Characteristics of the Existing Rainfed Rice-Bali Cattle Production Systems in Maliana, Bobonaro, Timor-Leste

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Abstract. The study area reveals that small-scale subsistence cropping of rice, maize and coffee remained in Maliana. Farmers obtained their income primarily from farming characterized by relatively low yield which they attributed poor application of improved technologies like the use of quality seeds, fertilizer and other inputs. Other than crops, farmer-respondents also integrate Bali cattle in their farms during fallow period where rice straw became available for the animals. Farming systems are diverse and most farmers also raise livestock (cattle, water buffalo, goats, sheep, chickens and pigs). Native pastures which comprise mainly native grasses and some legumes such as Leucaena (ipil-ipil), Gliricidia (madre de cacao) and other edible plants provide a cheap source of feed. Livestock range freely with no grazing management which gradually lead to loss of vegetative cover and soil erosion. Moreover, survey results reveal that majority of farmer-respondents had inherited the practice of raising Bali cattle from their parents. It was found that they have been raising cattle from 5 to 40 years. A big proportion of respondents got their knowledge for raising cattle from the government with conditions such as provision of training on feeding, pest and disease control, free vaccines and other technical support. As a consequence, farmers mentioned that the availability of inexpensive and quality forages, especially during the long dry season (6-7 months) is a major constraint on cattle production in the seven villages of Maliana. The farmers depend heavily on locally available natural feed resources, but there is a shortfall due to limited land availability and uncertain local climatic patterns. This is aggravated by the inadequate support extended to farmers in terms of improved technology in crop-livestock farming system is aggravated by the scarcity of resources and reluctance of farmers to adopt improved technologies.

Keywords: Bali cattle, crop-livestock farming, small-scale farmer.

1. Introduction

Small crop-livestock production system dominates the agricultural landscape of Timor-Leste. This system is conceptualized as a subsystem of a larger farming system that is composed of households and all the economic activities under the control of the family. Agricultural commodities in the country include many different crops and animals. However, these commodities are produced mainly in some
parts of Timor-Leste because each region has its own specific climate. The main commodities that are found in the country are food crops (rice, maize, peanuts, soybean, cassava and sweet potato), tree crops (candlenut, coconut, coffee and cloves) and livestock (Bali cattle, water buffaloes, pigs, goats, sheep, chicken, ducks and horses) [1].

Generally, the livestock production systems in the country are small-scale with one to three cattle per household. These are raised mostly in the wet and dry land under traditional management [1]. The traditional system is characterized by low levels of economic efficiency derived in a diversified agriculture system and based on a few hectares of land to support household needs [2].

At present, the government of Timor-Leste is prioritizing the improvement of the cattle industry for both export and for food security. The livestock’s contribution to GDP is only 4.5% of the GDP of agriculture. However, demand for livestock products in local, national and regional levels have increased sharply since the last decade. Ruminant population has remained static or declining slightly in the last twenty years or so, a situation that is often attributed to the status of the local feed supplies as well as to the traditional livestock management systems being practiced. Consequently, the challenges to increase food production from limited cultivable land become even stronger and more pressing. It is in this context that the potential of crop-livestock integration can be fully explored. Therefore, the objective of the present study is to characterize the existing rainfed rice-Bali cattle production systems in Maliana, Bobonaro, Timor-Leste.

2. Methodology
The study was conducted in seven villages of Maliana, Bobonaro, Timor-Leste from May to July, 2014. Maliana is one of the six districts of Bobonaro with flatter areas where maize and rice are grown. These areas have some permanent irrigation, which provides water for rice fields throughout the year. In normal years, maize planting commences in November and rice planting follows around December/January. A second rice crop is planted in March/April for harvesting around September.

A survey questionnaire was developed to gather information about rainfed rice-Bali cattle production system in the different villages of Maliana, Bobonaro, Timor-Leste. Seven villages were purposively selected based on the total Bali cattle population. From the total population of Maliana, sample farmer-respondents were randomly chosen based on the following criteria: cultivate 0.5-2.0 ha of rainfed rice and raise 3 to 5 heads of Bali cattle.

Relevant data obtained from the survey were subjected to descriptive statistics and then used to investigate the interactions among the different subsystems of the farming system.

3. Results and Discussion
General description
Bobonaro district is located in the west of Timor-Leste and extends nearly 100 km from north (the coast) to south, following the border between Indonesia and Timor-Leste. It consists of six sub-districts and is an important area for maize and rice production, with rice predominant in the flatter sub-districts of Maliana, Atabae and Cailaco. The other sub-districts of Bobonaro, Lolotoe and Balibo are hilly and important for sweet potatoes, candlenut, coffee and soybean. The sub-districts in the mountains have more rainfall, whilst the flatter areas have some permanent irrigation, which provides water for rice fields throughout the year. In normal years, maize planting commences in November and rice planting follows around December/January. A second rice crop is planted in March/April for harvesting around September. Bobonaro sub-district has extensive natural pastures and strong potential for future cattle development. Cattle, water buffalo, horses, pigs and chickens are raised in the lowland rice production areas and goats are common and well suited in other sub-districts. In view of the extensive destruction during the independence referendum in this part of the country, farmers are also comparatively more engaged in reconstruction of houses than in other areas.

In terms of cattle population, Balibo topped with a total of 7,286 heads followed by Atabae with 6,130 heads. Bobonaro and Cailaco recorded a total of 5,793 and 4,224 heads, respectively. Meanwhile, Maliana and Lolotoe recorded the smallest cattle population of 4,207 and 2,854 heads,
respectively [1]. A total of 120 farmer-respondents were chosen in the seven villages of Maliana. These farmers met the criteria of cultivating at least 0.5-2.0 ha of rainfed rice and raising three to five heads of Bali cattle.

More than half (59.2%) of farmer-respondents had a combination of rainfed and irrigated farms while more than one-third (39.2%) had rainfed farms. The remaining respondents (1.7%) had lowland irrigated farms. Most farmers practice subsistence farming. One of the most important decisions to make in rainfed farming is what crops to grow, and in what sequence and combination. These decisions are heavily influenced by the whole range of agro-climatic, socioeconomic, and agronomic factors.

### Bali Cattle Production and Management Practices

Most farmers in Timor-Leste practice small-scale subsistence cropping of rice, maize and coffee. However, farming systems are diverse and most farmers also raise livestock (cattle, water buffalo, goats, sheep, chickens and pigs). Native pastures are extensive throughout the country, covering over 200,000 ha or 10% of the country’s area. Proportions vary depending on the district and its suitability for other agricultural activities. Pastures comprise mainly native grasses and some introduced legumes such as Leucaena and other edible plants. These pastures, whether native or introduced, provide a cheap source of feed. Livestock range freely with no grazing management. Heavy grazing, leading to loss of vegetative cover and erosion is common.

In particular, Bobonaro sub-district has extensive natural pastures and strong potential for future cattle development. Cattle, water buffalo, horses, pigs and chickens are raised in the lowland rice production areas. Cattle ownership largely determines social status in village communities. Owners of large numbers of cattle are important people in society and are always involved in important village events. Animals are considered valuable assets for farmers to help cope with economic difficulties. They provide funds for emergency needs such as children’s schooling, deficits of staple foods during lean seasons, or funerals of family and relatives. Farmers are reluctant to slaughter animals for their own consumption, except during funerals, festivals or wedding celebrations. Cattle are more valuable than goats, sheep and pigs from a social point of view but they are not as easy to sell. Goats, sheep and pigs can be sold easily whenever farmers face economic difficulties. Ruminants are important for meeting the needs of major local markets throughout the territory [3].

Survey results reveal that majority (90.8%) of farmer-respondents had inherited the practice of raising Bali cattle from their parents. It was found that they have been raising cattle from 5 to 40 years. A big proportion of respondents (96.7%) got their knowledge for raising cattle from the government with conditions such as provision of training on feeding, pest and disease control, free vaccines and other technical support. A summary of the management practices in Bali cattle production in terms of type of cattle raised, reasons for raising, characteristics preferred of cattle to raise and reasons, method of feeding, method of feeding during the dry and wet seasons, roughages available in the locality, sanitary practices, problems encountered and person to contact for assistance in case of problems with cattle (Table 1).

All of respondents had been raising Bali cattle. Slightly less than half (45%) raised cattle for market while others mentioned common (14%), good in adapting to local food (10%), easy to control and grow faster (10%) and serves as a form of saving for children’s education and culture pattern (11%). In terms of characteristics of cattle preferred, more than half (57.5%) cited conformation followed by age (34.2%). Farmers preferred these characteristics because these are determinants of cattle which are good in adapting to local conditions and commands high selling price in the market.

Most of the farmers (60.8%) let loose their animals to graze while 39.2% practice tethering. A very small proportion practice combination of tethering and giving additional grass/straw and cut carry (5.0% and 1.7%, respectively). In terms of method of feeding during the dry season, most farmers (65%) practice combination of tethering and giving additional grass/straw while another 28.3% practice tethering for their animals. On the other hand, during the wet season, 45.8% of respondents let loose their animals to graze and 42.5% still practice tethering the whole day. Reports showed that little attention is paid to proper nutrition of village livestock, which suffer feed shortages and starvation, especially late in the long dry season. Supplements are hardly used at all [3].
Table 1. Bali cattle production and management practices in seven villages of Maliana, Bobonaro, Timor-Leste, 2014

| Item                                      | Frequency | Percent |
|-------------------------------------------|-----------|---------|
| **Type of cattle raised**                 |           |         |
| - Bali                                    | 120       | 100.0   |
| **Reasons for raising**                   |           |         |
| - intended for market                     | 54        | 45.0    |
| - source of cash for emergency            | 17        | 14.2    |
| - good in adapting to local feeds        | 12        | 10.0    |
| - easy to control and grow faster         | 12        | 10.0    |
| - saving money for children’s education   | 13        | 10.8    |
| - others (easy to raise, easy to monitor, resistant to diseases, inexpensive, need for health) | 12 | 10.0 |
| **Total**                                 | 120       | 100.0   |
| **Characteristics preferred**             |           |         |
| - body conformation                       | 73        | 60.8    |
| - age                                     | 41        | 34.2    |
| - color                                   | 1         | 0.8     |
| - size                                    | 3         | 2.5     |
| - age and body conformation               | 2         | 1.7     |
| **Total**                                 | 120       | 100.0   |
| **Reasons for preferred characteristics** |           |         |
| - good in adapting to local conditions   | 69        | 57.5    |
| - indication of being ready for selling   | 24        | 20.0    |
| - determinant of cattle price             | 21        | 17.5    |
| - easy to raise                           | 3         | 2.5     |
| - color indicates pureness of breed       | 3         | 2.5     |
| **Total**                                 | 120       | 100.0   |
| **Method of feeding**                     |           |         |
| - grazing                                 | 73        | 60.8    |
| - tethering the whole day                 | 47        | 39.2    |
| - tethering part of the day and give additional straw/grass | 6 | 5.0 |
| - cut and carry                           | 2         | 1.7     |
| **Total**                                 | 120       | 100.0   |
| **Method of feeding during dry season**   |           |         |
| - grazing                                 | 11        | 9.2     |
| - tethering the whole day                 | 34        | 28.3    |
| - tethering part of the day and give additional straw/grass | 78 | 65.0 |
| - cut and carry                           | 2         | 1.7     |
| **Method of feeding during wet season**   |           |         |
| - grazing                                 | 55        | 45.8    |
| - tethering the whole day                 | 61        | 42.5    |
| - tethering part of the day and give additional straw/grass | 16 | 13.3 |
| - cut and carry                           | 3         | 2.5     |
| **Common roughage available**             |           |         |
| - grass/weeds                             | 26        | 21.7    |
| - rice straw                              | 120       | 100.0   |
| - ipil-ipil leaves                        | 117       | 97.5    |
| **Management practiced**                  |           |         |
| - castration                              | 78        | 65.0    |
| - branding                                | 1         | 0.8     |
| Dehorning | Total | Percentage |
|-----------|-------|------------|
| Yes       | 41    | 34.1       |
| No        | 79    | 65.9       |

| Housing | Total | Percentage |
|---------|-------|------------|
| shed    | 11    | 9.2        |
| none    | 109   | 90.8       |

| Sanitary measures practiced | Total | Percentage |
|-----------------------------|-------|------------|
| vaccination                 | 92    | 76.7       |
| deworming                   | 19    | 15.8       |
| tick control                | 9     | 7.5        |

| Knowledge on different aspects of cattle production | Total | Percentage |
|------------------------------------------------------|-------|------------|
| breeding and selection                               |       |            |
| Yes                                                   | 52    | 43.3       |
| No                                                    | 68    | 56.7       |
| feeding farm by-product                              |       |            |
| Yes                                                   | 64    | 53.3       |
| No                                                    | 56    | 46.7       |
| feeding concentrate                                  |       |            |
| Yes                                                   | 64    | 53.3       |
| No                                                    | 56    | 46.7       |
| feeding vitamin and mineral                           |       |            |
| Yes                                                   | 63    | 52.5       |
| No                                                    | 57    | 47.5       |
| planting forage/legume                                |       |            |
| Yes                                                   | 64    | 53.3       |
| No                                                    | 56    | 46.7       |
| separate housing                                      |       |            |
| Yes                                                   | 63    | 52.5       |
| No                                                    | 57    | 47.5       |
| cleaning barn                                         |       |            |
| Yes                                                   | 63    | 52.5       |
| No                                                    | 57    | 47.5       |
| pests and diseases                                    |       |            |
| Yes                                                   | 65    | 54.2       |
| No                                                    | 55    | 45.8       |

| Source of knowledge | Total | Percentage |
|---------------------|-------|------------|
| Government offices  | 59    | 49.2       |
| NGOs                | 7     | 5.9        |
| not applicable      | 54    | 45.0       |

| Family member responsible for cattle raising | Total | Percentage |
|---------------------------------------------|-------|------------|
| wife                                        | 1     | 0.8        |
| son/daughter                                | 84    | 70.0       |
| in-laws                                     | 34    | 28.3       |
| husband                                     | 1     | 0.8        |

| Problem encountered | Total | Percentage |
|---------------------|-------|------------|
| diseases            | 120   | 100.0      |

| Person to contact for assistance | Total | Percentage |
|----------------------------------|-------|------------|
| veterinarian                     | 75    | 62.5       |
| neighbor                         | 20    | 16.7       |
| fellow farmer/friend             | 25    | 20.8       |
| Total                            | 120   | 100.0      |

*multiple responses
Rice straw and ipil-ipil leaves were the most common roughage available in the locality. These roughages are available because open pastures is present in the area and that minimal feeding management is practiced. In raising Bali cattle, farmer-respondents practiced three common measures namely castration (65%), dehorning (34.1%) and branding (0.8%). Practically housing is not provided since majority (90.8%) had their animals let loose all the time while the rest (9.2%) kept them in sheds in their backyards. Farmer-respondents practiced some sanitary measures to prevent pests and diseases on their animals. About 76.7% of farmers practiced vaccination, 15.8% practiced deworming and 7.5% practiced tick control.

Farmers were asked whether they have knowledge on the different aspects of cattle production which include breeding and selection, feeding farm by-product, feeding concentrate, feeding vitamin and mineral, planting forage/legume, separate housing, cleaning barn and pests and diseases. In all these aspects of cattle production, similar observations were found, that is, half of them have knowledge and the other half did not have any. Slightly less than half (49.2%) obtained their knowledge from government offices while others cited NGOs (5.9%) as their source. A big proportion of the respondents (45%) answered that this was not applicable. It was found that wives and husbands were not responsible in caring for their livestock. Sons and daughters (70%) and in-laws (28.3%) were the household members responsible in caring for their farm animals.

Disease was the major problem encountered by farmers and most of them (60%) consult a veterinarian while other farmers sought the help of fellow farmers/friends (19%) and neighbours (17.2%). Diseases are an important constraint throughout the country, exacerbated because animals are grazed extensively on common pastures. The most common diseases are haemorrhagic septicaemia and leptospirosis, which often cause mortality. Vaccination programs against anthrax and haemorrhagic septicaemia are reported to reach about 80% of cattle and water buffalo. Overall, diseases are not well controlled and high mortality rates occur in some herds and flocks [3].

Findings suggest that livestock husbandry is not a primary livelihood and that animals are not well managed in terms of feeding, housing, health, and reproduction. Generally, animals are raised using traditional practices which means grazing with little restriction in open natural pastures and periodically being penned or tethered in the afternoon after one or two days grazing. There is almost no improved management, although there is an example of dairy cattle being raised and fed with supplements in Lautem and Dili by the Catholic Mission [3].

**Bali Cattle Production Performance**

Bobonaro sub-district has extensive natural pastures and strong potential for future cattle development. Cattle, water buffalo, horses, pigs and chickens are raised in the lowland rice production areas. Bali cattle are the most preferred in the small holding system, due to their rusticity, fertility and low calf mortality. An average family often plants a wide range of crops and at the same time keep livestock such as pigs and chickens, buffalo or Bali cattle; and do forestry management on their property. The Bali cattle performances are presented in Table 2.

**Table 2.** Bali cattle performance in seven villages (*sucos*) of Maliana, 2014

| Criteria                  | N  | Mean ± Sd | Min | Max |
|---------------------------|----|-----------|-----|-----|
| Birth weight (kg)         | 120| 20.28 ± 3.6 | 12  | 29  |
| Weaning weight (kg)       | 120| 47.51 ± 6.3 | 3   | 53  |
| Weaning age (months)      | 120| 6.52 ± 0.6  | 6   | 8   |
| Calving age (months)      | 120| 12.40 ± 1.5 | 1   | 15  |
| Number of calves per year | 120| 2.52 ± 1.1  | 1   | 6   |
| Mature weight (kg)        | 120| 164.04 ± 3.8| 160 | 170 |
| Maturity age (months)     | 120| 13.91 ± 4.2 | 8   | 19  |
In this study, birth weight is at least 12 kg and the heaviest is 29 kg with an average of 20 kg. The range of this finding was almost the same with that of the recorded birth weight of Bali cattle which was 38 kg [4]. Other observation showed that the average birth weight of Bali cattle was 14.29 kg [5].

The average weaning weight was 47.5 kg, with a range of 3 to 53 kg. In the study, it was found that weaning weight was way below the standard weaning weight reported as 82.9 kg [4, 6] This suggests that weaning weight is dependent on the innate calf growth capacity in addition to the ability of dams in raising their calves. The dam factor plays an important role in affecting the weaning weight, in addition to the calf’s potential. Weaning is the period of withdrawing the calf from the cow. In this study, weaning age ranged from six to eight months with an average of 6.5 months (195 days).

In this study, calving age was at least one month and the maximum was 15 months with an average of 12.4 months. According to a study of 800 cattle in seven villages in Maliana of Timor Leste, average age at first calving was 29 months (range 20-40 months) and the average inter-calving interval was 16 months (range 11-40 months) [7]. Findings are in contrast with the recorded standard calving age of Bali cattle which was 32 months [4].

In this study, calving rate of Bali cattle was found to be at least one per year to as high as six with a mean calving rate of 2.5. According to an intensive monitoring survey of Bali and Ongole cattle on a few major islands in Nusa Tenggara (Lombok, Sumbawa, Flores and Timor and Sumba) carried out through the Cattle Health and Productivity Survey (CHAPS) of the Eastern Islands Veterinary Project (EIVSP) for the three year period (1990–1993), it was found that the mean calving rate of Bali cattle in Timor (64 ± 12%) was lower than those recorded in Sumbawa (72 ± 22%), Lombok (74.4 ± 11%) and Flores (78 ± 13%). It was emphasized that calving rates vary between sites due to the differences in the environment particularly the availability of feed resources and differences in management between sites and between individual farmers [8].

Weight of mature Bali cattle ranged from 160 to 170 kg. Results were relatively lower than those found by [4] and [9], that among mature female Bali cattle across eastern Indonesia which weighed 211-270 kg whereas male Bali cattle weighed between 250-270 kg. Growth rate of Bali cattle under village conditions was low primarily due to insufficient supply of high-quality feeds [10, 11].

In this study, it was recorded that Bali cattle matures within 8 to 19 months for an average of 13.5 months. Generally, the mature age of bulls start when the red hair and reddish brown color on the body turns black gray/dark bluish black and completely black. This condition could be seen around of 12 – 18 months of age [12].

Marketing of Bali Cattle

Bali cattle (Bos sondaicus/javanicus) account for almost 27% of total beef cattle in Indonesia. They are the predominant breed in the eastern islands and are highly favored by smallholder farmers for their high fertility, low calf mortality and generally higher market price [13]. On the other hand, the collaborative experiences in Asian Farming System Network showed that livestock contributes 20-40% of the net farm income farmers [14, 15].

Marketing of Bali cattle is summarized according to age of sold animals, market value of animals (Table 3), reasons for selling, place of selling, time of selling and mode of payment (Table 4). In the study, animals were sold at the age of at least 15 months and as old as 15 years. Average age of cattle for market was 29 months or equivalent to 2 ½ years. All the culls were integrated in the number of animal sold out, while the culls animal is sold at US$ 200 to US$300 each. Bali cattle were sold to as low as US$ 400 to as much as US$ 900. However, prices varied depending on the age of cattle. Full-grown cattle demand the highest price while the young (calf, bull and heifer) command lower costs.

Farmers reported that selling their animals was brought about for their need for money for their children’s education and culture. Majority (99.2%) of respondents sold their animals in the market while a small portion (0.8%) sold them to other members of the family. In general, selling takes place in the morning. Selling of meat, carcass, manure and other by-products of cattle was done as early as 5:00 to 6:00 am. The cash basis was the usual mode of payment of selling animals. There were few instances that barter was practiced.
Table 3. Age and market value of animals sold in seven villages (*sucos*) of Maliana, 2014

| Criteria                  | N  | Mean ± Sd   | Min | Max |
|---------------------------|----|-------------|-----|-----|
| Age (months)              | 120| 29.25 ±14.2 | 15  | 180 |
| Market value (US$)        | 120| 588.75 ±94.7| 400 | 900 |
| Cattle                    | 119| 1419.45 ±752.6| 500 | 9100|
| Cow                       | 117| 443.16 ±372.6| 200 | 4400|
| Steer                     | 82 | 216.16 ±120.2| 100 | 1150|
| Calf                      | 116| 122.80 ±79.7 | 80  | 880 |
| Bull                      | 117| 573.93 ±109.8| 100 | 800 |
| Heifer                    | 77 | 213.83 ±83.0 | 100 | 600 |

Table 4. Reasons for selling, place of selling, time of selling and mode of payment of payment in selling animals in seven villages (*sucos*) in Maliana, 2014

| Item                                    | Frequency | Percent |
|-----------------------------------------|-----------|---------|
| Reasons for selling*                    |           |         |
| ● Need for money for education          | 120       | 100.0   |
| ● Cultural traditions                   | 120       | 100.0   |
| Place of selling                        |           |         |
| ● Market                                | 119       | 99.2    |
| ● Neighborhood                          | 1         | 0.8     |
| Time of selling                         |           |         |
| Meat                                    |           |         |
| ● 5 AM                                  | 17        | 14.2    |
| ● 6 AM                                  | 82        | 68.3    |
| ● Morning, unspecified time              | 13        | 10.8    |
| ● No answer                             | 8         | 6.6     |
| Manure                                  |           |         |
| ● 5 AM                                  | 11        | 9.2     |
| ● 6 AM                                  | 76        | 63.3    |
| ● Morning, unspecified time              | 7         | 5.8     |
| ● No answer                             | 26        | 21.6    |
| Carcass                                 |           |         |
| ● 6 AM                                  | 10        | 8.3     |
| ● Morning, unspecified time              | 1         | 0.8     |
| ● No answer                             | 109       | 90.8    |
| Mode of payment*                        |           |         |
| ● Cash                                  | 120       | 100.0   |
| ● Barter                                | 8         | 6.6     |

*multiple responses

Findings are supported by ACIAR’s report [9] about the social capital and cattle marketing in Bali and Lombok, Indonesia which highlighted that: (a) Smallholders’ decisions to sell cattle are based on a need for cash at a particular time, rather than based primarily on price. (b) The timing of sale (and purchase) is influenced by the availability of feed and cash, and social responsibilities. Smallholders do not tend to respond to price signals. (c) Smallholders prefer to buy at the market because of the greater choice available, but they like to sell on-farm for a number of reasons, including better price, less chance of being cheated, lower risk of injury to cattle, and lower transport costs.

Problems and Constraints

Based on the interview of farmer-respondents, the key constraints on cattle production in the seven villages of Maliana is the availability of inexpensive and quality forages, especially during the long dry season (6-7 months). The farmers depend heavily on locally available natural feed resources, but there is a shortfall due to limited land availability and uncertain local climatic patterns. Moreover,
the inadequate support extended to farmers in terms of improved technology in crop-livestock farming system is aggravated by the scarcity of resources and reluctance of farmers to adopt improved technologies.

Strategy for improving the quantity and quality of feed options on-farm fell into three main categories: improved use and management of existing fresh forages and crops (especially tree legumes such as *gliricidia* and *leucaena* and elephant grass), introduction of new forage grasses and legumes to increase fresh forage supply options, and better use and improvement of crop residues (e.g. peanut, rice straw).

4. Conclusions

The study revealed the importance of Bali cattle among farmers’ livelihood in Timor-Leste. Bali cattle is one among the ruminants most commonly raised in the country and primarily depended on native pastures. Traditionally, Bali cattle production is constrained with low production rate, low milk production, high calf maturity, slow growth rate, low meat quality and incidence of diseases which was attributed to unavailability of adequate forage to feed these animals the whole year round. The availability of native pastures is not sufficient with the number of ruminants in each district. However, the government of Timor-Leste is strongly committed to boost the livestock industry by addressing the challenges of low production and performance through the development of management interventions suitable for the country. Considerable researches have been conducted to respond to the continuous decline in Bali cattle population brought about by the current production systems.

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