Current and future goat production in Jembrana Regency, Bali Province

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Abstract. This study was undertaken to establish a database for improving goat production in Bali. A survey was conducted from January to June 2014 on 68 farmers integrated with farm commodities, owning a total of 258 goats in Mendoyo District. Data on flock dynamics were 49 kidding occurrences in 2014 delivered 67 kids; 67% were single born, 29% were twins and 4% were triplets/quadruplets. The kids were a mixture of Gembrong, Benggala, Kacang, Etawah, and PE that had a 24% mortality rate. Litter size was on average 1.37 kids from does with 1st to 6th parity. Kids were housed in battery systems and fed fresh roughages with cut and carry feeding systems. The average bodyweights of female weaners 22.9±1.6 kg were significantly lower (P<0.01) than of male weaners 29.8±1.9 kg at day 135. This growth was supported by the abundance of available feed, and the housing used meant low incidence of parasites as indicated by FAMACHA© scores which were generally low (P<0.01). Fourteen goats were sold for IDR 22 M. Smallholder farmers in Mendoyo District reared goats in small flocks as the farmers had just re-started rearing goats again resulting in inefficient goat production, particularly when labour costs were included.

1. Introduction

Mendoyo District was selected as the sampling area as it had the largest goat population among the districts in Jembrana Regency [1]. Although Jembrana was designation regency for improvement of goat farming that was officially promulgated by the Indonesian Minister of Agriculture [2], this regency has had a large reduction in the number of goat farmers as well as goats, over the last 25 years. Jembrana Regency previously had 42,751 goats or about 45% of the total 95,430 goat population in Bali Province in 1990 [3]. In 1990, this was about double the current number of goats in Buleleng Regency i.e. 24,905 goats or triple that of Karangasem Regency i.e. 13,861 goats. Other villages in Jembrana Regency that previously had large numbers of goats and goat farmers [3] had been visited. However, these villages at the time of this study had none or very few goats and goat farmers. Available literature presented little information on the reasons some smallholder farmers had stopped farming goats years ago or they had just re-started farming goats recently, as well as the current situation of their goat rearing under smallholder production systems in Mendoyo District.

Most of the smallholder farmers studied in Mendoyo District apparently re-started rearing goats as they had received Simantri Programmes in October 2013 and April 2014 (Tunas, W. 2014, pers.

comm. 9 June) that motivated them to resume or improve their goat rearing management [4]. The smallholder goat farmers mostly had small flocks; therefore, they were increasing the number of goats in their flocks and apparently would not sell goats prior to Eid Qurban. A case study was conducted from the 3rd to 30th June 2014 to establish a database of current reproductive and productive efficiency of goat farming in Mendoyo District as they contributed about 2.4% of the total 841.8 km² size of Jembrana Regency, and as well they contributed about 11% of the total of 68,457 goats in Bali Province [1]. The objective of this study was to establish a database of the reproductive and productive efficiency of goat farming under smallholder production systems in Mendoyo District in Jembrana Regency, as well as a socioeconomic analysis of these systems. The database was used to set up development strategies for improving goat production, in Bali Province.

2. Materials and Methods

The goat farming studied in Jembrana Regency encompassed a village in Mendoyo District. Mendoyo District is located in West Bali National Park, the conservation forest of Jembrana Regency that is located in the western part of Bali. Jembrana Regency is situated $8^0$9'58" to $8^0$28'2" south and $114^0$26'28" to $115^0$51'28" east with average ambient temperatures 26.2 ^{0}C, and 83% annual average relative humidity, 1,721 mm rainfall and 3 knots wind velocity (www.bmkg.go.id). Most of the people lived in agricultural sectors and their income was derived primarily from soybean, coconut, cacao, coffee, and cloves plantations [1].

All 68 goat-owning families were interviewed, based on structured questionnaires, and 258 goats were observed to obtain data i.e. breed-type, sex, age, dentition status (I_0, I_1, I_2, I_3, I_4, toothless), FAMACHA© score, bodyweight, chest circumference, body length, height at withers and rump height, birth type (single and multiple), and parity were recorded over a month of direct animal observations. From the 258 goats, 67 kids were born during the data collection. Data was only collected in June 2014; therefore, data on goat reproductive performance was taken from the previous year. Most of the smallholder goat farmers had just re-started rearing goats and housed their goats only in battery housing systems; therefore, average daily gain of goats, kidding intervals as well as the effects of housing systems were not presented. The inputs included feeds, veterinary services, drugs, and labour cost i.e. labourers (from the family). The outputs obtained included sales of live animals, manure or goat products consumed at home which were then converted into cash (IDR million). IDR 1 million was equivalent to AUD$100.00.

Age of kids were estimated from their dentition status (I_0) while their birth dates were estimated by using the farmer's data and they were confirmed by looking at the condition and size of the dam's mammae or date of post-partum mating [5]. Kids were weaned, on average, at about 135 days of age. All 68 goat owning families completed questionnaires on a range of topics i.e. goat feeding and breeding management, income from goats and other sources and the demographics of people living on the farm. The relationships between liveweights and other factors were established using a linear regression analysis while correlations of the goats liveweight with other factors were computed by using SPSS version 22.

3. Results and Discussion

3.1 Household labourers and their profiles

Identifying the roles and the profiles of smallholder farmers involved in goat rearing under smallholder production systems in Mendoyo District could be used to improve their goat production. Ceasing goat rearing for quite some time, for various reasons, smallholder farmers in Mendoyo District re-started rearing goats again in October 2013 and April 2014 when they received Simantri Programmes (Tunas, W. 2014, pers. comm. 9 June). Smallholder farmers faced problems such as having traumatic experiences where their goats got sick and had low performance and/or died due to mouth and foot diseases; lack of capital to restart rearing goats again; low numbers of 2 ± 0.1 household labourers; and not being young anymore (47.3 ± 1.4 years) to manage their crops along

with rearing goats at the same time. This indicated that the farmers were old and did not have much physical energy necessary to contribute to farming as would be expected from them. On the other hand, farmers who reared small flock sizes produced insufficient goat manure to fertilize the 0.9 ± 0.1 ha of their crops. Strangely farmers that had the highest education level tended to have the lowest labourer ratio, the smallest turn off rate and generated loss in both GM(A-B) IDR (4.661 ± 1.312) million and GM/doe IDR (2.518 ± 0.244) million.

Number of 0.2 ± 0.1 children per household also caused the reduction in the number of goats in Mendoyo District. Farmers' children went to study in Denpasar City or to work on cruise ships overseas. [6] and [7] reported that cruise ship work was an increasingly popular career choice for senior high school graduates in Bali Province. Limitations of the availability of family labourers resulted in a new critical threshold for farm growth strategies in Mendoyo District. Based on its low profitability and the amount of labour required, it is unlikely that the younger generations would be interested in taking up goat husbandry, so it is a trend that is bound to continue. This seemed to be a constraint to improving goat rearing in Mendoyo District.

However, 16% of the households in the present study were aged between 65 and 73 years with 9.2 ± 1.1 years of goat rearing experience and cultivated 0.9 ± 0.1 hectare of crop farms integrated with goat rearing although they were not young anymore. Smallholder goat farmers in Malang Regency, East Java, besides cultivating an average of 1.35 ha for crop farms, 32% respondents reared about 8 to 20 goats per household involving more family members as labourers i.e. 5-7 household labourers whose ages were younger than Indonesian manpower age standard i.e. 10 to above 65 years old [8].

This study revealed that the level of education of the household played an important role in dictating the best production parameters. The level of farmer education *per se*, could be expected to improve the efficiency of goat production, but it is hypothesised that farmers with a better education would implement improved husbandry practices. Although farmers' education level did not significantly affect their GM/doe, the farmers with the highest education level i.e. graduated from high school tended to have higher GM/doe IDR (2.419 ± 0.542) million. This indicated that the higher education level of the farmers, the better the decisions they make for efficient goat production such as having larger numbers of does per household, and having a larger ratio of household labourers to their goats. It may be assumed that increased education leads to a better understanding on how to have more efficient goat production [9] and [10]. Education and governance have major impacts on agricultural efficiency; therefore, farmers should have higher levels of education [11].

3.2 Goats and their profiles

Flock size, more importantly the number of does owned by households, was one of the factors that influenced the GM(A-B) or GM/doe gained by smallholder farmers in Bali Province. Smallholder farmers in Mendoyo District reared goats that were a mixture of Gembrong, Benggala, Kacang, Etawah Grade, PE and their crossbreds or backcrosses. All the body dimension measurements of preweaned, weaner and yearling males were significantly higher than of preweaned, weaner and yearling females ($P<0.05$). The average of 29.8 ± 1.9 kg bodyweights of male weaners in this study were significantly higher ($P<0.01$) than the 22.9 ± 1.6 kg of female weaners (Table 1). This was in agreement with [12] and [13] who reported that male kids grew faster and heavier than female kids. The reasonable growth rates of preweaned and weaned kids indicated that smallholder farmers in Mendoyo applied good kid rearing management, thus improving goat production.

Average height at withers of goats reared in Mendoyo District i.e. 66.0 ± 0.7 cm was categorized as a Large type goat [14] and [15] (Table 2). Based on the body dimension measurements, it appeared that goats were PE goats with longer ears. This indicated that larger size goats usually produced more milk and meat than smaller ones [15] and [16]. Female yearlings aged 0.5 – 1 year studied in Mendoyo District had an average of 26.2 ± 1.4 kg bodyweight, 66.1 ± 1.5 cm chest circumferences and 64.8 ± 1.3 cm height at withers. These body dimensions were within the range of the required physical standard of PE breeding stock by [17]. This indicated that it was a good time to expand the number of goats in Mendoyo District as good breeding stock was being farmed.

Table 1. Average chest circumference, bodyweight and FAMACHA© score of different physiological state from 258 recordings of goats reared in Mendoyo Districts Bali

Class of goat	Chest circumference (cm)		Bodyweight of goats (kg)		FAMACHA© score	
	No. of goat	Mean ± SEM	No. of goat	Mean ± SEM	No. of goat	Mean ± SEM
F preweaned	13	48.9 ± 2.0^{a}	13	10.5 ± 1.9^{a}	13	1.2 ± 0.2^{a}
F weaner	18	61.1 ± 1.7^{b}	18	22.9 ± 1.6^{b}	18	1.5 ± 0.2^{bijkl}
F yearling	22	66.1 ± 1.5^{cjk}	22	26.2 ± 1.4^{c}	22	1.3 ± 0.2^{aimn}
F pregnant	75	75.3 ± 0.8^{dlmn}	75	35.6 ± 0.8^{d}	75	1.3 ± 0.1^{cop}
F lactating	16	78.2 ± 1.8^{elop}	16	38.0 ± 1.7^{ej}	16	1.9 ± 0.2^{do}
F dry	48	74.4 ± 1.0^{tmoq}	48	33.4 ± 1.0^{fj}	48	1.6 ± 0.1^{ep}
M preweaned	18	48.3 ± 1.7^{a}	18	13.6 ± 1.6^{a}	18	1.7 ± 0.2^{a}
M weaner	13	68.9 ± 2.0^{gjr}	13	29.8 ± 1.9^{g}	13	1.1 ± 0.2^{fjm}
M yearling	11	69.8 ± 2.1^{hkqr}	11	28.7 ± 2.0^{h}	11	1.3 ± 0.2^{gk}
M buck	24	78.1 ± 1.5^{inp}	24	36.2 ± 1.4^{i}	24	1.7 ± 0.1^{hln}
All goats	258	66.9 ± 0.5	258	27.5 ± 0.5	258	1.5 ± 0.0

Class of goat	Chest circumference (cm)		Bodyweight of goats (kg)		FAMACHA© score	
	No. of goat	Mean ± SEM	No. of goat	Mean ± SEM	No. of goat	Mean ± SEM
All females	192	71.1 ± 0.8^{a}	192	31.3 ± 0.9	192	1.4 ± 0.0
All males	66	66.6 ± 1.4^{b}	66	27.5 ± 1.6	66	1.5 ± 0.1
All goats	258	68.8 ± 0.8	258	29.4 ± 0.9^{c}	258	1.5 ± 0.0^{c}

F=Female, M=Male. All preweaned=aged 0 – 4.5 months; All weaner=4.5 month – I_0; All yearling=I_1; F pregnant, F lactating, F dry, and buck had I_1 – toothless.
Means in a column with different superscripts differed significantly at the .05 level.

Table 2. Average body length, height at withers and rump height of different physiological state from 258 recordings of goats reared in Mendoyo Districts Bali

Class of goat	Body length (cm)		Height at withers (cm)		Rump height (cm)	
	No. of goat	Mean ± SEM	No. of goat	Mean ± SEM	No. of goat	Mean ± SEM
F preweaned	13	59.0 ± 2.8^{a}	13	49.1 ± 1.7^{a}	13	51.5 ± 1.7^{a}
F weaner	18	72.6 ± 2.3^{b}	18	59.0 ± 1.4^{b}	18	61.3 ± 1.5^{b}
F yearling	22	80.4 ± 2.1^{cjk}	22	64.8 ± 1.3^{cjk}	22	68.1 ± 1.3^{cjk}
F pregnant	75	91.5 ± 1.2^{dlmnov}	75	69.3 ± 0.7^{dlmn}	75	73.4 ± 0.7^{dlm}
F lactating	16	94.3 ± 2.5^{elqr}	16	72.9 ± 1.5^{eo}	16	75.6 ± 1.6^{eln}
F dry	48	91.6 ± 1.5^{tmqst}	48	68.8 ± 0.9^{tlpq}	48	71.9 ± 0.9^{tmop}
M preweaned	18	58.7 ± 2.3^{a}	18	49.3 ± 1.4^{a}	18	51.8 ± 1.5^{a}
M weaner	13	80.4 ± 2.8^{gju}	13	65.8 ± 1.7^{gjmpr}	13	68.1 ± 1.7^{gjoq}
M yearling	11	85.4 ± 3.0^{hknsu}	11	64.4 ± 1.8^{hknqr}	11	69.2 ± 1.9^{hkpq}
M buck	24	93.7 ± 2.1^{iprtv}	24	75.1 ± 1.3^{io}	24	77.2 ± 1.3^{in}
All goats	258	80.8 ± 0.7	258	64.0 ± 0.4	258	66.8 ± 0.5

Class of goat	Body length (cm)		Height at withers (cm)		Rump height (cm)	
	No. of goat	Mean ± SEM	No. of goat	Mean ± SEM	No. of goat	Mean ± SEM
All females	192	86.4 ± 1.1^{a}	192	66.6 ± 0.7^{a}	192	69.9 ± 0.7^{a}
All males	66	79.9 ± 1.8^{b}	66	64.5 ± 1.2^{a}	66	67.0 ± 1.2^{b}
All goats	258	83.2 ± 1.1	258	65.5 ± 0.7	258	68.5 ± 0.7

F=Female, M=Male. All preweaned=aged 0 – 4.5 months; All weaner=4.5 month – I_0; All yearling=I_1; F pregnant, F lactating, F dry, and buck had I_1 – toothless.
Means in a column with different superscripts differed significantly at the .05 level.

Expanding quality-breeding stock could be one of the development strategies that will help in improving their goat production.

Overall, 49 parturitions produced 67 kids that were born in the first six months of 2014 in Mendoyo District. There were 75 pregnant does or 54% of the 139 does recorded in the 68 flocks in 2014 in Mendoyo District. This figure was larger than 25% of flock sizes recommended by [18]. This

indicated that flock size could be expanded in two or three years to achieve a larger proportion of does, and bucks owned per household in Mendoyo District. Expanding flock size by households could be one of the development strategies that will help in improving their goat production with no goats sold in 2014.

The largest flock of 53 goats that included four bucks and 39 does, six female preweaned kids, a female weaner, two female yearlings and a male preweaned kid, had 37 pregnant does and was making a big effort to expand flock size in Mendoyo District. This was shown by selling zero goats and thus they had zero per cent annual turn off rate in 2014. Furthermore, the smallholder farmer had four bucks to mate the 39 does to ensure a high pregnancy rate i.e. 95% had been achieved, thus a high kidding rate. [17] required 34 ± 6 kg, 76 ± 7 cm and 71 ± 5 cm for breeding stock PE does aged 1-2 years while 49 ± 9 kg, 80 ± 8 cm and 67 ± 5 cm for breeding stock PE bucks aged 1-2 years for the three measurements, respectively.

This indicates that having a large flock size with the correct proportion of does and bucks as well as having three household labourers per household and a high standard of breeding stock could be one of the development strategies that will help in improving their goat production.

3.3 Socioeconomic analysis

Overall, total GM/doe of IDR (138.500) million with an average IDR (2.518 ± 0.174) million ranged from a loss of IDR 6.275 million to a profit of IDR 3.396 million. Of the 258 goats studied, 14 goats were sold in 2014 for the total price of IDR 22 million that contributed 48% to the total income of IDR 45.540. Total sale of manure contributed 52% or IDR 23.542 million and sale of goats contributed 48% or IDR 22 million to the total income of IDR 45.542 million for the flocks studied in Mendoyo District.

Although goat rearing contributed a high income i.e. GM (A-B) IDR 6.792 million and GM/doe IDR 3.396 million to the farmers, farmers in Mendoyo District preferred increasing the number of goats in their flocks. Their goats were quality-breeding stock as they achieved the required physical standard of [17]. Other farmers including the one who had the largest flock of 53 goats were expanding their flocks and apparently would not sell goats prior to Eid Qurban. Expanding flocks by smallholder farmers studied in Mendoyo District almost made a zero per cent of turn off rate and thus generated negative GM(A-B) and GM/doe. This indicated that in future, Mendoyo District could have more goats to produce organic fertilizer for their crops and to sell both fertilizer and live animals.

The average turn off rate recorded in 2014 was 5 ± 3% where only preweaned female and male kids and weaners female and male kids were sold in 2014. It was likely that smallholder farmers in Mendoyo District were not able to sell more goats prior to Eid Qurban in October 2014. Therefore, the turn off rate was likely to be stable and would not significantly affect GM(A-B) and GM/doe in all flock sizes. As members of the smallholder goat farmers association who received the Simantri programme, they had an agreement with the Bali Government that they would not sell their goats until they kidded. Overall, goat rearing in Mendoyo District, had average GM(A-B) and GM/doe of IDR (4.376 ± 0.565) million and IDR (2.518 ± 0.174) million, respectively, when they had a low turn off rate of 5 ± 3%. When all flocks were ranked based on GM/doe, only one flock had a positive GM/doe of IDR 3.396 million and this flocks consisted of four goats that included two does, and six goats were sold and had a 150% turn off rate. However, an assumption was made that owning the four goats with one buck, one female yearling and two does, in 2014, produced three female and three male kids (i.e. 2 does X 3 kids X 2 as twins per 2 years with 0% mortality). Therefore, when a female kid was kept for replacement, two female and three male kids and a culled doe could be sold with a 150% turn off rate.

Overall, goat rearing in Mendoyo District, had average GM(A-B) and GM/doe of IDR (4.376 ± 0.565) million and IDR (2.518 ± 0.174) million, respectively, when they had a low turn off rate of 5 ± 3%. When all flocks were ranked based on GM/doe, only one flock had a positive GM/doe of IDR 3.396 million and this flocks consisted of four goats that included two does, and six goats were sold and had a 150% turn off rate. However, an assumption was made that owning the four goats with one buck, one female yearling and two does, in 2014, produced three female and three male kids (i.e. 2

does X 3 kids X 2 as twins per 2 years with 0% mortality). Therefore, when a female kid was kept for replacement, two female and three male kids and a culled doe could be sold with a 150% turn off rate.

The bottom 20 households of GM/doe generated the largest loss of IDR 6.275 million when the farmer who had eight goats including one doe and sold no goats. Although this farmer did not generate the largest loss of GM(A-B), the farmer generated the largest loss of GM/doe as the GM(A-B) was divided by one doe. In contrast, the household that had the largest flock of 53 goats including 39 does had the largest ratio of household labourers to goats i.e. 17.7 goats per household had the largest total variable cost of IDR 42.271 million as well as the largest loss of GM(A-B) of IDR 37.435 million. However, this household was the 18th of the top 20 for GM/doe. This indicated that the number of does owned per household largely dictated the efficiency of goat production. The larger the number of does owned by the household, the greater opportunity they had efficient goat production and thus generated higher GM/doe ($P<0.05$).

Other factors that also contributed to these two production parameters had to be considered. Annual equivalent working hours, the labourer to goat ratio or farmer education level of flock size did not significantly ($P>0.05$) affect the GM/doe. This indicated that as long as the number of does owned per household did not generate positive values of GM(A-B) and GM/doe, other factors contributed to generate higher positive or negative values for GM(A-B) and GM/doe. That was as long as the number of does owned per household covered labourer, feed and health control costs, farmers generated positive GM(A-B) and GM/doe.

Goat marketing in Mendoyo District was not well managed by goat farmer associations as they had just re-started rearing goats again and had only sold a few goats. Goat brokers were common in Mendoyo District, and as such, there was a longer supply chain and this potentially reduced the possibility of gaining better selling prices for goat farmers in Mendoyo District. Most of the transactions between goat farmers and buyers occurred on goat farms. Goat buyers were categorised as four types: breeder, meat retailers, satay sellers and occasional buyers. As the goat population reduced in Jembrana Regency, farmers as well as larger satay sellers preferred buying goats from East Java Province that provided stable and lower prices. Smallholder farmers did not have any constraints to marketing their goats. In contrast, they faced constraints to fulfil the opportunities as well as the challenges to supply demand for goats within Bali Province, particularly for Eid Qurban.

3.4 Effects of managerial and environmental factors on production parameters

Although bodyweight is an important economic trait in meat type animals, all households interviewed in Mendoyo District were not sure how to predict the age of their goats and had never weighed their goats even when they sold them. Furthermore, farmers had never recorded the productive nor reproductive parameters of their goats. This is a constraint to rearing goats in Mendoyo District as it means farmers have no data on how well their animals are performing.

3.4.1 Objectives of goat keeping. All households interviewed in Mendoyo District had just re-started rearing goats again after they had experienced low goat production and great losses due to mouth and foot diseases in their goats. Therefore, their main priority of keeping goats was to increase the size of their flocks, as the amount of goat manure produced per household was insufficient to supply their organic fertilizer. This was in agreement with [19] who reported that to have high cacao production, one ha of cacao plantations needed goat manure produced by 25 to 28 goats. This indicated that the smallholder farmers in Mendoyo District have the opportunity to increase crop productivity with more goats; but expansion of their flocks may be constrained by their age and low numbers of children.

3.4.2 Feed and feeding management. Goats in this study were fed with fresh *Caliandra calothrysus, Gliricidia sepium, Sesbania sesban, Erythrina variegata, Artocarpus heterophyllus* or other bushes or field grasses at about 5 kg/goat/day regardless of their physiological state. This result was supported by [20] who reported that smallholder farmers in Bali, apart from growing crops as their main production, also practiced traditional silvipastoral systems by growing shrubs and trees and keeping

livestock as a sideline.[14] stated that goats were great economic value ruminants for their efficient converters of low-quality forages into quality meat and milk products. This was supported by [21] who reported that feeding goats with various herbaceous roughages provided balanced proportions of nutrients in the goat's diet as they contained natural antioxidant rich diets that have become especially important for their growth, survival, maintenance and health status. This feeding management resulted in comparable bodyweights for all physiological states of goats reared in Mendoyo District (Table 1).

Smallholder farmers in this study also fed their goats with unfermented chopped cacao pods of about 100 g/goat/day. This was in agreement with [22] who suggested that goats be fed with un-processed cacao pods at a maximum amount of 100 g/goat/day, that increased daily weight gain of 70 g/goat/day. This was due to the un-processed cacao pods containing low protein, relatively anti nutritional compounds such as lignin, tannin and theobromine that limited the efficiency of its digestion [23]; [24] and [25].

Utilizing treated cacao pods or coffee pulp from their agriculture wastes, as goats feed that was mixed with cut and carry feeding, might be the best choice because of their limited number of household labourers or their old age. [8] reported that cut and carry feeding systems, such as looking for roughage, smallholder farmers in Malang Regency needed 36% of their daily labourer, while transporting the roughage, mixing the roughage with other feedstuffs and feeding the goats required about 12%, 5% and 21%, respectively. Cleaning goat housing and rearing kids, the farmers needed about 1% and 25% of daily labourer hour, respectively. Since feeding management was the most time consuming and costly for goat farming [26], by treating the cacao pods and coffee pulp, the farmers could minimise problems. Cacao pod contains crude protein from 6.8 to 13.8%; NDF from 55.3 to 73.9% and ADF from 38.31 to 58.98% was a good fibre source and could replace grass for goats [25]. Fermented cacao pods by using *P. chrysosporium* increased crude protein up to 13.8% from 8.7% of untreated cacao pods thus increased daily gain of goats from 102 g/goat/day [23] and 100 to 125 g/goat/day as well as milk production from 1.00 to 1.25 litre/goat/day [24]. Utilizing these agricultural wastes as goats feed rather than leaving them as mulch also helped to conserve the environment of Mendoyo District.

3.4.3 Health and disease control management. Although the farmers studied in Mendoyo District never injected their goats with Klosan200™ (an anthelmintic) or any other medications to control diseases or parasites, the incidence of anaemia as measured by the FAMACHA© technique in all classes of goats was nil. This was probably due to the housing management system being well maintained. Furthermore, the smallholder farmers in Mendoyo District had just received the package of Simantri Programme including the goat housings that apparently new.[27] suggested to house goats in individual battery housing systems for hygienic reasons as it was easy to clean the houses as well as to collect the goat manure. In addition, smallholder farmers had paid attention to the cutting height as well as the cutting time of roughages fed to their goats.

However, the mortality rate in the present study i.e. 24% of newly born kids was considered high as six kids died when they were born as twins and triplets. This was probably due to the kids born having low birth weights. Furthermore, most of the goats were housed quite a distance from farmers' houses, so the goat farmers paid less attention when the low birth weights newly born kids needed help to ensure they received sufficient quantities of colostrum as well as does' milk. This result was confirmed by [28] who reported that low birth weights of kids who needed help with suckling, does having little or no milk, and does abandoning their kids were the major contributors to high mortality of newly born kids. The distance to the goat housing also increased the occurrence of metabolic disturbances, toxicity, bloat and scabies in preweaned kids. High kid mortality as well as the distance to the goat housing were constraints to improving goat rearing in Mendoyo District.

4. Conclusion

In conclusion, smallholder farmers in Mendoyo District reared goats in small flocks as the farmers had just re-started rearing goats again resulting in inefficient goat production, particularly when labour

costs were included.

Animal and Human Ethics Approvals

The University of Queensland Animal and Human Experimentation Ethics Committee, in agreement with the Australian National Health and Medical Research Council guidelines under approval numbers SAFS/A52/13 and SAFS/H13/19, respectively, approved the research conducted in this study.

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