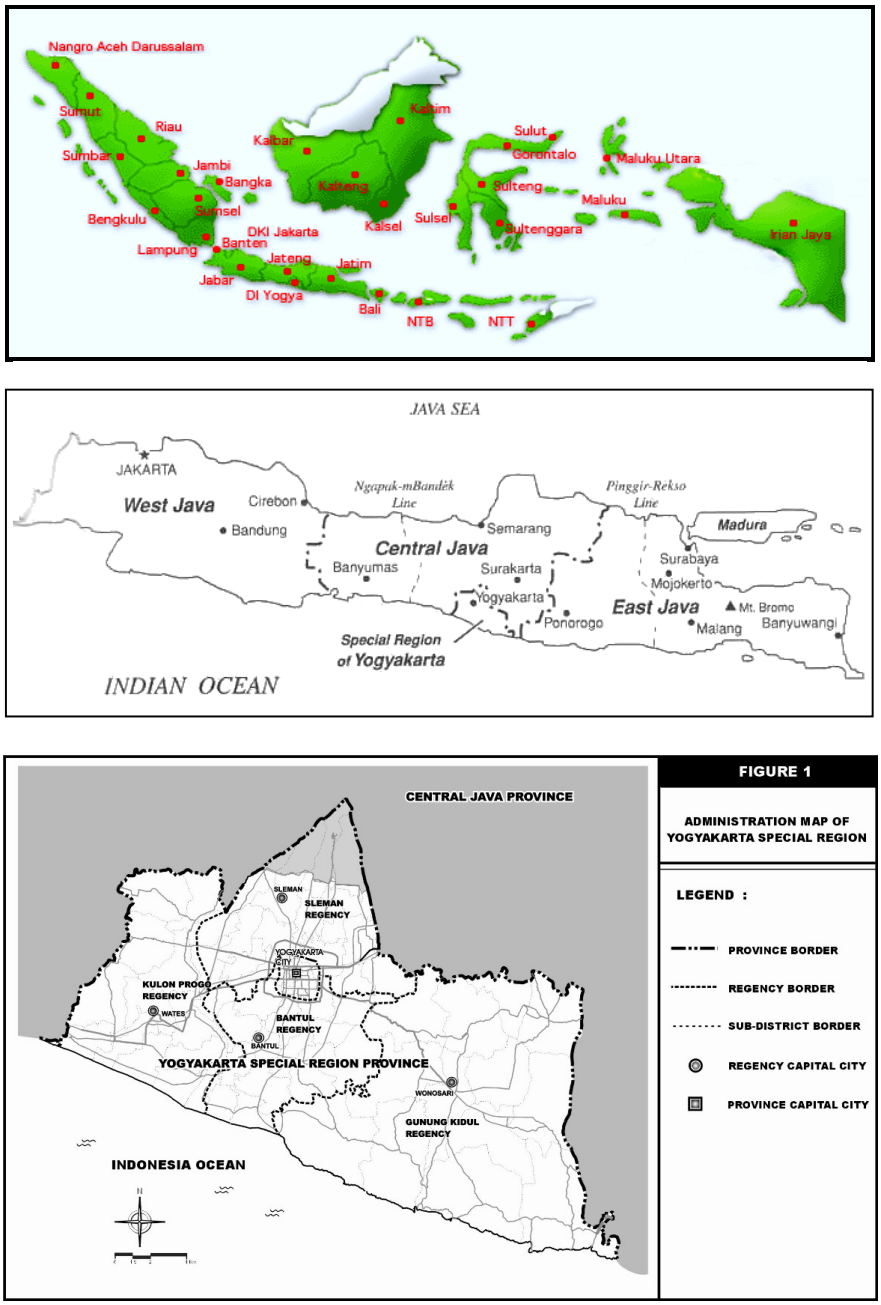

Figure 1
Map of Indonesia, Java Island and Yogyakarta Province with districts (source: PEMDA-DIY, 2005)

1.2.3. Land use and agriculture activities

Yogyakarta Province is the smallest province after Jakarta, and consists of 5 districts (regencies), namely Kulon Progo (586.27 km^2), Bantul (506.85 km^2), Gunungkidul (1485.36 km^2), Sleman (574.82 km^2) and Yogyakarta city (32.50 km^2) (Badan Pusat Statistik, 2000). Three of these districts are selected for the in-depth study of this thesis, namely Bantul (representation of lowlands), Sleman (representation of middle zone) and Kulon Progo (representation of uplands area). The land area of Yogyakarta Province is 318 580 ha, which is used for paddy fields, either irrigated or rain-fed (18.3%), house compounds and surroundings (26.9%), dry-lands (30.7%), water surface (0.2%), fallow lands (0.3%), wood lands (9.7%), agriculture estates (0.5%), state owned forest (5.4%) and others (7.9%).

The main crop produced in Yogyakarta Province is paddy. Table 1 presents the harvested area, yield rate, and production of wetland paddy in Yogyakarta Province from 1997–2004. Apart from paddy, maize, cassava, sweet potatoes, peanuts, soybeans and green peanuts are grown. In 2003, their production accounted around 204 129; 764 409; 7578; 57 767; 35 562 and 563 ton, respectively (PEMDA-DIY, 2005). In 2005 it is predicted that harvested area and production of paddy in Yogyakarta Province will be 134 642 ha and 661 591 ton (BPS-Statistic of Indonesia, 2005). The large harvested area and production during 2004 takes dry-land paddy into account, while the previous data did not. These figures indicate that there is an abundance of crop residues which can be used as a source of livestock feed.

The gross regional domestic product (GRDP) per capita in Yogyakarta Province in 2002 was Rp 5 215 431 and the annual growth rate of GRDP was 3.4%. The livestock sub-sector contributed around 11.7% to the total agricultural sector, while the contribution of the agricultural sector to the total GRDP of Yogyakarta Province was 16.8% (BPS-Statistics of D.I. Yogyakarta, 2005).

Table 1
Harvested area, yield rate, and production of wetland paddy in Yogyakarta Province

Year	Harvested area (ha)	Yield rate (Qt/ha)	Production (ton)
1997	98 046	56.19	550 887
1998	102 027	51.58	526 238
1999	96 189	51.75	497 826
2000	99 519	54.53	542 679
2001	99 150	54.67	542 079
2002	98 049	54.87	537 955
2003	94 629	55.53	525 521
2004*	132 684	52.60	692 968

Source: BPS-Statistics of D.I. Yogyakarta 2005
*BPS-Statistics of Indonesia, 2005

1.2.4. Human population

The population in Yogyakarta Province in 2000 was recorded at 3.12 million (50.4% female and 49.6% male) as shown in Figure 2. The annual growth rate of the population was 0.72% and the population density was 979.2 per km^2. Over 30 years, the population increased around 40%. Forty two percent of the population is living in the rural areas, while 58% is in the urban areas. Compared to the eighties, the number of people living in the rural areas has decreased by almost 50%. The population below the poverty line is around 16 and 21% in the urban and rural areas, respectively. The Indonesian poverty line in both urban and rural areas is defined in terms of the consumption expenditure required to fulfill individual basic food and non-food needs. The food component is defined as the total expenditure required providing 2100 calories of energy per day. The non-food component is defined as the essential expenditure on non-food items, which includes 25 to 27 commodities such as clothing, housing, education, health, and transportation. Based on a socio-economic survey, highest percentages of the population by age group were 15-19 years old (11.4%) and 13.1% was 60 years and older (Badan Pusat Statistik, 2000).

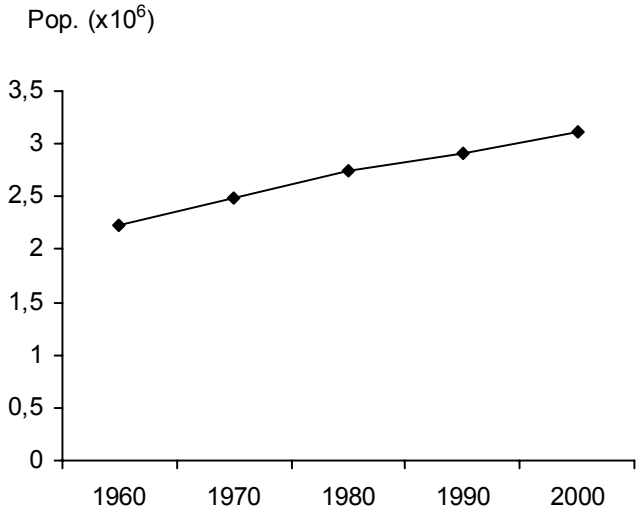

Figure 2
Population increase in the period 1960-2000 in Yogyakarta Province (source: BPS-Statistics of D.I. Yogyakarta, 2005)

Figure 3 gives the number of crop farmer households and livestock households in Yogyakarta Province. The number of crop farmer households was 4 times higher than livestock households. During the last ten years the number of households keeping livestock has remained the same.

Figure 3
Changes in number of crop households and livestock households in Yogyakarta Province over the period 1983-2003 (source: BPS-Statistics of D.I. Yogyakarta, 2005)

1.2.5. Livestock population

The livestock population in Yogyakarta Province from 2000 to 2004 is presented in Table 2. Goats are the most numerous amongst the ruminants followed by beef cattle. The sheep population is about one third of the goat population. Poultry are dominated by broiler chickens: more than 70% of the poultry population, followed by native chickens and commercial layers. The large number of poultry in 2002 was caused by a major increase in the number of broilers in that year.

Table 2
Numbers of livestock in Yogyakarta Province, 2000-2004

	Year				
Livestock	**2000**	**2001**	**2002**	**2003**	**2004***
Beef cattle	206 714	211 889	217 186	224 247	226 489
Goats	266 894	261 958	272 170	241 007	243 417
Sheep	73 600	71 389	73 421	79 174	79 966
Dairy cattle	4069	4454	4917	6645	6977
Buffaloes	6741	5735	5636	5618	5674
Horses	866	1015	929	784	792
Pigs	8317	9576	9924	10 116	10 217
Poultry	18.9×10^6	22.6×10^6	37.3×10^6	22.7×10^6	23.6×10^6

*Preliminary results
Source: BPS-Statistics of D.I. Yogyakarta, 2005

Livestock can easily enter or leave districts or provinces. The highest number of animals coming into Yogyakarta Province was sheep (Table 3). This could be caused by the preference of consumers for sheep to be sacrificed for religious festivities. The large increase in beef cattle coming into Yogyakarta in 2002 is caused by the import of beef

Table 3
Immigration of livestock (head) into Yogyakarta Province, 2000-2004

	Year				
Livestock	**2000**	**2001**	**2002**	**2003**	**2004***
Beef cattle	50	121	19 045	708	715
Goats	29 178	25 580	11 655	10 709	10 816
Sheep	84 330	91 953	89 300	59 112	59 703
Buffaloes	261	453	433	437	441
Horses	1991	1350	1014	1419	1433
Pigs	2 182	3 760	3821	3885	3924

*Preliminary results
Source: DEPTAN, 2005

cattle, especially Australian Commercial Cross (ACC) to be raised by private companies in feedlot systems. The number of pigs entering Yogyakarta Province also tends to increase every year.

Table 4 gives the number of livestock going out of Yogyakarta; unfortunately no data were available during 2003-2004. The highest number of livestock going out of Yogyakarta were goats. This can be explained by the selling of live goats out of Yogyakarta Province. In recent years, two districts in Yogyakarta Province, namely Kulon Progo and Sleman, have been known as breeding area for goats. Farmers in these districts usually sell live kids outside Yogyakarta Province for breeding.

Table 4
Emigration of livestock (head) from Yogyakarta Province, 2000-2004

	Year				
Livestock	**2000**	**2001**	**2002**	**2003**	**2004**
Beef cattle	923	700	29 859	NA	NA
Goats	27 271	51 387	28 679	NA	NA
Sheep	2279	1511	3077	NA	NA
Buffaloes	365	1,488	468	NA	NA
Horses	447	181	119	NA	NA
Pig	3230	2676	4199	NA	NA

NA=Not available
Source: DEPTAN, 2005

Table 5 shows the number of livestock slaughtered in Yogyakarta during 2000-2004. There was a tendency that the number of livestock slaughtered decreased in this period, except for pigs. Sheep and goats seem to have the highest decrease, primarily during 2003-2004. Compared to 2000, the number of sheep being slaughtered during 2004 decreased almost 50%, while goats decreased by 25%. The recorded number of sheep and goats slaughtered could be far less than the actual number, because small ruminants can also legally be slaughtered in the farms and villages. In addition, cooked

Table 5
Registered livestock slaughter (head) 2000-2004

	Year				
Livestock	**2000**	**2001**	**2002**	**2003**	**2004***
Beef cattle	24 121	22 827	22 843	20 732	20 939
Goats	21 749	22 132	23 959	16 211	16 373
Sheep	34 958	27 500	26 239	17 799	17 977
Buffaloes	182	187	117	83	84
Horses	1206	1101	1096	1156	1168
Pig	3848	3804	3662	4285	4328

*Preliminary results
Source: DEPTAN, 2005

meat is also sold by small vendors: "*sate kambing*", an Indonesian delicacy available in restaurants and street stalls. The vendors slaughter animals themselves.

The price of livestock per kilogram live weight varies widely between the species of livestock; the highest priced were beef cattle, while for pigs prices were the lowest. In 2002, the price of beef cattle, goats/sheep, buffaloes, pigs and broilers at the retailers were Rp 16 417; 14 667; 8627; 8500 and 9250 per kg live weight, respectively (DEPTAN, 2005).

1.3. Agro-ecological zones and small ruminants

Agro-ecological zones have a characteristic interrelationship between farming systems and various environmental features, not just climate (White et al., 2001). FAO (1996) defines agro-ecological zones on the basis of combinations of soil, land-use and climatic characteristics. The particular parameters used in the definition focus on the climatic and soil quality requirements of crops and on the management systems under which the crops are grown. Agriculture in Asia shows great diversity in land-use patterns, and in the cropping and livestock systems. This reflects the wide range of physical environments in the region, which differ in such factors as climate, soils, altitude, topography and slope (Devendra and Thomas, 2002).

Sheep and goats can adapt to a remarkably wide ecological spectrum ranging from extremely hot dry and cold dry regions to humid, tropical areas (Peters, 1988). In South and South East Asia, sheep and goats are largely concentrated in the rain-fed lowlands, including the semi-arid and arid agro-ecological zones, and the upland areas in mainly mixed farming situations (Devendra, 2001). Goats are more widespread than sheep throughout the sub-region (Devendra and Thomas, 2002). Goats are often found in areas where there are abundant browsing possibilities, whereas sheep are more used for grazing.

In Indonesia, classification of agro-ecological zones is generally based on altitude. In Yogyakarta Province, three agro-ecological zones are identified: lowlands, middle zone, and uplands. Each zone has a different topography, soil types, soil fertility and agro-climatic conditions. These result in different cropping patterns, land use management, production potential, and consequently feed resources. Lowlands (< 100 m above sea level) are characterised by irrigated paddy mixed with cassava growing. The main component of feed is field grass. The predominant types of livestock are cattle and buffaloes. Farmers use them as draught animals. Middle zones are found at approximately 100 – 500 m asl. In these zones, multiple cropping systems are the main activity in agriculture where the combination between paddy fields and annual crops (maize, groundnut, cassava, vegetables) plays an important role. The populations of small ruminants and large ruminants in this zone are relatively the same. Uplands are found at about > 500 m asl. Here annual crop production systems are found. The main crops are cassava, maize, groundnut and vegetables. Some perennial crops are also available i.e. banana, cacao and coconut. Small ruminants are particularly found in these zones because upland areas do not favour intensive paddy fields (Ivory and Semali, 1987; Sabrani and Levine, 1993).

According to Thahar and Petheram (1983), there are four main systems of livestock management systems, namely: herded systems (full grazing), hand feeding (cut-and-carry feeding), tethered grazing and free-range grazing, moreover, there are many combinations of these practices. In practice, only small proportions of ruminants are kept entirely in herded systems and tethered grazing, due to the limitation of labour availability. So, the common production systems for small ruminants in Indonesia are: 1). cut-and-carry, where forages and other feeds are brought to continuously housed animals, and 2). grazing under tree crops, along roadsides, on temporarily idle croplands and soccer fields.

In Indonesia, Javanese fat-tailed sheep and Etawah-grade goats (Figures 4 and 5) are the predominant types of sheep and goats raised by the farmers. Some farmers also keep Javanese thin-tailed sheep and Kacang goats, the indigenous breeds of sheep and goats. There is no information regarding the exact numbers of each type of sheep and goats in Indonesia.

In all agro-ecological zones both sheep and goats can be found, although preferences of farmers and policy makers for sheep or goats differ between zones. Sheep are said to be suitable for farming systems dominated by rice monoculture in lowland areas, while Etawah-grade goats are said to be more suitable for farming systems in the middle zone and uplands, because of the abundant availability of tree leaves. Kacang goats are kept by farmers in upland limestone areas (Gunung Kidul district), because Kacang goats adapt more easily to these harsh environmental conditions.

Figure 4
Javanese fat-tailed sheep

Figure 5
Etawah-grade goats (*Peranakan Etawah*)

1.4. Research sites

The research sites of this study, Bantul, Sleman and Kulon Progo districts, were chosen because they represent different agro-ecological zones. Each district has a different infrastructure and distance to a market, with Bantul district (lowlands) having

the most favourable infrastructure and it is close to the provincial capital Yogyakarta. The Sleman district (middle zone) is characterised by a long distance to markets but roads are in a relatively good condition; it is a region with many educational institutes; it is also relatively close to the capital. The Kulon Progo district (uplands) has limited access to markets and roads are in a poor condition. The variation in human population density is dependent on the resources available, the distance and ease of access to large urban areas, which influences the availability of off-farm employment and the access to markets (Ifar, 1996). The population density in the Bantul, Sleman and Kulon Progo districts are 1684, 1500 and 633 per km^2, respectively. The livestock infrastructure, such as livestock markets (6 in each district) and abattoirs (1-2 in each district), are relatively similar (Dinas Pertanian DIY, 2004).

Bantul district, at the average height of 100 m above sea level, represents lowlands with a steep southern seashore. The hilly part comprises only 10% of the whole area. The district is a fertile area with large paddy and sugar cane fields, in which agriculture including livestock contribute around 30% of the gross regional domestic product (GRDP). The GRDP per capita was Rp 3 169 446 (Kabupaten Bantul, 2005). In addition, annual crops such as maize, cassava and soybean are also grown. The majority of the land in this district is used for house compounds and surroundings (39.9%), paddy fields, either irrigated or rain-fed (32%), dry-lands (13.4%), wood lands (3.6%), state owned forest (2.1%) and others (9%). The population in 2003 was 796,863; with 19.8% of them under the poverty line and an annual population increase of 0.85%. People are working in five main activities, namely agriculture, trading, industry, services and others, as shown in Figure 6. The unemployment recorded is around 6.6% (Kabupaten Bantul, 2005). The

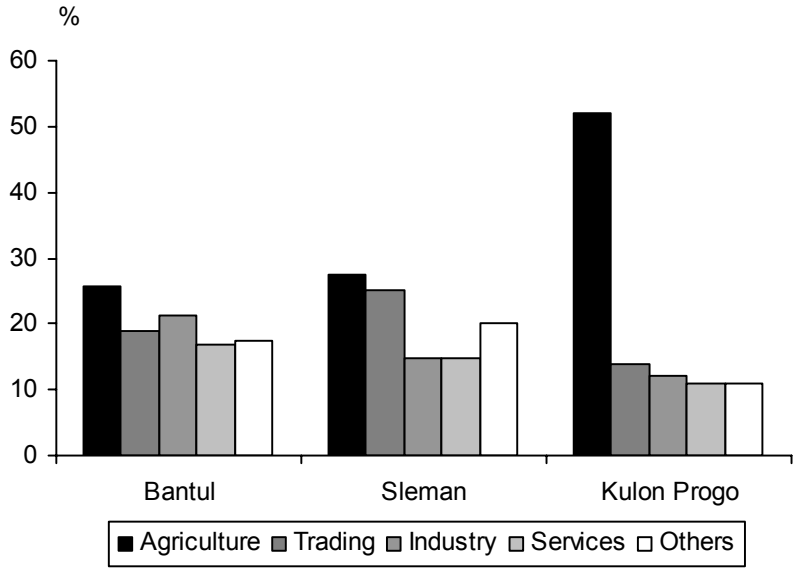

Figure 6
Main job of household heads in Bantul, Sleman and Kulon Progo districts (source: BPS-Statistics of D.I. Yogyakarta, 2005)

predominant types of livestock are cattle. Cattle are well integrated with crop production. Farmers use cattle as draught animals and sources of manure, and cattle utilise crop residues and by-products. Cattle types kept by farmers include Ongole-grade cattle (in Indonesia called *Peranakan Ongole*, PO), Simpo (Simmental-grade) and Limpo (Limousine-grade). The crosses resulted from the artificial insemination programme. Herd sizes are relatively small, 2 to 4 heads, because rearing livestock is secondary to crop production. On average, land possession is around 900 m^2 (Kabupaten Bantul, 2005). Livestock farmers practise grazing on all available grazing areas, largely uncultivated lands including marginal land, roadsides and soccer fields.

Sleman District lies in the Northern part of Yogyakarta, at the foot of Merapi Volcano. The height varies from 140m to 600m above sea level. There are a few villages seated 1200 above sea level. The land is mostly fertile and gets enough water because of the forest on the slope of Mount Merapi. The main food crops are paddy, soybean and peanuts on the black volcanic soils of the lowlands, cassava and maize are grown in the limestone hills. Land use consists of paddy fields (40.7%), dry-lands (11.2%), farmyard (32.7%) and others such as state owned forest, ponds, roads, and soccer fields (15.4%). Paddy fields decrease 0.96% annually. The contribution of the agricultural sector to the GRDP was the smallest compared to the Bantul and Kulon Progo districts, 19.1% from the total GRDP. The GRDP per capita was Rp 4 502 102 (Kabupaten Sleman, 2005). Total population in this district was 862 314; 8.2% of them live under the poverty line. People in Sleman district are working in agriculture, trading, industry, services and in other sectors, as shown in Figure 6. The unemployment recorded was around 5.2%. Rearing small ruminants in combination with cattle is common in this district. The predominant type of cattle is Ongole-grade cattle, other types such as Simpo and Limpo, are also found. Some farmers also keep dairy cattle, the herd sizes are 2-5 head. Land possession varies from 0.1 to 2 ha (Kabupaten Sleman, 2005). Livestock is usually integrated with tropical fruits. Legume trees are grown on the vertical face of terraces in crop-livestock systems.

Kulon Progo district mostly is a hilly area. The Menoreh hill resort lies in the northern part with its average height 573m above sea level. Close to the Southern seashore the height is about 160 m above sea level. The land is quite fertile and suitable for commercial crops. The land-use in this district is dominated by house compounds and surroundings (33.4%), followed by dry-lands (31.3%), irrigation paddy fields (15.5%), wood lands (4.5%), rain-fed paddy fields (3%), state owned forest (1.8%), small amount of ponds (0.03%) and others (not specified) (10.3%). The population in this district was 453 019 in 2004. The annual increase in population is 0.57%, however, during the period of 1990-2000 the growth rate decreased around 4%. In this district more than 40% of the families are living below the poverty line. The majority of people in this district are working in the agricultural sector as shown in Figure 6. This sector contributes around

40% of the total gross regional domestic product (GRDP) and the GRDP per capita was only Rp 969 943 (Kabupaten Kulon Progo, 2005). The unemployment is around 6%. Uplands do not favour irrigated paddy fields. Livestock are integrated with annual crop production and tropical fruit trees. The most prevalent ruminants kept by farmers are goats. A few farmers kept cattle, mostly Ongole-grade cattle in a relatively small herd, on average 2 head. Land possession is around 0.5 ha (PEMDA-DIY, 2005). Farmers integrate their annual crops with legume trees, which function as a fence and provide feed for small ruminants.

1.5. Rationale and objectives

1.5.1. Rationale

The Indonesian government policy has always focused on crop production, while livestock especially small ruminants have been given less attention. The factors that have created such low priority for the livestock sub-sector are the dependence on cropping for food, population pressure, diminutive farm sizes, low incomes gained from agriculture, lack of development capital and the inconsistency in the government planning. Every arable piece of land is used for the production of human food (Thahar and Petheram, 1983; Lefroy et al., 2000; Delve et al., 2001; Hamadeh et al., 2001). Even the dikes between the paddy fields on which formerly grass was allowed to grow, are now used for growing crops such as cassava. These developments have led to a shift in small ruminant production systems from grazing into more intensive (i.e. confinement) systems in the lowlands, and migration of small ruminants to the higher altitude zones which have less intensive farming systems that do not favour intensive crop cultivation.

In many countries common property resources for grazing continue to decline and the dependence on crop residues for animal feed is increasing (Zerbini and Thomas, 2003). This increasing role of crop residues in animal feeding is widely recognised (Savadogo, 2000). As there are alternative uses for crop residues, strategic utilisation of this resource in crop production and animal nutrition is an important factor in order to optimise their efficiency (Preston, 1994). In mixed crop-livestock systems, animals are the weakest component, they have to adjust to the crops more than vice versa (Schiere et al., 2002). The changes in resources, are expected to have a major impact on the development of small ruminant production systems.

Lapar et al. (2003) state that smallholders generally have inadequate capital resources including physical and financial resources, but also intellectual capital resources such as experience, education and extension. Households in rural areas do not usually have access to banking facilities and thus have come to rely on investment in their stock, serving as “current accounts” (Lebbie, 2004). In Java, households like to acquire

livestock at an early stage of household development, however, most households lack the capital to do this (Ifar, 1996).

The availability of markets for livestock products is a key factor and adequate market pricing for livestock products is necessary (de Haan et al., 1996). The demand and price of small ruminants increase dramatically near the religious festivities, for example, around *Idul Fitri* and *Idul Adha* celebrations. Prices drop rapidly when the farmers have urgent cash needs due to lack of staple food, crop failures, preparation of paddy fields, and paying school fees for their children. This usually happens in August-October. So, demand and supply are not balanced. The marketing system of small ruminants involves many actors before small ruminants reach consumers. An understanding of the marketing system of small ruminants is needed to explore the possibilities of farmers to arrange their production system in relation to demand.

In developing countries, the concern regarding the effects of livestock on the environment has not been given much attention, because livestock development programmes are focused on productivity to fulfil the increasing demand of livestock products. In Indonesia, government policies on small ruminant development are also production oriented and no attention is given to their impact on the environment. Schulte (1997), and El Aich and Waterhouse (1999) claim that in tropical countries small ruminants can be a great threat to their immediate environment. Since the Indonesian farmers manage their small ruminants traditionally and in small numbers, the pollution threat might be small, but the closely connected family quarters and ruminant houses could create a pollution problem.

An understanding of the development pathways of small ruminant systems can help to explore the prospects of small ruminant production systems. Such an understanding has to be based on participatory approaches involving all stakeholders. This can help to understand factors affecting the change of production systems and it can be used to improve small ruminant development programmes in the future. It is hypothesised that small ruminants play a different role in different agro-ecological zones in relation to land use, use of resources and contribution to the family's livelihood. The general objective of this study is to analyse the behaviour of small ruminant production systems in order to understand their development prospects in three different agro-ecological zones in Central Java, Indonesia.

1.5.2. Objectives of the study

The first objective of this study was to investigate the dynamics of small ruminant production systems in different agro-ecological zones. Differences in resources, access and allocation, and demand patterns result in different production systems and production goals. Population pressure, increasing human food requirements, government policies,

changes in resource endowment and marketing opportunities are expected to be driving forces for changes in small ruminant production systems.

The second objective was to explore possibilities for sustainable development of small ruminant production in different agro-ecological zones.

The following research questions were thus addressed to achieve the objectives of the study:

1. What are the dynamics of small ruminant production systems in different agro-ecological zones? The specific questions are:
   - what are driving forces for changes in small ruminant systems?
   - what is the role of small ruminants and how do small ruminants contribute to the livelihood of farming households?
   - what are small ruminant performances under traditional management?
   - what is the relationship between supply and demand of small ruminants?
   - what is the impact of housing small ruminants on the environment?
2. What are possibilities for sustainable development of small ruminant production in different agro-ecological zones?

1.6. Outline of the thesis

Chapter one gives information on the role of small ruminants, a general description of the Yogyakarta province and research sites, Bantul (lowlands), Sleman (middle zone) and Kulonprogo (uplands) districts, and the objectives of the study. Chapter two addresses the dynamics of small ruminant production systems in Central Java. This chapter, based on a literature review and interviews, describes the development of small ruminant production from the pre-independence of Indonesia to recent times. In addition, by using the combination between direct interviews and field measurements, this chapter describes the reasons for keeping small ruminants. In chapter three, preferences in keeping either sheep or goats are explained on basis of feeding practices and performances of small ruminants. In chapter four, the marketing of small ruminants is discussed. The impact of small ruminants on the environment is studied in chapter five. In chapter six, the prospects of small ruminant production are discussed using different scenarios. Finally, chapter seven integrates the results in a general discussion on the development and constraints, and the sustainability prospects of small ruminants in Central Java, Indonesia.

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Chapter 2

Dynamics of small ruminant production: case-study in Central Java, Indonesia

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Abstract

Indonesia is a country where small ruminants play an important role in the livelihood of rural people and in religious festivities of the majority of the population. This paper presents driving forces for small ruminant development in Central Java, from both historical and current perspectives. By using participatory rural appraisal techniques, 30 key informants, 150 small ruminant farmers and 71 neighbours that had no small ruminants in three different agro-ecological zones of Yogyakarta Province, namely lowlands, middle zone and uplands, contributed their past and present experiences regarding small ruminants.

The changes in small ruminant systems related to changes in the types of animals kept, in animal numbers and in farmer's management. Farmers themselves replaced the original thin-tailed sheep by fat-tailed sheep, whereas governmental programmes, both before and after independence, promoted the replacement of Kacang goats by Etawah-grade goats. Agro-ecological conditions had a major impact on the type of small ruminants kept and management of animals. The intensification of land use has resulted in major changes in management. In the middle zone and uplands the majority of small ruminants are kept in confinement, whereas in the lowlands small ruminants are mainly kept in a combination of grazing and confinement. Conditions at household level, household members and time available, are major factors determining whether farmers keep small ruminants or not. Both small ruminant farmers and neighbours concluded that the prospects for small ruminants, in particular goats, are most promising in the uplands, due to the possibilities of selling Etawah-grade breeding stock. Only those small ruminant development programmes had impact on small ruminant production systems that took into account the perceptions of the farmers and were adapted to possibilities and constraints at household level.

Keywords: Policies, Agro-ecological zones, Households, Small ruminants, Indonesia.

2.1. Introduction

In developing countries, small ruminant systems are very dynamic. This is reflected in a 68% increase in animal numbers in developing countries in the period 1970-2004 (FAO, 2004), and in a change in management systems because of the pressure on grazing lands. Small ruminant development programmes have, however, rarely been successful, because ecological constraints, and social and economic circumstances of the target groups were not considered (Morand-Fehr and Boyazoglu, 1999; Kosgey et al., 2006).

In South East Asia, Indonesia is an example of a country where small ruminants are typically identified with small farmers; easy to manage, prolific and having a ready market (Soedjana et al., 1988). They also play a key role in Moslem religious festivities. Over the past 35 years the small ruminant population in Indonesia has more than doubled to the present number of 21.6 million animals (DEPTAN, 2005). The management systems are changing in response to the availability of resources. At the start of the introduction of small ruminants in development programmes (around 1920), grazing areas were available for most small ruminant farmers. Robinson (1977) concluded that sheep and goats were fed with no specific crop or forage other than what could be found in the grazing areas. The increase in the human population requires the use of all available land for the production of food. As a consequence, livestock farmers had to change from grazing towards cut-and-carry feeding (Palte, 1989). This process still continues today. Lowland areas have a more favourable infrastructure for agricultural production than higher altitude areas. Consequently, lowland areas have more intensive land use systems than the higher altitude areas. It can be expected that next to agro-ecological conditions, also specific social and economic conditions at household level will have a major impact on small ruminant development.

In order to exploit the potential of small ruminants in rural development, it is necessary to understand the constraints to, and opportunities for, small ruminant production. As a step towards that improved understanding, this paper describes historical and current driving forces for change, at different hierarchical levels, in small ruminant systems in different agro-ecological zones in Yogyakarta Province in Central Java, Indonesia.

2.2. Materials and Methods

2.2.1. Study area

This study was done in three agro-ecological zones of Yogyakarta Province, Indonesia. Yogyakarta Province is situated in the southern part of Central Java and consists of five districts. Three of these districts were chosen as study areas; Bantul

represents lowlands (< 100 m above sea level), Sleman represents middle zone (found at approximately 100 – 500 m asl) and Kulonprogo represents uplands (about > 500 m asl). Each zone has a different infrastructure and distance to markets, with the lowlands having the most favourable infrastructure and the uplands having limited access to markets and roads that are usually in poor condition. The middle zone is characterised by a long distance to markets, but roads are in a relatively good condition. Further differences exist in soil types, soil fertility and agro-climatic conditions. Lowlands are characterised by rice monoculture systems combined with cassava production. The predominant types of livestock are cattle and buffalo. Large ruminants can make use of the abundant amounts of rice straw available in the lowlands. In the middle zone multiple cropping systems are the main agricultural activity with combinations of paddy fields and annual crops (maize, groundnut, cassava, vegetables). The populations of small and large ruminants in this zone are comparable to the lowlands. Uplands are characterised by annual and perennial crops, such as cassava, maize, groundnut, vegetables, bananas and coconuts. In particular goats are found in the uplands.

2.2.2. Data collection

Secondary data on small ruminants from pre-independence up to recent times were obtained from the Animal Husbandry Office and the Agricultural Department of Yogyakarta Province. Participatory approaches were used to collect qualitative and quantitative information on small ruminants in the three agro-ecological zones.

The participatory approaches consisted of interviewing 150 small ruminant farmers and 71 neighbours not keeping small ruminants during the period July 2002 – February 2003, discussions with 30 key persons (older people, the heads of farmers' groups and sub-villages) in February 2003, and a SWOT analysis to structure the perceptions of farmers and key persons on internal Strengths and Weaknesses and external Opportunities and Threats (Watson and Cullis, 1994) in the period July – December 2003. The farmers were selected at random in the three zones. Information on animal management, number of animals, experience in keeping animals, land possession, age, household composition, and household members involved in keeping small ruminants were gathered by interviewing the head of a household. They were also asked about the relative importance of the different motives for keeping small ruminants, like savings, manure or cash income. An inventory of changes in management was made by asking the respondents to compare the present management system with the management system used by their family around the year 1985. The neighbouring farmers were asked about their reasons for not keeping small ruminants, their former experience in keeping small ruminants, and their perception on the future of small ruminants. Ten key persons in each zone were interviewed to gain a better understanding of small ruminant development in each area. The 150 farmers and the key persons were interviewed

individually using a historical time line approach (Watson and Cullis, 1994). A historical time line is a list of key events in the life of the community that helps to identify its past trends, events, problems and achievements. The past experience of both farmers and older people on small ruminant production was linked to specific historical developments in Indonesia. The individual interviews with farmers took on average 3 h, whereas the interviews with neighbours and key persons took about 2 h. In this study, a SWOT was conducted in three stages. Firstly, the key persons were asked to identify the issues of the SWOT. Secondly, these issues were discussed with individual farmers and additional issues were included. Thirdly, the issues of the individual farmers and key persons were discussed in farmers' group discussions, involving 25 farmers in each zone, to reach consensus about the issues and their place in the SWOT. The SWOT information was collected in the second half of 2003, after the period of interviewing farmers and key persons. The SWOT group discussions took about 5 h. The group discussions were rather informal; they were led by the first author of this paper, assisted by undergraduate students.

Quantitative information was analysed using one-way ANOVA analysis with agro-ecological zone as factor. The reasons for keeping small ruminants were analysed by using preference ranking.

2.3. Small ruminants in pre-independent Indonesia

In Java, two native breeds of small ruminants exist, namely Javanese thin-tailed sheep and Kacang goats. These breeds can be described as prolific, with small mature body size (± 25 kg) and well adapted to harsh conditions (Hardjosubroto, 1994). Javanese thin-tailed sheep are usually white and have black patches around the eyes and nose, the tail shows no sign of fat and does not reach the hocks (Mason, 1980). Kacang goats are relatively small with a compact body frame, and have erect ears and short horns in both sexes. Most of the animals are black or brown (Sodiq, 2004).

In the 18th and 19th century, during the Dutch administration there was little interest in sheep or goats (Barwegen, 2005). Private traders imported exotic sheep and goats to introduce bigger and milk producing animals. Arab traders are said to have brought fat-tailed sheep from southwest Asia. As early as 1731 the Government decided to import fat-tailed Kirmani (also known as Baluchi) males from Persia. This decision was repeated in 1754, and in 1779 importers were offered monetary inducements, but there is no evidence that any action was taken (Mason, 1980). It was recorded in 1802 that sheep of the Cape breed were thriving in the vicinity of Batavia (Jakarta) (Mason, 1980). There is no description of these Cape sheep, but it seems likely that they were of the fat-tailed Afrikaander breed from South Africa. During the 1860s there were several imports of Merinos from Australia. These two breeds were crossed with each other and

with the local Garut sheep by sheep breeders around Garut. Fat-tailed sheep became well established in Madura from where they spread into East Java. The crossing of the fat-tailed sheep with the local thin-tailed sheep produced the Javanese fat-tailed sheep.

Other imports of Australian Merinos took place in 1897, 1903 and 1906 and of Romney Marsh in 1912 and 1914 (Mason, 1980). Later, the Texel breed was imported by the Dutch. These importations had hardly any impact.

The Dutch started to import Etawah (Jamnapari) goats from India in 1925 (Supijono, 1970). These goats were crossed with Kacang goats to increase the body size of goats and to introduce milking of goats. Farmers kept the Etawah-grade goats under good management as the price of these goats was relatively high. The government supported this with the *"Pundhutan program"*: the government bought the best goats and distributed them to other farmers. Etawah-grade goats are distinctly different from Kacang goats with a larger body frame, long hanging ears, convex face and larger horns.

During the Dutch colonial period the small ruminant numbers increased from about 130 000 in 1858 to 7 million in 1940. The major increase occurred between 1920, at the start of government interventions in sheep and goat production, and 1940 and coincided with a steep increase in the human population (Barwegen, 2005). The Japanese administration (1942-1945) had a negative effect on the development of small ruminants. The *Pundhutan program* was stopped and the colonial government confiscated animals to be slaughtered without any rewards for the farmers. This resulted in rapidly decreasing numbers of small ruminants.

2.4. Government policies in the post-independent period

The left side of Figure 1 summarises historical events and government policies from independence onwards, with an emphasis on small ruminant development programmes (in italics). The right side of Figure 1 shows the impact of these events and policies on small ruminant development based on farmers' and key persons' experiences.

Following Indonesia's independence in 1945, a government policy to stimulate goat production started again (Supijono, 1970). In 1949, the government launched the *"Gaduhan"* (sharing programme); farmers shared male goats owned by the government. In 1951, the government also started with goat contests. Both these programmes did increase farmers' interest in raising goats. The unstable political situation preceding and following the civil war in 1965 stopped many agricultural development programmes. The discontinuation of the goat development programmes caused a lack of interest of farmers in goats. In the same period high mortality of goats occurred due to eating too many leucaena and kapok leaves. Consequently, many farmers changed their goats for cattle, in particular in the lowland areas. This was supported by a governmental cattle sharing programme.

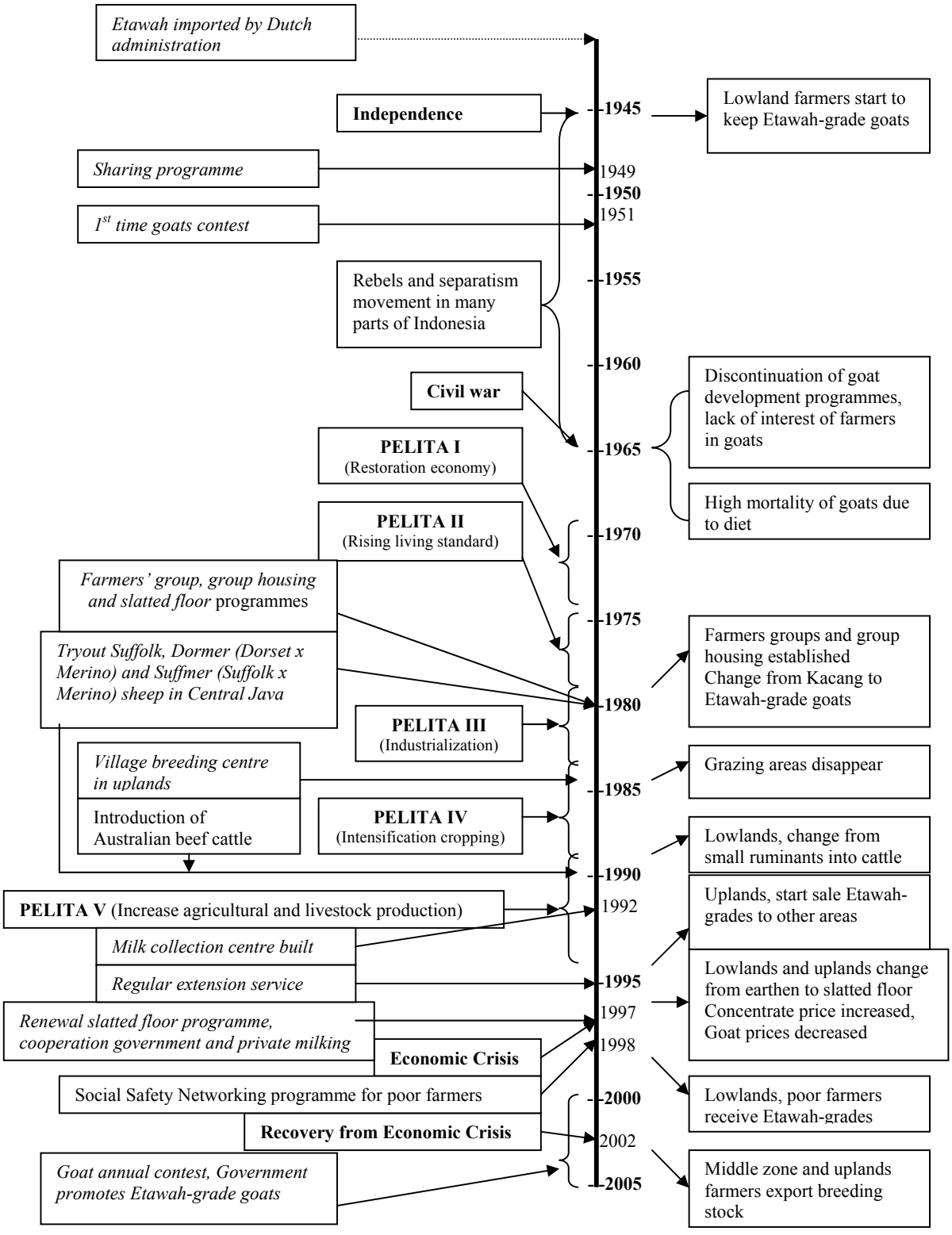

Figure 1
Historical time line of the effects of small ruminant programmes (in italics) and agricultural development in general on small ruminant development in Central Java, Indonesia

From 1969 to 1994, the five-year development programmes (PELITAs) were strongly advocated in Indonesia. Although the farmers were well aware of these development programmes, they said that their small ruminant production was not influenced very much by these programmes. Main emphasis in the development programmes was on crop production and agricultural industries.

In the 1980s, livestock development programmes started again. The government advised the farmers to form farmers' groups. Farmers' groups help farmers to exchange information and experiences on agricultural practices. These farmers' groups have continued up till now. At the same time, the government also introduced small ruminants group housing (*kandang kelompok*), meaning that farmers moved small ruminants from their own compounds to a common small ruminant barn in the village. With this programme, the government hoped that extension services could be intensified, control of the small ruminants' health could be improved, and artificial insemination and pregnancy tests could be conducted regularly. A group small ruminant house is continuously supervised and is expected to prevent threats from outside, such as stealing. Group housing is also expected to minimise pollution, as the houses were planned far away from living quarters. Despite these efforts, the group housing programme has not been successful. In the lowlands, it is very difficult to find adequate land area for group housing. In the uplands, land is not the main bottleneck. Here, group housing projects were established far away from the living quarters of the owners of the animals, consequently farmers could not supervise their small ruminants every day, which made that farmers did not continue with the group housing. In the middle zone local government authorities made land available for group housing projects. People in the middle zone are used to cooperating and farmers like to exchange experiences within their groups. Four group housing projects are still active in the middle zone. In 1980, the government started to promote the use of slatted floors in small ruminant sheds (*Kandang Pangung* program). Farmers can collect the manure under the slatted floor and it is also considered to be more hygienic. In 1997, this programme was renewed. Farmers adopted the slatted floors readily, especially in the lowlands, because farmers very much value the collected manure as fertiliser for their paddy fields (lowlands) and fruit trees (middle zone and uplands).

In the middle of the 1980s, the local government started to promote Etawah-grade goats again; in particular their dual functions: production of meat and milk were considered attractive. Etawah-grade goats are much larger in size (average body weight 40 kg) than Kacang goats (Sodiq, 2004). To increase the Etawah-grade population, the government launched a village-breeding centre in the uplands to produce replacement stock in 1985. In 1990, the government introduced Australian beef cattle and as a consequence some farmers, mainly in the lowlands, changed keeping small ruminants to keeping cattle. In 1992, a milk collection centre was built. This milk centre assists

farmers in selling their surplus milk. In 1997, a cooperation programme between the government and a private milk company started with the aim to process surplus milk. The extension service has provided intensive training to the farmers on the importance of goat milk and milk processing. There has, however, been little progress in goat milking.

The Economic crisis of 1997 increased the concentrate feed prices and decreased small ruminants prices. In 1998 the government launched the Social Safety Networking programme to help poor farmers who suffered from the crisis. As a part of this programme, poor farmers in the lowlands received Etawah-grade goats. The governmental support for goat production in Central Java has continued in the 21st century. Public institutions are involved in extension, performance monitoring and in annual contests for Etawah-grade goats.

There have hardly been any specific development programmes on sheep. During the 1980s, the policy in Central Java was to try out the Suffolk, Dormer (Dorset x Merino) and Suffmer (Suffolk x Merino). This was not successful.

2.5. Changes in types of small ruminants, management and animal numbers

The timeline (Figure 1) indicates that over the years, small ruminant types and management systems changed. At the start of independence, most farmers in the lowlands changed their sheep for goats. In the 1970s some changed back to sheep, due to the intensification of land use. Sheep are considered to be more suitable than goats to graze marginal grazing sites (road sides, soccer fields, harvested plots). Farmers have changed their thin-tailed sheep for fat-tailed sheep, which are now the dominant type of sheep. Major motives for this change have been the larger body size of fat-tailed sheep and the preference of consumers for meat of fat-tailed sheep and of the tail in particular (Mason, 1980). The promotion of Etawah-grade goats made them the dominant type of goat. The uplands, and recently also the middle zone, of Central Java have become well-known breeding areas for Etawah-grades. In 2002, farmers in the middle zones and uplands had an opportunity to export breeding stock of Etawah-grade goats. In the lowland areas, Etawah-grade goats are crossed again with Kacang goats resulting in so-called Bligon goats. Bligon goats have a smaller body size and shorter ears than Etawah-grade goats.

Figure 2 presents the changes in the sheep and goat populations over the period 1970-2003. In the lowlands the sheep population has decreased from 1980 onwards. The number of goats decreased from 1970-1980, thereafter the number of goats gradually increased until the Asian economic crisis in 1997. In the middle zone, the number of goats gradually increased from 1985 to 2000. In the uplands, there was a sharp increase in the number of goats from 1970 to 1990. Thereafter it dropped again. This drop started long before the Asian economic crisis. It coincided with the decrease in human population in the 1990s in the uplands (annual growth rate -0.04%, from 1990–2000 vs

an annual increase of 1.2% in the lowlands and 1.5% in the middle zone in the same period) (BPS-Statistics of D.I. Yogyakarta, 2005). The introduction of Australian beef cattle could also be considered a factor affecting the decrease of small ruminant numbers in the 1990s. From 2000 onward Indonesia has recovered from the Asian economic crisis and the small ruminant populations in the different agro-ecological zones have increased again, except for sheep in the uplands.

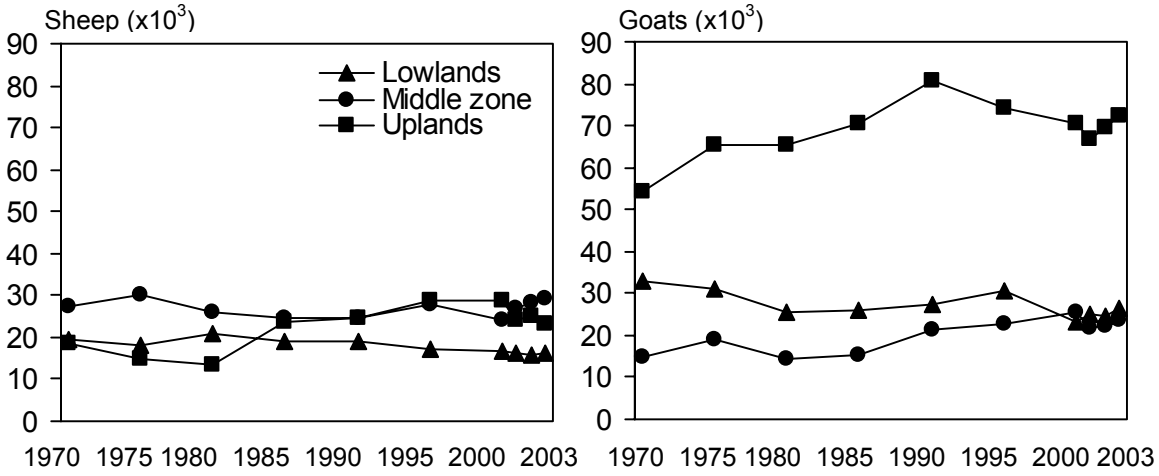

Figure 2
Sheep and goat populations in Central Java, Indonesia from 1970 to 2003 (source: BPS-Statistics of D.I. Yogyakarta, 2005)

Figure 3 presents the changes in small ruminant management systems between 1985 and 2003. In 2003, the interviewed farmers in the lowlands tended to keep small ruminants in a combination of grazing and confinement, whereas more than 70% of the interviewed farmers in the middle zone and in the uplands kept small ruminants in confinement. In the lowlands, middle zone and uplands 40%, 16% and 28% of the households respectively had changed their management system in this period. The main reasons for these changes were the limited availability of household members for working with small ruminants (for 50%, 25% and 50% in the households that had changed their management system for the lowlands, middle zone and uplands respectively), declining grazing areas (30%, 37.5% and 25% in the lowlands, middle zone and uplands respectively) and less time available (20%, 37.5% and 25% in the lowlands, middle zone and uplands respectively).

The changes in floor types are shown in Figure 4. In the lowlands and uplands in 2003 almost 70% of the interviewed farmers used a slatted floor, while in the middle zone 40% used slatted floors. In 1985, only about 20% of the households used slatted floors. Farmers in the middle zone had different perceptions of slatted floors than farmers

in the other zones. In the lowlands and uplands bamboo sticks were used as slats, whereas farmers in the middle zone had group houses, with good quality timber and concrete slats, as examples. Thus, middle zone farmers were rather reluctant to use slatted floors, because of the perceived costs of a slatted floor and their fear for lameness in their animals.

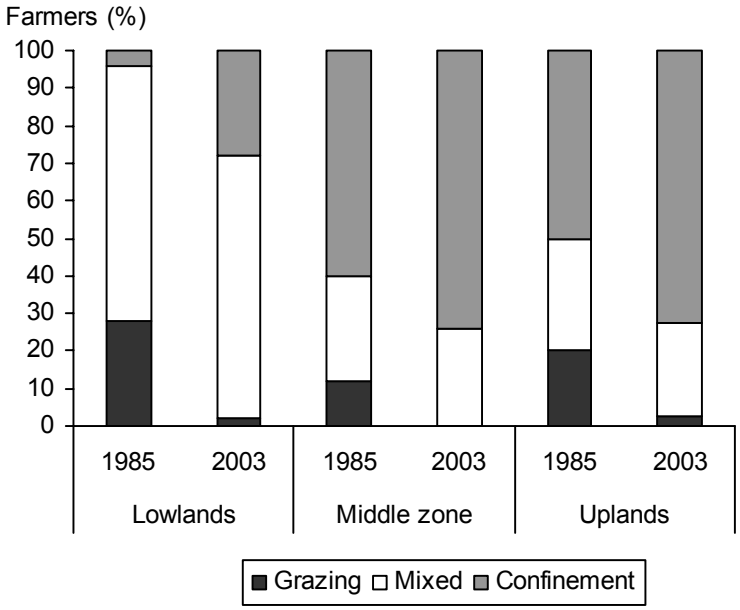

Figure 3
Small ruminant production systems in 1985 and 2003 in three agro-ecological zones in Central Java, Indonesia

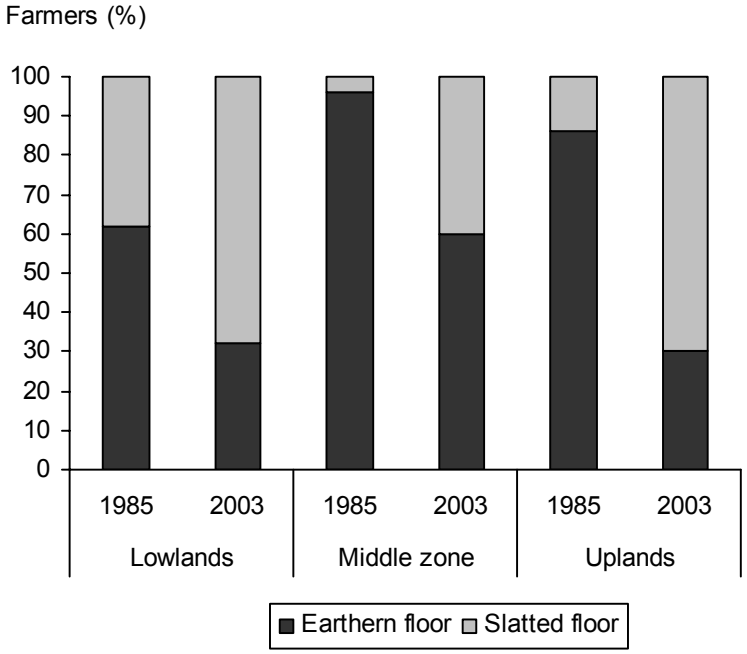

Figure 4
Floor type of housing in 1985 and 2003 in three agro-ecological zones in Central Java, Indonesia

2.6. Current small ruminant production

Table 1 presents the Strengths, Weaknesses, Opportunities and Threats (SWOT) of small ruminants in different agro-ecological zones. High prolificacy of small ruminants and high quality of manure were considered to be the main strengths of small ruminants in all zones. Abundance of forage is a strength in the middle zone and uplands. In the uplands the quality of the Etawah-grade goats are seen as a major strength, which gives them the opportunity of selling breeding stock to other areas in and even outside Indonesia. The main weakness in all zones is susceptibility of small ruminants to diseases, such as scabies, bloat, and poisoning because of too many leucaena and kapok leaves in the diet. Feed shortage, traditional management and lack of household labour were considered weaknesses in the lowlands. Easiness to sell and stable prices of small ruminants were seen as opportunities. In the lowlands sheep are easy to sell because of the demand for sheep during important Moslem festivities. Regular extension services were seen as an opportunity in the middle zone and upland areas. Capital access (credit from banks or government) was an opportunity in the lowlands and uplands, whereas this was a threat in the middle zone, because the farmers here had no possibility of obtaining formal credit. In the lowlands, stealing was the main threat for small ruminants, while in the middle zone and uplands it was the competition in selling Etawah-grade kids with farmers in other areas.

Table 1
Strengths, Weakness, Opportunities, and Threats of small ruminants in three agro-ecological zones, Central Java, Indonesia

	Lowlands	**Middle zone**	**Uplands**
Strengths	Prolific breeds Good quality of manure	Prolific breeds Good quality of manure Abundance of forage	Prolific breeds Good quality of manure Abundance of forage Demand for Etawah
Weaknesses	Susceptibility to diseases Feed shortage Traditional management Lack of household labour	Susceptibility to diseases	Susceptibility to diseases
Opportunities	Easy to sell Access to credit	Stable prices Regular extension advice	Easy to sell outside Java Access to credit Regular extension advice
Threats	Stealing	Competition with other areas in selling kids Limited access to credit	Competition with other areas in selling kids

Table 2 presents farm household characteristics, flock sizes, and reasons for keeping small ruminants. The average age of the small ruminant farmers was about 50

years. It varied widely: from 30 up to 90 years. Land owned by the farmers with small ruminants was significantly different (P<0.05) between the zones: lowland farmers possessed the smallest area of land, whereas upland farmers had the largest area of land. Small ruminant farmers in the middle zone and uplands had, on average 25 years of experience in keeping small ruminants, whereas lowland small ruminant farmers had only 10 years of experience (P<0.05). Lowland small ruminant farmers also had significantly fewer animals than upland farmers (P<0.05).

Table 2
Characteristics of small ruminant farmers and reasons for keeping small ruminants in three agro-ecological zones in Central Java, Indonesia

	Lowlands	**Middle zone**	**Uplands**
Number of farmers *(n)*	50	50	50
Farmers age *(y)*	$50.9^{a} \pm 2.00$	$54.8^{a} \pm 1.90$	$50.4^{a} \pm 2.20$
Land owned *(ha)*	$0.17^{a} \pm 0.03$	$0.31^{b} \pm 0.04$	$0.59^{c} \pm 0.08$
Experience in keeping small ruminants *(y)*	$10.2^{a} \pm 0.90$	$24.3^{b} \pm 1.60$	$25.0^{b} \pm 1.20$
Number of small ruminants per household *(n)*	$4.1^{a} \pm 0.30$	$5.1^{ab} \pm 0.30$	$6.0^{b} \pm 0.50$
Household size *(n)*	$4.1^{a} \pm 1.70$	$3.8^{a} \pm 0.90$	$4.3^{a} \pm 1.10$
Households members involved in small ruminants *(n)*	$2.0^{a} \pm 0.80$	$2.6^{b} \pm 0.60$	$2.1^{a} \pm 0.70$
Time spent *(h d^{-1})*	$3.5^{a} \pm 0.2$	$3.7^{a} \pm 0.1$	$4.2^{a} \pm 0.1$
Father	$2.0^{a} \pm 0.2$	$1.4^{a} \pm 0.2$	$2.4^{a} \pm 0.2$
Mother	$1.1^{a} \pm 0.2$	$1.2^{a} \pm 0.7$	$1.4^{a} \pm 0.2$
Child	$0.3^{a} \pm 0.1$	$1.1^{b} \pm 0.4$	$0.4^{a} \pm 0.2$
Others	0.1	0	0
Reason for keeping small ruminants *(Mean rankings[1])*:			
Saving	$2.9^{a} \pm 0.04$	$2.7^{a} \pm 0.07$	$2.8^{a} \pm 0.07$
Manure	$1.8^{a} \pm 0.07$	$1.5^{b} \pm 0.07$	$1.9^{a} \pm 0.10$
Cash income	$1.2^{a} \pm 0.08$	$1.8^{b} \pm 0.10$	$1.4^{a} \pm 0.10$

[1]Ranking: 1 = less important, … 3 = most important
[a,b]Different superscripts denote significant differences between means within rows (P<0.05)

In the lowlands and uplands about half of the household members were involved in small ruminant activities; in the middle zone, this was about 70% (P<0.05). In the middle zone, children were more involved in small ruminant management than in the other zones. The total hours per day available for small ruminants varied from 3.5 (lowlands with 4.1 animals) to 4.2 (uplands with 6.0 animals). Fathers were mostly involved in daily management of small ruminants, feed collection and marketing, while cleaning the houses was the responsibility of the mother. Children did not have a special job; their involvement depended on their time available.

Keeping small ruminants for savings, which is a kind of insurance against foreseen and unforeseen events, was the main reason for keeping small ruminants in all three agro-ecological zones. Manure was the second most important reason for keeping small ruminants in the lowlands and the uplands. In the middle zone cash income was

significantly ($P<0.05$) more important than in the lowlands and uplands, maybe because the middle zone has recently become an important area for the selling of Etawah-grade breeding stock.

Table 3 presents the household characteristics and perceptions of small ruminant production of neighbours without small ruminants. The main reasons of the neighbours for not keeping small ruminants were lack of capital, insufficient household labour available and insufficient time available because the head of the household had another main activity. Only a few neighbours were not interested in small ruminants. The average number of household members of small ruminant farmers and neighbours was almost the same: 4 and 3.7 respectively. Most of the neighbours had experience in keeping small ruminants. Neighbours had less land than the small ruminant farmers, in particular in the uplands (0.2 ha vs 0.6 ha for small ruminant farmers). Nevertheless, land shortage was not often mentioned as a reason for not keeping small ruminants.

Table 3
Characteristics of neighbours with or without previous experience with small ruminants, and their perception of small ruminant production in three different agro-ecological zones, Central Java, Indonesia

	Lowlands		**Middle zone**		**Uplands**	
Experience	**Yes[1]**	**No[2]**	**Yes**	**No**	**Yes**	**No**
Neighbours *(n)*	16	7	14	12	18	4
Age *(y)*	51.6 ± 3.3	42.3 ± 4.9	51.1 ± 4.9	56.3 ± 5.3	53.2 ± 3.1	42.0 ± 6.5
Land owned *(ha)*	0.12 ± 0.04	0.10 ± 0.06	0.25 ± 0.06	0.20 ± 0.06	0.23 ± 0.04	0.20 ± 0.08
Household size *(n)*	3.7 ± 0.3	4.0 ± 0.4	3.9 ± 0.3	4.0 ± 0.5	3.3 ± 0.3	3.8 ± 0.6
Main Job *(%):*						
Farmers	56.3	42.9	71.4	66.7	16.7	25.0
Casual labourer	37.5	0.0	14.3	33.3	16.7	0.0
Regular job	6.3	57.2	14.3	0.0	66.7	75.0
Reason for not keeping small ruminants *(%):*						
Capital	25.7	17.7	35.7	50.0	19.1	22.2
Hh labour[3]	20.0	17.7	14.3	10.0	38.1	22.2
Time	20.0	35.3	21.4	10.0	9.5	33.3
Feed availability	14.3	17.7	14.3	10.0	19.1	0.0
Land shortage	5.1	5.9	7.1	10.0	4.8	11.1
Not interested	14.3	5.9	7.1	10.0	9.5	11.1
Prospect of small ruminants *(%)*:						
Good	0.0	0.0	42.9	16.7	83.3	0.0
Bad	100.0	100.0	14.3	50.0	16.7	75.0
Did not know	0.0	0.0	42.9	33.3	0.0	25.0

[1]Yes = neighbours who had experience in keeping small ruminants
[2]No = neighbours who had no experience in keeping small ruminants
[3] household members available for working with small ruminants

In the lowlands all neighbours said that the prospects for small ruminants were bad. In the uplands the prospects are judged more positive, at least according to more than 80% of

the households with previous experience with small ruminants. This could have been caused by the demand for Etawah-grade breeding stock, which was mentioned as one of the strengths of small ruminants in the uplands. In the middle zone about 43% of the farmers with previous experience with small ruminants were positive about their prospects. Neighbouring farmers in the middle zone and the uplands with no experience in keeping small ruminants were not positive about the prospects of small ruminants.

2.7. Discussion

Driving forces for changes in livestock systems operate at different aggregation levels. In order to understand the opportunities and constraints of small ruminants in rural development we studied historical and current driving forces at country, regional, agro-ecological zone and household levels in Yogyakarta Province. At country level, the increase in the human population over the past 150 years was accompanied by an overall large increase in the small ruminant population. Major political and economic crises have had a temporarily negative impact on small ruminant numbers. The latest example is the Asian economic crisis, which started in 1997. The recovery from this economic crisis is reflected in increases in animal numbers in most agro-ecological zones in Yogyakarta Province (Figure 2). Small ruminant development in Indonesia started with the introductions of fat-tailed sheep by private traders and Etawah goats by the administration during the Dutch colonial period. At that time these introductions had not much influence on the small ruminant population, but gradually fat-tailed sheep and Etawah-grade goats have replaced the original thin-tailed sheep and Kacang goats. The change from thin-tailed sheep to fat-tailed sheep was done by the farmers themselves, without any interference from the government. Major driving forces for the change to fat-tailed sheep have been the preference of small ruminant farmers for animals with a larger body size and the consumer preferences for meat of fat-tailed sheep (Mason, 1980). It is surprising that sheep have been neglected in development programmes because of the preference of consumers for sheep to be sacrificed for religious festivities.

At regional level, the local government has launched many different small ruminant development programmes, only few of which were successful. Livestock development programmes often fail because of a lack of awareness regarding farmers' priorities and resources (Valdivia, 1999; Floyd et al., 2003). The group housing programme failed, because the local government overlooked local conditions such as land availability, safety, and the psychological factor of farmers wanting to see their own animals daily. A prominent example of a policy that did not fit with the perceptions and resources of both consumers and farmers has been the promotion of Etawah-grade goats for milking. The consumers' acceptance is very low. They have the opinion that goat milk is very different from dairy milk and it has a "strong taste". Farmers do not favour

goats for milking either, because of their low production and because farmers cannot store surplus milk unless they have a refrigerator. At present, the government promotes Etawah-grade goats in the lowland areas in villages with relatively large numbers of poor families through the Social Safety Networking programme (*Jaring Pengaman Sosial*). This programme started during the economic crisis at the end of the 1990s. The limited access to good quality feeds in the lowlands is one of the reasons for the decline in the number of small ruminants in the lowlands. So, whether the promotion of Etawah-grade goats in the lowlands will be successful is doubtful.

The sharing programme and farmers groups have been adopted by the farmers. The success of these programmes is based on the economic and societal conditions of the farmers concerned. The sharing programme helps farmers who would like to keep small ruminants but do not have enough capital, while farmers groups accommodate farmers who need to exchange and share their experiences in keeping small ruminants. In addition, farmers groups also act as facilitator to apply for credit, from either government or private sources. Other successful provincial government policies were the slatted floor programme and village breeding unit. They fitted the perceptions and local condition of the farmers. The use of local materials, bamboo sticks, as slats helped to adopt the slatted floors. In addition, keeping the small ruminants on slatted floors makes it easy to collect the manure. Farmers very much value the collected manure as fertiliser for their fruit trees and also for paddy. Village breeding centres helped the farmers to improve genetic potential of their goats. The extension services and goat contests programmes also had a positive impact. Farmers need information to improve the management systems of small ruminants. The perception of farmers was that participation in goat contests means that the price of their goats will increase.

Over the years, the intensification of land use for crop production has resulted in major changes in small ruminant management in all three agro-ecological zones. In 2003, three-quarters of the farmers in the middle zone and in the uplands kept small ruminants in confinement, while farmers in the lowlands tended to keep small ruminants in a combination of grazing and confinement. Grazing only was hardly practised anymore. The agro-ecological conditions not only determine the availability of feed resources, they also determine the household members available and their time available for small ruminant activities. Although small ruminant flock sizes were small (4-6 animals), small ruminant activities took, on average, 3.8 h d^{-1}. In the lowlands keeping small ruminants is even more so a secondary activity, next to the main activity of producing rice, than in the middle zone and uplands. In the lowlands, households were involved in different other secondary activities such as cassava processing, and shops, and they had much less experience in keeping small ruminants: 10 y vs 25 y for households in the middle zone and uplands. The middle zone and upland farmers must have started with small ruminants when they started their family. In all three agro-ecological zones, lack of household

members available for small ruminant activities and lack of time were important motives for neighbours for not keeping small ruminants. It was not so that they were not interested in small ruminants. Lack of capital was also an important motive for not keeping small ruminants, despite the fact that keepers of small ruminants in the lowlands and uplands stated that credit from governmental sources or banks for small ruminants was available. At the time of the SWOT such credits were not available in the middle zone, however, in 2005 such credits have also become available in this zone for farmers groups and the remaining group housing projects.

The role small ruminants play in the livelihood of the people has not changed so much, although the small ruminant production systems have changed considerably. The main reason for keeping small ruminants is their function as a capital asset, followed by the production of manure. Both the SWOT and the opinions of neighbours indicated that small ruminants in the upland areas have better prospects than those in the lowlands and middle zone. In the lowlands, both feed and household resources are major limiting factors, and all neighbours concluded that the prospects for small ruminants were not good. Overall, conditions at household level: capital, household members and time available were main determinants for keeping small ruminants.

The differences in the types of small ruminants kept, in changes in animal numbers, and in management within a relatively small area, as the Province of Yogyakarta, Central Java indicate that conditioning factors at the lower hierarchical levels, agro-ecological zone and household, are the most important driving forces for changes in small ruminant systems. Small ruminant development programmes have to fit the perceptions of the farmers and the local resources available.

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Chapter 3

Preferences for sheep or goats in Indonesia

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This chapter is submitted to Small Ruminant Research

Abstract

This paper aims to explore farmers' preferences for sheep or goats on the basis of feeding practices, animal and flock performances and socio-economic benefits of small ruminants in different agro-ecological zones in Central Java, Indonesia. In total, 150 smallholder farmers were selected from three agro-ecological zones, namely 50 farmers in the lowlands, 50 farmers in the middle zone and 50 farmers in the uplands. Weekly visits, and regular weighing of small ruminants, and of feed offered and refused were done to complete the performance data of small ruminants. The major differences in agro-ecological conditions that affect the choice for sheep or goats were the availability of cassava peels in the lowlands, favouring a choice for sheep, and the abundance of leaves in the middle zone and uplands, which favours keeping goats. Although sheep were given more opportunities to graze than goats, grazing was not a major component in the sheep diets. In the middle zone and uplands, goats grew slightly faster than sheep and does produced more weaners per year than ewes. In particular, in the uplands, the economic benefits indicated that farmers benefit more from goats than from sheep. The promotion of goats by the government, the family tradition of keeping sheep or goats, the preference for sacrificing sheep for religious festivities, or the high initial investment needed to buy breeding stock of Etawah-grade goats could be other important motives to keep sheep or goats.

Keywords: Small ruminants, Growth rates, Feeding practices, Reproduction, Economic benefits, Indonesia.

3.1. Introduction

In developing countries, small ruminant farmers are almost exclusively found in resource-poor environments. Sheep and goats are complementary in their feeding habits (Peters, 1988). Goats are often found in areas where there are abundant browsing possibilities, whereas sheep are more used for grazing. The choice of the appropriate species is recognised as one of the imperatives in increasing the contribution of small ruminants to rural livelihoods (Devendra, 2001). Added to ecological conditions, also economic and social conditions play a role in farmers' choices (Forson et al., 1997; Bekele and Drake, 2003).

Indonesia is a country where agro-ecological conditions are believed to have an important impact on the type of small ruminants kept, although in all agro-ecological zones both sheep and goats can be found. Farmers, policy-makers and scientists perceive that the availability of better quality forages in multiple cropping systems in higher altitude areas make these areas suitable for goats, because they believe that goats need better quality feed and thrive better on tree leaves (Budisatria et al., 2005a). Sheep are said to be suitable for farming systems dominated by rice monoculture in lowland areas. Historically, development programmes in Indonesia focussed on goats rather than on sheep. For Moslem religious festivities, however, consumers prefer to sacrifice sheep rather than goats (Budisatria et al., 2005b). Farmers in Indonesia do not keep sheep and goats together; they own goat-only or sheep-only enterprises. They often rely heavily on their experiences from past years when assessing the potential for success of keeping sheep or goats (Sodiq, 2004). This will include not only production but also adaptability to feeding conditions and diseases, and the provision of non-market production, such as manure and capital asset functions (Ifar, 1996).

The purpose of this study was to explore if farmers' preferences for sheep or goats can be explained by available feed resources, animal and flock performances and socio-economic benefits for small ruminants in different agro-ecological zones in Central Java, Indonesia. In Indonesia, Central Java is known for the quality of its small ruminants and has different agro-ecological zones in relatively close proximity.

3.2. Materials and methods

3.2.1. Study area

The study was performed in three agro-ecological zones in the Province of Yogyakarta (Central Java – Indonesia). Each zone has different topography, soil types, soil fertility and agro-climatic conditions. The lowlands are found at less than 100 m above sea level (asl). The average annual rainfall is 2099 mm and the average number of rainfall days is 11 days/month with monsoon rains from October to April (Badan Pusat

Statistik, 2000). The lowlands are characterised by paddy fields. The dikes between the paddy fields are used for growing crops such as cassava. Many households have cassava processing as home industry. Small ruminants are mainly raised by households with little or no land. The middle zone is defined as the area between 100 and 500 m asl. The average annual rainfall is 3888 mm and the average number of rainy days is 20 days/month with monsoon rains from November to April. The characteristics of this zone are multiple cropping systems, with a combination of paddy fields and annual dry land crops. The uplands are found above 500 m asl. The average annual rainfall varies from 1319 to 5255 mm, with 8 rainy days/month and monsoon rains from November to March. The main crops are cassava, maize, groundnut and vegetables. Some perennial crops are also available, i.e. banana, cacao and coconut.

3.2.2. Data collection

In total, 150 small ruminant farmers were randomly selected: 50 farmers in the lowlands, 50 farmers in the middle zone and 50 farmers in the uplands. These farmers kept Etawah-grade goats or Javanese fat-tailed sheep.

3.2.2.1. Feeding practices

Many different feeds were offered to the small ruminants and this varied widely among the zones. Some feeds were not offered regularly. This study concentrated on the dominant feeds offered by the farmers. Feed intake was measured for small ruminants from 6-12 months old. The feed intake, feed offered and refused was weighed during one week every month for a period of 3 months in the dry season and 3 months in the wet season. Feed analyses were done to calculate dry matter (DMI) and crude protein intakes (CPI) on DM basis. Farmers usually offered feed twice a day, in the morning and afternoon. To be able to weigh feed resources offered, the feed was separated into individual categories. Farmers were asked whether they grazed their animals and for how many hours/day. Feed intake during grazing was not measured.

3.2.2.2. Performances

The growth and reproductive performances were investigated from September 2001 to August 2003. In each zone, we started with 50 pre-weaning male and female sheep and 50 pre-weaning male and female goats for the measurement of growth. However, during the monitoring period, some animals died, were sold or were transferred out. Sheep and goats were weighed monthly in the morning, before feeding. To calculate the average daily gain (ADG), initial bodyweight was subtracted from final body weight and the result was divided by the period of measurement. The growth rates were calculated for four age periods: 0-3 months, 3-6 months, 6-12 months and over 12 months.

Each zone was represented by 25 ewes and 25 does for measuring reproductive performances. The data consisted of first mating age, gestation period, weaning age, first postpartum mating (PPM), lambing/kidding intervals (KI), service per conception (S/C) and litter size. All farmers received a recording card, which contained the above-mentioned information. Weekly visits were made to assist farmers in completing the recording card correctly.

3.2.2.3. Quality of manure

The chemical composition of manure was tested for carbon (C), nitrogen (N), phosphorus (P), potassium (K), nitrate (NO_3^-) and ammonia (NH_3). In total 27 samples of sheep and goat manure from three agro-ecological zones (4 sheep and 5 goat manure samples per zone) were collected and analysed. Manure samples were collected from the floor of small ruminants houses, a composite sample of about one kg was taken from several sample points. Solid manure samples were collected and handled in small plastic bags. Manure was then analysed in the laboratory of the Environmental Health Bureau, Yogyakarta. Sampling and analysing manure were done during the dry season.

3.2.2.4. Production and socio-economic benefits

Small ruminants' contributions in terms of production, and socio-economic benefits (financing and insurance benefits) over a period of one year (July 2002 – June 2003) were calculated by using an equation described by Bosman et al. (1997) and Ayalew (2000). The production was estimated as follows:

$Y_k = FS_k - IS_k + S_k - P_k + OT_k - IT_k + C_k$, where

Y_k = net production of small ruminants (kg)
FS_k = body weight (kg) of the flock at the end of the observation period
IS_k = body weight (kg) of the flock at start of the observation period
S_k = body weight (kg) of all small ruminants sold
P_k = body weight (kg) of all small ruminants purchased
OT_k = body weight (kg) of all small ruminants transferred out
IT_k = body weight (kg) of all small ruminants transferred in
C_k = body weight (kg) of all small ruminants slaughtered

During the recording period, only pre-weaning animals died, no mature animals died.
Value added (VA) was calculated using the equation:

VA = (Y_k x price per kg) – feed cost

Variable cash costs in this study only considered concentrate feed costs. Medicines were not used. The prices of small ruminants per kg of bodyweight were based on the average prices farmers received when they sold small ruminants divided by body

weight. Prices were relatively high during periods of religious festivities and relatively low during periods of urgent cash needs.

The value of manure (VM) was calculated as the total DM of the manure produced times the estimated price per kg DM of manure:

VM = DM manure x price per kg

The intangible benefit from financing is the result of disposal of animals as and when required to enable households to meet cash needs, and represents the saving on transaction costs of borrowing money (Bosman et al., 1997). The benefit from financing was estimated as :

F_k = OM_k x f, where:

F_k = benefit from financing

OM_k = (C_k + S_k + OT_k) x price per kg

f = financing factor for the area studied

The financing factor (f) differed between the regions. Formal interest rate of credit in the lowlands was 6%, while in the middle zone and uplands it was 9% (Bank BNI-Yogyakarta, 2003, personal communication).

The intangible insurance benefit is related to the capital invested in a flock as a guarantee for meeting unexpected expenditures and can be compared to an insurance premium (Bosman et al., 1997). The intangible insurance benefit is expressed as an amount per year:

I_k = W_k x s, where:

I_k = insurance benefit

W_k = average flock weight x price per kg

s = insurance factor for the area studied

The factor s was set at 8% (Asuransi Bumiputera-Yogyakarta, 2003, personal communication). This represents the insurance premium that would have to be paid if there was an insurance market.

The total benefits (Y) from keeping small ruminants over a period of one year was estimated as:

$Y = VA + VM + F_k + I_k$

Information on the total hours per day available for small ruminants was gathered by interviewing the head of the households.

3.2.3. Statistical analysis

The analysis model for testing differences in ADG between sheep and goats within each zone included initial weight as co-variable. The initial bodyweight at different ages did not differ significantly, either between male sheep and goats or between female sheep and goats in the three zones. Feed intake, first mating age, length

of pregnancy, weaning age, postpartum mating, lambing/kidding intervals, service per conception, litter size and production and socio-economic benefits of keeping small ruminants were analysed using T-test analysis.

3.3. Results

Figure 1 presents the feed resources offered to sheep and goats during the dry and wet seasons in the three agro-ecological zones. In the dry season, in the lowlands, feed

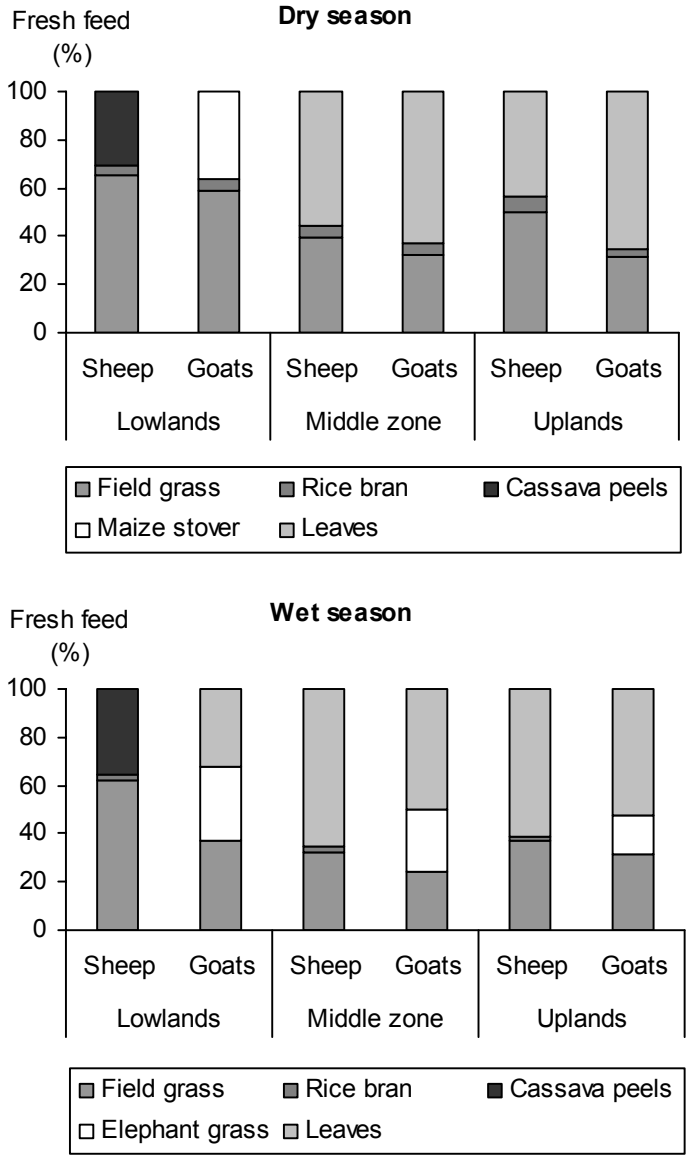

Figure 1
Feed composition (in % of fresh feeds offered) for small ruminants during the dry and wet seasons in three agro-ecological zones in Central Java, Indonesia

consisted of a combination of field grass and crop residues (cassava peels for sheep and maize stover for goats): 67% of sheep feed consisted of field grass and 31% of cassava peels, while for goats, field grass was around 59% and maize stover was 36%. Abundant cassava peels were available in the lowlands, because farmers have cassava processing as home industry. Cassava peels were only offered to sheep, because farmers had bad experiences with feeding cassava peels to goats. In the middle zone and uplands, feed of small ruminants mainly consisted of field grass and leaves (e.g. leaves of legume and fruit trees, hibiscus). All farmers in the three zones supplied their small ruminants with rice bran as extra feed during the dry season, however the amount was low: less than 10% of the feeds fed.

In the wet season, goat farmers fed elephant grass and stopped the rice bran supplementation. Sheep, in contrast, were not supplied with elephant grass in any agro-ecological zone. Goat farmers in the lowlands replaced maize stover with leaves.

Table 1 gives feed intake (FI), dry matter intake (DMI) and crude protein intake (CPI) during the dry and wet seasons in the three agro-ecological zones. During the dry season there was no significant difference between sheep and goats in FI, DMI and CPI, in the lowlands, middle zone and upland areas, except for crude protein intake in the uplands, which was significantly ($P<0.05$) higher in goats. During the wet season, FI, DMI and CPI were significantly higher ($P<0.05$) in goats than in sheep in all zones, except DMI in the lowlands. Sheep and goats in the lowlands had the lowest intakes of feeds provided compared to the other zones. Compared to the dry season, FI increased by 12.3 to 30.7% during the wet season, while DMI and CPI did not vary much between the

Table 1
Feed intake (FI), dry matter intake (DMI) and crude protein intake (CPI) of sheep and goats during dry and wet seasons in three agro-ecological zones in Central Java, Indonesia (kg/day) (Mean ± S.E.)

Intake	Lowlands		Middle zone		Uplands	
	Sheep	**Goats**	**Sheep**	**Goats**	**Sheep**	**Goats**
N	25	25	25	25	25	25
Dry season						
FI	$3.28^{a} \pm 0.44$	$3.59^{a} \pm 0.74$	$3.82^{a} \pm 0.49$	$3.61^{a} \pm 0.76$	$3.43^{a} \pm 0.57$	$3.68^{a} \pm 0.49$
DMI	$1.20^{a} \pm 0.29$	$1.26^{a} \pm 0.19$	$1.37^{a} \pm 0.12$	$1.27^{a} \pm 0.17$	$1.30^{a} \pm 0.15$	$1.24^{a} \pm 0.08$
CPI	$0.08^{a} \pm 0.02$	$0.07^{a} \pm 0.01$	$0.15^{a} \pm 0.02$	$0.15^{a} \pm 0.03$	$0.13^{a} \pm 0.03$	$0.15^{b} \pm 0.02$
Grazing practise *(%)*	92	60	60	36	68	20
Grazing time *(h)*	$4.1^{a} \pm 0.15$	$3.8^{a} \pm 0.14$	$3.5^{a} \pm 0.22$	$3.4^{a} \pm 0.18$	$3.5^{a} \pm 0.15$	$3.4^{a} \pm 0.20$
Wet season						
FI	$3.7^{a} \pm 0.10$	$4.03^{b} \pm 0.09$	$4.0^{a} \pm 0.19$	$4.4^{b} \pm 0.07$	$3.93^{a} \pm 0.06$	$4.81^{b} \pm 0.07$
DMI	$1.31^{a} \pm 0.02$	$1.22^{b} \pm 0.01$	$1.33^{a} \pm 0.05$	$1.38^{b} \pm 0.07$	$1.32^{a} \pm 0.01$	$1.47^{b} \pm 0.04$
CPI	$0.09^{a} \pm 0.01$	$0.12^{b} \pm 0.01$	$0.15^{a} \pm 0.02$	$0.17^{b} \pm 0.03$	$0.15^{a} \pm 0.02$	$0.17^{b} \pm 0.04$

[a,b]Different superscripts denote significant differences between means within rows in the same agro- ecological zone ($P<0.05$)

dry and the wet seasons, except for the higher DMI of goats in the uplands and CPI of goats in the lowlands in the wet season.

Almost all sheep farmers in the lowlands practised grazing and more than half of the sheep farmers in the middle zone and uplands still grazed their animals. Goat farmers tended to keep their goats in cut-and-carry feeding systems, except in the lowlands where 60% of the goats also were grazed. The average numbers of grazing hours for sheep and goats were 4.1 and 3.8 respectively in the lowlands, 3.5 and 3.4 in the middle zone, and 3.5 and 3.4 in the uplands. The differences in grazing times between sheep and goats were not significant. Grazing was not practised daily, it depended on the time available, and it was done in the dry season only. In the lowlands, the most common grazing areas were fallow fields, roadsides and soccer fields. Farmers brought their sheep to these fields and took the sheep home at midday when they returned from their activities in the fields. Surprisingly, the FI, DMI, and CPI of feeds provided varied only 1-2% between sheep or goats given the opportunity to graze and sheep or goats not being able to graze.

The average daily gain (ADG) of male and female sheep and goats in the three agro-ecological zones is presented in Table 2. Pre-weaning male goats grew better ($P<0.05$) than male sheep, while in the 3-6; 6-12 and more than 12 month-old categories male animals did not differ significantly in ADG, except in the middle zone where male sheep grew significantly ($P<0.05$) faster than male goats. Body weights at 15 months of age did not differ significantly between sheep and goats either in the lowlands, middle zone and uplands.

Table 2
Average daily gain (ADG) of male and female sheep and goats in three agro-ecological zones in Central Java, Indonesia (g/head/day) (Mean ± S.E.)

Age		Lowlands		Middle zone		Uplands	
(months)	n	Sheep	Goats	Sheep	Goats	Sheep	Goats
Male							
0-3	150	$96.0^{a} \pm 4.2$	$100.2^{b} \pm 2.8$	$103.4^{a} \pm 4.2$	$114.4^{b} \pm 3.6$	$98.2^{a} \pm 5.7$	$122.1^{b} \pm 2.7$
3-6	144	$76.7^{a} \pm 3.1$	$78.5^{a} \pm 4.1$	$82.6^{a} \pm 3.1$	$82.3^{a} \pm 5.2$	$79.7^{a} \pm 5.1$	$88.2^{a} \pm 4.3$
6-12	132	$49.9^{a} \pm 3.2$	$41.9^{a} \pm 3.4$	$56.4^{a} \pm 2.8$	$44.5^{b} \pm 4.5$	$53.9^{a} \pm 3.5$	$49.3^{a} \pm 3.5$
>12	132	$38.1^{a} \pm 2.4$	$35.8^{a} \pm 2.5$	$39.4^{a} \pm 2.7$	$52.1^{b} \pm 3.6$	$38.2^{a} \pm 2.1$	$42.6^{a} \pm 3.5$
ADG-male	132	67.2^{a}	64.1^{b}	70.5^{a}	73.3^{b}	67.5^{a}	75.6^{b}
BW[1] *(kg)*		27.8^{a}	27.0^{a}	28.5^{a}	28.9^{a}	29.3^{a}	31.3^{a}
Female							
0-3	150	$95.4^{a} \pm 4.8$	$106.5^{b} \pm 3.7$	$90.0^{a} \pm 2.5$	$116.7^{b} \pm 2.5$	$95.3^{a} \pm 6.0$	$120.9^{b} \pm 2.0$
3-6	144	$74.8^{a} \pm 4.5$	$79.1^{a} \pm 3.4$	$76.6^{a} \pm 3.2$	$79.6^{a} \pm 4.0$	$76.6^{a} \pm 4.6$	$93.9^{b} \pm 3.8$
6-12	132	$48.5^{a} \pm 3.3$	$38.1^{b} \pm 4.9$	$54.7^{a} \pm 3.7$	$42.3^{b} \pm 2.8$	$52.7^{a} \pm 3.4$	$48.1^{a} \pm 3.6$
>12	132	$27.4^{a} \pm 2.0$	$19.6^{a} \pm 2.1$	$36.6^{a} \pm 2.8$	$36.1^{a} \pm 3.1$	$27.9^{a} \pm 1.9$	$28.4^{a} \pm 2.0$
ADG-female	132	61.5^{a}	60.8^{a}	64.5^{a}	68.7^{b}	63.1^{a}	72.8^{b}
BW[1] *(kg)*		26.8^{a}	26.7^{a}	27.8^{a}	27.7^{a}	27.9^{a}	29.8^{a}

[a, b]Different superscripts denote significant differences between means within rows in the same agro-ecological zone ($P<0.05$)
BW[1] = body weight at 15 months of age

Also female pre-weaning goats grew faster than pre-weaning sheep (P<0.05) in all three zones. In the age category 3-6 months female goats grew significantly faster than sheep (P<0.05) in the uplands. In the age category 6-12 months female sheep grew significantly faster than goats (P<0.05) in the lowlands and middle zone. In the middle zone and the uplands, both male and female goats had a significantly higher total ADG (P<0.05) than sheep, whereas male sheep had a significantly higher ADG (P<0.05) than male goats in the lowlands. Overall, sheep and goats in the lowlands showed the lowest ADG.

Reproductive performances of female sheep and goats are presented in Table 3. In all three zones, sheep were mated significantly earlier than goats (P<0.05), on average about 1.5 months earlier. Goats in the lowlands and middle zone mated latest. The gestation periods of sheep and goats ranged from 149 to 151 days. They differed significantly between sheep and goats in the middle zone (P<0.05). In the middle zone, goats were weaned significantly (P<0.05) later than sheep by 9 days. On average, sheep and goats were mated again at four months after parturition. Parturition intervals of sheep and goats varied from 263 to 279 days for sheep and from 271 to 283 days for goats. In the middle zone, the difference of 14.5 days in parturition interval between sheep and goats was significant (P<0.05). Services per conception did not differ significantly between sheep and goats in the different zones. Most sheep and goats needed more than one mating before becoming pregnant. The litter size of sheep and goats showed significant differences (P<0.05). Goats were more prolific than sheep in all zones. There were significantly different survival rates (P<0.05) between sheep and goats in the lowlands and uplands, in the lowlands in favour of sheep and in the uplands in favour of goats.

The quality of manure is presented in Table 4. The nutrient components varied widely among zones and among manure samples in the same zone. The C/N ratio was

Table 3
Reproductive performance of sheep and goats in three agro-ecological zones in Central Java, Indonesia (Mean ± S.E.)

Reproductive parameters	Lowlands		Middle zone		Uplands	
	Sheep	Goats	Sheep	Goats	Sheep	Goats
Number of animals	25	25	25	25	25	25
First mating *(mths)*	$13.6^{a} \pm 0.4$	$14.9^{b} \pm 0.5$	$13.4^{a} \pm 0.5$	$14.9^{b} \pm 0.4$	$12.2^{a} \pm 0.3$	$13.8^{b} \pm 0.5$
Gestation period *(d)*	$150.4^{a} \pm 0.6$	$151.0^{a} \pm 0.4$	$148.7^{a} \pm 0.4$	$150.4^{b} \pm 0.4$	$149.3^{a} \pm 0.4$	$150.5^{a} \pm 0.4$
Weaning age *(d)*	$102.3^{a} \pm 3.0$	$106.4^{a} \pm 3.8$	$89.1^{a} \pm 3.5$	$98.4^{b} \pm 2.4$	$92.1^{a} \pm 4.3$	$91.5^{a} \pm 3.9$
PPM[1] *(d)*	$129.6^{a} \pm 3.2$	$131.4^{a} \pm 3.6$	$114.8^{a} \pm 3.6$	$127.6^{b} \pm 3.2$	$121.8^{a} \pm 4.6$	$122.2^{a} \pm 4.2$
KI[2] *(d)*	$278.7^{a} \pm 3.6$	$282.4^{a} \pm 3.7$	$263.5^{a} \pm 3.7$	$278.0^{b} \pm 3.3$	$271.1^{a} \pm 4.6$	$272.8^{a} \pm 4.2$
S/C[3] *(n)*	$1.9^{a} \pm 0.10$	$1.9^{a} \pm 0.05$	$1.6^{a} \pm 0.06$	$1.7^{a} \pm 0.05$	$1.7^{a} \pm 0.06$	$1.8^{a} \pm 0.05$
Litter size *(n)*	$1.5^{a} \pm 0.07$	$1.7^{b} \pm 0.06$	$1.6^{a} \pm 0.06$	$2.0^{b} \pm 0.09$	$1.6^{a} \pm 0.08$	$2.1^{b} \pm 0.06$
Weaning *(%)*	$89.1^{a} \pm 1.0$	$81.8^{b} \pm 2.5$	$91.5^{a} \pm 0.9$	$95.3^{a} \pm 0.7$	$84.1^{a} \pm 1.2$	$95.5^{b} \pm 0.8$

[a, b]Different superscripts denote significant differences between means within rows in the same agro-ecological zone (P<0.05)
[1]: PPM = Post Partum Mating; [2]: KI = Kidding Intervals; [3]: S/C = Service per Conception

Table 4
Quality of small ruminants' manure in three agro-ecological zones in Central Java, Indonesia (Mean ± S.E.)

Nutrient components	Lowlands		Middle zone		Uplands	
	Sheep	Goats	Sheep	Goats	Sheep	Goats
N	4	5	4	5	4	5
C *(%)*	30.5[a] ± 6.6	14.0[b] ± 2.2	22.2[a] ± 4.8	21.4[a] ± 3.9	17.9[a] ± 2.9	17.1[a] ± 3.8
N *(%)*	0.6[a] ± 0.2	1.1[a] ± 0.2	1.1[a] ± 0.4	2.1[a] ± 0.5	1.0[a] ± 0.4	1.4[a] ± 0.3
C/N	67.7[a] ± 20.0	14.1[b] ± 3.9	35.5[a] ± 14.3	10.8[b] ± 2.1	39.3[a] ± 22.3	12.8[b] ± 1.1
P *(mg kg^{-1})*	1465[a] ± 136	1910[a] ± 481	1842[a] ± 640	2502[a] ± 482	2196[a] ± 830	1226[b] ± 222
K *(mg kg^{-1})*	15993[a] ± 7116	21583[a] ± 3179	16682[a] ± 4826	12358[a] ± 2001	24511[a] ± 9610	16150[a] ± 5451
NH_3 *(mg kg^{-1})*	6598[a] ± 1899	13479[b] ± 1771	15992[a] ± 4155	24569[a] ± 6904	14267[a] ± 3032	20432[a] ± 2780
NO_3^- *(mg kg^{-1})*	5897[a] ± 1454	5747[a] ± 685	6276[a] ± 1554	7361[b] ± 639	4775[a] ± 1050	5230[a] ± 1173

[a, b]Different superscripts denote significant differences between means within rows in the same agro-ecological zone (P<0.05)

significantly (P<0.05) higher in sheep than in goat manure in all agro-ecological zones. So, sheep manure had a lower quality than goat manure.

Production and socio-economic benefits of sheep and goat flocks in different agro-ecological zones are shown in Table 5. In the lowlands sheep flocks had a significantly higher (P<0.05) value added and total benefits than goat flocks, whereas in the middle zone and uplands goat flocks had a significantly higher (P<0.05) value added. The biggest difference in production and socio-economic benefits between sheep and goats was found in the uplands. In the uplands, goats contributed around 25% more than sheep in the value added. In the lowlands and middle zone, the differences between sheep and goats in financing and insurance benefits were relatively small. In the uplands, goats had a 19%-higher financing benefit and a 27%-higher insurance benefit than sheep. The

Table 5
Production and socio-economic benefits of small ruminants flocks in three agro-ecological zones in Central Java, Indonesia, July 2002 – June 2003 (Mean ± S.E.)

Parameters	Lowlands		Middle zone		Uplands	
	Sheep	Goats	Sheep	Goats	Sheep	Goats
Flock size *(n)*	3.5	3.2	3.9	3.9	3.7	4.2
Net production *(kg y^{-1})*	91.4[a] ± 3.9	85.6[b] ± 4.0	94.5[a] ± 3.7	92.5[a] ± 3.5	99.2[a] ± 3.4	121.9[b] ± 3.6
Manure *(kg y^{-1})*	587[a] ± 33	588[a] ± 29	712[a] ± 41	707[a] ± 39	626[a] ± 31	776[b] ± 40
Benefits:						
Value Added (*Rp10^4 y^{-1})*	133[a] ± 2.8	125[b] ± 3.3	123[a] ± 4.2	129[b] ± 4.6	137[a] ± 5.5	172[b] ± 7.4
Time spent *(h d^{-1})*	3.6[a] ± 0.21	3.4[a] ± 0.12	3.7[a] ± 0.12	3.7[a] ± 0.15	4.2[a] ± 0.16	4.2[a] ± 0.24
VA per h *(Rp)*	1008[a] ± 21	1005[a] ± 27	918[a] ± 32	947[a] ± 34	894[a] ± 36	1113[b] ± 48
Financing *(Rp10^4 y^{-1})*	3.2[a] ± 0.5	3.3[b] ± 0.5	4.6[a] ± 0.4	4.8[b] ± 0.4	4.3[a] ± 0.4	5.1[b] ± 0.4
Insurance *(Rp10^4 y^{-1})*	16.2[a] ± 0.6	15.8[a] ± 0.6	18.3[a] ± 0.5	17.1[b] ± 0.5	16.9[a] ± 0.5	21.4[b] ± 0.5
Tot. benefits *(Rp10^4 y^{-1})*	152[a] ± 0.1	144[b] ± 0.1	146[a] ± 0.1	151[b] ± 0.0	158[a] ± 0.1	198[b] ± 0.1

[a,b]Different superscripts denote significant differences between means within rows in the same agro-ecological zone (P<0.01)
1 € = Rp 12 000 in 2004

contribution of goats in the uplands was the highest, the total benefit was 38% and 31% higher than goats in the lowlands and middle zone respectively. This was due to higher net production in kg and to better prices for breeding stock. In terms of value added per h, in all zones small ruminants contributed only small amounts to the families; in the uplands goats contributed significantly more than sheep ($P<0.05$).

3.4. Discussion

The differences in cropping patterns between the different agro-ecological zones in Central Java, and the intensification of land use, in particular in the lowlands, are only partly reflected in differences in the types of feed fed to small ruminants. Previous studies (Ifar, 1996; Marjuki et al., 2000) showed that field grass was an important ruminant feed resource. Our study indicates that field grass has remained an important feed in all zones and in both the dry and wet season: on average about 50 per cent of the fresh feed fed to sheep and close to 40 per cent for goats. Field grass is collected from roadsides, field borders, paddy field dykes, soccer fields, and other communal resources. Feeding of small ruminants in the lowlands differed from the other two zones. In the lowlands many farmers process cassava and use the peelings for feeding sheep. Farmers are afraid to feed cassava peeling to goats, as this has caused major losses of animals in the past, due to cyanide poisoning. So, in particular farmers with abundant cassava peels available keep sheep to make use of this feed resource. The feeds used in the middle zone and uplands are approximately the same. Close to 40 per cent of the fresh feed fed here are legume tree, fruit tree, cassava and hibiscus leaves. In both these zones farmers live close to forest areas, and often they integrate their annual crops with legume trees, which function as a fence and provide feed for small ruminants. The major difference between the dry and the wet season feeding was that goats received elephant grass in the wet season and therefore farmers stopped with rice bran supplementation in this season. It seems that sheep farmers have better access to rice bran, because sheep are more integrated with rice production than goats. For sheep the different feeds used were the same in the dry season and the wet season. The differences between sheep and goats in feed intake (FI), dry matter intake (DMI) and crude protein intake (CPI) were small. In the uplands in the wet season goats were fed better than sheep; goats had a significantly higher FI, DMI and CPI than sheep.

The recorded intakes do not include the intakes during grazing. In Indonesia, it is always said that sheep are used for grazing. Our results indirectly indicate that grazing is not a major component in the sheep diets. Indeed, sheep were grazed more than goats. In the lowlands almost all sheep had the opportunity to graze and in the other zones about two-thirds of the sheep could graze. Less than half of the goats were given the opportunity to graze. However, grazing did not have an effect on FI, DMI and CPI of the

feeds offered. The opportunity to graze more in the lowlands did not result either in better growth rates in sheep or goats in this agro-ecological zone. One explanation could be that small ruminants are fed early in the morning before they are taken out for grazing. And they are not taken out for grazing every day. Moreover, small ruminants are only allowed to graze in the dry season when there is not much grazing available. In the wet season, small ruminants are not grazed at all because farmers are afraid of bloat and of internal parasites such as helminths.

In the lowlands, there are not many leaves available to be fed and many farmers think that goats cannot be managed properly under this condition. Growth rates of goats in the lowlands were slightly less than of sheep, but differences in body weight between sheep and goats at 15 months of age were minimal. However, overall in the middle zone and uplands goats did better than in the lowlands. In the higher zones abundant tree leaves are available and farmers believe that this is a major strength in keeping goats (Budisatria et al., 2005a). In particular in the uplands, goats grew significantly faster than sheep.

Reproductive performance is one of the main determinants of productivity of small ruminants (Tano et al., 2003; Menendez-Buxadera et al., 2004). In the lowlands, goats had a larger litter size, but lower survival rates and longer kidding intervals than sheep. In the middle zone and uplands, litter sizes of goats were considerably higher than in sheep. The number of young weaned per ewe or doe per year was 1.8 for both sheep and goats in the lowlands, 2.0 and 2.5 sheep and goats respectively in the middle zone and 1.8 and 2.7 sheep and goats respectively in the uplands. It is well recognized that the nutritional status of animals influences their reproductive performance (Mukasa-Mugerwa et al., 2002; Lassoued et al., 2004; Melaku et al., 2004). Inounu et al. (1993) stated that higher prolificacy is advantageous only under conditions of adequate feeding and management. Overall, farmers in the middle zone and uplands seem to manage their small ruminants better than in the lowlands, as indicated by feed resources offered, and better survival rates and growth rates.

The differences in growth rates and reproductive performances are reflected in the production and socio-economic benefits. In the lowlands, sheep flocks had a better production and value added than goat flocks, while in the middle zone and uplands, the value added for goat flocks were higher than for sheep flocks. In the uplands the total benefits for goat flocks were 25% higher than for sheep flocks. This difference can be explained by the slightly higher goat flock sizes, the better technical performances and the higher prices for Etawah-grade breeding stock. This is also reflected in the higher values for financing and insurance for goats in the uplands. The returns per unit of labour (not considering the cost for the production factor capital) from keeping either sheep or goats were well below the minimum wage of labour in Yogyakarta Province, namely Rp 1500 per hour. Only for goats in the uplands the returns per hour nearly reached the

standard minimum of labour wage. On a daily basis the contribution from sheep and goats was very small. In the lowlands the farmers have easy access to formal credit, with a low interest rate (6%), while in the middle zone and uplands, formal credit is limited and farmers have to pay a high interest rate (9%). Financial services in the middle zone and uplands should be improved to make investments in goats more attractive. The role small ruminants play in the livelihood of the people has remained the same. Farmers do not assume that they can rely on small ruminants for their main income; small ruminants are considered to be of secondary importance after other agricultural activities. Therefore it seems unlikely that small ruminants in the future will become a main income earner for rural households.

The major differences in agro-ecological conditions that affect the choice for sheep or goats were the availability of cassava peels in the lowlands, favouring a choice for sheep and the abundance of leaves in the middle zone and uplands, which favours keeping goats. In particular, in the uplands, the economic benefits indicate that farmers benefit more from goats than from sheep. It can be concluded that the preferences for sheep or goats cannot solely be explained by feeding practices, and animal and flock performances. In the lowlands considerably more goats are kept than sheep (Budisatria et al., 2005a). The government has always promoted Etawah-grade goats. At present, in the lowlands credit programmes are established to help the poor households to get access to Etawah-grade goats to improve their livelihoods (Budisatria et al., 2005a). This promotion of Etawah-grade goats in the lowlands does not consider the feed resource base and the perception of farmers about feeding goats. In the middle zone about 25% more sheep are kept than goats and even in the uplands about one-quarter of the small ruminants are sheep (Budisatria et al., 2005a). This could be because it has always been a family tradition to keep sheep, or because of the preference for sacrificing sheep for the major Moslem feast of *Idul Adha.* The initial investment needed to buy breeding stock of Etawah-grade goats is about twice the investment needed to buy fat-tailed sheep breeding stock. This could be too high for the poorer families in the middle zone and particular in the uplands.

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Chapter 4

Religious festivities and supply and demand of small ruminants in Central Java – Indonesia

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Abstract

The objective of this study was to provide an overview of the small ruminant market system in Indonesia, with emphasis on the market opportunities during religious festivities. Main objects of the research were small ruminant markets in different agro-ecological zones, namely three markets in Bantul (lowlands), four markets in Sleman (middle zone), and three markets in Kulonprogo (uplands) districts, Yogyakarta Province. Each market was investigated two times in three market situations: normal, risky (critical period for farmers due to cash needs), and before the *Idul Adha* celebration. The data to be investigated included supply of small ruminants, quantity of small ruminants being sold, price and body weight. Added to this, 42 roadside sellers and 44 mosques were visited during *Idul Adha*. In each agro-ecological zone, 50 farmers were visited monthly to monitor their marketing strategies. Main actors in small ruminant marketing were the farmers, village collectors and long-distance traders. Only a few farmers sold small ruminants directly to the market. During *Idul Adha*, roadside sellers and mosques were also involved in the marketing system. Supply, demand, price and body weight varied widely between the three market situations, with a sharp peak during the month of *Idul Adha*. Compared to the normal situation, sheep supply, demand, price and body weight during *Idul Adha* increased 2.3, 2.7, 1.7, and 1.4 times respectively, while for goats the increases were 2.4, 3.2, 1.5, and 1.2 times respectively. The increase in prices was based on the higher body weight of animals offered during *Idul Adha* and a higher price per kg during *Idul Adha*. Sheep are preferred rather than goats to be sacrificed during *Idul Adha*. In the lowlands and the middle zone, the markets were dominated by sheep; however, in the uplands goats are the predominant type of livestock and goats dominated the small ruminants' markets. The *Idul Adha* period gives the small ruminant farmers higher benefits; however, most farmers do not seem to be able to match their small ruminant production to *Idul Adha*. Urgent cash needs were the main reason for disposing of small ruminants.

Key Words: Small ruminants, marketing, religious festivities, Indonesia.

4.1. Introduction

Small ruminants play a key role in Moslem religious festivities (Subandriyo, 1998; Jabbar, 1998). Each Moslem family who has a higher living standard is obliged to slaughter a sheep or a goat during the *Idul Adha*, feast of sacrifice, celebration. The birth of a child is also celebrated with the slaughter of a sheep or goat. Farmers use small ruminants to finance religious pilgrimages. In Indonesia, about 90% of the people are Moslem. This could offer a possibility for small ruminant farmers to benefit from the important role of small ruminants in the social life of the people.

For livestock development, the availability of markets is a key factor (de Haan et al., 1996). In Indonesia, the small ruminant markets are organised every 5 days. In addition, small ruminants are sold along the roadside by roadside sellers for *Idul Adha*. In general, market prices for small ruminants and rewards to the farmers in Indonesia do not seem to be very attractive (Baliarti, 2002). The prices for sheep and goats are closely linked with specific increases in demand or supply. Prices drop rapidly when the farmers have urgent cash needs due to e.g. lack of staple food, crop failures, preparation of paddy fields, and paying school fees for their children. This usually happens at the end of the dry season, during the period August-September. This period is the start of the school year and coincides with the preparation of the paddy fields. The availability of small ruminants for religious celebrations is absolutely necessary; therefore the demand and price for sheep and goats towards the *Idul Adha* celebration increases dramatically (Djajanegara and Chaniago, 1988).

The objective of this study was to provide an overview of small ruminant marketing in Central Java, especially the market opportunities due to the increase in demand during the *Idul Adha* celebration.

4.2. Materials and methods

4.2.1. Study area

The main objects of the research were small ruminant markets in Yogyakarta Province. This Province is situated in the southern part of Central Java. There are two seasons over the year, the wet and the dry season. The wet season usually begins in September and lasts till about April. The monthly rainfall varies between 3 mm and 496 mm. Yogyakarta Province comprises five districts, three of which were chosen as study area, namely Bantul, Sleman and Kulonprogo. These districts represent the lowlands, the middle zone and the uplands respectively. Low agro-ecological zones (< 100 m above sea level, asl) are characterised by rice monoculture systems. The predominant types of livestock are cattle and buffalo. Farmers use them for draught purposes; cattle are also used for fattening. Small ruminant production is characterised by extensive grazing along

roadsides, on other common lands and harvested crop fields, due to the limited number of feed resources available to the farmers for cut-and-carry feeding. Middle zones are found at approximately 100 – 500 m asl. In these zones, multiple cropping systems are the main agricultural activity where the combination of paddy fields and annual crops (maize, groundnut, cassava, vegetables) play an important role. The populations of small ruminants and large ruminants in this zone are relatively the same. Uplands are found at about > 500 m asl. Here, annual crop production systems are found. The main crops are cassava, maize, groundnut and vegetables. Some perennial crops are also available i.e. banana and coconut. In particular goats (Etawah-grade goats: crosses between local Kacang and Jamnapari, in Indonesia referred to as Etawah) are found in these zones because more leguminous trees are grown here. In Indonesia, farmers are of the opinion that goats thrive better on tree leaves and sheep are considered to be better suited for grazing.

Idul Adha is the feast of sacrifice for the Moslems. Time interval between *Idul Adha* is about 355 days. It is celebrated on the tenth day of the month *Dhu'l Hijja*. It is the sacrifice made by the pilgrims and it is performed as part of the ceremonies of the great pilgrimage. While the pilgrims are making their sacrifices at Mina in Saudi Arabia, the ceremony is observed simultaneously by Moslems everywhere. Each family who has a higher living standard is obliged to slaughter a sheep or a goat during this celebration. Cattle can be slaughtered for groups of persons. Mosques coordinate the distribution of meat among the poor in the society and the people who have sacrificed.

4.2.2. Market survey

A total of ten small ruminant markets, three markets in Bantul district, four markets Sleman district and three markets in Kulonprogo district were used in the study. These markets represent all small ruminant markets in these districts. Primary data were gathered from a survey in the small ruminant markets mentioned above. The total number of sheep and goats in the study areas in Bantul, Sleman and Kulonprogo can be estimated at about 800, 1500, and 1500 heads respectively. Small ruminant markets can be classified as to three situations, namely, good, normal and risky market situations. The good market situation means that the market is associated with the religious feast of *Idul Adha*. The *Idul Adha* marketing period starts at about three weeks before this feast. The normal market situation means that the market situation is not affected by special circumstances. The risky market means that the market situation for the small ruminants' farmers is critical, because in that period they need cash money for paying school fees and preparing paddy fields. The start of the school period (August-September) usually coincides with the end of the dry season.

Small ruminant markets are according to the local calendar, which includes periods of 5 days. The market day is every 5 days and each market has a different

opening day. Each market was investigated two times in the normal situation (April–May 2002), the risky situation (August-September 2002), and in the three-week period prior to the *Idul Adha* celebration (February 2002). The data collected included the supply of small ruminants, number of small ruminants sold, prices and body weights. The data were collected by interviews in the small ruminant market at the moment the buyer, usually a trader and sometimes a small vendor or an individual consumer, and the seller, usually a village collector and sometimes a farmer, reached an agreement.

4.2.3. Roadside sellers' survey

Interviews were also conducted with sellers at the roadside. Two weeks before the *Idul Adha* celebration, many people sell small ruminants at the roadside, although in their normal life, they are not small ruminant sellers. Roadside sellers buy small ruminants from the farmers or from small ruminant markets about four weeks before the *Idul Adha* marketing period starts. A total of 42 sellers was interviewed, most of whom located in the middle zone (24 sellers), while the others consisted of 9 sellers in the lowlands and 9 sellers in the uplands. Survey methods and data to be collected were the same as in the market survey. However, body weights could not be measured as the sellers refused this. The roadside sellers' survey started 2 weeks before the *Idul Adha* celebration.

4.2.4. Small ruminants slaughtered at mosques during Idul Adha

In total, 44 mosques were surveyed during *Idul Adha*, 15 in the lowlands, 20 in the middle zone and 19 in the uplands zone. These mosques were located in the study areas in the districts and represent about 20 per cent of all mosques in the three districts. The parameters investigated were the number of sheep, goats and cattle slaughtered during *Idul Adha*. Mosques were visited before the animals were sacrificed and interviews were done with the head of the mosque. This was also done to minimize misinterpretation, since the people usually use the term goat for both sheep and goats.

4.2.5. Farmers' interviews

In each of the study areas in the lowlands, middle zone and uplands 50 farmers were selected for monitoring small ruminant marketing. During one year (2002), the changes in small ruminant flocks were recorded monthly. In addition, farmers were also interviewed regarding their perception of the marketing of small ruminants, when they sold small ruminants, how small ruminants were sold and for what prices.

4.2.6. Data analyses

To evaluate the small ruminant markets in the different zones and during the different market situations an ANOVA model was used with zone and market situation as factors and number of animals offered, animals sold, price per animal and body weight

per animal, respectively as dependent variables. The differences between means were analysed by Tukey's (HSD) test. Numbers of animals offered and sold by roadside sellers and the prices of these animals, and numbers of animals being slaughtered at the mosques during *Idul Adha* were analysed using one-way ANOVA with zone as factor.

4.3. Results

Table 1 presents an overview of the sheep market situation for *Idul Adha*, the normal situation and the risky period in the lowlands, middle zone and uplands. Table 2 gives market information of goats for the different market situations and the different agro-ecological zones.

There was a large variation in number of sheep and goats offered for sale and in the number sold. The market situation had a significant effect ($P<0.05$) on number of sheep offered for sale and sold in the middle zone, and on the number of goats offered for sale in the uplands. In the normal market situation the number of goats offered for sale

Table 1
Number of animals offered and sold, prices and weights for sheep in three market situations and three agro-ecological zones in Central Java, Indonesia

	Market Situation	**Market location**			***P*****
		Lowlands	**Middle zone**	**Uplands**	
Number of markets		3	4	3	
		Mean S.E.	Mean S.E.	Mean S.E.	
Sheep offered *(n)*	*Idul Adha*	228.7[a] ± 88.9	206.5[a] ± 22.6	47.0[a] ± 7.0	0.07
	Normal	110.3[a] ± 45.7	89.5[b] ± 10.0	13.3[a] ± 2.4	0.07
	Risky	64.0[a] ± 23.0	99.5[b] ± 14.4	29.0[a] ± 11.7	0.05
Sheep sold *(n)*	*Idul Adha*	43.0[a] ± 18.5	70.0[a] ± 11.2	11.7[a] ± 6.9	0.04
	Normal	29.3[a] ± 10.6	12.5[b] ± 1.7	3.7[a] ± 2.0	0.04
	Risky	20.7[a] ± 6.6	27.8[b] ± 11.2	7.0[a] ± 3.6	0.30
Price *(Rp* x 1000)*	*Idul Adha*	722.0[a] ± 37.5	545.0[a] ± 24.8	528.0[a] ± 39.6	0.01
	Normal	350.0[b] ± 28.9	385.0[b] ± 11.9	325.0[b] ± 8.3	0.16
	Risky	424.5[b] ± 37.2	309.2[c] ± 16.9	219.7[b] ± 24.2	0.00
Body weight of sheep sold *(kg)*	*Idul Adha*	41.0[a] ± 0.9	31.5[a] ± 4.3	29.7[a] ± 1.0	0.08
	Normal	25.0[b] ± 2.3	25.2[a] ± 2.8	25.0[b] ± 0.3	0.97
	Risky	28.7[b] ± 3.8	20.2[a] ± 1.1	19.4[c] ± 0.9	0.04

[a,b] Different superscripts denote significant differences between means within columns ($P<0.05$) in each parameter
*1 € = Rp 12 000 in 2004
**P = significance between zones

was significantly higher ($P<0.01$) in the uplands than in the other zones. Overall, the number of sheep offered for sale and the number sold were much lower in the uplands than in the other zones, whereas the number of goats offered for sale and numbers sold were much higher in the uplands than in the other zones.

Figure 1 aggregates the number of small ruminants offered and sold per market day in the different market situations and in the different agro-ecological zones. It visualises the increase in market volume and in number of animals sold during *Idul Adha*. The differences in market volume and in animals sold between the normal and risky market situation were relatively small.

The percentages of sheep and goats being sold compared to the supply was low in all zones and market situations: during the month of *Idul Adha,* normal market situations, and risky market situations, they were on average 26%, 21% and 29% for sheep, and 27%, 20% and 36% for goats respectively. Some of the animals offered that were not sold were offered again on the next market day and sometimes the sheep or goats were offered to a different small ruminant market place.

Table 2
Number of animals offered and sold, prices and weights for goats in three market situations and three agro-ecological zones in Central Java, Indonesia

	Market Situation	**Market location**			***P*****
		Lowlands	**Middle zone**	**Uplands**	
Number of markets		3	4	3	
		Mean S.E.	Mean S.E.	Mean S.E.	
Goats offered *(n)*	*Idul Adha*	130.0[a] ± 120.0	26.8[a] ± 12.7	233.0[a] ± 37.7	0.14
	Normal	23.0[a] ± 13.5	18.0[a] ± 8.8	120.3[a,b] ± 31.8	0.002
	Risky	56.0[a] ± 34.5	22.3[a] ± 12.3	70.7[b] ± 17.7	0.31
Goats sold *(n)*	*Idul Adha*	27.7[a] ± 24.2	10.3[a] ± 5.6	69.0[a] ± 40.5	0.28
	Normal	12.0[a] ± 7.0	2.0[a] ± 1.2	19.0[a] ± 11.7	0.27
	Risky	26.0[a] ± 22.0	8.3[a] ± 4.3	18.7[a] ± 5.2	0.58
Price *(Rp* x 1000)*	*Idul Adha*	572.0[a] ± 35.8	488.0[a] ± 40.7	478.0[a] ± 21.5	0.22
	Normal	333.0[b] ± 33.3	350.0[b] ± 23.7	350.0[b] ± 28.9	0.68
	Risky	414.3[b] ± 11.8	263.7[b] ± 36.3	303.5[b] ± 11.3	0.02
Body weight of goats sold *(kg)*	*Idul Adha*	33.0[a] ± 1.2	31.5[a] ± 4.5	28.4[a] ± 1.3	0.48
	Normal	24.0[b] ± 1.2	25.2[a] ± 2.4	26.0[a] ± 0.6	0.24
	Risky	26.3[b] ± 1.5	17.8[a] ± 3.3	22.6[a] ± 2.1	0.13

[a,b]Different superscripts denote significant differences between means within columns ($P<0.05$) in each parameter

*1 € = Rp 12 000 in 2004

**P = significance between zones

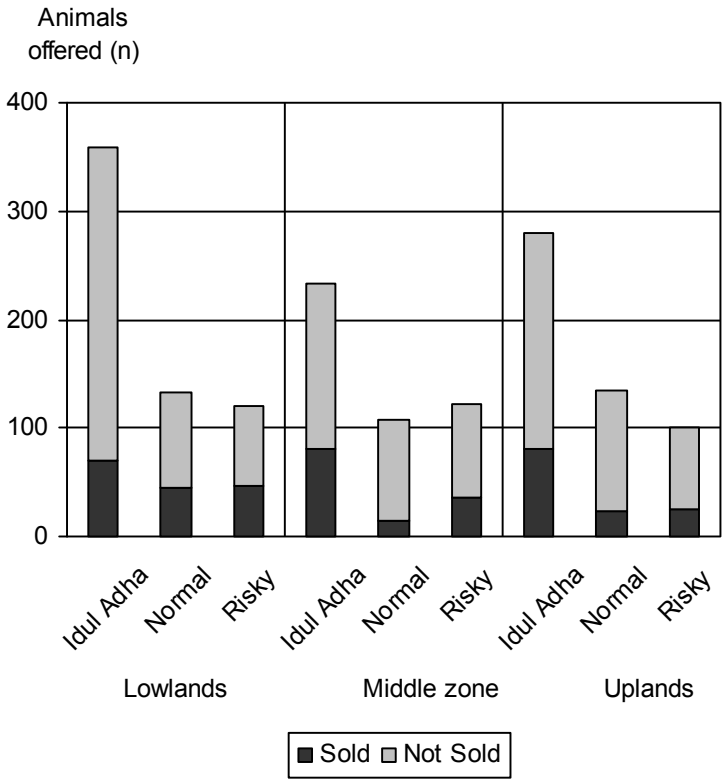

Figure 1
Average number of small ruminants offered and sold per market day in the *Idul Adha*, normal and risky market situation in three agro-ecological zones in Central Java, Indonesia

Market situation had a significant effect on the prices and body weights of sheep and goats sold for most market locations. Compared to the normal and risky market situations, prices of sheep being sold during *Idul Adha* increased, on average, 1.7 and 1.9 times respectively. Compared to the normal and risky market situations, prices of goats being sold during *Idul Adha* increased, on average, 1.5 and 1.6 times respectively. In the lowlands the prices of sheep and goats in the risky situation tended to be higher than in the normal situation, which was the opposite of the situation in the middle zone and the uplands. The highest prices for sheep during *Idul Adha* were found in the lowlands ($P<0.01$). The price of goats during *Idul Adha* also tended to be higher in the lowlands than in the middle zone and uplands. Market location had a significant effect on the price of sheep during the risky market situation ($P<0.001$) with the highest price in the lowlands.

Small ruminants being sold a few days before the *Idul Adha* celebration were all male, more than one year old, and with a minimum body weight of 25 kg. The increase in price during *Idul Adha* was related to the increase in body weight and the increase in price per kg of body weight. The prices of sheep per kg body weight during *Idul Adha*

were 17.6, 17.3, and 17.8 thousand rupiah for the lowlands, middle zone and uplands respectively, while during the normal market situation they were 14.0, 15.3, and 13.0 thousand rupiah respectively and during the risky market situation they were 14.8, 15.3, and 16.2 thousand rupiah respectively. The body weight of goats being sold varied widely between zones and the market situations. The price of goats per kg body weight was much higher during *Idul Adha* compared to the other market situations. During the *Idul Adha* market situation, the prices of goats per kg body weight for the lowlands, middle zone and uplands were 17.3, 15.5, and 16.8 thousand rupiah respectively, while during the normal market situation they were 13.9, 13.9, and 13.5 thousand rupiah respectively, and during the risky market situation they were 15.8, 14.8, and 13.4 thousand rupiah respectively.

Table 3 presents an overview of the marketing of sheep and goats by roadside sellers. Most sellers in the lowlands and the middle zone offered sheep rather than goats, while sellers in the uplands mainly supplied goats. Only a few goats were being sold in the lowlands and middle zones. This was comparable with the trends in the small ruminant markets. The percentage of small ruminants being sold by roadside sellers was higher than what can be found in the markets: it was 48% for sheep and 56% for goats. The average prices per head tended to be higher in the lowlands than in the other zones and tended to be higher for sheep than for goats.

The average number of animals being slaughtered per mosque during the day of *Idul Adha* is given in Table 4. There was a significant difference ($P<0.01$) in the number of sheep being slaughtered between the different zones, while the number of goats and cattle did not differ significantly. In the lowlands and the middle zones, sheep were the

Table 3
Average number and prices of sheep and goats marketed through roadside sellers during the Islamic month of *Idul Adha* in three agro-ecological zones in Central Java, Indonesia

		Market location		
		Lowlands	**Middle zone**	**Uplands**
Number of sellers		9	24	9
		Mean S.E.	Mean S.E.	Mean S.E.
Animals offered *(n)*	Sheep	$31^{ab} \pm 7.03$	$43^{a} \pm 5.59$	$7^{b} \pm 1.38$
	Goats	$4^{a} \pm 1.02$	$3^{a} \pm 0.94$	$32^{b} \pm 6.73$
Animals sold *(n)*	Sheep	$21^{a} \pm 6.71$	$16^{a} \pm 1.93$	$2^{b} \pm 0.56$
	Goats	$2^{a} \pm 0.76$	$1^{a} \pm 0.29$	$19^{b} \pm 8.50$
Price	Sheep	$700.0^{a} \pm 13.03$	$606.3^{a} \pm 9.18$	$583.0^{a} \pm 24.72$
(Rp x 1000)*	Goats	$544.0^{a} \pm 16.02$	$506.0^{a} \pm 12.57$	$458.0^{a} \pm 87.42$

[a,b]Different superscripts denote significant differences between rows ($P<0.01$)
*1 € = Rp 12 000 in 2004

predominant type of animal being slaughtered during Idul Adha, in contrast with the uplands, where hardly any sheep were slaughtered.

Figure 2 presents the trends in the average number of small ruminants per farmer in the different agro-ecological zones for a period of one year. The trends show a drop in flock sizes during Idul Adha and in the risky period. This drop in small ruminant numbers in the lowlands, middle zone and uplands during Idul Adha was 0.5; 0.7 and 0.3 animals per farm respectively, while during August-September it was 0.3; 0.3 and 0.6 animals per farm respectively.

Table 4
Average number of small ruminants and cattle slaughtered during *Idul Adha* per mosque in three agro-ecological zones in Central Java, Indonesia

	Mosque Location		
	Lowlands	**Middle zone**	**Uplands**
Number of Mosques	15	20	19
	Mean S.E.	Mean S.E.	Mean S.E.
Sheep	$6.4^{a} \pm 0.87$	$9.3^{a} \pm 1.64$	$0.3^{b} \pm 0.73$
Goats	$3.8^{a} \pm 0.62$	$2.4^{a} \pm 0.61$	$2.8^{a} \pm 1.71$
Cattle	$2.4^{a} \pm 0.26$	$2.8^{a} \pm 0.31$	$1.9^{a} \pm 1.78$

[a, b]Different superscripts denote significant differences between means within rows ($P<0.01$)

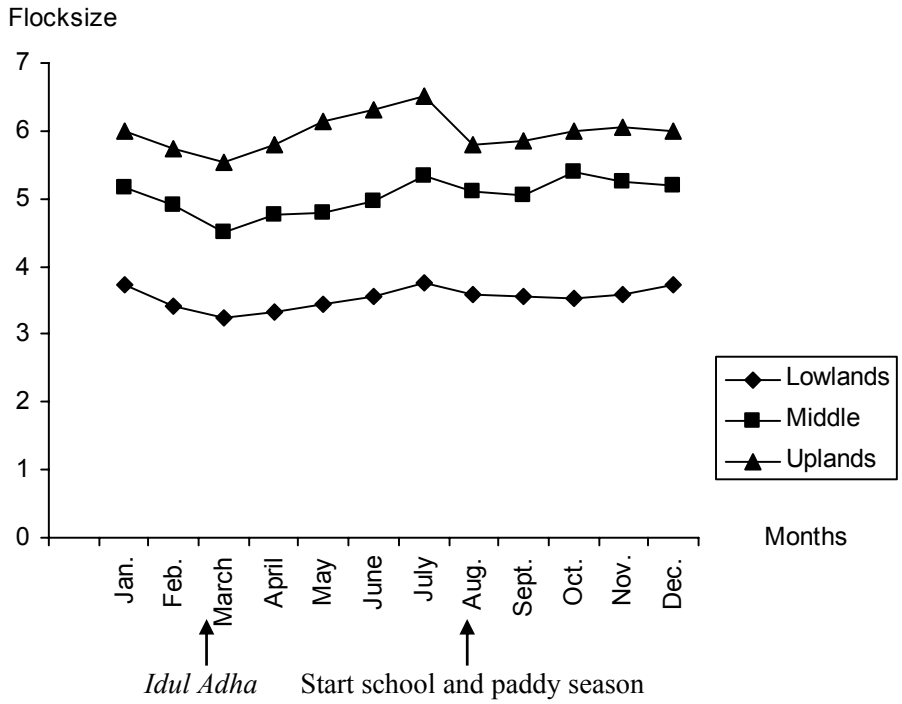

Figure 2
Changes over the year in flock size per farmer in three agro-ecological zones in Central Java, Indonesia

Table 5 gives farmers' information in relation to marketing of small ruminants. On average, 46% of the farmers had sold small ruminants over a period of one year. Forty and 55% of the farmers in the lowlands and middle zone who sold small ruminants sold them during *Idul Adha*. In the uplands this figure was only 21%. Mostly males were sold. The main reason for selling was urgent cash needs. In the lowlands and middle zone the selling prices of small ruminants during *Idul Adha* were 32% and 19% respectively,

Table 5
Farmers' information in relation to the marketing of small ruminants in three agro-ecological zones in Central Java, Indonesia

	Agro-ecological zones		
	Lowlands	**Middle zone**	**Uplands**
Number of farmers	50	50	50
Sales per farmer per year *(n)*	1.9	1.9	2.1
Farmers who sold small ruminants *(n)*	25	20	24
Sold in *Idul Adha (%)*	40	55	21
Sold in normal situation *(%)*	28	25	33
Sold in risky situation *(%)*	32	20	46
Type of small ruminants sold *(%)*			
Ram	77	29	44
Ewe	15	15	16
Doe	8	17	4
Lamb/Kid	0	39	36
Reason for sale *(%)*			
Urgent cash needs	48	39	58
Good price	29	46	38
Culling (sick, old animals)	24	16	4
Farmers sale price of small ruminants *(Rp* x 1000)*			
Idul Adha	490	475	NK
Normal situation	371	400	NK
Risky situation	282	350	NK
Small ruminants sold to *(%)*			
Village collectors (*Blantik*)	80	75	92
Small ruminants markets	13	0	0
Slaughter houses	7	25	8
Reason why animals sold via village collectors *(%)*			
Easy and fast	67	15	71
Reduced transport cost	11	46	12
High price	5	4	17
Long distance to markets	17	35	0
Price difference market and village collector *(%)*			
Yes	61	50	21
No	31	43	79
Did not know	8	7	0
Reliability of village collector in assessing price *(%)*			
Yes	67	81	50
No	8	15	0
Did not know	25	4	50

NK=not known; *1 € = Rp12 000 in 2004

higher than in the normal market situation and 74% and 36% respectively higher than in the risky market situation. In the uplands, the farmers did not give the exact price of small ruminants; most farmers in the uplands answered that they did not know the exact price. They were not so much aware of differences in prices between the *Idul Adha* period and other periods of the year. Most farmers (82%) sold their small ruminants to the village collectors. Overall, farmers felt that the village collectors were reliable in assessing the prices, although farmers invariably complained about the prices they received. In general, there was only very little market information available to them.

4.4. Discussion

In Indonesia, the small ruminant marketing system follows a unique model involving many stakeholders. The main actors are farmers, village collectors and long-distance traders. During religious festivities, roadside sellers and mosques are also involved in this marketing system. Also small vendors of roasted meat and other small dishes play a part; they are also butchers of small ruminants. In the cities, retail butchers sell mutton to, for instance, restaurants. Farmers rarely sell their animals directly on the small ruminant market due to the transport costs, the time required, and the fact that they are not in a strong bargaining position towards the traders. Farmers most commonly sell their small ruminants through the local village collector, to whom they generally have easy access, even in isolated areas. Farmers are familiar with this person who lives in the same village and sometimes is a member of a farmers group in the village.

Often, the village collector is assisted by 1-2 persons to buy or sell small ruminants. The village collector takes the animals to the small ruminant market. Only few farmers doubted the reliability of the village collectors in assessing the price. Overall, the difference in the prices received by the farmers during the normal and risky market situations and the market prices were not great, however, during *Idul Adha* the market prices and prices for which the roadside sellers sold animals were considerably (about one-quarter) higher than the prices received by the farmers. The supply of small ruminants was always much larger than the demand; on average only 26% of the animals offered on a single market day were sold. This indicates that small ruminant marketing is not very efficient. If the animals are not sold, village collectors bring them home and wait for the next market day or they take the animals to a different market place. When the study was done, it was found that we met the same village collectors in different small ruminant market places, which is possible because each small ruminant market has different opening days. Long-distance traders operate between small ruminant markets in different regions. They buy animals from the village collectors and sell them again on different markets. Traders can even stock animals over a longer period, while waiting for better market prices. The traders have small trucks with which they transport the animals;

some traders transport the animals to the capital city Jakarta. The buyers from these traders can be small vendors, retail butchers, or consumers. Consumers are often individuals who wish to celebrate the birth of a child, as it is stipulated in the Moslem rules that the birth of a son should be celebrated by slaughtering two male sheep or goats, while the birth of a daughter is celebrated by the slaughtering of one male sheep or goat.

Roadside sellers buy small ruminants from farmers or small ruminant markets about four weeks before the *Idul Adha* celebration. At this time the prices have not increased yet. They keep small ruminants in their home and send them to graze on football fields and roadsides. Two weeks before *Idul Adha*, they start to offer the small ruminants at a strategic position along the roadside where buyers have easy access. The buyers of small ruminants from the roadside sellers are individuals who intend to sacrifice the animal bought for *Idul Adha.* The percentage of small ruminants being sold was much higher on the roadsides than on the markets. The prices seem to be similar to the small ruminant market prices.

Idul Adha has a very significant effect on the small ruminants markets. All parameters investigated in the small ruminant markets tended to increase drastically: supply, demand, price, and body weight. Small ruminants being sold on one market day increased during *Idul Adha* 3.0 times and 1.4 times and the prices increased, on average, 1.6 and 1.8 times respectively as compared to the normal and risky market situations. The increase in prices was based on the higher body weight of animals offered during *Idul Adha* and a higher price per kg during *Idul Adha*. The higher body weight is the result of the requirement that small ruminants offered during the *Idul Adha* celebration are male animals of more than one year of age with 25 kg of body weight or more. The prices per kg body weight for sheep and goats were comparable. On average, the price per kg body weight during *Idul Adha* was 17.2 thousand rupiah, while during the normal and risky market situation this was 14.0 and 14.8 thousand rupiah respectively. In different regions, Mauritania, Pakistan, Nigeria and the Sahel (Thys and Wilson, 1996; Rodriguez et al., 1995; Jabbar, 1998; Turner and Williams, 2002), higher live weights of small ruminants marketed before the Islamic holidays have been found. In Ethiopia, prices were also seasonal with higher premiums paid during some religious festivals (Andargachew and Brokken, 1993). In 1982, Soedjana reported that prices tend to increase by as much as 25% during the month of *Idul Adha* in West Java. The present study showed much higher increases in prices. The major reason for this higher increase in prices is that each Moslem family who has a higher living standard would like to sacrifice during *Idul Adha* by slaughtering a sheep or a goat, and that the number of people with a higher living standard has considerably increased over the past two decades.

In the lowlands and middle zone, sheep were the predominant type of animals offered, being sold on the market and at the roadsides, and slaughtered in mosques. The upland markets were dominated by goats. According to Panin and Mahabile (1997),

Moslems' preference for sheep meat is a crucial factor for rearing sheep. Reasons for the preference of sheep could be related to a preference for fat meat (Thys and Wilson, 1996). Apart from the consumer's preferences, supply of small ruminants during the month of *Idul Adha* is affected by the farming practices of the zones. In the lowlands, sheep dominated supply and demand, although slightly more goats than sheep are kept. This could be related to the large supply of sheep from outside the region in the *Idul Adha* period. In the middle zone, slightly more sheep are kept than goats, while in the uplands considerably more goats are kept than sheep. The large increase in sheep sold during *Idul Adha* and the high number of sheep slaughtered in the mosques in the middle zone was closely linked to the living standard in this zone. The Sleman (middle zone) district had the highest gross regional domestic product (GRDP) per capita, namely 449.59 million rupiah, while in the Bantul (lowlands) and Kulonprogo (uplands) district they were only 2.33 and 2.06 million rupiah respectively (Badan Pusat Statistik, 2000). The Sleman region is close to the provincial capital Yogyakarta, it is also a region with many educational institutes.

The number of cattle slaughtered per mosque during *Idul Adha* did not differ between zones; on average, it was 2.4. The *Idul Adha* rules stipulate that cattle must be sacrificed by 7 people. So, people who would like to sacrifice cattle have to find six neighbours to join them. This is another reason why people prefer sheep and secondly goats for slaughtering during *Idul Adha*.

For the farmers, selling of small ruminants during the risky situation seems to be as important as selling during *Idul Adha*, but the prices are lower than those during *Idul Adha*. Farmers consider that rearing small ruminants is the best way to accumulate capital and to use it when they need urgent cash money. Most farmers sell one or two of their small ruminants in this situation. The farmers' information showed that in the risky market situation more farmers sold small ruminants than in the normal market situation and the prices farmers received were lower. The reason given by the farmers for disposing small ruminants was that they had urgent cash needs for school fees and preparation of paddy fields. In the middle zone and the uplands the risky market situation for the farmers was reflected in the lower body weight of small ruminants marketed compared to the normal situation. Consequently, the market price of small ruminants in these zones tended to decrease in the risky situation. This was not so for the price per kg body weight. In the lowland markets, the risky market situation for the farmers was not reflected in lower body weights and prices at the markets in the risky situation. These markets are more easily accessible by traders and buyers from outside the region than the markets in the middle zone and the uplands.

The small ruminants' marketing is reflected in the small ruminants' numbers owned by the farmers, as shown in Figure 2. The average number of small ruminants kept dropping rapidly in March, particularly in the lowlands and middle zone, in which month

the *Idul Adha* festivities took place. After the month of *Idul Adha*, the number of small ruminants increased again. In August, the number of small ruminants decreased, which coincided with the farmers urgent cash needs due to paddy field preparation, paying school fees for their children, and sometimes lack of staple food and crop failures. Thereafter the average flock sizes stabilised again.

Small ruminant farmers in the lowlands and middle zone were slowly but surely thinking differently about selling their small ruminants. About 20 percent of these farmers sold small ruminants during the *Idul Adha* celebration. In contrast, farmers in the uplands hardly seem to optimise their small ruminant production to the *Idul Adha* celebration. Upland farmers said that they were not aware of differences in prices between small ruminants during Idul Ada, normal or risky market situations.

Farmers claim that the major constraint in small ruminant marketing is the price they receive for their animals. For the farmers it is difficult to arrange their sale of small ruminants in relation to the period when the prices increase. In a smallholder setting the planning of selling animals is difficult anyway, in particular when the attractive market situation requires adult males of at least 25 kg, as the *Idul Adha* market does. Overall, about half of the sales were due to urgent cash needs, so it can be concluded that most farmers cannot make proper use of the *Idul Adha* market opportunity. In Pakistan, Rodriguez et al. (1995) also found that farmers felt that they were not in a position to bargain efficiently, because of the frequent need of selling small ruminants for urgent cash requirements. Farmers also complained that there was no marketing information available to them. The only information they receive is via the village collectors. For poultry products the government releases information on product prices on a regular basis. Such information should also be made available to small ruminant keepers. Maybe in the future, modern communication technologies could be helpful in this.

The consumers are in a weak position too. Recently, many people preferred to send money to their mosque instead of buying an animal themselves. A committee from the mosque buys small ruminants collectively from roadside sellers or from small ruminant markets. The actors who benefit most from the present marketing system seem to be the long-distance traders. The village collectors are the link between the farmers and the traders. They are often a respected member of the village society. In future they could start thinking of selling animals directly to small vendors and retail butchers, and not via long-distance traders. However, it should be realised that since the 1980s the road infrastructure has improved considerably and the long-distance traders have integrated the local markets into a national market system (Knipscheer et al., 1987). If the present marketing chain was shortened, this could also help to bring demand and supply more in agreement. Already, the marketing structure of small ruminants in our study seems to be simpler than in the previous study by Knipscheer et al. (1987). There were no intermediate traders (*Blantik cilik* and *Blantik gede*) found in our study. The marketing

model might also be shortened by strengthening farmers groups who could organise the slaughtering of livestock themselves and sell the products to the consumers. This could be beneficial for both farmers and consumers. However, it should be realised that small ruminants are only a secondary activity on a smallholder mixed farm. Farmers will not have much time available to spend on small ruminant marketing.

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Chapter 5

Air and water qualities around small ruminant houses in Central Java - Indonesia

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Abstract

There is general concern that livestock can have a profound effect on the environment, also in smallholder production systems. This paper presented the impact of small ruminants on the quality of air and water in and around small ruminant houses. In total 27 small ruminant houses from the three agro-ecological zones, lowlands, middle zone and uplands, in the Province of Yogyakarta, Indonesia were monitored to investigate gas emissions and water pollution. Air samples were taken by using a gas catching tool filled with absorbents for gases. The gases mainly consisted of ammonia, nitrogen oxides, dihydrogen sulphide, sulphur dioxide and hydrocarbons. Groundwater samples were collected from the farmers' wells, adjacent to the small ruminants houses. The main water chemical parameters analysed were pH, turbidity, iron, fluoride, calcium carbonate, chloride, manganese, nitrate, nitrite, dihydrogen sulphide, and organic matter, while the bacterial indicators were faecal coliform and total coliform. Gas concentrations in the air were highest inside the houses while around the houses their concentrations decreased rapidly on both the tailwind and headwind side. The concentrations of the gases were below the admissible levels assessed by the local government, except hydrocarbons in the middle zone, which was probably related to the storage of the manure inside the houses. The impact of small ruminants on water pollution was much greater than on air pollution. Some of the physico-chemical parameters showed high concentrations and nearly reached the admissible limit. The water sources had very high levels of faecal coliform bacteria and total coliform bacteria, two groups of bacteria used as indicators for water contamination caused by manure. It can be concluded that, in Central Java, management and housing of small ruminants close to the family quarters causes little environmental problems; however, attention should be paid to water quality.

Keywords: Small ruminants, Air quality, Water quality, Bacterial pathogens, Indonesia.

5.1. Introduction

In recent years there has been a great interest in the impact of livestock on the environment. One of the environmental issues is that livestock can be a source of anthropogenic emissions and water pollution (de Haan et al., 1996). Gases are usually produced by fermentation of roughages by ruminants, and by manure storage. Different air pollutants are released directly into the atmosphere in their unmodified forms and in sufficient quantities to carry a health risk for both humans and ecosystems, such as carbon dioxide, methane, nitrogen oxides, ammonia and dihydrogen sulphide (O'Neill and Phillips, 1992; Enger and Smith, 2000). Odour from manure can be problematic, for example through high concentrations of sulphur dioxide, which causes coughing, cramp of the respiratory tract and suffocation (Kovacs, 1985; Taylor and Field, 1998). Wastewater can contain high concentrations of pathogenic or indicator bacteria, which can act as a potential reservoir for contamination of groundwater (Gustafsson, 1997). Pollution is also caused by the extensive use of manure as fertiliser (Vidal et al., 2000). Slurry and faeces of grazing animals can carry a variety of bacterial and protozoan pathogens, and groundwater can be contaminated with nitrates and nitrites. These problems can have adverse effects on communities that depend solely on groundwater as a source of water. Indicator bacteria for faecal pollution are used for the determination of water pollution and the overall hygienic status of ecosystems (Cho et al., 2000).

The greatest impact of emissions comes from feedlot cattle, dairying, and commercial poultry and pigs (Dentener and Crutzen, 1994). The intensification of livestock production has encouraged farmers to rely more heavily on external inputs, and very often the waste is considered a disposal problem rather than a useful source of plant nutrients (Hooda et.al., 2000). In developing countries the family based smallholder mixed farming system will continue to be the dominant livestock production system. In smallholder systems livestock manure is still an important source of nutrients to fertilise the land. However, also smallholder systems are expected to intensify to meet the increasing demands due to population increase, urbanisation and economic progress (Delgado et al., 2001). In Indonesia, the government promotes intensification of small ruminant production to increase the animal protein consumption, especially in the rural areas (DEPTAN, 2003). Moreover, the demand for small ruminants increases rapidly, because of their multiple functions, including their role in religious festivities. Government policies on small ruminant development tend to be production oriented and no attention is given to their impact on the environment. Schulte (1997) and El Aich and Waterhouse (1999) claim that in tropical countries small ruminants can be a great threat to their immediate environment.

Indonesian farmers manage their small ruminants in traditional ways in small numbers, so this seems to be no immediate cause of concern for the environment.

However, small ruminants' houses are usually very close to the family quarters. The expected increase in numbers of small ruminants and the fact that small ruminants are kept so close to the living quarters can pose a pollution threat. In Yogyakarta province, the local government has published the acceptable limits of gas emission and water quality, in order to protect the environment (Yogyakarta Government, 1991). This paper investigates the effect of small ruminants on the air and water quality inside and around small ruminants' houses in Central Java.

5.2. Materials and Methods

5.2.1. Study area

The study was performed in three agro-ecological zones in the Province of Yogyakarta, Central Java, Indonesia. The classification of agro-ecological zones is primarily based on their altitude. Each zone has a different topography, soil types, soil fertility and agro-climatic conditions. The lowlands are found at less than 100 m above sea level (asl). The average annual rainfall is 2099 mm, the average number of rainfall days is 11 days/month with monsoon rains from October to April (Badan Pusat Statistik, 2000). The lowlands are characterised by a rice monoculture cropping system and the main component of animal feed is native grass. Cattle are the dominant livestock type. The middle zone has been defined as the area between 100 and 500 m asl. The average annual rainfall is 3888 mm, the average number of rainy days is 20 days/month with monsoon rains from November to April. Characteristics of this zone are multiple cropping systems, with a combination of paddy fields and annual crops. The populations of small ruminants and large ruminants are about the same. The uplands are found above 500 m asl. The average annual rainfall varies from 1319 to 5255 mm, with 8 rainy days/month and monsoon rains from November to March. The main crops are cassava, maize, groundnut and vegetables. Some perennial crops are also available, i.e. banana and coconut. In particular goats are found in these areas. The goats are Etawah grade goats: crosses between the local Kacang and Jamnapari (in Indonesia referred to as Etawah).

In total, 27 small ruminants' houses were included in this study. Each zone was represented by 9 small ruminants' houses. The numbers of small ruminants per house varied between 3 to 11 heads, the average age of the small ruminants was more than one year old and the bodyweight around 20-25 kg. On average, the density in the upland housing was 0.8 head/m^2, while in the middle zone and lowlands it was 0.7 head/m^2. All houses had an open construction. In addition, most houses in the lowlands and middle zone had an earthen floor, while in the uplands slatted floors were used. None of the farmers used bedding for their housing floor. Cleaning the small ruminants houses was a daily activity, in the middle zone however, faeces were kept for several days in the

houses. The management systems of small ruminants consisted of a combination between grazing and confinement, with the average grazing time being 3.6 hours per day. In the lowlands, feed composition consisted of field grass and crop residues such as maize straw and cassava peels, while in the middle zone and upland areas it contained a combination of field grass, roughages such as caliandra and elephant grass. Animals were supplemented with small amounts of rice bran.

The houses selected were dispersed widely from other houses to minimize the possibility for cross-contamination. Sampling of air and water was done at the same moment from May to July, 2002. Each house was sampled once. In the uplands, sampling and analysis were done in May, in the middle zone in June and in the uplands in July.

5.2.2. Air quality analyses

Prior to air sampling, the wind direction was assessed by using an anemometer and the temperature and humidity in the houses were recorded. Air samples were taken in the morning before the houses were cleaned and the sample spots were inside the house and 50 meters from the house on the tailwind (the wind coming from the direction of the houses) and the headwind (the wind coming towards the houses) sides. Air samples were taken for one hour using the gases catching tool. This tool consisted of an automatic small pump that catches the air and pumps it into 5 tubes. These tubes were filled with an absorbent needed to measure, ammonia, nitrogen dioxide, dihydrogen sulphide, sulphur dioxide, and hydrocarbons. Gas contents consisted of ammonia (NH_3), nitrogen dioxide (NO_2), dihydrogen sulphide (H_2S), sulphur dioxide (SO_2), and hydrocarbons ($C_nH_{2n+2;}$ mainly CH_4). Sampling, sample handling and analysis were in all cases in accordance with Leithe (1971) and the ASTM standard methods (1997), namely spectrophotometer and gas chromatography to analyse NH_3, NO_2, H_2S and SO_2 (Leithe, 1971) while hydrocarbons were analysed by non-dispersive infrared detectors (ASTM, 1997). NH_3 was analysed using indophenol reaction, NO_2 was determined with the Saltzman reagent, analysis of H_2S was done by using the methylene blue method (Jacobs method) and SO_2 was analysed according to the West and Gaeke method (Leithe, 1971).

5.2.3. Water quality analyses

Groundwater samples were collected from the farmers' wells located adjacent to the small ruminants houses (10 m). Some farmers did not have wells; they obtained their water from public water resources and the river. In the middle zone, we obtained only 4 groundwater samples due to the fact that most farmers used a drinking water pipe coming from the mountains. The methods used for water quality analyses were as described in Standard Methods for the Examination of Water and Wastewater (Greenberg et al., 1992). The main parameters analysed were pH, turbidity (measured in nephalometric turbidity units, NTU), calcium carbonate ($CaCO_3$), the ions of iron ($Fe^{2+/3+}$), fluoride (F^-),

chloride (Cl^-), manganese ($Mn^{2+/5+}$), nitrate (NO_3^-), and nitrite (NO_2^-), dihydrogen sulphide (H_2S), and organic matter. The bacterial indicators were faecal coliform and total coliform. These parameters were chosen in accordance with their general importance as water parameters assessed by the local government (Yogyakarta Government, 1991).

5.2.4. Statistical analyses

The air and water quality parameters were analysed by using an analytical model with zone as factor. The relationship between the number of small ruminants per house and the emissions were tested with General Linear Model test using numbers of small ruminants per house as covariable. The differences between means were analysed using the Tukey's (HSD) test.

5.3. Results

In Central Java, the small ruminant management systems differ between agro-ecological zones. In the lowlands, the farmers keep small ruminants in confinement during the night and graze them during the day, while in the middle zone and uplands, most farmers keep small ruminants in confinement only. Farmers in the lowlands cleaned the houses every day, when the animals were grazed. In the middle zone, small ruminants manure was kept in the barn for several days. Farmers in the uplands usually had a small pit to put the manure, adjacent to the houses.

The average temperatures, humidities and wind velocities inside the houses are presented in Table 1. The zones differed significantly ($P<0.05$) in temperature and humidity. Temperature and humidity ranges were from 25 to 30 °C and 60 to 91% respectively. The highest average temperature was found in the lowlands, 29.2 °C, while the uplands had, on average, the highest humidity, 81.7%. The wind velocity varied widely, ranging from 0.4 to 4.5 km h^{-1}. However, it did not differ significantly between the agro-ecological zones.

Table 1
Average temperature and humidity inside, and wind velocity outside small ruminants' houses in three agro-ecological zones in Central Java, Indonesia

	n	Temperature (°C)		Humidity (%)		Wind velocity (km/h)	
		Mean	*S.E.*	*Mean*	*S.E.*	*Mean*	*S.E.*
Zone							
Lowlands	9	29.2[a]	0.22	75.9[a]	0.94	2.7[a]	0.29
Middle zone	9	27.4[b]	0.14	67.7[b]	1.13	2.3[a]	0.36
Uplands	9	27.9[b]	0.26	81.7[c]	0.99	2.4[a]	0.48

[a.b.c]Different superscripts denote significant differences between means within columns ($P<0.05$)

The statistical analysis showed that the differences in zones and the numbers of small ruminants per house did not have a significant effect on the NH_3 concentration, the NO_2 concentration and on SO_2 inside (Table 2) and around the houses (Tables 3 and 4)

Table 2
Gases concentration (ppm) inside small ruminants' houses in three agro-ecological zones in Central Java, Indonesia

Air parameters	n	Agro-ecological zone: Lowlands Mean	Lowlands S.E.	Middle zone Mean	Middle zone S.E.	Uplands Mean	Uplands S.E.	b	Accept. Limit[1)]
NH_3	9	0.36[a]	0.11	0.42[a]	0.06	0.40[a]	0.09	0.010	2.00
NO_2	9	0.010[a]	0.002	0.013[a]	0.002	0.013[a]	0.001	-0.0003	0.20
H_2S	9	0.016[a]	0.008	0.032[b]	0.010	0.022[a]	0.006	-0.0023	0.03
SO_2	9	0.002[a]	0.0004	0.004[a]	0.0007	0.004[a]	0.0011	-0.0003	0.30
C_nH_{2n+2}	9	0.02[a]	0.02	0.48[b]	0.17	0.03[a]	0.02	0.020	0.24

[a,b]Different superscripts denote significant differences between means within a row (P<0.05)
b: regression coefficient for number of animals
[1)]Yogyakarta Government, 1991

Table 3
Gases concentration (ppm) on tailwind side small ruminants' houses in three agro-ecological zones in Central Java, Indonesia

Air parameters	n	Agro-ecological zone: Lowlands Mean	Lowlands S.E.	Middle zone Mean	Middle zone S.E.	Uplands Mean	Uplands S.E.	b	Accept. Limit[1)]
NH_3	9	0.13[a]	0.06	0.12[a]	0.03	0.17[a]	0.02	0.003	2.00
NO_2	9	0.008[a]	0.002	0.011[a]	0.002	0.012[a]	0.003	0.0001	0.20
H_2S	9	0.003[a]	0.001	0.011[b]	0.003	0.008[a]	0.002	0.0008	0.03
SO_2	9	0.003[a]	0.0007	0.001[a]	0.0004	0.004[a]	0.0017	-0.0007	0.30
C_nH_{2n+2}	9	0.03[a]	0.02	0.27[b]	0.014	ND[a]	-	0.01	0.24

[a,b]Different superscripts denote significant differences between means within a row (P<0.05)
b: regression coefficient for number of animals
ND= not detectable; [1)]Yogyakarta Government, 1991

Table 4
Gases concentration (ppm) on headwind side small ruminants' houses in three agro-ecological zones in Central Java, Indonesia

Air parameters	n	Agro-ecological zone: Lowlands Mean	Lowlands S.E.	Middle zone Mean	Middle zone S.E.	Uplands Mean	Uplands S.E.	b	Accept. Limit[1)]
NH_3	9	0.11[a]	0.07	0.08[a]	0.03	0.22[a]	0.04	0.009	2.00
NO_2	9	0.008[a]	0.003	0.005[a]	0.001	0.009[a]	0.001	-0.0007	0.20
H_2S	9	0.004[a]	0.001	0.008[a]	0.002	0.010[a]	0.002	-0.0002	0.03
SO_2	9	0.002[a]	0.0005	0.001[a]	0.0002	0.002[a]	0.0007	-0.0007	0.30
C_nH_{2n+2}	9	0.010[a]	0.010	0.120[b]	0.050	ND[a]	-	0.010	0.24

[a,b]Different superscripts denote significant differences between means within a row (P<0.05)
b: regression coefficient for number of animals
ND= not detectable; [1)]Yogyakarta Government, 1991

All observations were well below the acceptable limit. In general, the NO_2 concentrations in the surrounding of small ruminants' houses were only slightly lower than inside the houses. All observations were well below the acceptable limit.

The zones had a significant effect ($P<0.05$) on the H_2S concentration inside the houses (Table 2) and on the tailwind and headwind sides (Table 3 and Table 4), while the differences in the numbers of small ruminants per house did not have a significant effect indicated by the low value of regression co-efficient. In the lowlands, H_2S ranged between 0.007 and 0.065 ppm, while in the middle zone and uplands it ranged between 0.004 – 0.099 and 0.006 – 0.079 ppm respectively. The H_2S concentration was the highest in the middle zone. The average value inside the houses for the middle zone was well above the acceptable level. The H_2S concentration decreased rapidly at 50 m from the house, either on the tailwind (range: 0.003 – 0.018 ppm) or on the headwind (range: 0.002 – 0.012 ppm) side. The average level of H_2S inside the houses was 3.3 times higher than in the tailwind and the headwind.

The zone had a significant effect ($P<0.05$) on the hydrocarbons concentration, either inside the house (Table 2), or on the tailwind (Table 3) and headwind sides (Table 4), while the numbers of small ruminants per house did not have a significant effect because the regression co-efficient was low. The average hydrocarbons content in the middle zone was 5.6 to 26.2 times higher than in lowlands and uplands, and 2 times higher than the acceptable limit of 0.24 ppm. The hydrocarbons concentrations on the tailwind and headwind sides were much lower than those inside the houses. The average level of hydrocarbons inside the houses was 1.8 and 4.5 times higher than in the tailwind and the headwind respectively. The decrease in hydrocarbons concentration on the tailwind and headwind side, compared to inside the houses, was -50; 44; 100% and 50; 75; 100% for lowlands, middle zone and uplands respectively. The levels of hydrocarbons inside small ruminants' houses ranged between 0 to 1.5 ppm, while on the tailwind and headwind sides it ranged between 0 to 1.30 and 0 to 0.40 ppm respectively.

Table 5 presents the quality of ground water (sources of farmers' drinking water) adjacent to the small ruminants' houses. Zones did not have a significant effect on the physico-chemical values of water such as turbidity, iron, fluoride, manganese, nitrate and nitrite, except for the acidity (pH). The highest pH was found in the uplands, pH ranged between 6.4 in the lowlands and 7.4 in the uplands. All observations were well below the acceptable limit. In all zones, there was a high variability for the majority of parameters, caused by the differences in the housing systems and the management of small ruminants, such as cleaning the houses.

The groundwater was relatively clean in terms of turbidity in all zones. The concentration of manganese was high, in the lowlands the average concentration, of 1.01 mg l^{-1}, was much higher than the acceptable limit of 0.10 mg l^{-1}. In the lowlands, it varied from 0.05 to 4.86 mg l^{-1}, while in the middle zone and uplands it varied from 0.05 to 0.34

Table 5
The quality of ground water around small ruminants' houses in three agro-ecological zones in Central Java, Indonesia

Water parameters	Zone						*P*	Accept. limit[1)]
	Lowlands		Middle zone		Uplands			
	Mean	*S.E.*	*Mean*	*S.E.*	*Mean*	*S.E.*		
Number of samples	9		4		8			
pH	6.74[a]	0.07	6.80[a]	0.00	7.08[b]	0.09	0.02*	6.5-8.5
Turbidity *(NTU units)*	1.33[a]	0.76	0[a]	0.00	2.50[a]	0.98	0.30	5
$Fe^{2+/3+}$ *(mg l^{-1})*	0.05[a]	0.01	0.04[a]	0.003	0.09[a]	0.02	0.08	0.3
F^- *(mg l^{-1})*	0.37[a]	0.10	0.21[a]	0.09	0.12[a]	0.03	0.10	1.5
Cl^- (*mg l^{-1}*)	36.03[a]	9.13	30.66[a]	19.83	10.26[a]	2.00	0.08	250
$CaCO_3$ *(mg l^{-1})*	155.56[a]	26.27	96.67[a]	36.84	143.88[a]	32.03	0.57	500
$Mn^{2+/5+}$ *(mg l^{-1})*	1.01[a]	0.87	0.05[a]	0.00	0.11[a]	0.04	0.21	0.10
NO_3^- *(mg l^{-1})*	3.32[a]	2.27	3.50[a]	1.93	0.86[a]	0.39	0.54	10
NO_2^- *(mg l^{-1})*	0.001[a]	0.0003	0.0013[a]	0.001	0.020[a]	0.02	0.52	1.00
H_2S *(mg l^{-1})*	ND		ND		ND		-	0.05
Organic matter *(mg l^{-1})*	3.72[a]	1.65	2.11[a]	0.28	2.71[a]	0.69	0.75	10
Total coliform *(cfu/100 ml)*	1822[a]	263	920[a]	0.00	1579[a]	404	0.35	0
Faecal coliform *(cfu/100 ml)*	793[a]	317	202[a]	169.3	853[a]	326	0.54	0

**P*<0.05
[a,b]Different superscripts denote significant differences between means within a row (*P*<0.05)
ND = not detectable
[1)]Yogyakarta Government, 1991

mg l^{-1}. The concentrations of nitrate and nitrite, known as primarily inorganic compounds from livestock wastewater and manure, were not excessive. Nitrate was much higher in the lowlands and middle zones than in the uplands, however, the nitrate levels were well below the acceptable limit.

There was a high concentration of microbiological faecal indicators. They varied widely between zones and water sources. In the lowlands, the lowest number was 4 cfu/100ml and the highest was 2400 cfu/100ml, while in the middle zone and the uplands it varied from 23 to 2400 cfu/100ml for coliform. The number of total coliform was 2 and 1.7 times higher and faecal coliform was 3.9 and 4.2 times higher in the lowlands and uplands than in the middle zone respectively; however, the differences between zones in total and faecal coliform were not significant.

5.4. Discussion

In the lowlands and uplands, all small ruminant houses had slatted floors, while the houses in the middle zone had an earthen floor. This results in a difference in manure management between the agro-ecological zones. In the middle zone manure is kept for several days inside the barn. The farmers in the uplands used small ruminants' manure as main sources to fertilise their crops. They perceived that small ruminants manure is the

best fertiliser for palm fruit trees. The benefits of the use of manure in crop production are improvements in soil physical properties and the provision of N, P, K, increases the soil organic matter content, which leads to an improved water infiltration and water holding capacity (Hoffmann et al., 2001). Farmers actually recognise a difference in quality among manure and compost (Tanner et al., 2001), however, there was no compost made by the farmers in this study. Composting manure requires a lot of labour and it must be handled carefully to prevent immature compost. From environmental point of view, however, compost would have a positive effect on reducing environmental problems caused by livestock. In some areas of West Java, farmers have produced a traditional compost to suit particular soil and crop types, by mixing faeces and feed in small pits, as done by some upland farmers in this study.

The temperature inside the houses was slightly higher in the uplands than in the middle zone, which could have been affected by the type of floor. In addition, animal densities of the houses in the uplands were slightly higher than in the middle zone (0.8 head m^2 *vs* 0.7 head m^2). However, these animal densities were relatively low and had no significant effect on the concentrations of the different gases. The highest concentration of all gases in the study was found in the middle zone. This may have been caused by the different management of the faeces.

The concentrations of the different gases decreased rapidly outside the small ruminant houses and were below the acceptable limits that were assessed by the local government, except for hydrocarbons on the tailwind side in the middle zone. In general, the concentrations on the tailwind side were not really different from the headwind side.

H_2S concentrations inside the houses were near the maximum level allowed by the local government. The acceptable limit of H_2S is 0.03 ppm (Yogyakarta Government, 1991), whereas the level observed was, on average, 0.023 ppm. In the middle zone, the H_2S concentration was well above the acceptable level, it was caused by the management of faeces, as faeces was not removed directly from the houses. For the large ruminants in Central Java average levels of H_2S inside the houses was much larger than in this study: 0.06-0.12 ppm (Baliarti et al., 1994; Budisatria, 1995). The California state-wide ambient air quality standard (CAAQS) for H_2S is also using 0.03 ppm as acceptable limit (Collins and Lewis, 2000). The World Health Organization (WHO) recommends that, in order to avoid substantial complaints about odor annoyance among the exposed population, H_2S concentrations should not be allowed to exceed 0.005 ppm, with a 30-minute averaging time (WHO, 1981), a level much lower than the acceptable limit used by the Yogyakarta Government. The average level of NH_3 inside the houses was 0.39 ppm, the maximum concentration found was 1 ppm, whereas the acceptable limit is set at 2.0 ppm (Yogyakarta Government, 1991). The average level of NH_3 inside the houses in this study was well below than in the study for large ruminants in Central Java (Baliarti et al., 1994), with an NH_3 level of 1.4 ppm. Both H_2S and NH_3 have received much attention,

primarily because of their effects on human and animal health, odour, and because of corrosive effects of H_2S on materials (Schulte, 1997; Tamminga, 1992). Above levels of 7 ppm, there was an association between NH_3 concentration and health problems of the workers and with 11 ppm, pigs showed reduced growth rates (Donham, 1991). Compared to these values, it can be said that smallholder small ruminant production systems, with a relatively small number of small ruminants per house (3 - 11 heads) pose no serious threat as far as NH_3 emissions are concerned. Hydrocarbons concentration inside the houses in the middle zone was, on average, 2 times higher than the acceptable limit of 0.24 ppm (Yogyakarta Government, 1991). The average level of hydrocarbons inside the houses in the middle zones was quite similar with the study for large ruminants in Central Java (Budisatria, 1995), which found a hydrocarbons level around 0.48 ppm. In the middle zone the concentrations of hydrocarbons on the tailwind side were also higher than the acceptable limit. The high hydrocarbons concentrations in the middle zone could have been caused by the manure management in this zone, as hydrocarbons can result from microbial degradation of animal wastes. Burning of feed refusals may also have contributed to the higher concentrations of hydrocarbons in the middle zone.

Although in agriculture, the effect of emissions of NO_2 and SO_2 are poorly understood, they can be dangerous in case of interaction with aerosols, causing respiratory diseases (Schulte, 1997). The NO_2 and SO_2 concentrations in this study, however, were much lower than the acceptable limits.

Generally, it can be stated that small ruminants in this study had little impact on air quality; however, attention should be paid to H_2S and hydrocarbons concentrations inside and outside the small ruminant houses. There could be two main reasons for the low gaseous concentrations in our study. Firstly these concentrations are related to the diet. Schulte (1997) concluded that feed with high protein and their degradation pathways are known to be the sources of many environmental problems. Feed compositions of small ruminants are dominated by field grass and crop residues. With the low levels of protein in these feeds, it can be predicted that the waste they produce will result in low emissions (Archer and Nicholson, 1992). Secondly, the houses construction; all small ruminants' houses in our study were open constructions with good air circulation, so the emissions dispersed rapidly (Guingand et al., 1997; Schulte, 1997; Tamminga, 1992). Thus, under smallholder farming conditions and low external inputs, small ruminants might have little impact on the environment, at least for the regional scope, i.e. Yogyakarta Province in this study. Environmental problems are much more prominent in intensive systems, with large numbers of animals and high levels of concentrate feed. In Indonesia, the expected increase in small ruminant numbers will be gradual; no intensive small ruminant systems are expected to develop. Although small ruminants are kept under traditional management, they could also have a global impact. Consideration of greenhouse gas emissions, was only done by incorporating hydrocarbons. This study did

not take nitrous oxide (N_2O) and carbon dioxide (CO_2) emissions into account. Indirectly, livestock is associated with N_2O emissions from arable land through manure use (Steinfeld et al., 1997). Emissions of CO_2 are predominantly the result of the use of fossil fuel (Tamminga, 2003) and human activities, such as fossil fuel burning and deforestation (de Boer, 2003). In addition, the contribution of agriculture in general and animal production in particular to CO_2 emissions is relatively small. Even in industrialised countries with highly mechanised production systems these emissions do usually not exceed 5% (Sauerbeck, 2001).

Small ruminants had more impact on water quality. In the lowlands, manganese concentrations were considerably higher than the acceptable limit. This was probably the result of the relatively high manganese contents of the soils in the lowlands. For other physical-chemical indicators the concentrations were considerably lower than the acceptable limits. Also, nitrate and nitrite were considerably lower than the acceptable limits. Because the farmers rarely applied inorganic N fertilisers, the concentrations of nitrate and nitrite in this study originated from small ruminant's manure. For pig production in Illinois, Krapac et al. (2002) also mentioned that any nitrate contamination was probably associated with the spreading of manure on the surrounding fields. Cho et al., (2000) stated that nitrate and nitrite concentrations of water sources are thought to be a result of nitrification of ammonium N or direct introduction of nitrate from animal manure. They found that in heavily contaminated water, nitrate and nitrite concentrations were 13.9 mg l^{-1} and 17.0 µg l^{-1} respectively. The maximum admissible concentration for the nitrate in the drinking water assessed by World Health Organization (WHO) was 50 mg l^{-1} while this study showed levels of only 0.9 – 3.5 mg l^{-1}. The standard, of 10 mg l^{-1}, assessed by the local government was also much lower than international standard. So, this study showed low concentrations of nitrate and nitrite. Nitrogen concentration in available form will determine how much is at risk from leaching, however traditional farmyard small ruminant manure has only a low proportion of nitrogen in available form.

The acceptable limits for the numbers of total and faecal bacteria were set by the local government at an unrealistically low level of 0 cfu/100 ml. Cho et al. (2000) found values of 80 cfu/100 ml in uncontaminated groundwater. The numbers of total and faecal bacteria were found to be much higher than this value of 80 cfu/100 ml. About 70% of the water sources had more faecal coliform, and 90% had more total coliform. The numbers of total and faecal coliform were also higher than in the studies done by Cho et al. (2000), and Crowther et al. (2002) in heavily contaminated areas in Korea and the United Kingdom. For large ruminants in Central Java, even higher numbers of faecal coliform were found (Baliarti et al., 1994): 1400 – 3700 cfu/100 ml. The high pH in all zones might have contributed to the high levels of total and faecal coliform. Nola et al. (2002) stated that pH affects the dynamics of faecal coliform. Previous studies have identified a host of local scale factors, such as moisture content and topography, which

affect the survival of faecal indicator organisms (Van Donsel et al., 1967 cited by Crowther et al., 2002). The highest number of the faecal and total coliform was found in the lowlands. The depth of the water sources has an effect too. Goss et al. (1998) found that contamination with bacteria reduced significantly when the well depth was 30 m and Krapac et al. (2002) found groundwater at depths of about 33 and 82 m containing few numbers of faecal coliform (7 colonies/100 ml), although in the manure pit samples the bacteria number exceeded 24,000 colonies/100 ml. In our study, the depth of the water resources ranged from 10 – 15 meters. Because the farmers in our study had no other animals and the location of human faeces (septic tank) was far away from the water resources, the high concentration of bacteria in this study is expected to originate from small ruminants manure. In addition, high concentrations of bacteria in tropical countries like Indonesia are predictable, because of the climate (high temperature and humidity). Smith et al. (1999) found that in Yogyakarta, most of the wells tested had bacterial counts ranging from 0 to 2300 cfu/100 ml. These levels are comparable to the levels in the present study (4 to 2400 cfu/100 ml faecal coliform, and 23 to 2400 cfu/100 ml total coliform). Therefore, before water can be used as drinking water, it must be boiled to destroy bacterial pathogens.

Both, physical-chemical values and bacterial counts were lower in the middle zone than those in the lowlands and uplands, which indicated that the groundwater in the middle zone was less contaminated than in the other zones; however, the number of groundwater samples in the middle zone was small, as most farmers obtained their water from a pipe coming from the mountains. This study, however, did not take water samples from pipes into analysis, since small ruminants have no effect on the water quality from pipes because this water originates from mountain groundwater located far away from residential areas with no livestock.

The results of this study can be used as an entry point for further research, especially in developing countries. Research regarding the impact of small ruminants on the environment is generally aimed at land degradation in extensive grazing, while effects on the air and water pollution have received less attention. Considering that in Asia small ruminants' production systems are changing or have changed from grazing to confinement, research topics might shift from land degradation issues to air and water pollution.

5.5. Conclusion

This study showed that small ruminants had little impact on the air quality inside and around small ruminants' houses. The impact of small ruminants on water pollution was considerable. There was a high contamination of total and faecal coliform in the water resources adjacent to small ruminant houses. It is strongly recommended that

groundwater in the study area be boiled before being used as drinking water, the housing is cleaned daily.

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Chapter 6

Opportunities for change in small ruminant systems in Central Java-Indonesia

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Abstract

Indonesia is one of the countries where sheep and goat production systems do not match their potential in improving rural livelihoods. This study evaluates sheep fattening and goat breeding innovation scenarios for small ruminant systems in Central Java. The scenarios were based on what could realistically be expected in three agro-ecological zones. Sheep fattening on basis of rice bran supplementation was suggested as feasible innovation for the lowlands. In sheep fattening scenario 1, farmers are proposed to fatten 5 male sheep two times a year up to a final body weight of around 35 kg. In sheep fattening scenario 2, farmers are proposed to fatten sheep in one round of 9 months up to the age of one year for the feast of sacrifice, *Idul Adha,* demand. In sheep fattening scenario 3, farmers are proposed to fatten male sheep in two periods, one round with 5 animals as in scenario 1, and another round with 5 animals sold at one year of age for *Idul Adha.* The middle zone and the uplands have become well-known breeding areas for Etawah-grade goats. Goat breeding scenarios were based on a breeding unit with 3 does and involved reductions of kidding intervals from present average values of 278 (middle zone) and 273 (uplands) days to 240 and 220 days. The sheep fattening scenarios indicated that if farmers can start specialising in sheep fattening the technical and economic results can be improved compared to the present sheep production system in which breeding of sheep and sale for meat are both practised. Sheep fattening scenario 3 showed the highest net liveweight production in kg and the highest value added. When the opportunity labour costs were included in the calculations, fattening of sheep still produced a positive net return to the farmers, but this time highest returns were produced by scenario 2, because less labour is required in this scenario. So, matching sheep fattening to the *Idul Adha* demand is theoretically possible. A goat breeding unit with 3 does produced 2.2 and 1.7 times more kids for than in the real situation in the middle zone and uplands, respectively. Reducing kidding intervals resulted in 1.2 and 1.3 times more kids sold for the kidding intervals 240 and 220 days in the middle zone; while in the uplands the number of kids sold could increase 1.1 and 1.3 times respectively. Family labour was by far the highest input. The breeding scenario calculations indicated that goat breeding could make a positive contribution to the livelihood of goat farmers, in particular, if the management of goats is improved.

Keywords: Sheep fattening, Goat breeding, Value added, Indonesia

6.1. Introduction

Often, it is said that small ruminants can make a contribution to better livelihoods of the rural poor in developing countries (Devendra and Chantalakhana, 2002; Morand-Fehr and Boyazoglu, 1999; Sinn et al., 1999). In South East Asia, Indonesia is one of the countries with increasing numbers of small ruminants, who, according to policy makers, NGO's and other institutions, could improve the ability of households to stabilize their income and can help to increase animal protein consumption (Satari, 1987; DEPTAN, 2003). Recent studies on small ruminant systems in Central Java, an area in Indonesia known for the quality of its small ruminants, indicated that, if households have sufficient family labour for the management of small ruminants, small ruminants are an appreciated secondary activity. Small ruminants were multifunctional, the economic benefits of keeping small ruminants, however, were low (Budisatria et al., 2005a).

Innovations in small ruminant systems have to match the specific agro-ecological conditions. In Central Java, in lowland areas small ruminants are integrated with paddy and cassava production. In the higher altitude areas (middle zone and uplands) small ruminants can make use of the abundant leaves available. In the lowlands, there are not many leaves available and many farmers think that goats cannot be managed properly under this condition. However, sheep had only slightly better performances than goats in the lowlands (Budisatria et al., 2005a). The lowlands have a more favourable infrastructure than the middle zone and uplands. Farmers in the lowlands have easy access to markets. The uplands have the poorest infrastructure and 40 per cent of the families live below the poverty line. The demand and prices of small ruminants increase considerably before the feast of sacrifice, *Idul Adha*. In the lowlands, the market situation is relatively stable throughout the remainder of the year, whereas, in the middle zone and uplands prices dropped at the end of dry season when urgent cash is needed for e.g. land preparation and payment of school fees (Budisatria et al., 2005b).

It has been found that performances of sheep can be improved with relatively low levels of supplementation of rice bran (Basuno and Petheram, 1982; Martawidjaja et al., 1982; Pond et al., 1994; Budisatria, 1996; Merkel et al., 1999). In the lowlands farmers have easy access to rice bran. So, sheep fattening on basis of rice bran supplementation could be a feasible innovation in the lowlands, in particular when farmers could arrange the sale of fattened males in relation to the period of the feast of sacrifice.

The higher altitude areas have become well known breeding areas for Etawah-grade goats and farmers can receive relatively high prices for breeding stock (Budisatria et al., 2005b). Goat breeding with the aim to supply the market with kids for breeding could offer an opportunity to increase the contribution of goats to rural livelihoods. Although the numbers of kids weaned per doe per year were around 2.5, kidding intervals

were relatively long: on average over 270 d. So, reducing kidding intervals could offer scope to increase the number of kids available for sale in the middle zone and uplands.

Kosgey et al. (2006) concluded that small ruminant improvement programmes that were seen to be successful were those that were simple, pragmatic, and ran at low cost. This study evaluates sheep fattening and goat breeding innovation scenarios for small ruminant systems in different agro-ecological zones in Central Java, Indonesia.

6.2. Materials and methods

6.2.1. Study area

This study was based on sheep and goat production in three agro-ecological zones in the Province of Yogyakarta, Indonesia. This Province is situated in the southern part of Central Java. The classification of agro-ecological zones in Central Java is primarily based on their altitude. Each zone has a different topography, soil types, soil fertility and agro-climatic conditions. The lowlands (100 m above sea level (asl)), are characterised by irrigated paddy fields mixed with cassava. The main feed resources used for small ruminants are field grass and crop residues (Budisatria et al., 2005a). The middle zone (between 100 and 500 m asl) is characterized by multiple cropping systems, with a combination of paddy fields and annual crops. In the uplands (above 500 m asl) the main crops are cassava, maize, groundnut and vegetables. Some perennial crops are also available, i.e. banana and coconut. In both the middle zone and uplands the main feed resources used are native grass and leaves of legume trees, fruit trees, cassava and hibiscus (Budisatria et al., 2005a). In total, 150 small ruminant farmers were randomly selected for small ruminant performance recording and interviews on their opinion about small ruminant farming: 50 farmers in the lowlands, 50 farmers in the middle zone and 50 farmers in the uplands. These farmers kept Etawah-grade goats or Javanese fat-tailed sheep. A detailed description of the study sites and data collection is presented in Budisatria et al. (2005a). Table 1 shows selected characteristics of small ruminant farming systems in the lowlands, middle zone and uplands.

6.2.2. Scenario studies

In the lowlands, sheep fattening was proposed by some farmers as a feasible innovation. Here, average daily gain could be improved from the present 0.06 to 0.15 kg d^{-1} per head by increasing the level of rice bran supplementation from the present level of 0.13 to 0.3 kg d^{-1} (Basuno and Petheram, 1982; Martawidjaja et al., 1982; Budisatria, 1996). Four of the 25 selected sheep farmers already supplemented their sheep with 0.3 kg rice bran per day and their sheep, in the age category 3 to 12 months, had indeed, an average daily gain of around 0.15 kg. Farmers mentioned during interviews that the maximum number of sheep they can keep at one time was 5. They lack household labour

and feed resources to manage more animals. In sheep fattening scenario 1, farmers are proposed to fatten 5 male sheep two times a year, with an initial bodyweight 10 kg and average daily gain around 0.15 kg. Then, sheep can be sold at 9 months of age with a final bodyweight of around 35 kg. In sheep fattening scenario 2, farmers are proposed to fatten sheep in one round of 9 months up to the age of one year, with initial body weight of 10 kg and average daily gain of 0.1 kg. It is expected that in this scenario farmers can arrange their sheep fattening in relation to *Idul Adha*. Males to be sold for *Idul Adha* have to be one year of age and have to weigh at least 25 kg (Budisatria et al., 2005b). In sheep fattening scenario 3, farmers are proposed to fatten male sheep in two periods, one round with 5 animals from 3-9 months of age as in scenario 1, and another round with 5 animals bought at 6 months of age at an initial bodyweight of 18 kg and average daily gain of 0.1 kg up to one year of age. Mortality during the fattening period is assumed to be 10%, which is in line with the present mortality rate of sheep kept by farmers in the lowlands (Budisatria et al., 2005a).

Table 1
Characteristics of small ruminant farming systems in the lowlands, middle zone and uplands, in Central Java, Indonesia (source: Budisatria et al., 2005a)

	Lowlands		**Middle zone**		**Uplands**	
	Sheep	*Goats*	*Sheep*	*Goats*	*Sheep*	*Goats*
Flock size	3.5	3.2	3.9	3.9	3.7	4.2
Flock composition						
Adult female	1.6	1.5	2.1	1.9	2.2	2.5
Adult male	0.7	0.6	0.5	0.7	0.5	0.6
Lamb/Kid	1.2	1.1	1.3	1.3	1.0	1.1
Lambing/Kidding interval (*d*)	279	282	264	278	271	273
Lambs/Kids weaned per ewe/doe y^{-1}	1.8	1.8	2.0	2.4	1.8	2.7
Feed sources	fld. grass, cass. peels, rice bran	fld. grass, leaves, maize stover, rice bran, el. grass	fld. grass, leaves, rice bran, el. grass	fld. grass, leaves, rice bran, el. grass	fld. grass, leaves, rice bran, el. grass	fld. grass, leaves, rice bran, el. grass
Time spent *(h d^{-1})*	3.6	3.4	3.7	3.7	4.2	4.2
Value Added* *($Rp10^3 y^{-1}$)*	1328	1249	1227	1293	1364	1718
VA – opportunity lab. costs *($Rp10^3 y^{-1}$)*	- 643	-613	-777	-733	-930	-572
Additional benefits** *($Rp10^3 y^{-1}$)*	192	191	229	229	212	265

* value added based on liveweight production and manure
** based on financing and insurance value estimations
1 € = Rp 12 000 in 2004

The input values used for the sheep fattening scenarios are shown in Table 2. Three selling price levels are suggested: sheep fattening scenario 1 with an average price received by farmers over the normal and risky (end of dry season) market situations; sheep fattening scenario 2 with a level where animals are sold for prices received by farmers during the last few weeks before *Idul Adha*; sheep fattening scenario 3 with a level where animals from one fattening round are sold for the price during religious festivities and the others are sold for the price received by farmers during the normal and risky market situations. The different price levels are based on interviews with the selected farmers (Budisatria et al., 2005b). Farmers do not use veterinary services. The labour accounted in the scenario study is only adult labour, whereas the family labour used under the present production systems includes children (Budisatria et al., 2005a).

Table 2
Inputs values for proposed three sheep fattening scenarios in the lowlands in Central Java, Indonesia

Parameters	**Scenarios***		
	1	**2**	**3**
Start weight (*kg*)	10	10	10 and 18
End weight (*kg*)	37	37	36
Rice bran ($kg\ d^{-1} head$)	0.3	0.2	0.3 and 0.2
Feedlot period (*d head*)	180	270	180
Mortality (%)	10	10	10
DM manure production ($kg\ d^{-1}\ head$)	0.5	0.5	0.5
Price weaner sheep ($Rp10^3$)	250	250	250 and 300
Selling price ($Rp\ kg^{-1}$)	13500	19000	13500 and 19000
Price rice bran ($Rp\ kg^{-1}$)	600	600	600
Manure price ($Rp\ kg^{-1}$)	150	150	150
Time spent ($h\ d^{-1}$)	3.2	3.2	3.2
Opportunity family labour costs ($Rp\ h^{-1}$)	1500	1500	1500

*Scenario 1: two fattening rounds of animals from 3-9 months of age;
Scenario 2: one fattening round of animals from 3-12 months of age;
Scenario 3: one fattening round of animals 3-9 mths and one round of animals from 6-12 mths of age
1 € = Rp 12 000 in 2004

The aim of the breeding scenarios was to increase the number of kids for sale, with a constant flock size of three female goats. The kids will be weaned when they are three months old and will be sold directly after weaning. In the middle zone and uplands present goat farms have 1.6 and 1.9 does respectively, with kidding intervals of on average 278 and 273 d respectively (Table 1). Eleven of the 50 does monitored had kidding intervals around 240 days, the level needed to get 3 litters per 2 years. This kidding interval was used as one of the goat breeding scenarios in calculations of the effect of reducing kidding intervals. The calculations also included a kidding interval of 220 days. This will require less matings per conception than the present level of 1.7-1.8

(Budisatria et al., 2005a). The reduction of kidding intervals requires that a breeding buck is available at each farm.

6.2.3. Simulation model calculations

A simulation model (Figure 1) was developed with Stella® software to simulate the performance of a goat breeding farm and the effect of reducing kidding intervals. Table 3 gives the initial parameters used in this model, which are based on actual figures resulting from monitoring sheep and goat performances in Central Java (Budisatria et al., 2005a).

First, the present kidding intervals (278 and 273 days for the middle zone and uplands respectively) were simulated on basis of a flock size of adult females of 3. Second, the effects of kidding intervals of 240 and 220 days were simulated.

The development of the flock size was calculated based on the equation:

goats (t) = goats (t-dt) + births – deaths- sales-culled goats) * dt

This equation means that the number of goats at a certain time t is equal to the number of goats at time t-dt plus the number of births minus deaths minus kid sales minus culled goats.

The number of kids born was influenced by the kidding intervals and litter size, therefore, the births inflow, which equals the number of culled goats, was calculated by using the equation:

births = goats * litter size * (365/kidding intervals)

The mortality parameter refers to the mortality from birth to weaning (90 days), in this

Table 3
Model input values used in the simulations of the effects of actual and reduced kidding intervals for goat flocks in Central Java, Indonesia

Parameters	**Model values**
Reproduction parameters:	
Number of does	3
Kidding intervals (*d*)	278; 273; 220 and 240
Litter size	2
Mortality up to weaning (%)	5
Replacements (%)	25
Input parameters:	
Rice bran (*kg d^{-1} per head*)	0.15 and 0.3
Price rice bran (*Rp kg^{-1}*)	650
Time spent (*h d^{-1} per adult head*)	0.5
Extra labour used for kids (*h d^{-1} per kid*)	0.25
Manure production (*kg d^{-1} per head*)	0.5
Kid selling price (*Rp 10^3 per head*)	400
Culled goats selling price (*Rp 10^3 per head*)	500
Manure price (*Rp kg^{-1}*)	150
Opportunity costs labour (*Rp h^{-1}*)	1500

1 € = Rp 12 000 in 2004

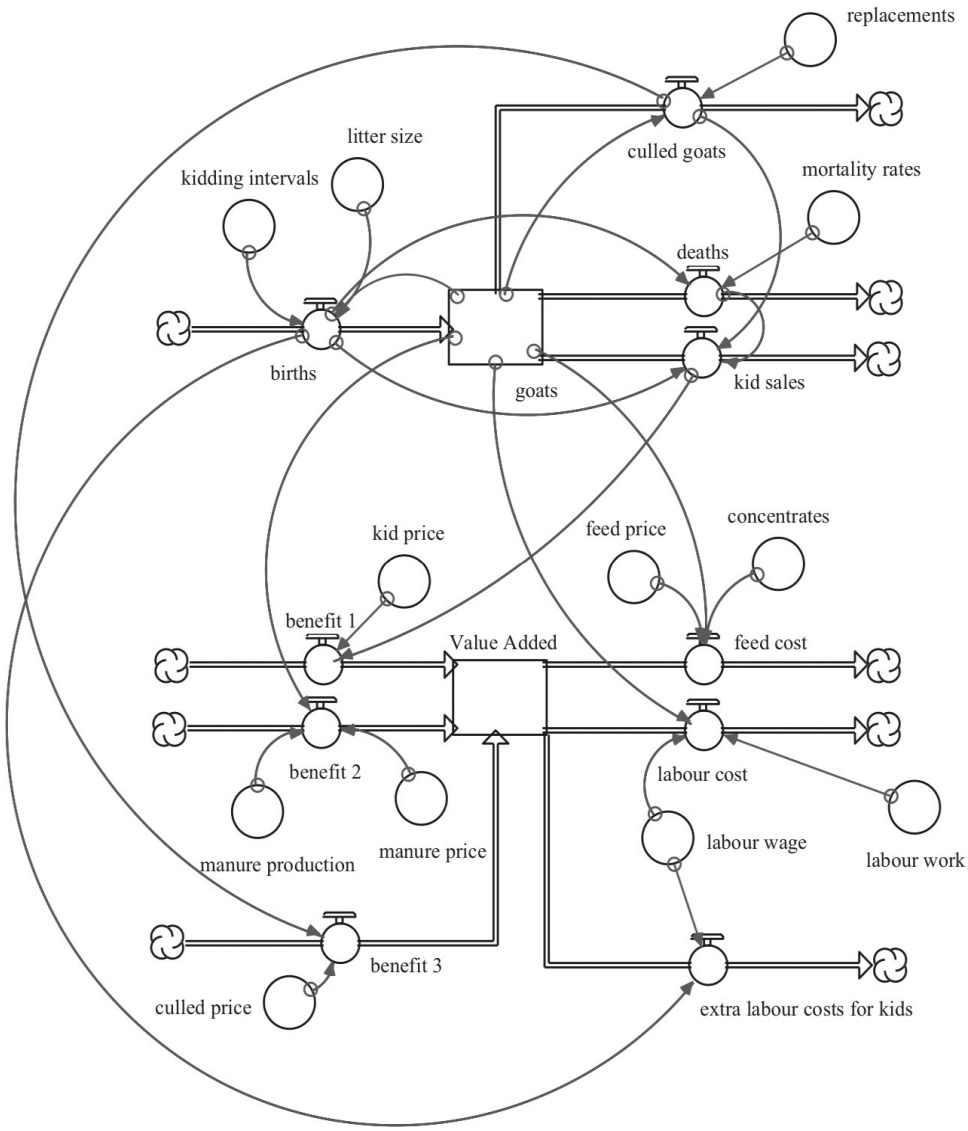

Figure 1: Simulation model to simulate the performance of a goat breeding
(○ indicates a variable, ▭ indicates a stock, ⟶ indicates a flow)

study, it was set to 5%. In equation form, the mortality was:

deaths = births * mortality rates

The culled goats parameter refers to number of goats being replaced, it was:

culled goats = goats * replacements

The numbers of kids sold was determined by the mortality rate and the numbers of kids to be used as breeding stock, which equals to the number of culled goats:

kid sales = births - culled goats – deaths

Feed costs were based on the concentrates (rice bran) fed:

feed cost = concentrates* (goats + 1)*feed price*365

The feed costs only take rice bran supplementation into account. The collection of roughages (field grass and leaves) is included in the family labour spent. The opportunity family labour costs were based on the time (hours) that farmers spent per day:

labour cost = labour wage*labour work*(does + 1)*365

extra labour cost for kids = labour wage*labour work*births*90

The number of goats is based on the number of does increased with 1 male goat.

The added value consisted of income from selling kids (benefit 1), manure (benefit 2), and culled goats (benefit 3):

benefit 1 = kid price * kid sales

benefit 2 = manure production * manure price * (goats + 1) * 365

benefit 3 = culled goats * culled price

6.3. Results

6.3.1. Sheep fattening

Table 4 gives the results of the sheep fattening scenarios for the lowlands. Cash inputs included the purchase of weaned sheep and rice bran. Farmers feed also cassava peels and field grass. The collection of these feeds is included in the family labour hours spent. Benefits of keeping sheep were cash income from selling sheep for slaughter and for *Idul Adha*, and manure.

Table 4
Impact of sheep fattening scenarios on net liveweight and manure production, and economic costs and benefits (in $Rp10^3\ y^{-1}$) in the lowlands of Central Java, Indonesia

Parameters	**Scenarios***		
	1	**2**	**3**
Inputs**:**			
Sheep fattened per year (*h*)	10	5	10
Weaner costs per year	2500	1250	3500
Feed costs	324	243	324
Labour ($h\ d^{-1}$)	3.2	3.2	3.2
Opportunity costs family labour	1752	1296	1752
Outputs:			
Net liveweight production *(kg)*	333	165.5	324
Manure *(kg)*	821.5	607	821
Income from selling sheep	4495	3164	5265
Income from manure	123	91	123
Value Added	1795	1762	2064
VA – opportunity labour costs	43	466	312
VA per d *(Rp)*	4917	4826	5655

*Scenario 1: two fattening rounds of animals from 3-9 months of age
Scenario 2: one round of animals from 3-12 months of age
Scenario 3: one round of animals 3-9 mths and one round of animals from 6-12 mths of age
1 € = Rp 12 000 in 2004

Sheep fattening scenario 1 with two fattening rounds for the average marketing conditions and scenario 3 with one fattening round for the average marketing conditions and one for the *Idul Adha* period showed the highest net liveweight production in kg. Scenario 3 gave the highest value added. The value added of scenario 1 was about the same as the value added of scenario 2 with one fattening round producing 1-year old males for the *Idul Adha* period. When the opportunity labour costs were included in the calculations, fattening of sheep still produced a positive net return to the farmers, but this time highest returns were produced by scenario 2, because less labour is required in this scenario.

6.3.2. Goat breeding

Table 5 shows the technical and economic results of model simulations for a breeding unit with 3 does on basis of present kidding intervals and reduced kidding intervals in the middle zone and uplands. A breeding unit with three does could, on basis of present kidding intervals, produce close to 7 kids for sale. Reducing kidding intervals resulted in an increase of kids sold by 18% and 30% respectively for the kidding intervals 240 and 220 days in the middle zone; while in the uplands this was 15% and 26% respectively. Family labour was by far the highest input. The value added estimates were 14-17% higher with a kidding interval of 240 d and 25-28% higher with a kidding interval of 220 days when compared with the present kidding intervals.

Table 5
Model simulations of the effects of present and reduced kidding intervals on the number of kids sold per year and economic benefits (in $Rp10^3$ y^{-1}) of goat breeding in the middle zone and uplands of Central Java, Indonesia

	Present intervals		**Reduced Intervals**	
	278 days (Middle Zone)	**273 days (Uplands)**	**240 days**	**220 days**
Flock size (*adult head*)	3.0	3.0	3.0	3.0
Births	7.9	8.1	9.1	10.0
Deaths	0.4	0.4	0.5	0.5
Culled goats	0.8	0.8	0.8	0.8
Kid sales	6.7	6.9	7.9	8.7
Feed costs	285	285	285	285
Opportunity costs family labour	1362	1368	1402	1433
Income sales of kids	2694	2760	3168	3483
Income manure	82	82	82	82
Income sales of culled does	375	375	375	375
Value Added	2866	2932	3340	3655
VA – opportunity labour costs	1504	1564	1938	2223
VA per d *(Rp)*	7852	8033	9150	10014

1€ = 12 000 rupiah, in 2004.

6.4. Discussion

The sheep fattening scenarios indicated that if farmers in the lowlands can start specialising in sheep fattening the technical results (Table 4) can be improved compared to the present sheep production system in which breeding of sheep and sale for meat are both practised (Table 1). Consequently, sheep fattening resulted in 32-55% higher value added benefits, on basis of liveweight production and manure, than from the present production system. The scenarios did not take the intangible benefits into account; it is expected that fattened sheep are purely kept for the market. The calculations indicate that fattening of sheep in two rounds in the lowlands can give sufficient returns to the hours of family labour used. The returns were highest when farmers can fatten sheep in two rounds with one round for the *Idul Adha* market (Scenario 3) . Peters (1988) and Reynolds and Adediran (1994) already concluded that when the demand for small ruminant meat is high and prices are attractive, short-term fattening, rather than breeding would appear more commercially attractive. By using a relatively high supplementation level of rice bran compared to the real situation had as consequence that feed costs were 2 and 2.6 times higher than in the actual situation (Budisatria et al., 2005a). So, the sheep fattening scenarios require access to capital to purchase weaners and rice bran. In the lowlands, this does not have to be a major problem, farmers have easy access to formal credit from government of private institutions with relatively low interest rates.

In the real situation, 16% of sheep farmers already fattened sheep. This is about the percentage of sheep farmers that can start fattening males on basis of the present average flock size in the lowlands of 1.9 ewes and number of weaners per ewe per year of 1.8 (Table 1). However, because of the relatively good infrastructure in the lowlands farmers can obtain weaners from other areas and a higher percentage of sheep farmers could start fattening sheep.

Sheep fattening scenarios 2 and 3 show that matching fattening sheep to the *Idul Adha* demand is theoretically feasible. In the present situation, however, none of the farmers fatten sheep to match the *Idul Adha* demand. They find it too difficult to plan their sale of animals in relation to the period when the prices increase. Farmers also complained that there was no marketing information available to them, the information they receive is via the village collectors (Budisatria et al., 2005b). Without accurate market information, farmers are seriously disadvantaged in basic decision making concerning production opportunities and marketing options.

Monitoring goat flock performances in the middle zone and uplands showed that the number of kids available for sale were 3 and 4 respectively. The differences in the results between the goat breeding scenarios based on present kidding intervals and the real values (Table 1) in the middle zone and uplands are the result of the larger number of does in the simulated situation. As a consequence, kids produced and being sold

increased significantly. Compared to the scenarios with the real kidding intervals, the kidding interval of 240 days resulted in 14-17% higher number of kids for sale and the interval of 220 days in 25-28% increase in number of kids for sale.

Reducing kidding intervals to 240 days could be technically feasible, considering that 16% and 28% of goats kept by farmers in the middle zone and uplands already had kidding intervals of around 240 days. Reducing kidding intervals to 220 days will be difficult to achieve. Farmers have to improve their present management in order to reduce the kidding intervals. Long kidding intervals result from does not being mated because bucks are absent, limited farmers knowledge on basic physiology of reproduction in small ruminants especially oestrus detection and duration (Gatenby and Subandriyo, 1986). Improving the reproduction capacity can be done by making bucks available to does. Farmers also have to reduce post partum mating intervals by better feed management and reducing weaning age of kids. In the 240 and 220 days kidding interval scenarios, better feed management was simulated by increasing the rice bran supplementation, it was around 2 times higher than supplementation done by farmers (Budisatria et al., 2005a). In the real situation, farmers with goats showing 240 d kidding intervals also used more rice bran supplementation. Reducing kidding intervals also implies that farmers have to wean kids when these are three months old.

The most important input in the breeding scenarios was family labour. This labour is mainly used to collect roughages. More kids also means more family labour input for daily care. The breeding scenario calculations indicate that goats could give a positive return to the family labour used, in particular if the management of goats is improved. Overall, the breeding scenarios resulted in higher returns to the family labour used than the sheep fattening scenarios. The middle zone and uplands are known for the quality of their small ruminants, primarily Etawah-grade goats (Budisatria et al., 2005a). So, marketing of kids for breeding seems not to be a constraint. Farmers sell Etawah-grade breeding stock even to farmers outside Central Java. The initial investment needed to buy breeding stock of Etawah-grade goats is quite high and it could be too high for the poor families (Budisatria et al., 2005a). The availability of micro credit systems is necessary.

The sheep fattening and goat breeding scenarios show that on a daily basis the returns remain low: 41-49% of the minimum labour wage (estimated at Rp 12 000) for sheep fattening and 65-83% of the minimum labour wage for goat breeding. Farmers with sufficient household labour available, however, will not consider the labour costs as real costs (Qureshi, 1993). Hamadeh et al. (2001) said that the inclusion of family labour cost in an economic analysis significantly inflates the total costs, which can have a negative effect on feasibility of an innovation. Alternative employment opportunities are limited either because they are not available, particularly in the uplands, or because household members are not competitive in these job markets.

The scenario studies were made as simple as possible in order to be easily adopted by farmers. It can be concluded that when households have sufficient family labour for the management of small ruminants, it is possible to have income-increasing activities with sheep or goats.

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Chapter 7

General Discussion

The objective of this thesis was to analyse the behaviour of small ruminant production systems in order to understand their development pathways in three different agro-ecological zones in Central Java, Indonesia. To attain this objective, the dynamics, preferences for sheep or goats, market opportunities, environmental effects and opportunities for changes in small ruminant systems were studied. This chapter focuses on the methodology used, the development of small ruminant systems, sustainability issues primarily related to small ruminants' contribution to the livelihood of farmers, and the prospects of small ruminants.

7.1. The methodology evaluated

The multiple goals related to small ruminants, combined with the complexity of their management, and the resources and social arrangements involved, make small ruminants a production system that is inherently difficult to study and to understand. The data to answer the research questions were gathered by studying literature to obtain primary and secondary data, interviewing farmers and key persons, organising group meetings, field observations and monitoring feeding practices and animal performances, and laboratory analyses. Some of the secondary data in this study were taken from the statistical data base published by the local government. Although in some cases the reliability of these data could be questioned, i.e. unemployment rate in the study areas around 6% (this is almost similar to the unemployment rate in developed countries); these data sources were assumed to be reliable. A combination of methodologies involving regular monitoring of animal performances (i.e. weekly visits) at farm level for at least one year, and farmers interviews and group meetings were used to understand small ruminant systems. To obtain accurate data on farming conditions was a complicated and time-consuming process. Farmers might overestimate their land possession, age, experience and the time they spent on small ruminant activities. Recording cards were found to be a useful tool to collect information at farm level in addition to the information collected by regular visits, detailed observations, and measurements. Farm level information has to be supported by reliable secondary data sources. The information gathered from the farmers has to be reliable too. This depends very much on the way of interviewing the farmers. Being in rapport with the farmers is essential, and appropriate techniques for interviewing are important to avoid the "yes-no" answers. The participatory methods used proved useful to understand small ruminant farmers' resources and perceptions. A disadvantage of these methods is that each farm visit and group meeting requires considerable time. Farmers will not tell their true story during a short visit.

7.2. Development of small ruminants systems

The development of small ruminant production systems in Central Java-Indonesia was influenced by many factors at different aggregation levels. At country level, the driving forces were population growth, economic and political crises, and government policies. At regional level, local government programmes were important along with the agro-ecological conditions. At the lowest level (farmers' household), access to capital and household members and their time availability were important driving forces for small ruminant development. These driving forces had significant effects on the production systems, preferences for different types of animals, numbers of animals, and the way small ruminants were managed.

7.2.1. Farmers perspective

During about one century of small ruminant development in Indonesia, the characteristics and role of small ruminants have remained more or less the same. They are typically identified with smallholders, have a small size, use the land around the house, have simple housing needs and low feed requirements, utilise agricultural by-products, produce meat and act as live savings in case of farmer's urgent cash requirements, produce dung to fertilise the land, and can contribute to farm income. Their high reproduction rate and early marketable age allow small ruminants to adapt flexibly to the limited resources of smallholder farmers.

The number of small ruminants owned by the farmers was relatively small: 4 – 6 head/family. The fact that small ruminants were kept by older farmers (on average more than 50 years old) with a low educational background might explain why the role of small ruminants has remained the same. The accumulation of knowledge via education is an important factor in economic development (Asfaw and Admassie, 2004). Smallholder farmers generally have inadequate resources including physical, financial and intellectual capital resources (Lapar et al., 2003). Although they had 10 (lowlands) to 25 (middle zone and uplands) years of experience in keeping small ruminants, this experience had little impact on small ruminant management.

In smallholder farming systems, the availability of household labour is critical; farmers cannot rely on hired labour to manage their small ruminants. Small ruminants were the responsibility of the parents, while children were not much involved in small ruminant activities. Young adults want to look for employment in other sectors of the economy. The migration of young adults to cities also had a significant effect on animal husbandry practices because of reduced available household labour. Farmers did not want their children to succeed them as a farmer either, they prefer their children to be employed with civil service or private companies (Budisatria, 2000).

The position of small ruminants in the farming systems is secondary to crop production. Farms are small and the land is primarily used for the production of food and cash crops. The lowlands are a good example of how sheep perform this secondary role. Many farmers in the lowlands have cassava processing as main activity. This results in abundant cassava peelings available, which, if they are not utilised, can cause environmental problems. Sheep are the best choice to utilise these crop residues. Because of their small body size, their management is not so time-consuming compared to cattle, and most importantly, sheep adapt better to this kind of feed compared to goats. The intensification of crop production caused small ruminant farmers to change from grazing to cut-and-carry feeding. In the lowlands, 76 percent of the sheep and goats were still able to graze, whereas in the middle zone and uplands around 60% of the sheep farmers still grazed their animals while for goats, it was less than 40%. Grazing, however, was not practised daily, it depended on the time available, and it was done in the dry season only. Consequently, grazing is not a major component in the small ruminants' diet, contrary to the common perception in Indonesia that grazing is very important for sheep. Grazing gives, however, exercise for small ruminants and grazing also gives farmers the opportunity to clean their small ruminants' houses. Another factor why small ruminants are only of secondary importance is that the prices farmers receive for small ruminants do not seem to be attractive. Prices are closely linked with demand and supply fluctuations over the year. In addition, farmers are reluctant to "taking risks". They will not invest in their small ruminants unless they have proof that this will give sufficient returns. In fact, farmers have never assumed that small ruminants can make a major contribution to their cash income.

7.2.2. Government policy perspective

From 1969 onwards, the Indonesian government has released long-term development plans. In each five-year development programme, PELITA, the national government stressed agriculture to support rural development. Agricultural development aims to accelerate economic development and to improve traditional agricultural practices. During five periods of PELITA, however, no specific programmes were directed to small ruminants. Government concentrated on crop production (mainly rice). Java is a crowded island, the pressing need to feed the growing population and the fact that there is little scope for the expansion of the existing agriculture area has forced government to develop a policy of intensifying farming in the existing agricultural areas. For livestock, programmes mainly addressed poultry and beef cattle production. The provincial government of Yogyakarta released several programmes to intensify small ruminant production after independence. In these programmes goats received much more attention than sheep. The potential dual function of goats in producing meat and milk was considered attractive. Another reason why goats were preferred was the perception that

goats are bigger animals. This perception seems to be based on their bigger body frames. The monitoring of body weights of sheep and goats showed that at 15 months of age sheep and goats hardly differed in body weight, only in the uplands goats were on average 7 percent heavier than sheep.

Often, local government programmes, such as group housing and goat milking, were not adopted by the farmers, because of a lack of awareness regarding farmers' priorities and resources. Governments do not seem to consider what the farmers needs and priorities are (Trutmann et al., 1996; Schiere, 1999; Abegaz, 2005). Farmers classify, choose, improvise and adapt programmes depending on their circumstances. Before they adopt programmes, farmers need to see that the programmes work better than their present practices. The government programmes for small ruminants usually aimed at increased production while neglecting marketing possibilities and the multiple functions small ruminants have. In addition, the programmes do not seem to consider the socio-economic conditions of the small farmers. One example is the Safety Networking programme, which uses Etawah-grade goats in the lowlands to decrease farmers poverty caused by the economic crisis of the late 90s. In the lowlands, however, the availability of feed resources, in particular roughages and leaves, is less favourable for keeping goats. This implies that keeping Etawah-grade goats will only be possible with relatively large inputs of concentrates.

The promotion of slatted floors in small ruminant houses, the sharing programme, in which farmers share male goats owned by the government, and farmers groups are examples of programmes that worked well and still exist because they were adapted to farmers needs and took the economic and societal conditions of the farmers into account. The sharing programme helps the farmers who would like to keep small ruminants, but do not have enough capital. Farmers groups accommodate farmers who need to exchange and share their experiences in keeping small ruminants and give farmers easy access to credit. The slatted floor programme aimed at improving the health status of both farmers and small ruminants because a slatted floor is considered to be more hygienic and farmers can easily collect the manure under the slatted floor. Farmers very much value the manure collected as fertiliser for their fruit trees and also for paddy. In the middle zone, farmers were rather reluctant to use slatted floors because of the perceived costs of a slatted floor and the fear for lameness in their animals. The group housing projects in this zone had solid concrete or timber floors. Farmers saw this as an example of slatted floors. In this zone, the slatted floors programme could be more successful if farmers are shown how the costs to build slatted floors can be minimised by utilising locally available materials, such as bamboo sticks.

Governmental programmes, both before and after independence, promoted the replacement of Kacang goats by Etawah-grade goats. This has certainly contributed to the erosion of the local *Kacang* goats, which are very well adapted to the low input mixed

farming systems in harsh environments. Nowadays, most farmers in Java prefer to keep Etawah-grade goats or, as in the lowlands, they use them as sires to produce Bligon goats: the crossbred between Etawah-grade and Kacang goats. The success in the promotion of Etawah-grade goats has also contributed to the change-over from grazing into cut-and-carry feeding. The perception of farmers was that the higher nutritional demands of Etawah-grade goats could not be supplied by grazing alone, and farmers changed their small ruminant production system into cut-and-carry feeding systems. Government policies directed at intensification of crop production had, however, the greatest impact on the way small ruminants are kept. Every arable piece of land is used for the production of human food. Even the dikes between the paddy fields, on which formerly grass was allowed to grow, are now sometimes used for growing crops such as cassava. Common or private grazing lands have become scarce.

7.3. Sustainability issues of small ruminants

Population pressure, unemployment, rural-urban migration and intensification of agricultural activities are said to be important issues in sustainable development in developing countries. The term sustainability refers to a balanced relationship among environmental, socio-cultural and economic aspects, which means that for a system to be sustainable, it should be technically feasible, environmentally sound, economically viable and socially justifiable (Nardone et al., 2004). For smallholder farmers, it might be difficult to consider sustainable development under their multi-purpose goals of keeping small ruminants. It might also involve a radical change in thinking about the production process of small ruminants with more attention to the animals, to environmental conservation, and to food quality and safety. But, most importantly, small ruminants have to contribute to the livelihoods of smallholder farmers in a sustainable way.

Interest in the concept of sustainable development in animal production is often illustrated by considering the negative environmental consequences of the intensive animal production systems. Animals are often considered to be the cause for non-sustainability (Schiere et al., 2002). In Indonesia, government policies for small ruminant development are production oriented, it is assumed that increased production will automatically result in higher incomes for the resource-poor households. The intensification of small ruminant production, if not well managed, may specifically contribute to pollution of water resources, the emission of greenhouse gasses and the loss in biodiversity.

To understand the potential for small ruminants in different agro-ecological zones, we need to be aware of the sustainability prospects of small ruminant production. A methodological approach to assessment of the contribution of animal production systems to sustainable development involves four steps: description of the situation and problem

identification, identification of relevant EES issues, translation of issues into suitable sustainability indicators, and a final assessment of the contribution of sustainability indicators to sustainable development (De Boer and Cornelissen, 2002). This section discusses EES issues of small ruminant development.

7.3.1. Economic issues

The most important economic issue for small ruminants is their contribution to farmers income. The regional minimum wage of Yogyakarta Province for unskilled adult labour is about Rp 1500 per h. The returns per unit of labour from keeping small ruminants were found to be well below this level. This was supported by statements of neighbouring farmers with no experience in keeping small ruminants; they believed that small ruminants could not be used for obtaining a cash income. However, subsistence small ruminant farmers do have broader production objectives that are driven by their immediate subsistence needs rather than market demands. In subsistence agriculture farmers make rational decisions to maximise overall benefits from limiting resources (Scoones, 1992; Orskov and Viglizzo, 1994; Devendra, 1999). This implies that farmers accept low live weight gain and that poorer quality feeds can also be utilised. Farmers did not rank cash income as main motive for keeping small ruminants. Farmers referred to their small ruminants as a saving (*tabungan* in Javanese) that provides security. In our economic evaluation this was represented by insurance and financing benefits. Manure also has a financing value, as, without it, farmers need to purchase more expensive inorganic fertiliser to secure crop production; this primarily applies to the farmers in the middle zone and uplands. In these zones, farmers integrate small ruminants with tropical fruits, as they assume that small ruminants manure has a higher quality than other manure. The scenario studies of income generating innovations indicated that for some farmers income could be increased by sheep fattening (lowlands) and goat breeding (middle zone and uplands). Although scenario studies can never include all adequate factors that affect a system under study (Udo et al., 2001; Thornton and Herrero, 2001), they indicated how small ruminants could improve the income situation. To do this, farmers have to improve their present management practices and have to match their small ruminant systems to the market situation.

The target value used in this study to assess the economic issue seems to be too optimistic. Firstly, because minimum wages were assessed by the local government to be able to live sufficiently under city conditions. Secondly, for the older and poor farmers in the rural areas with interest in small ruminants, it is better to keep small ruminants and accept that the cash returns will be small than to get nothing because of the absence of job opportunities. There was a contradiction between farmers' reason for keeping small ruminants and the results of socio-economic calculations. Farmers assigned a low value to cash income, while socio-economic calculations showed that physical production had

the highest contribution to total income. Farmers do not expect that they can rely on small ruminants for their main income. This might explain why farmers consider small ruminants mainly as a saving. The gradual increase in growth of small ruminants and their ability to reproduce provide farmers with a suitable means of accumulating wealth.

In Indonesia the marketing of small ruminants is a major problem, i.e. market uncertainty, lack of market information, and the complex marketing system. The supply and demand of sheep and goats fluctuate throughout the year, and often they are not in accordance with each other. The demand for and price of small ruminants increased dramatically during the weeks before *Idul Adha*, the feast of sacrifice. But this had not a great effect on farmers' livelihoods. When farmers can sell small ruminants during the period prior to the *Idul Adha* festivities, they do not sell small ruminants directly to the consumer. The prices received by the farmers during *Idul Adha* were about one-quarter lower than the market prices. The flock sizes are too small to arrange the sale of small ruminants in relation to the period when the prices increase. So, the *Idul Adha* period did not have a large impact on the present small ruminant systems. About half of the sales were due to urgent cash needs, mainly at the end of the dry period when cash is needed for land preparation, which coincides with the period when cash is needed for school fees. Under this condition, farmers are not in a position to bargain. The sheep fattening scenarios showed that the effect of non-continuous demand because of religious activities could give some farmers the opportunity to professionalize their activities to a limited extent.

The marketing infrastructure of small ruminants in Indonesia is complex and involves many actors before small ruminants reach consumers (Figure 1). Under a long chain of marketing, it can be predicted that farmers as producers receive low prices and that consumers as the final link, who consume small ruminants' products, deal with high prices. The supply of small ruminants at the markets was always much larger than the demand. Village collectors have to take an animal 2-3 times to a market before it is finally sold. They incorporate this in the prices offered to the farmers. This is also the case with cattle; it reflects the inefficiency of livestock marketing in Indonesia. Improving the small ruminants' market model and increasing the bargaining power of the farmers are needed. If the present marketing chain was shortened, this could help to bring demand and supply more in agreement.

There are neither regular market information on prices and supplies nor grades and standards available for both farmers and consumers with regard to small ruminants. This could also be a reason why farmers felt that they receive unfair prices for their animals. In contrast, consumers felt they have to pay high prices. In developing countries, information about supply and demand is usually by word of mouth, which is not always very reliable (Oludimu and Owokade, 1995). Farmers as producers without relevant, accurate market information are seriously disadvantaged in basic decision making

concerning production opportunities and marketing options. In the future, young farmers might be able to use mobile phones to receive market information from the livestock market office or from friends living in the city.

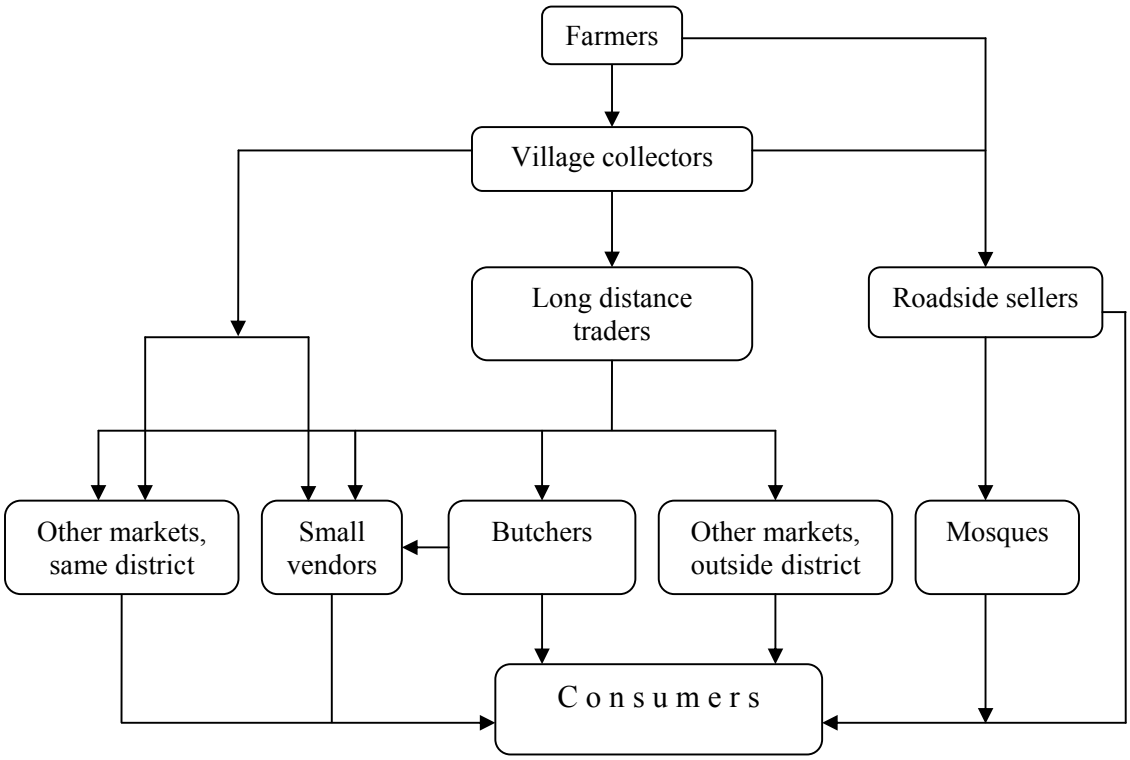

Figure 1
Small ruminants marketing systems in Yogyakarta-Central Java

Kosgey et al. (2006) argued that formation of farmers associations and development of marketing facilities would help and enable farmers to get better prices for their animals and/or products. Seleka (2001) said that one way of strengthening small ruminant marketing is by improving the capacity of existing cooperatives. In Indonesia, the marketing model could be shortened by strengthening farmers groups who could organise the slaughtering of livestock themselves and sell the products to the consumers. This could be beneficial for both farmers and consumers. But, because small ruminants are only a secondary activity, farmers do not have much time available to spend on small ruminants marketing. At present, only 5 percent of all farmers sell their animals directly on the market.

7.3.2. Ecological issues

The ecological issues are related to manure. In principle, manure is a commodity, in many areas a valuable one, but in surplus areas often with a negative value because of

its role in emissions to the environment. It is difficult for society to separate the environmental issues from other services of livestock farming, such as cheap food of a certain quality and safety (Milne, 2005). Societies, as in Indonesia, might value the environment less highly than what could be expected. When people have higher standards of living, environmental issues are perceived to be more important. Environmental issues regarding livestock production in developing countries are more focused on land degradation, deforestation and over-grazing, while environmental pollution is given less attention. In Indonesia, there is also lack of knowledge about air and water pollution caused by livestock. In this study, land degradation and over-grazing were not an issue, because most farmers rely on cut-and-carry feeding.

Small ruminant farmers gave a high value to manure, it was the second main reason for keeping small ruminants. They consider manure essential to maintain soil fertility, to fertilise paddy fields and tropical fruits. Manure is not traded, which indicates that farmers value manure for their own use and that the amounts produced are not in excess of what is needed. After excretion, manure is usually stored during a certain length of time. During storage, microbial conversions may occur. This results in the production and loss of gases, the concentration of which depends on the origin of the manure and the storage conditions. Cleaning the small ruminant houses was a daily activity in the lowlands and uplands, in the middle zone, however, faeces were kept for several days in the houses. The emission produced also depends on the number of animals, level of productivity, and type of diet with high roughage diets producing proportionately more. Small ruminants' houses are usually very close to the family quarters. It was expected that this could pose a pollution threat, although small numbers of animals are kept by the farmers. In Yogyakarta province, the local government has published acceptable limits of gas emission and water quality, in order to protect the environment (Yogyakarta Government, 1991). The most important complaint from neighbouring households is the odour from small ruminant manure. The H_2S and NH_3 levels in and around the small ruminant houses were below the acceptable limits, except for H_2S inside the houses in the middle zone. The concentration of hydrocarbons in the middle zone also was higher than the acceptable limit. These high concentrations in the middle zone were probably related to the storage of manure inside the houses in this zone. Other gas emissions were well below the acceptable limits.

The management and housing of small ruminants close to the family quarters resulted in very high levels of faecal coliform bacteria and total coliform bacteria in groundwater, two groups of bacteria used as indicators for water contamination caused by manure. Contamination of groundwater by small ruminants can result if runoff from manure storage percolates through the soil close to a well. The high concentration of faecal coliform could be a serious problem for future development of small ruminants, because of the current community concern related to water quality. In Yogyakarta, most

farm families depend on private wells for their drinking water resources, so the contamination of groundwater caused by small ruminants will affect human health, and therefore the impact of manure on drinking water can be considered a societal issue too.

7.3.3. Societal issues

Societal issues relate to animal welfare and societal acceptance of production methods, and human welfare. The animal welfare issue is considered more relevant in Europe, in particular in North West Europe, than in developing countries (De Boer and Cornelissen, 2002). Human welfare, however, is considered very important.

Small ruminant farmers clean their small ruminant houses regularly because they were concerned that their animals would cause odour problems for their neighbours. They also pay attention that their animals do not damage their neighbours' crops.

The high concentrations of faecal coliform in the water indicated that small ruminant wastes were not treated adequately. Consequently, attention has to be given to potential human health problems caused by exposure to bacterial contaminants in the groundwater.

Small ruminants play a key role in the religious festivities since the majority of people in Indonesia are Moslem. Each family with a higher living standard has to sacrifice a sheep or a goat for *Idul Adha*. Farmers are not considered to belong to this group and, in general, do not sacrifice an animal for *Idul Adha*. Farmers finance religious pilgrimages partly by selling small ruminants. Marriages and the birth of a child are also celebrated with the slaughter of a sheep or goat. If farmers do not own small ruminants, they have to spend a considerable sum of money to buy small ruminants for such religious celebrations. So, small ruminants are also culturally important for farmers. The number of people with a higher living standard will increase further. It is expected that in the future the demand for sheep, the preferred animal to be sacrificed, will increase during the *Idul Adha* period. So, small ruminants will continue to be a socially important rural resource.

Many rural households will continue with small ruminants also because it has been a family tradition to keep either sheep or goats. Some farmers will always keep small ruminants whether they contribute to household income or not. Most families want to see their sheep or goats every day. They also act as hobby animals. This psychological factor might have both positive and negative effects on the sustainable development of small ruminants. On the positive side, farmers will manage small ruminants as well as possible. On the negative side, to fulfil that psychological factor, farmers usually keep small ruminants close to their living quarters, causing pollution of drinking water sources. Moreover, it was one of the reasons that the group housing projects were not successful.

The involvement of children in the small ruminant activities was relatively small: 0.3 – 1.1 h d^{-1}. If they were involved this indicated that farmers actually had insufficient

household labour to care for the small ruminants. Actually, farmers did not expect their children to become a farmer. This contributes to a reducing interest of the young generation in keeping livestock. This could result in a decrease in the small ruminant population because small ruminant farmers were on average over 50 years of age. So, in the future, a conflict can be expected between the demand for small ruminants for religious festivities by the increasing city population with higher living standards and a decreasing number of small ruminant farmers.

7.4. Prospects of small ruminants

It is often said that small ruminants can be used as a tool in fighting poverty for the rural farmers (Sinn et al., 1999; Dossa et al., 2003; Iniguez, 2004; Kristjanson et al., 2004; Lebbie, 2004; Holmann et al., 2005; Peacock, 2005; Saadullah et al., 2005). This is mainly based on the premise that sheep and goat keepers are among the poorer groups in society (Kristjanson et al., 2004; Morand-Fehr and Boyazoglu, 1999). This study, however, indicated that the potential capacity of small ruminants to improve livelihoods of the rural poor is not realised. It seems that keeping small ruminants is more a sign that farmers are poor, than that it can help them to move out of poverty.

In each agro-ecological zone, unemployment was recorded to be at around 6%; the actual number of unemployment could be more, since many people consider themselves farmers when they have no regular job. The family labour resources also are generally uncompetitive to find appropriate jobs because of their lack of education. Keeping small ruminants could be inevitable for such family labour. Therefore, small ruminants can be considered an alternative employment opportunity for family labour.

Small ruminants, in particular goats, are most numerous in the uplands. Here, more than 40% of the families live below the poverty line. Statistical data showed a tendency that during the 90s the population decreased in the uplands. This was caused by migration of people to the city seeking better employment. Consequently, the numbers of goats during that time also decreased (Figure 2, Chapter 2), because social changes that took place in the community had a direct impact on small ruminants practices. This indicates the need for a substantial effort to improve the living conditions of the rural people in uplands. Goat keeping can be used to motivate the farmers who do not keep small ruminants yet, so at least poverty and urbanisation can be reduced, especially for uneducated people. The goat breeding scenarios indicated that a goat breeding unit with three does could give returns to the family labour used well above the minimum wage level per h. On a daily basis the returns were still below the minimum wage level for one person.

Farmers in the middle zone and uplands start to change their small ruminant marketing. They sell weaners and male goats for breeding, not for meat. These areas are

now well-known in Indonesia as breeding centres for Etawah-grade goats. Farmers or farmers organisations from outside areas and sometimes from outside of Java are looking for the best goats from these areas. This is a great opportunity for the farmers to increase their income. Farmers can also try to make better use of *Idul Adha* festivities by selling small ruminants directly to the mosque. In recent years, Moslems who wish to sacrifice during *Idul Adha*, prefer to send money instead of live small ruminants to the mosque. In particular, farmers groups can sell animals cooperatively.

Farmers have limited access to credit systems and they have to pay a relatively high interest rate. Therefore, easy credit access at low interest rates for households that wish to keep sheep or goats has to be made available. This could be done by the local government in cooperation with public banks. Jabbar et al. (2002) have argued that to reach poor and liquidity-constrained smallholders the credit must also be provided at a cost they can afford, while the system remains viable. The costs include interest charges and transaction costs. For small amounts of money, the latter becomes most critical. Lower interest rates would encourage innovation. Peacock (2005) argued that successful livestock development relies on the provision of credit to enable poor people to acquire small ruminants or new breeding stock.

The improvement of small ruminant production might be difficult to realise and faces many constraints, but also some opportunities. In the future, rising human population, higher incomes, urbanisation and changing consumer preferences will fuel increased demands for small ruminants. With human population pressure continuing to increase, the continued improvement and intensification of small ruminant production systems is inevitable, especially when alternative employment opportunities are limited because they are not available and household members are not competitive in the job markets. This situation might create an opportunity to promote and improve keeping small ruminants. However, there is need for some considerations. Firstly, we have to change farmers' opinion regarding small ruminant functions. As long as farmers are of the opinion that small ruminants cannot be used as an important source of income, they will always regard small ruminants as a secondary activity. Secondly, adequate and regular support from government and private sector is needed, because small ruminant development will require capital investment, infrastructure and efficient marketing systems. Regular extension services have to be made available to the farmers to improve farmers' knowledge in keeping and marketing small ruminants and to motivate farmers who do not keep small ruminants yet. Farmers often complain that extension services rarely visit them and the extension services force the farmers to adopt programmes that do not fit farmers' conditions. The Livestock Office of the local government, which is responsible for the extension services, could, for example, reward extension workers who serve farmers well. In Indonesia, the success in poultry development resulted from interventions, either from government or private companies, that facilitated farmers with

credit access, market information, inputs (i.e. feed, veterinary inputs, breeding stock), and improvement of the knowledge of farmers in management and marketing aspects. Formerly, poultry and small ruminant farmers were in the same situation: small farms and poultry and small ruminants as secondary activities. The government released the Nucleus Scheme for smallholders (*PIR= Peternakan Inti Rakyat*), involving private companies to help poultry farmers in finding the capital and inputs for farming. This programme has had a great effect on the way of poultry being kept, especially broilers. Now, poultry are managed by farmers in intensive systems with 2500-5000 poultry per farm. For small ruminants, it might be difficult for the farmers to keep large numbers, because large amounts of capital will be needed. A nucleus scheme programme can be used for basic development of small ruminants with modifications on the number of small ruminants kept by the farmers. Ten to 15 small ruminants per farm could possibly be realised. Adaptation of a nucleus scheme for small ruminants, however, needs some considerations. There is a tendency that intensification of poultry through the nucleus scheme makes farmers too much dependent on imported feeds and credit availability. The intensive poultry systems have suffered most from the Asian economic crisis; many broiler farmers went bankrupt. Small ruminant programmes have to consider farmers' resources. In particular, the availability of household members, capital and feed resources.

Improvement of small ruminant production is only possible by realising that each agro-ecological zone has different characteristics. Efforts to improve small ruminant production need to be facilitated by stronger institutions, local empowerment and regulation of access to resources. The local government, scientists, extension workers, and farmers themselves have to work together, because improving small ruminant production means that farmers need access to reliable and affordable support services, offering them access to knowledge and inputs, including credit and other financial services, and marketing information. This study can support the local government to release programmes for small ruminants based on the farmers' resources and the potency of each zone. The government has to play an effective facilitating role with supportive legislation and investment in rural infrastructure. This study provides farmers in the three agro-ecological zones information on the constraints and possibilities of small ruminants which can be considered in their choice of an appropriate small ruminant system.

7.5. Conclusions

- The characteristics and role of small ruminants in Indonesia have remained more or less the same since the start of small ruminant development programmes, which was around 1920
- The increase in human population and the intensification of crop production has resulted in less attention for small ruminants

- The widely expressed expectations that small ruminant production has potential to improve household income of resource-poor farmers have not been substantiated by valid data from practice
- Grazing does not contribute to small ruminant diets
- Farmers do keep small ruminants because "they did this already for a long time", and it is partly also a "hobby", consequently they want to have them nearby their living quarters
- Small ruminants do play an important role during religious festivities, although farmers do not seem to profit from this increased demand
- The demand of sheep during religious festivities can be exploited more by farmers cooperatives
- Given the dependency on water wells in rural areas, more attention is required to hygiene management of livestock in close proximity to human housing
- It is expected that the income from sheep and goats will remain additional to the major farming enterprise
- Sheep fattening can contribute to household income in the lowlands, if sufficient family labour is available
- Goat breeding can contribute to household income in the middle zone and uplands, if sufficient family labour is available
- Farmers organisations will be a prerequisite to improve the farm-gate prices by improved marketing strategies
- Government policy-making has to start with bottom-up approaches involving farmers themselves
- Government policy to reduce urban growth requires appropriate policies in the poorest areas, like the uplands of Central Java, this will require micro credit facilities with relatively low interest rates
- Successful small ruminant production requires close collaboration between farmers organisations, extension services, banking facilities and effective government policymakers

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Summary

Summary

Small ruminants are an important but neglected resource in developing countries. Sheep and goats provide their owners with a broad range of products and socio-economic services. They are closely linked with the poorest people.

In South East Asia, Indonesia is an example of a country where small ruminants play an important role in the livelihood of the rural people and in religious festivities of the majority of the population. The increase in the human population requires the use of all available land for the production of food. As a consequence, small ruminant farmers had to change from grazing towards cut-and-carry feeding. The agro-ecological conditions are believed to have an important impact on the type of small ruminants kept, although, in all agro-ecological zones both sheep and goats can be found. Farmers, policy-makers and scientists perceive that the availability of better quality forages in multiple cropping systems in higher altitude areas make these areas suitable for goats. Sheep are said to be suitable for farming systems dominated by rice monoculture in lowland areas. The government promotes intensification of small ruminant production to increase the animal protein consumption and to improve the income-situation of rural households. The demand and price of small ruminants increase near the religious feast of sacrifice. Prices drop rapidly when the farmers have urgent cash needs. Government policies on small ruminant development tend to be production oriented and no attention is given to their possible impact on the environment. Indonesian farmers manage their small ruminants in traditional ways in small numbers, usually very close to the family quarters. The expected increase in numbers of small ruminants and the fact that small ruminants are kept so close to the living quarters can pose a pollution threat. An understanding of the development pathways of small ruminant systems and their consequences can help to explore the prospects of small ruminant production systems.

Small ruminant production systems are complex. The multiple goals related to small ruminants, combined with the complexity of their management, and the resources and social arrangements involved, make small ruminants keeping an enterprise that is inherently difficult to study and to understand. This study analysed the behaviour of small ruminant production systems in order to understand their development prospects in the three different agro-ecological zones in Central Java, Indonesia. Central Java is known for the quality of its small ruminants and has different agro-ecological zones in relatively close proximity.

The objectives of this research were:

1. to evaluate the dynamics of small ruminant production systems in different agro-ecological zones in terms of
   - driving forces for changes in small ruminant systems
   - the role of small ruminants in the livelihood of farming households

- small ruminant's performances under traditional management
- supply and demand of small ruminants
- impact of housing of small ruminants on the environment

2. to explore possibilities for small ruminant development in different agro-ecological zones.

Three districts of Yogyakarta Province, Central Java-Indonesia, were selected to be the research sites, namely Bantul (lowlands), Sleman (middle zone) and Kulon Progo (uplands) districts. Each district has a different infrastructure and distance to a market, with Bantul district (lowlands) having the most favourable infrastructure being close to the provincial capital Yogyakarta. The Sleman district (middle zone) is characterised by a long distance to markets but roads are in a relatively good condition; it is a region with many educational institutes. The Kulon Progo district (uplands) has limited access to markets and roads are in a poor condition. The data to answer the research questions were gathered by studying literature to obtain primary and secondary data on small ruminant development from the pre-independence of Indonesia (around 1920) onwards, interviewing farmers and key persons, group meetings, field observations, monitoring feeding practices, animal performances and marketing strategies, and laboratory analyses on air and water qualities inside and around small ruminants houses. One hundred fifty small ruminants' farmers, 71 neighbouring farmers and 30 key persons were selected randomly for an in-depth study on small ruminant development. Added to this, quantitative data were collected from 10 small ruminant markets, 44 mosques and 42 roadside sellers. Data were collected over the period 2001-2003.

During about one century of small ruminant development in Indonesia, the role of small ruminants has remained more or less the same, whereas major changes occurred in the types of animals kept, in animal numbers and in farmer's management. Small ruminant systems have been influenced by many factors at different aggregation levels. At country level, driving forces for change were population growth, economic and political crises, and government policies directed at intensification of crop production. At regional level, local government programmes were important along with the agro-ecological conditions. The provincial government of Yogyakarta released several programmes to intensify small ruminant production after independence. In these programmes goats received much more attention than sheep. Often, local government programmes emphasising on e.g. group housing and goat milking, were not adopted by the farmers, because they did not fit the local resources available and the perceptions of the farmers. The promotion of slatted floors in small ruminant houses, the sharing programme, in which farmers share male goats owned by the government, and farmers groups are examples of programmes that worked well and still exist because they were adapted to farmers needs and took the economic and societal conditions of the farmers into account. At the lowest level (farmers' household), access to capital and household

members and their time availability were major factors determining whether households keep small ruminants or not.

Farmers themselves replaced the original thin-tailed sheep by fat-tailed sheep, whereas governmental programmes, both before and after independence, promoted the replacement of local Kacang goats by Etawah-grade goats. Major motives for the change in sheep breed have been the larger body size of fat-tailed sheep and the preference of consumers for meat of fat-tailed sheep. The promotion of Etawah-grade goats has resulted in the fact that they are now the dominant type of goat. Etawah-grade goats are larger in size than Kacang goats. In the lowland areas, Etawah-grade goats are crossed again with Kacang goats resulting in so-called Bligon goats.

The number of small ruminants owned by the farmers was relatively small: 4 – 6 head/family. They were kept by older farmers (on average more than 50 years old) with 10 (lowlands) to 25 (middle zone and uplands) years of experience in keeping small ruminants. The position of small ruminants in the farming systems is secondary to crop production. Farms are small and the land is primarily used for the production of food and cash crops. The intensification of land use has resulted in major changes in management. In the middle zone and uplands the majority of small ruminants are kept in confinement, whereas in the lowlands small ruminants are mainly kept in a combination of grazing and confinement. Grazing, however, was not practised daily, it depended on the time available, and it was done in the dry season only. Consequently, grazing is not a major component in the small ruminants' diet, contrary to the common perception in Indonesia that grazing is important for sheep. The differences in cropping patterns among the different agro-ecological zones in Central Java, and the intensification of land use, in particular in the lowlands are only partly reflected in differences in the types of feed fed to small ruminants. Field grass has remained an important feed in all zones in both the dry and wet season. The major differences in agro-ecological conditions that affect the choice for sheep or goats were the availability of cassava peels in the lowlands, favouring a choice for sheep and the abundance of leaves in the middle zone and uplands, which favours keeping goats. In the middle zone and uplands, goats grew slightly faster than sheep and produced more offspring per year than sheep. In particular, in the uplands, the economic benefits indicated that farmers gained more benefits from goats than from sheep.

The most important economic issue for small ruminants is their contribution to family income. The returns per unit of labour from keeping small ruminants were found to be well below the regional minimum wage level. This was supported by statements of neighbouring farmers with no experience in keeping small ruminants; they believed that small ruminants could not be used for obtaining a cash income. However, small ruminant farmers did not rank cash income as main motive for keeping small ruminants. Farmers referred to their small ruminants as a saving (*tabungan* in Javanese) that provides

security. Manure was the second main reason for keeping small ruminants. Farmers assume that small ruminants manure has a higher quality than other manure. It is used to fertilise paddy fields and tropical fruit trees.

The housing of small ruminants close to the family quarters resulted in very high levels of faecal coliform bacteria and total coliform bacteria, two groups of bacteria used as indicators for water contamination caused by manure. Consequently, attention has to be given to the potential human health problems caused by exposure to bacterial contaminants in the groundwater. Small ruminants did not have a significant impact on air pollution; concentrations of the gases were below the admissible levels assessed by the local government, except for hydrocarbons in the middle zone, which was probably related to the storage of the manure inside the houses in this zone.

The supply and demand of sheep and goats fluctuated throughout the year. The demand for and price of small ruminants increased dramatically during the weeks before *Idul Adha*, the feast of sacrifice. Sheep are preferred rather than goats to be sacrificed during *Idul Adha*. In the lowlands and the middle zone, the markets were dominated by sheep. In the uplands goats are the predominant type of livestock and goats dominated the small ruminant markets. The small ruminant marketing system in Indonesia follows a unique model involving many stakeholders. Main actors were the farmers, village collectors and long-distance traders. During *Idul Adha*, roadside sellers and mosques were also involved in the marketing system. Farmers rarely sell their animals directly on the small ruminant market. Farmers most commonly sell their small ruminants through the local village collector, to whom they generally have easy access, even in isolated areas. The prices received by the farmer were considered to be low. The prices received by the farmers during the *Idul Adha* period were about one-quarter lower than the market prices. The flock sizes are too small to make it possible to arrange the sale of small ruminants in relation to the period when the prices increase. So, the *Idul Adha* period did not have a large impact on the present small ruminant systems. In the lowlands, the market situation is relatively stable outside the *Idul Adha* period, whereas, in the middle zone and uplands prices dropped at the end of dry season when urgent cash is needed for e.g. land preparation and payment of school fees. Overall, about half of the sales were due to urgent cash needs.

It is unlikely that small ruminants will become a main income earner in rural households. If households have sufficient family labour for the management of small ruminants, small ruminants are an appreciated secondary activity. Farmers in the middle zone and uplands can sell weaners and male goats for breeding. These areas are now well-known in Indonesia as breeding centres for Etawah-grade goats. This is an opportunity for the farmers to increase their income. Farmers can also try to make better use of *Idul Adha* festivities by selling small ruminants directly to the mosque. In particular, farmers groups can sell animals cooperatively.

Scenario studies on the improvement of small ruminant production, either through sheep fattening systems in the lowlands and goat breeding in the middle zone and uplands showed that such innovations could increase the physical output and economic benefits from keeping small ruminants. The sheep fattening scenarios showed that the effect of non-continuous demand because of religious activities could give some farmers the opportunity to professionalize their activities to a limited extent.

With human population continuously increasing, the continued intensification of small ruminant production systems is inevitable, especially in areas where alternative employment opportunities are limited, because they are not available or household members are not competitive in the job markets. Intensification of small ruminant production is only possible by realising that each agro-ecological zone has different characteristics. Efforts to improve small ruminant production need to be facilitated by stronger institutions, local empowerment and regulation of access to resources. The local government, scientists, extension workers, and farmers themselves have to work together, because improving small ruminant production means that farmers need access to reliable and affordable support services, offering them access to knowledge and inputs, including credit and marketing information.

Samenvatting

Samenvatting

Schapen en geiten zijn een belangrijke maar zeer ondergewaardeerde dierlijke bron in ontwikkelingslanden. De houderijsystemen zijn echter zeer complex. Kleine herkauwers worden er voor meerdere doelen gehouden. Dit, in combinatie met de diverse management systemen en sociale engagementen, draagt er toe bij dat het bestuderen van schapen- en geitenhouderij ook complex is.

In dit onderzoek is de dynamiek van de schapen- en geitenhouderij bestudeerd, met als doel de ontwikkelingsmogelijkheden te onderzoeken in verschillende agro-ecologische zones in centraal Java in Indonesië. Hierbij werd gekeken naar:

- sturende krachten voor veranderingen in de schapen- en geitenhouderij
- de functie van kleine herkauwers in de kostwinning van boerengezinnen
- productiviteit van schapen- en geitenhouderij onder traditioneel management
- vraag naar en aanbod van kleine herkauwers
- de invloed van de behuizing van schapen en geiten op de omgeving
- toekomstmogelijkheden van de schapen- en geitenhouderij.

Als onderzoeksgebied werden drie districten in Yogyakarta Province in centraal Java geselecteerd: Bantul, Sleman, en Kulon Progo. Deze districten vertegenwoordigen drie agro-ecologische zones. Bantul (laagland) heeft een goede infrastructuur en ligt dicht bij de provinciale hoofdstad Yogyakarta. Sleman (middengebied, tussen 100 en 500 m boven zeeniveau) heeft goede wegen, maar de afstand tot markten is groot. Kulon Progo (hoogland) heeft slechte wegen en een slechte toegang tot markten.

Via literatuurstudie werd inzicht verkregen in de ontwikkeling van de schapen- en geitenhouderij. Ook zijn interviews met boeren en dorpsoudsten en vergaderingen met boerengroepen gehouden, observaties in het veld gedaan, voerstrategieën bepaald, producties gemeten, marketingstrategieën bepaald, en de lucht- en waterkwaliteit in en rond schapen- en geitenhokken geanalyseerd.

Gedurende de laatste eeuw is de functie van schapen en geiten min of meer ongewijzigd gebleven, waarbij echter wel grote veranderingen zijn opgetreden in het type dieren dat gehouden werd, evenals in de aantallen en de houderij. De lokale schapen zijn voor een groot deel vervangen door vetstaartschapen terwijl de lokale Kacang geiten vervangen zijn door Etawah geiten. Gedurende de laatste 35 jaar is het aantal schapen en geiten in Indonesië verdubbeld. Met name in het hoogland is het aantal geiten sterk gestegen. De beschikbaarheid van graaslanden is sterk afgenomen. Sturende krachten voor deze veranderingen kwamen van diverse aggregatie niveaus. Op nationaal niveau waren sturende krachten de bevolkingsgroei, economische en politieke crises, en overheidsbeleid gericht op intensivering van de gewasproductie. De regionale overheid van Yogyakarta Province heeft na de onafhankelijkheid diverse programma's voor

intensivering van de schapen- en geitenhouderij gestart. Alleen de programma's die aansloten bij de behoeftes en percepties van de boeren hadden succes. Op bedrijfsniveau hebben het aantal gezinsleden en hun beschikbare tijd en beschikbaarheid van geld een belangrijke rol gespeeld in het wel of niet houden van kleine herkauwers.

De geïnterviewde boeren waren gemiddeld meer dan 50 jaar en hielden gemiddeld 4-6 kleine herkauwers. De boeren in het laagland hebben gemiddeld 10 jaar ervaring met het houden van kleine herkauwers, en die in het middengebied en het hoogland gemiddeld 25 jaar. Het beschikbare land (0.2-0.6 ha) is voornamelijk bestemd voor productie van voedsel voor eigen gebruik en voor verkoop; geiten en schapen zijn slechts van secundair belang. De intensivering van landgebruik heeft geleid tot een verschuiving in management van schapen en geiten. In het middengebied en het hoogland wordt de meerderheid van de dieren binnen gehouden. Dit in tegenstelling tot het laagland, waar de dieren voornamelijk in een combinatie van grazen en op stal gehouden worden, waarbij de graastijd afhankelijk is van de beschikbare tijd en alleen in het droge seizoen plaatsvindt. Grazen is dus geen regulier onderdeel van het rantsoen, dit in tegenstelling tot de algemene mening in Indonesië dat schapen horen te grazen. Echter gras is wel een belangrijk onderdeel van het rantsoen in alle gebieden, zowel in het droge als het natte seizoen. Er zijn verschillen in het beschikbare voer tussen de agro-ecologische zones, die de keuze tussen het houden van schapen of geiten beïnvloeden. De beschikbaarheid van cassavaschillen in het laagland is gunstig voor het houden van schapen. De overvloedige beschikbaarheid van bladeren in het middengebied en het hoogland daarentegen is gunstig voor het houden van geiten. In het middengebied en hoogland groeiden geiten sneller en produceerden meer lammeren per jaar dan schapen. Economische berekeningen toonden aan dat in het hoogland boeren meer winst maakten met het houden van geiten dan met schapen. Echter het inkomen uit kleine herkauwers bleek in alle agro-ecologische zones ver beneden het regionale minimumloon te liggen.

Boeren beschouwen hun geiten en schapen als spaarpot, die economische zekerheid geeft en kapitaal opbouwt voor slechte tijden. Mestproductie is de tweede reden voor het houden van kleine herkauwers. Deze mest wordt in het laagland benut voor de rijsvelden en in het middengebied en het hoogland voor de fruitteelt.

De vraag naar en aanbod van schapen en geiten fluctueerde sterk gedurende het jaar. De vraag naar en prijs van kleine herkauwers steeg drastisch gedurende de weken voorafgaand aan het offerfeest (Idul Adha). Boeren leken echter niet te profiteren van deze stijging. Ze verkopen hun dieren zelden rechtstreeks op een markt of aan consumenten, meestal gaat dit via een tussenhandelaar. Ongeveer de helft van de verkochte dieren werden verkocht gedurende de maanden augustus en september, de periode van grote behoefte aan contant geld voor het voorbereiden van de velden voor nieuwe rijstaanplant en voor het nieuwe schooljaar.

De huisvesting van schapen en geiten vlakbij het woonhuis resulteerde in zeer hoge concentraties aan fecale coliform bacteriën en totale hoeveelheid coliform bacteriën. Deze beide bacteriegroepen worden gebruikt als indicatie voor watervervuiling door mest. Het is dus van groot belang dat er aandacht wordt besteed aan potentiele humane gezondheidsproblemen als gevolg van blootstelling aan bacterieel besmet grondwater. De schapen- en geitenhouderij had geen significant effect op luchtvervuiling, behalve in het middengebied waar het methaangehalte van de lucht boven het door de lokale overheid toegestane niveau lag.

Het is onwaarschijnlijk dat kleine herkauwers een belangrijke inkomstenbron zullen worden voor boeren. Als huishoudens voldoende tijd beschikbaar hebben is het houden van kleine herkauwers een gewaardeerde secundaire activiteit. Boeren kunnen proberen meer geld te verdienen door ten tijde van het offerfeest dieren rechtstreeks of via boerengroepen aan de consumenten of een moskee te verkopen. Voor boeren in het middengebied en het hoogland is er een markt voor geitenlammeren voor de fokkerij.

Verbetering van het houden van schapen en geiten moet ondersteund worden door het versterken van organisaties en lokale initiatieven en het reguleren van toegang tot informatie-, geld- en voerbronnen. De lokale overheid, wetenschappers, voorlichters, en boeren zullen dus moeten samenwerken. Hierdoor hebben boeren toegang tot betrouwbare en goedkope ondersteuning, die hun toegang geeft tot informatie en benodigdheden, inclusief kredietverstrekking en marktinformatie.

Ringkasan

Ringkasan

Di negara berkembang, ruminansia kecil berperan sangat penting, akan tetapi keberadaannya sering terlupakan. Domba dan kambing memberikan berbagai macam kontribusi dan fungsi sosial-ekonomi bagi pemiliknya. Domba dan kambing selalu identik dengan penduduk yang sangat miskin.

Di Asia Tenggara, Indonesia adalah salah satu contoh negara yang dalam kurun waktu satu abad, ruminansia kecil berperan penting dalam kesejahteraan penduduk pedesaan dan perayaan keagamaan bagi mayoritas penduduk. Peningkatan populasi penduduk menyebabkan hampir seluruh lahan yang tersedia digunakan untuk memproduksi tanaman pangan. Sebagai akibatnya, peternak ruminansia kecil harus mengubah sistem pemeliharaan dari penggembalaan ke arah yang lebih intensif yaitu dikandangkan secara penuh. Kondisi zone agro-ekologi diyakini mempunyai pengaruh yang penting pada jenis ruminansia kecil yang dipelihara, walaupun domba dan kambing dapat dijumpai pada semua zone agro-ekologi. Peternak, pembuat kebijakan, dan ahli peternakan meyakini bahwa ketersediaan pakan hijauan dengan kualitas yang lebih baik pada sistem multi tanaman di daerah yang lebih tinggi membuat daerah tersebut lebih cocok untuk kambing. Domba, sebaliknya dikatakan lebih cocok untuk sistem pertanian yang didominasi oleh tanaman padi di daerah rendah. Pemerintah mempromosikan intensifikasi ruminansia kecil untuk meningkatkan konsumsi protein hewani asal ternak dan untuk meningkatkan pendapatan peternak di pedesaan. Permintaan dan harga ternak ruminansia kecil biasanya meningkat menjelang hari raya qurban. Harga ternak menurun pada saat peternak membutuhkan uang yang mendadak. Kebijakan pemerintah dalam pengembangan ternak ruminansia kecil cenderung hanya beorientasi pada peningkatan produksi dan hampir tidak ada perhatian yang diberikan terhadap timbulnya dampak lingkungan. Peternak di Indonesia memelihara ternak mereka dengan cara yang masih tradisional dan dalam jumlah yang relatif kecil, lokasi kandang sering berdekatan dengan rumah peternak. Keinginan untuk meningkatkan populasi ruminansia kecil dimasa mendatang dan kenyataan bahwa ternak ruminansia kecil dipelihara berdekatan dengan rumah peternak, dapat menyebabkan polusi lingkungan. Memahami arah perkembangan ruminansia kecil dan konsekuensi yang ditimbulkannya dapat membantu kita untuk mengekplorasi prospek ruminansia kecil di masa mendatang.

Sistem produksi ruminansia kecil adalah kompleks. Tujuan pemeliharaan yang beraneka macam, ditimbah dengan kompleksitas manajemen, sumber daya dan perencanaan sosial yang terlibat, menyebabkan pemeliharaan ruminansia kecil merupakan suatu usaha yang pada dasarnya sulit untuk dipelajari dan dimengerti. Studi ini menganalisis sistem produksi ternak ruminansia kecil dalam rangka memahami prospek perkembangan ruminansia kecil dimasa mendatang pada tiga zone agro-ekologi

yang berbeda di daerah Yogyakarta-Indonesia. Yogyakarta, saat ini dikenal karena kualitas ternak ruminansia kecil terutama kambing yang sangat baik dan mempunyai zone agro-ekologi yang berbeda pada daerah yang sangat berdekatan. Tujuan dari studi ini adalah :

1. Untuk mengevaluasi dinamika sistem produksi ternak ruminansia kecil pada tiga zone agro-ekologi, ditinjau dari sudut :
   - faktor pendorong terjadinya perubahan sistem pemeliharaan ruminansia kecil
   - peranan ruminansia kecil terhadap kesejahteraan keluarga peternak
   - kinerja ruminansia kecil pada sistem pemeliharaan tradisional
   - permintaan dan penawaran ruminansia kecil
   - dampak kandang ruminansia kecil terhadap lingkungan
2. Untuk mengeksplorasi kemungkinan pengembangan ruminansia kecil pada tiga zone agro-ekologi yang berbeda.

Tiga kabupaten pada Propinsi Daerah Istimewa Yogyakarta – Indonesia, dipilih sebagai lokasi studi, yaitu Bantul (daerah rendah), Sleman (daerah sedang) dan Kulon Progo (daerah tinggi). Setiap kabupaten memiliki infrastruktur dan jarak dengan pasar yang berbeda. Kabupaten Bantul mempunyai infrastruktur yang lengkap dan berdekatan dengan pusat kota. Kabupaten Sleman mempunyai karakteristik jarak dengan pasar relatif jauh akan tetapi mempunyai kondisi infrastruktur yang sangat baik, dan juga dikenal sebagai lokasi berbagai macam perguruan tinggi. Kabupaten Kulonprogo, mempunyai akses terhadap pasar dan kondisi infrastruktur relatif terbatas. Data-data yang diperlukan diperoleh baik melalui studi pustaka, data sekunder tentang perkembangan ruminansia kecil sejak sebelum kemerdekaan (sekitar 1920) sampai dengan saat ini, wawancara dengan peternak dan tokoh-tokoh masyarakat, pengamatan langsung di lapangan dan mengamati manajemen pemberian pakan ternak, kinerja ternak dan strategi pemasaran, analisis laboratorium untuk mengetahui kualitas udara didalam dan sekitar kandang dan kualitas air sumur. Pada setiap kabupaten, dipilih secara acak sekitar 50 peternak ruminansia kecil untuk dilibatkan secara mendalam dan berkelanjutan tentang perkembangan ruminansia kecil. Selain itu, data kuantitatif juga diperoleh dari sekitar 10 pasar hewan ruminansia kecil, mesjid dan juga pedagang ruminansia kecil di pinggir jalan menjelang hari raya Idul Adha. Pengambilan data dilakukan selama kurang lebih dua tahun, yaitu sejak tahun 2001 sampai dengan 2003.

Selama kurang lebih satu abad perkembangannya, peranan ruminansia kecil masih tetap sama, sedangkan perubahan signifikan yang terjadi adalah pada jenis ternak yang dipelihara, jumlah ternak dan sistem pemeliharan. Sistem produksi ternak ruminansia kecil dipengaruhi oleh berbagai macam faktor pada berbagai tingkat yang berbeda. Pada tingkat nasional, faktor pendorong terjadinya perubahan adalah pertumbuhan penduduk yang cepat, krisis ekonomi dan politik, dan kebijakan pemerintah yang diarahkan pada intensifikasi produksi tanaman pertanian. Pada tingkat daerah, faktor pendorongnya

adalah program yang dilaksanakan oleh pemerintah daerah. Pemerintah Daerah Istimewa Yogyakarta, terutama setelah kemerdekaan, menjalankan beberapa program yang bertujuan untuk intensifikasi ruminansia kecil. Pada program ini, pemerintah lebih memberikan perhatian terhadap ternak kambing dibandingkan dengan ternak domba. Beberapa program pemerintah daerah seperti kandang kelompok dan kambing perah, tidak banyak diadopsi oleh peternak karena tidak sesuai dengan kondisi, situasi dan persepsi peternak serta sumber daya lokal yang tersedia. Promosi kandang panggung untuk ruminansia kecil, program gaduhan, yaitu peternak menggaduh kambing jantan milik pemerintah, dan kelompok peternak adalah beberapa program yang berjalan dengan baik dan masih bertahan sampai dengan saat ini karena sesuai dengan kebutuhan peternak dan mempertimbangkan kondisi sosial ekonomi peternak. Pada tingkat terendah yaitu tingkat keluarga peternak, akses terhadap modal, ketersediaan waktu dan jumlah anggota keluarga merupakan faktor yang sangat menentukan apakah peternak akan memelihara ruminansia kecil atau tidak.

Peternak mengganti domba lokal dengan domba peranakan ekor gemuk atas kehendak sendiri, sedangkan program pemerintah, baik sebelum dan sesudah kemerdekaan, lebih mempromosikan penggantian kambing Kacang dengan kambing Peranakan Etawah dan Bligon. Motif utama peternak mengganti bangsa domba adalah ukuran tubuh yang relatif lebih besar pada domba ekor gemuk dan kegemaran konsumen terhadap daging domba. Promosi Peranakan Etawah secara nyata menunjukkan bahwa pada saat ini, mayoritas peternak memelihara kambing Peranakan Etawah. Peranakan Etawah mempunyai ukuran tubuh yang lebih besar dibandingkan dengan kambing Kacang. Di daerah rendah, Peranakan Etawah disilangkan kembali dengan kambing Kacang untuk menghasilkan Bligon.

Jumlah kepemilikan ruminansia kecil relatif kecil, berkisar antara 4-6 ekor per peternak. Ruminansia kecil dipelihara oleh peternak yang berumur lebih dari 50 tahun, dengan pengalaman beternak berkisar antara 10 tahun (di daerah rendah) sampai dengan 25 tahun (di daerah sedang dan tinggi). Ruminansia kecil pada sistem pertanian masih menempati poisi kedua setelah produksi tanaman pangan. Lahan pertanian yang sempit menyebabkan setiap tanah yang tersedia digunakan untuk bercocok tanam dan memproduksi tanaman pangan. Intensifikasi penggunaan lahan pertanian telah mengakibatkan terjadi perubahan yang besar terhadap sistem pemeliharaan ruminansia kecil. Di daerah sedang dan tinggi, sebagian besar ruminansia kecil dipelihara dengan cara dikandangkan secara penuh, sedangkan di daerah rendah, ruminansia kecil terutama dipelihara dengan sistem kombinasi antara penggembalaan dan dikandangkan. Penggembalaan tidak dilakukan setiap hari, tergantung waktu luang yang tersedia dan dilakukan hanya pada musim kemarau. Sebagai akibatnya, penggembalaan bukanlah merupakan komponen utama pada pakan ruminansia kecil, hal ini berlawanan dengan persepsi umum di Indonesia bahwa penggembalaan adalah sangat vital pada ternak

domba. Perbedaan pola tanam diantara zone agro-ekologi dan intensifikasi penggunaan lahan terutama di daerah rendah hanya sebagian kecil mempengaruhi perbedaan tipe pakan yang diberikan pada ruminansia kecil. Rumput alam tetap merupakan pakan utama di seluruh daerah baik pada saat musim kemarau ataupun musim hujan. Perbedaan kondisi zone agro-ekologi yang berpengaruh besar terhadap pilihan untuk memelihara ternak domba atau kambing adalah ketersediaan kulit ketela di daerah rendah yang menyebabkan peternak memilih ternak domba, dan melimpahnya dedaunan/ramban di daerah sedang dan tinggi yang membuat peternak lebih memilih untuk memelihara kambing. Di daerah sedang dan tinggi, kambing menunjukkan pertumbuhan yang lebih cepat dan menghasilkan keturunan per tahun yang lebih banyak dibandingkan domba. Analisis ekonomi menunjukkan bahwa peternak yang memelihara kambing memperoleh keuntungan finansial yang lebih tinggi dibandingkan dengan yang memelihara domba.

Isu ekonomi yang paling penting untuk ruminansia kecil adalah kontribusinya terhadap pendapatan peternak. Pendapatan per unit tenaga kerja dari memelihara ruminansia kecil bagaimanapun juga masih lebih rendah dibandingkan dengan upah minimum regional. Hal ini didukung pernyataan dari tetangga peternak yang tidak memelihara dan tidak mempunyai pengalaman memelihara ruminansia kecil, bahwa ruminansia kecil tidak dapat diandalkan sebagai mata pencaharian pokok. Oleh karena itu, peternak tidak menempatkan ternak ruminansia kecil sebagai tujuan utama untuk memperoleh pendapatan. Peternak lebih memilih bahwa fungsi ruminansia kecil hanyalah sebagai tabungan yang memberikan rasa aman. Pupuk merupakan tujuan kedua dari memelihara ruminansia kecil. Peternak berpendapat bahwa kotoran yang berasal dari ruminansia kecil mempunyai kualitas yang lebih baik dibandingkan kotoran ternak yang lain. Pupuk yang berasal dari ruminansia kecil biasanya digunakan untuk memupuk tanaman salak dan juga padi. Kandang ruminansia kecil yang berdekatan dengan rumah peternak menyebabkan tingginya kandungan coliform tinja dan coliform total, dua kelompok bakteri yang digunakan sebagai indikator utama pencemaran air sumur yang disebabkan oleh kotoran. Sebagai akibatnya, perhatian yang lebih serius harus diberikan terhadap potensi terjadinya masalah kesehatan peternak dan keluarganya. Ruminansia kecil tidak mempunyai pengaruh yang signifikan terhadap pencemaran udara, konsentrasi gas-gas yang berada di udara sekitar kandang masih dibawah ambang baku mutu yang ditetapkan oleh pemerintah setempat, kecuali pada hidrokarbon di daerah sedang, yang kemungkinan besar dihasilkan dari proses penyimpanan kotoran ternak di dalam kandang.

Setiap tahun, permintaan dan penawaran ternak kambing dan domba sangat berfluktuasi. Permintaan dan harga ruminansia kecil biasanya meningkat drastis menjelang hari raya Idul Adha. Terdapat kecenderungan bahwa domba lebih disukai sebagai hewan qurban dibandingkan dengan kambing. Di daerah rendah dan sedang, pasar hewan didominasi oleh ternak domba. Di daerah tinggi, kambing merupakan ternak

yang paling banyak ditawarkan di pasar hewan. Pada saat peternak bisa menjual ruminansia kecil menjelang hari qurban, mereka menjual ternaknya tidak langsung ke konsumen. Harga yang diterima peternak selama Idul Adha kurang lebih 25% lebih rendah dibandingkan dengan harga pasar. Jumlah kepemilikan ternak yang kecil nampaknya merupakan kendala bagi peternak untuk dapat merencanakan penjualan ternak pada saat harga tinggi, sehingga, Idul Adha tidak berpengaruh besar terhadap peternak pada saat ini. Di daerah rendah, situasi pasar relatif stabil kecuali pada saat Idul Adha, sedangkan di daerah sedang dan tinggi, harga ternak ruminansia kecil turun drastis pada akhir musim kemarau pada saat peternak membutuhkan dana mendadak, seperti untuk penyiapan lahan dan pembayaran uang sekolah. Secara keseluruhan, sekitar setengah dari seluruh peternak menjual ternaknya dengan alasan kebutuhan mendadak. Sistem pemasaran ternak ruminansia kecil di Indonesia mempunyai mata rantai yang panjang dan melibatkan banyak pihak. Pihak yang paling berperan adalah peternak, blantik desa dan pedagang jarak jauh. Selama Idul Adha, pedagang pinggir jalan dan masjid juga terlibat dalam sistem pemasaran ruminansia kecil. Peternak umumnya sangat jarang menjual ternaknya langsung ke pasar hewan. Sebagian besar dari mereka menjual melaui perantara blantik desa yang umumnya dapat dengan mudah ditemukan sekalipun pada daerah yang terisolir. Oleh karena itu, harga yang diterima oleh peternak relatif rendah.

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Ruminansia kecil kelihatannya masih belum bisa dijadikan sumber penghasilan utama keluarga peternak di pedesaan. Apabila peternak mempunyai tenaga kerja keluarga yang cukup untuk memelihara ruminansia kecil, hal ini membantu untuk menjadikan ruminansia kecil sebagai aktivitas kedua. Skenario studi untuk meningkatkan produksi ruminansa kecil baik melalui usaha penggemukan di daerah rendah maupun penurunan interval kelahiran di daerah sedang dan tinggi menunjukkan bahwa inovasi tersebut dapat meningkatkan pendapatan dan keuntungan ekonomi dengan memelihara ruminansia kecil. Skenario penggemukan domba menunjukkan bahwa permintaan yang tidak kontinyu yang disebabkan oleh kegiatan keagaamaan dapat memberikan kesempatan kepada peternak untuk memelihara ruminansia kecil secara secara profesional dalam ruang lingkup terbatas.

Sejalan dengan meningkatnya populasi penduduk, intensifikasi pemeliharaan ruminansia kecil tidak dapat dihindarkan lagi, terutama di daerah dimana kesempatan

untuk memperoleh pekerjaan yang layak sangat terbatas karena tidak tersedianya lapangan pekerjaan ataupun karena anggota keluarga tidak mampu bersaing untuk memperoleh pekerjaan. Intensifikasi produksi ruminansia kecil hanyalah mungkin dengan menyadari bahwa setiap zone agro-ekologi mempunyai karakterstik yang berbeda. Usaha-usaha yang dilakukan untuk meningkatkan produksi ruminansia kecil memerlukan fasilitas dan dukungan dari institusi yang lebih kuat, sumber daya lokal dan regulasi terhadap akses sumber daya. Pemerintah daerah, ahli peternakan, penyuluh lapangan dan peternak sendiri harus bekerja sama karena meningkatkan produksi ternak ruminansia kecil berarti bahwa peternak harus mempunyai akses yang dapat dipercaya dan pelayanan yang mudah, memberikan peternak ilmu pengetahuan dan masukan yang diperlukan termasuk akses terhadap kredit lunak dan informasi pasar.

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honestly opened my mind on what is good or bad for one person may not be so for others, it depends on the point of view, it is like the two contradictive characteristics between *Duryadana* and *Bima*. Once again, *Matur nuwun* for everything.

Many thanks go to Prof. Dr. Ir. Endang Baliarti, SU. (Bu Endang), and Dr.Ir. Tridjoko Wisnu Murti, D.E.A., who supervised me during the fieldwork and provided me invaluable help, giving me solutions on unforeseen problems. Bu Endang, I do not know, how I can express my thanks for your patience, encouragement, invaluable help especially securing my budget. I always remember your message "work hard, try and try again". Pak Tridjoko, you always fought for me to get my rights (funding) from the project. I will never forget your advice, "give a proof to all people that you are able to finish your study although with less financial support". Special thanks also go to my collegues and my best friends Panjono, S.Pt., M.P., and Tri Satya Mastuti Widi, S.Pt. M.Sc., (Bu Widi) for their contribution either during fieldwork, or during discussions. Thanks Bu Widi, you very well organised the undergraduate students, preparing the time schedule for visiting farmers, arranging the budget, and supporting me with supplementary data when I needed urgent information. I often bothered you when I had problems with my passport and extension of my study. You are a good organizer. Special thanks are due to my undergraduate students (Wiwit, Ardi, Andar, Dwi, Imah, Mimin, Wiji, Ririn, Nana, Rita) who were involved in collecting data, visiting farmers weekly under often difficult conditions, mountain tracking and experiencing the "mystic story" when we were in Kulonprogo. Many thanks to all small ruminants farmers in Bantul, Sleman and Kulonprogo Districts, Yogyakarta, Indonesia, that collaborated and allowing me to conduct this study. They spent much time to discuss with me, sharing their home and food, although they knew that this study would not generate results to improve their livelihood.

I would like to express my gratitude to the Indonesian Student Association Wageningen (PPI-Wag.), who acted as my friend, family and supported me during my stay in Wageningen. I'm glad to be a part of PPI-Wageningen. Special thanks are going to Pak Hasan, Pak Ru, Pak Muli, Pak Yurdi and Pak Hadi families. For the Indonesian MSc students 2002 (Adit, Indra, Ilo, Kang Yusep, dr. Dwi, Ratna and other gang members), thanks a lot for your warm friendship. I never forget your "acting" for my birthday; it was really a very big surprise to me.

My very special thanks go to the BULOK group for their warm friendship and kind-heartedness. All of you were meaningful during my stay in Wageningen, helped me when I felt homesick, you know. When I came to Wageningen in early 2005 after two years of field study, I had no idea what should I do to reduce my boredom and stress after full days working with the computer. The BULOK offered me a lot of things to do, sport, especially badminton, football, except swimming (do not try to convince me to join the swimming), I'll miss the lunch and dinner together, regularly BBQ program (Bantingan

Yuuuk) even during bad weather. Pak Didik, I'll miss your advice and warm discussions on everything and forgive me for compelling you to be a smoker. Kang Wir, I'm still waiting on your BUZZ to inform me "*Cerita Kriminal*" or update news from TANAH AIR, keep in your mind to be KOMPOR. Pak Budi, I'll never forget your Peyek and Bala-bala (Uenaak tenaan), also playing guitar. Pak Hadi, the BULOK must realise (specially Pak Didik and Kang Wir) that we are the best and the strongest badminton couple. Pak Dje, thank you for your time to teach me Al-Qur'an. Oman, I will miss our *Gule, Pepesan* and cooking together. Pak Muli, thanks for giving me *mie-rebus* and *mie-goreng* every Friday afternoon, after we finished the prayer meeting.

For my mother and my mother-in-law, many thanks to you for your support, patience and praying for me. May Allah bless you. Ibu Nafi'ah, I express my gratitude for your kindness to take care of my family when I was away in Wageningen. My father and father-in-law who have deceased, I deeply feel you will be happy knowing that your son finally can finish his studies, although faced by many problems. I'm pleased to graduate, but I'm so unhappy that you cannot be present at my graduation. My brother and sister, Made, Sari, Mas Haris, Hatta, Om Bangkit, Mbak Hanif, thank you for your support.

Last but not the least, none of this work could have been performed without long lasting support of my lovely wife, Hayina Chusniyati, my son Naufal Catra Rahmadian (Catra), and my daughter, Denaya Shabrina (Naya), particularly during difficult periods, far away from you all, feeling lonely and homesick. I never imagined that I had to leave all of you so many times. My wife, forgive me for temporarily neglecting my responsibility as a father, you were a single parent during my study, taking care of our children. Their moral support kept me optimistic, their crying kept me awake and strong, their faith in the accomplishment of this work kept me going. It is time to go back home now, joined with all of you to be a blissful family after a long time being dissociated from you.

Curriculum vitae

I Gede Suparta Budisatria, the author of this thesis was born on May 22, 1968 in the city of Karangasem, Bali Province, Indonesia. During the period 1975-1984, he completed his Basic and Elementary School in Karangasem, Bali Province. In 1987, he finished the High school in Yogyakarta Province, Indonesia. In the same year, he entered the faculty of Animal Science, Gadjah Mada University, Yogyakarta. He received the degree of Ir. in Animal Husbandry, in 1992. Two years later, in 1994, he has been formally admitted as a staff member of the Animal Production Department at the same University; a position he holds up to now. He is responsible for lecturing of subjects related to livestock production, primarily on meat and draught power, with as special subject small ruminant production. Apart from lecturing, he is active in research and public service related to the above mentioned subjects. In 1998, under the Quality for Undergraduate Education (QUE) Project sponsored by the World Bank, he was selected as a candidate for doing post-graduate education at Wageningen University and Research Centre (WUR), The Netherlands. He came to Wageningen to start his MSc. program in October 1998. During this study period, under the guidance of dr J.B. Schiere, he became interested in sheep production. He graduated and received the degree of MSc Animal Science at the end of January 2000. His thesis was entitled "Urea molasses feeding in sheep: socio-economic and technical suitability in Central Java". One year later, his PhD research project (sandwich construction) on 'Small ruminant production systems development in different agro eco-zones in Central Java-Indonesia' was accepted to be conducted under supervision of Prof.dr. A.J. van der Zijpp and dr. H.M.J. Udo. After obtaining his PhD degree, he will return to Yogyakarta-Indonesia to continue his work as lecturer at Gadjah Mada University.

Training and Supervision Plan		**Graduate School WIAS**	
Name PhD student	I Gede Suparta Budisatria		
Group	Animal Production Systems		
Daily supervisor(s)	Dr. H.M.J. Udo		
Supervisor(s)	Prof. A.J. van der Zijpp		
Project term	from : 2001 until : 2005		
EDUCATION AND TRAINING (minimum 21 cp, maximum 42 cp)		**year**	**cp***
The Basic Package (minimum 2 cp)			
WIAS Introduction Course (mandatory)		2005	1,0
Course on philosophy of science and/or ethics (mandatory)		2001	1,0
Subtotal Basic Package			**2,0**
Scientific Exposure (conferences, seminars and presentations, minimum 5 cp)			
International conferences *(minimum 2 cp)*			
3rd International Seminar on Tropical Animal Production "Animal Production and Total Management of Local Resources", Yogyakarta, 15-16 October, 2002		2002	0,5
International Conference on Redesigning Sustainable Development on Food and Agricultural System for Developing Countries. Yogyakarta, 17-18 September		2003	0,5
11th Animal Sciences Congress of the Asian-Australasian Association of Animal Production Societes. Kualalumpur, 5-9 September 2004		2004	1,0
Seminars			
The contribution of Herbivore-Agriculture to Sustainable National Systems,Yogyakarta		2004	0,2
WIAS Science Day, 2001, 2003, 2005		2001/03/05	0,6
WIAS Choices for the Future Seminar		2005	0,2
Presentations *(minimum 4 original presentations of which at least 1 oral, 0.5 cp each)*			
ISTAP 3 (poster presentation)		2002	0,5
The 11th AAAP (oral presentation), Malaysia		2004	0,5
Poster presentation at Choices for the Future Seminar		2005	0,5
Oral Presentation at The Seminar on evaluation of conducting cooperation, Gadjah Mada University, Yogyakarta, 16 January 2006		2006	0,5
Subtotal International Exposure			**5,0**
In-Depth Studies (minimum 4 cp)			
Disciplinary and interdisciplinary courses			
Training on Standard test for livestock farming, "Profitable and Bankable business of beef cattle based on local resources. Yogyakarta, 5 - 15 November		2001	2,0
Workshop on Animal Science. Small ruminant development in Indonesia, Yogyakarta		2004	0,5
Workshop on strategy for Poverty Alleviation through livestock development, Yogyakarta 27-28 January 2006		2006	0,5
In depth study on "Strengthening the rural society through keeping Kacang Goats in Grobogan, Central Java. January 2005 - February 2006		2005/2006	2,0
Subtotal In-Depth Studies			**5,0**
Professional Skills Support Courses (minimum 2 cp)			
English conversation Training in Yogyakarta, Indonesia (August to December 2004)		2004	1,0
Career perspectives course		2005	1,0
Subtotal Professional Skills Support Courses			**2,0**

Research Skills Training (apart from carrying out the PhD project, optional)	year	cp
Preparing own PhD research proposal (maximum 4 cp)	2000	4,0
Special research assignments		
Research on feasibility study and performance of small dairy farming in Yogyakarta	2004	1,0
Research on livestock waste management by using biogass technique applied to the farmers to improve milk quality and production cost efficiency	2004	1,0
Subtotal Research Skills Training		**6,0**
Didactic Skills Training (optional)		
Lecturing		
Lecturing on Animal Production, Gadjah Mada University	2004	1,2
Lecturing on Introduction to Animal Husbandry, Gadjah Mada University	2003	1,2
Lecturing on Management Feedlot, Gadjah Mada University	2002	1,0
Lecturing on The Science of Draught Power Animals	2005/2006	1,0
Supervising MSc theses *(maximum 1 cp per MSc student)*		
Local supervisor for the thesis of Tri Satya Mastuti Widi, M.Sc.	2003	1,0
Subtotal Didactic Skills Training		**5,4**
Management Skills Training (optional)		
Membership of boards and committees		
Member of advisory team on the development of goats for poverty alleviation, collaboration Gadjah Mada University and Social Department, Republik of Indonesia	2005/2006	1,0
Subtotal Management Skills Training		**1,0**
Education and Training Total (minimum 21 cp, maximum 42 cp)		**26,4**

*One credit point (cp) equals a study load of approximately 40 hours

Colophon

Cover pictures by Gede Budisatria:
A father together with his children standing in front of the sheep house, on the left salak leaves are growing. Farmers integrate their small ruminants (producing manure to fertilise) with this tropical fruit. Revenues of small ruminants are used especially at the start of the school year. In many cases goats are kept in confinement, while sheep are allowed to graze.

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