

Characterization of Smallholder Beef Cattle Production System in Central Vietnam –Revealing Performance, Trends, Constraints, and Future Development

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ABSTRACT

The objective of this study is to evaluate the characteristics of smallholder beef cattle production in Central Vietnam. A total of 360 households were interviewed by using semi-structured questionnaire; a total of 606 beef cows were investigated for evaluating calving interval (CI). Thirty-two fattening cattle were monitored for the estimation of diet structure. Results showed that the cattle herd size was 4.32-4.45 cattle/household. In North Central (NC), 55% of surveyed farmers kept local cattle, 45% kept crossbreeds, and none of surveyed farmers keeping exotic breeds. In South Central (SC), 63% of surveyed farmers kept cross cattle, 32% kept local cattle, and 5% kept exotic breeds. In the breeding method, 70% of surveyed farmers used artificial insemination (AI), 20% used natural mating (NM), and only 10% used both AI and NM in SC, whereas in NC 40% of farmers used AI, 40% used NM, and 20% used both AI and NM. The variety of feedstuffs fed to cattle including roughages and concentrate. The concentrate in the diet for fattening cattle was 25%-35% and protein level was 11%-13%, and the average daily gain of cattle was 0.51-0.63 kg/day. The CI of cows was 12-13 months in SC, whereas in NC it was 13-14 months. There were numerous constraints to cattle production in surveyed households including diseases, lack of good quality feed sources, breeds, knowledge, and lack of capital. In conclusion, cattle production in Central Vietnam is small scale and still largely extensive. There are constraints that must be solved to improve livestock systems in the near future, especially when shifting towards semi-intensive and/or intensive cattle production systems.

Keywords: breeding; cattle production; farm size; cattle feeding; Vietnam

INTRODUCTION

Livestock production plays a crucial role in poverty reduction of the rural poor people in the developing countries (Stür *et al.*, 2016) and 1 billion of poor people in the world depend on livestock for their livelihoods (McDermott *et al.*, 2010). Similar to the condition in developing countries, livestock production plays a very important role in Vietnam, not only in providing high value protein products for human consumption, increasing income, and improving living standard of smallholder farmers, but also contributing to crop cultivation by supplying valuable manure, which is often assumed as an undervalued resource (Dung *et al.*, 2013). Cattle production is one of the most important livestock husbandries for smallholder farmers and has become more and more important in agricultural systems for household livelihoods in Vietnam (Dung *et al.*, 2013). In 2018, the number of cattle reached 5.8 million heads, with the Central Region accounting for 42.0% of national cattle production (GSO, 2018). Farming in the Central Region is constrained by many characteristics such as low fertility sandy soils and harsh climatic conditions characterized

by long and hot dry season and shorter rainy season (Parsons *et al.*, 2013; Dung *et al.*, 2015). The characteristic of beef cattle production system in Central Vietnam is low-input and small-scale enterprises (Quang *et al.*, 2015). Smallholder cattle production has traditionally relied on extensive grazing, supplemented by the use of crop residues especially rice straw. Generally, poor cattle nutrition and husbandry contribute to low performance (Dung *et al.*, 2013; Dung *et al.*, 2015).

The demand for beef is increasing in recent years, particularly in the major urban centers, due to the increasing disposable incomes of the local population and tourism. The supply of domestic beef is not enough to meet the national demand and this condition was illustrated by the import of 262,321 live cattle and nearly 42,000 tons of meat (mainly beef with bone), which were worth a total of \$410 million in 2018 (MARD, 2018). Furthermore, each province in the Central Region has many guidelines and policies to develop livestock production and cattle husbandry, as they are considered as crucial animals in agricultural economic development of each province (Ba *et al.*, 2015). Therefore, these policies create an opportunity for development of cattle

production, thus cattle production in Central Vietnam has gradually developed, the proportion of crossbred cattle has increased over the years; being 35% in 2010 and already 60% in 2018 (GSO, 2018). Cattle production systems tend to move from extensive to semi-intensive and intensive systems (Ba *et al.*, 2015). However, to fully utilize this opportunity, there are several impediments that are needed to be solved, especially animal management, together with feed and feeding systems led to low cattle performances. To understand more about the current situation of cattle production systems in Central Vietnam, appropriate measures should be done, especially in the smallholder sector. However, up to now, there is no study characterizing the smallholder beef cattle production systems in Central Vietnam, especially information on the current performance, trends, and constraints of cattle production.

Therefore, this study was conducted to evaluate the diversity of cattle production and the extent to which it contributes to rural household resources, in addition to document different production systems, breeds and breeding systems, feeding practices, cattle performances, and constraints to smallholder beef cattle productivity in Central Vietnam. This information is pre-requisite for planning development strategies to improve current cattle production systems in Vietnam or shifting from extensive production systems to semi-intensive or intensive ones in a sustainable approach.

MATERIALS AND METHODS

Study Location

The study took place in Central Vietnam (Figure 1) covering 14 provinces with a total land area of 95,817.3 km² and a total population of 19,798.8 thousand people (GSO, 2016). Central Vietnam is the most impoverished region in the country. The government is trying to increase beef cattle production in this region. They need scientific base to launch new beef cattle production policies. The cattle production system in this region is different from the other two regions in Vietnam (North and South), and this region has the highest cattle population percentage in Vietnam. In 2017, this region had 2,290,251 heads of beef cattle accounting for 42.0% of total beef cattle in the country (GSO, 2018). Beef cattle in this region are raised at smallholder production system (GSO, 2018). The Central Region is divided into two areas: North Central (NC) with 6 provinces and South Central (SC) with 8 provinces (Figure 1). These two regions had some different characteristics (Table 1). The research was designed to compare the cattle production system between the two regions. Four provinces were selected for conducting studies included Quang Binh and Quang Tri provinces from NC, Quang Nam, and Quang Ngai provinces from SC. A total of 360 households were selected (90 households per province). The households were randomly selected (by using Random function in the Excel program) for interviewing based on the list of smallholder beef cattle keepers provided by the Department of Agriculture and Rural Development of each selected province. The study was conducted from

January 2016 to October 2017. The summary of the study area characteristics, age, and education level of respondents are presented in Table 1.

Data Collection

Household owners engaged in taking care of cattle were interviewed, using a semi-structured questionnaire consisting of three parts: (i) farm resources focused on population (total people, total labor per household) and land used (total land, agriculture land, and cut and carry grassland), (ii) cattle production related to herd size and structure, breeds and breeding practices and rearing systems, feedstuff used for cattle, and some constraints for cattle production, and (iii) cattle production related to reproduction performance focused on calving interval and calving to conception interval. A total of 606 beef cows (319 cows in NC area and 287 cows in SC area) were investigated for calving interval and calving to conception interval by interviewing household owners. The calving interval was calculated as the number of days between the two continuous farrowing.

The structure of diet for fattening cattle was estimated by monitoring at smallholder farmers. A total of 32 households (15 in NC and 17 in SC) having fattening cattle activities were selected for monitoring. Feedstuffs used daily for cattle in the fattening period (60-80 days) were recorded every day at each household. Feed intake was determined by recording the quantity of feed offered and refused daily. Total dry matter (DM) intake included total concentrate intake plus roughage intake

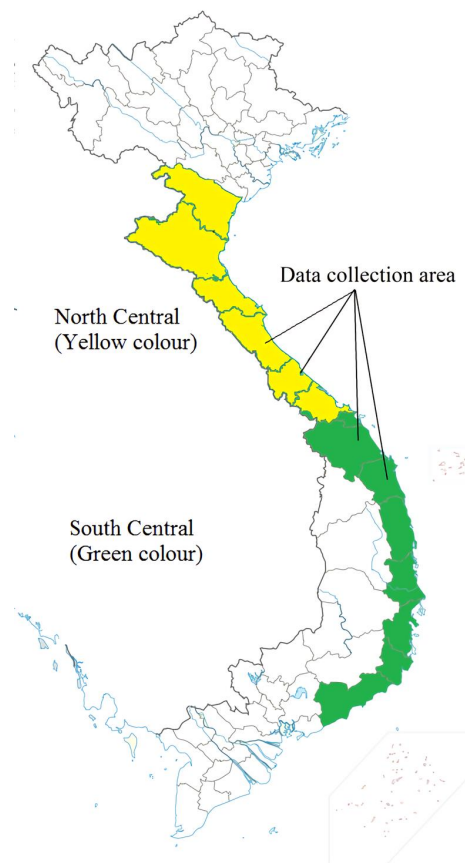


Figure 1. Location of the study in the map of Vietnam

(DM basis) were calculated. The proportion of concentrate and roughage in the diet intake was the ratio of the amount of concentrate or roughage to the total DM intake. The nutrients values of feedstuffs (DM and CP) were estimated based on the database of composition and nutritive value of the animal feed in Vietnam of the National Institute of Animal Science, Vietnam (NIAS, 2001). The average daily gain (kg/d) was calculated based on the final and initial body weights of cattle and the number of days to achieve the final body weight from the initial body weight (days).

Data Management and Analysis

All collected data were inputted and coded in the Microsoft Excel software (2010) and analyzed using the SPSS version 16.0. The analyses of data included descriptive statistics of frequency, percentage, mean, and standard deviation. In addition, one-way analyses of variance were used to test the differences between regions in terms of labor resources, land area per household, cattle dietary characteristics, and daily weight gain of fattening cattle. Means were considered different when p value of the F test was $p=0.05$.

RESULTS

Farming Resources and Cattle Herd Structure

Farming resources including total population, total labor, and total land were similar among both regions in Central Vietnam ($p>0.05$), whereas agriculture land as

well as cut and carry grassland area were significantly different between NC and SC areas ($p<0.05$) (Table 2). The average number of people per household in Central Vietnam ranged from 4.11 to 4.74 with more than 50% of people were the labor. The land area of household was small in the present study, only 0.89 ha per household in NC and 0.91 ha per household in SC, in which 43% was agricultural land in NC and 75% in SC area (Table 2). Overall, the cattle herd size was from 4.32 (in NC) to 4.47 (SC) heads of cattle per herd. There was no significant difference ($p>0.05$) in herd size between North and South regions of Central Vietnam (Table 2). The number of cows was accounted to be the highest in cattle herd (Table 2), then calf at the age of < 12 months, and cattle at the age of 12-24 months.

Cattle Breeds, Breeding Practices, and Rearing Systems

In the NC region of Vietnam, the majority of surveyed farmers (55%) kept local cattle (Vietnam yellow cattle), 45% of surveyed farmers kept crossbreeds, and none farmers kept exotic breed. In contrast, in SC, 63% of surveyed farmers keeping cross cattle, 32% of farmers kept local cattle, and 5% of farmers kept exotic breeds (Figure 2). In the breeding practice, 70% of surveyed farmers used artificial insemination (AI) for upgrading breed, 20% of surveyed farmers used natural mating, and only 10% used both AI and natural mating in SC, whereas in NC only 40% of farmers used AI, 40% of farmers used natural mating, and 20% of farmers used both AI and natural mating. The present study observed that there were three main rearing systems of cattle

Table 1. Basic characteristics of surveyed farms

Provinces	Regions	Characteristics	Surveyed farms	Age of respondents	Education level of respondents
Quang Binh	North Central	Small farms, local breeds, poor accessibility of extension services, international border with Laos and Vietnam in the western	90	20-30 years old: 2.4%	Primary school: 37.8%
Quang Tri			90		
Quang Nam	South Central	Small farms, crossbred breeds, local breeds, more accessibility of extension services;	90	41-50 years old: 55.4%	High school: 10.0%
Quang Ngai			90		

Table 2. Population, land area per household, and cattle herd structure in surveyed farms

Items	Region		P
	North Central (N=180)	South Central (N=180)	
Total population (people/household)	4.74±1.26	4.11±0.98	>0.05
Total labor (people/household)	2.92±1.57	2.90±0.91	>0.05
Total land area (ha/household)	0.89±0.15	0.91±0.36	>0.05
Agriculture land area (ha/household)	0.38±0.12	0.68±0.17	<0.05*
Cut and carry grass land area (ha/household)	0.05±0.01	0.08±0.01	<0.05*
Total cattle (head/household)	4.32±1.90	4.47±1.89	>0.05
Structure (%)			
Cows	41.00	35.78	-
Calf <12 months age	26.60	30.88	-
Cattle 12-24 months age	16.71	23.43	-
Cattle > 24 months age	15.68	10.07	-

Note: * = significant at $p<0.05$

production in two regions in Central Vietnam, including i) free grazing, ii) grazing and feeding supplementation, and iii) stall feeding (Figure 2). In SC, 50% of households practiced the grazing and feeding supplementation, especially 30% of surveyed households had utilized stall-feeding, and only 20% of household used free-grazing systems. Meanwhile, 60%, 30%, and 10% of the respondents practiced free grazing, grazing and feeding supplementation, and stall-feeding, respectively.

Feed and Feeding

The variety of feedstuffs fed to cattle among smallholders in Central Vietnam were roughages feed and concentrate feed (Table 3). In the NC region, more

than 70% of farmers rearing cattle only used natural grass and rice straw, only 56.7% of surveyed farmers grew grass for cattle. In the SC region, more than 75% of surveyed farmers used cut and carry grass, natural grass, and rice straw for cattle. Overall, the proportion of surveyed farmers in the SC region used concentrate feed for cattle was higher compared to that in the NC region. Results of estimation of structure of diet for fattening cattle showed that the proportion of concentrate in diet, protein level in concentrate or protein level in diet for fattening cattle in SC region was higher than that in the NC region ($p < 0.05$) (Table 4). The average daily gain (ADG) of cattle in the present study was 0.51 kg/day in NC region and 0.63 kg/day in the SC region (Table 4).

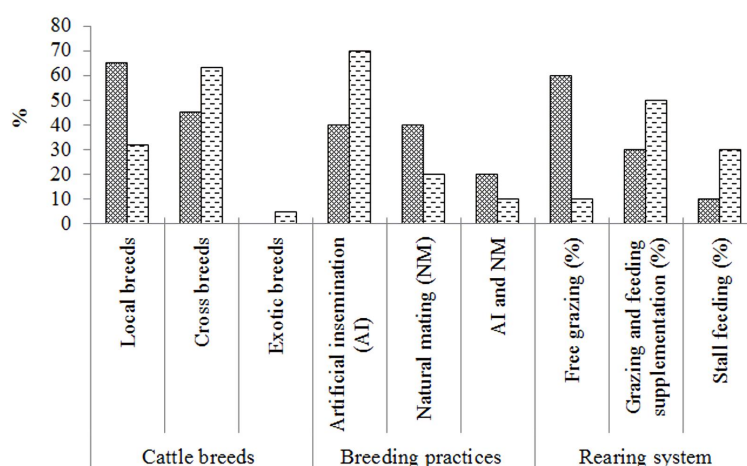


Figure 2. Cattle breeds, breeding, and rearing system practices in surveyed farms (■ North Central; ▨ South Central)

Table 3. Feedstuffs used for cattle in the surveyed farms

Feedstuff used for cattle	North Central (N=180)		South Central (N=180)	
	Frequency	Percentage	Frequency	Percentage
Roughages				
Cut and carry grass	102	56.7	173	96.1
Natural grass	130	72.2	142	78.9
Rice straw	150	83.3	180	100.0
Maize foliage	98	54.4	122	67.8
Cassava foliage	30	16.7	37	20.6
Banana stem	57	31.7	30	16.7
Concentrates				
Commercial feed	63	35.0	116	64.4
Cassava powder	120	66.7	138	76.7
Maize meal	52	28.9	122	67.7
Rice bran	111	61.7	168	93.3
Broken rice	42	23.3	58	32.2
Peanut cake	14	7.78	24	13.3
Cassava residues	12	6.67	120	66.7
Supplementation				
Molasses	16	8.89	13	7.22
Urea	10	5.55	18	10.0
Mineral premix	10	5.55	13	7.22
Brewer's gain	17	9.44	97	53.8

Table 4. Estimate the structure of diet and average daily gain of fattening cattle at smallholders

Items	Regions		p
	North Central (N=15)	South Central (N=17)	
Diet characteristics			
Concentrate in diet (%)	25.4±2.22	34.5±2.53	<0.01**
Roughage in diet (%)	74.6±2.45	65.5±2.67	<0.01**
Crude protein in concentrate (%)	12.2±0.25	15.4±1.21	<0.05*
Crude protein in diet (%)	11.5±0.87	13.2±0.91	<0.05*
Average daily gain (kg/day)	0.51±0.12	0.63±0.17	<0.01*

Note: * = significant at p<0.05; ** = significant at p<0.01

Cattle Reproduction

There were significant differences in the mean calving interval (14-15 months compared to 12-13 months) between the NC and SC regions. Fifty six percent of cows in SC had calving interval <13 months, compared to only 24.6% in NC, while calving interval <14 months were 74% and 52%, respectively (Figure 3) in NC and SC. Calving interval was long or short depending on calving to conception interval (CCI). Fifty-eight percent of cows in SC had CCIs <90 days, compared to 10% in the NC region, while CCIs <120 days were 75% and 26%, respectively (Figure 4).

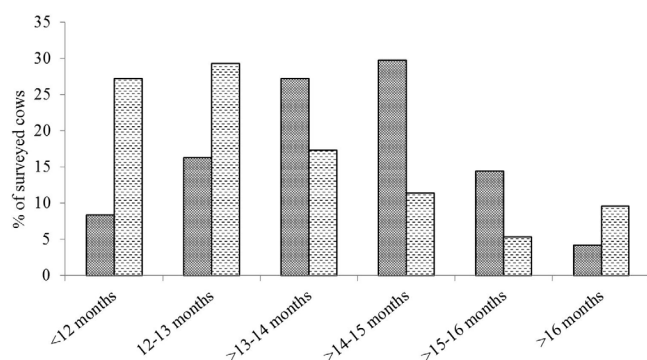


Figure 3. Calving interval of beef cows in the study area (North Central; South Central)

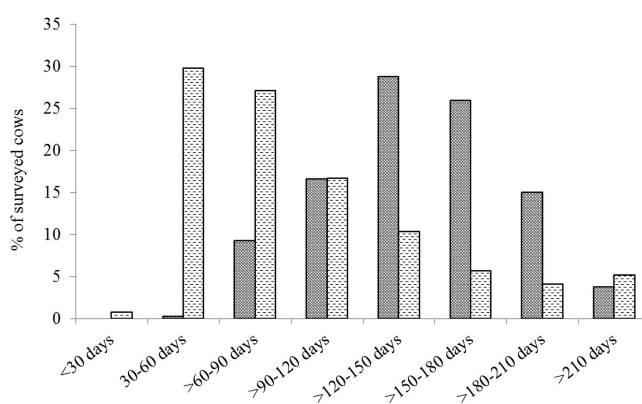


Figure 4. Calving to conception interval frequency for cows from the households surveyed (North Central; South Central)

Challenges and Constraints

There were numerous constraints identified in cattle production in surveyed households including diseases, lack of good quality feed sources, breeds, knowledge, lack of capital, and labor (Table 5). Some common diseases were still occurred, such as food and mouth disease (FMD), Pasteurellosis, and diarrhea. Although a high proportion of households vaccinated cattle (mainly against FMD and Pasteurellosis), these diseases still occur every year (12%-34% of farms) and this is a major challenge in livestock production in Vietnam.

DISCUSSION

In cattle production, the resources including the land area, number of people per household, and labor are very important in determining the success of livestock enterprises. For example, as was also concluded in Parsons *et al.* (2013), farming resources affect decision-making and acceptance of new technology in cattle production, such as choice of breed, choice of rearing system and developing cultivated forages. Since more than 50% of people in the surveyed household are the labor, this fact indicates that the labor is a good factor for the development of cattle production in Central Vietnam, because cattle production needs labor for cutting grass and for daily care (Parsons *et al.*, 2013). Parsons *et al.* (2013) recommend that available land area is an opportunity to raise cattle extensively on non-

Table 5. Constraints to cattle production in the surveyed farms

Constraints	North Central (N=180)		South Central (N=180)	
	Frequency	Percentage	Frequency	Percentage
Common diseases				
Foot and mouth disease	57	31.7	29	16.1
Pasteurellosis	62	34.4	22	12.2
Diarrhea (unknown etiology)	22	12.2	24	13.3
Lack of good quality feed sources	115	63.9	92	51.1
Lack of good quality breeds	135	75.0	35	19.4
Lack of skills in cattle production	158	87.8	89	49.4
Capital for cattle production	36	20.0	22	12.2
Labor	25	13.9	28	15.6

agricultural land. However, the land area of household is quite small in our case. This result shows that land is not an advantage factor for the development of grazing cattle production systems in Central Vietnam. The land is limited for grazing, thus intensive production is more likely, therefore cattle are kept in cages most of the time of the day and receive cut grass and concentrate at stall.

Furthermore, cut and carry grassland is very small and fragmented, only accounted for 11%-13% of the agricultural land. It is one of the constraints of the cattle farming system. Increasing cut and carry grassland areas is a requirement to shift the cattle production systems towards intensive ones in Central Vietnam. The cattle herd size in the present study is similar to that reported by Parsons *et al.* (2013) that the average number of cattle per household in South Central Vietnam is from 3.5 to 9.39 heads. However, the cattle herd size in the present study region is higher than that reported in the North of Vietnam, which is similar to those reported by Ngoan *et al.* (2015) and Phung *et al.* (2016), or in High land region in Vietnam as previously reported by Dung *et al.* (2016), but smaller than that in South Vietnam reported by Phung *et al.* (2017). For example, if compared to smallholder beef cattle production systems in different agro-ecological zones in the neighboring countries, in this case Cambodia (Samkol *et al.*, 2015), the cattle herd size in Central Vietnam is higher. Small-scale cattle husbandry is suitable for the narrow area of the land, such as in Central Vietnam. However, to improve productivity, it is necessary to improve the quality of breed, especially increasing the proportion of crossbred cattle. According to the objective of Vietnam Government (Vietnam Government, 2008), crossbreeding cattle in Vietnam should reach 50% of total herd by 2020. Thus, it can be seen that the proportion of crossbreeding cattle in the Central region exceed the governmental target. These results are due to the various policies of cattle production development in each province of the Central region. To speed up the proportion of crossbred cattle, the use of AI technique is necessary. Based on the recommendation from Tesfu *et al.* (2014), the number of male calves born by AI was slightly higher than that of by natural mating and the other way around was for female calves. The selection of the breeding method depends on farmers, body weight of cows, inseminator, and veterinary services in each region. Using AI technology requires cows with large body weights to reduce calving difficulties and placenta retention. In general, in the SC region, the body weights of cows were higher and the inseminators were more available than that in the NC region; this may be the cause of the higher percentage of farmers in the SC region using AI than that in the NC region.

Feeding is an important factor in livestock production (Mazimpaka *et al.*, 2017). Grazing is the most extensive form of production, on the other hand stall-feeding is based on feeding such feeds as grass, crop residues, concentrates, and rice straw. These observations are similar to the results reported by Parsons *et al.* (2013). The results of rearing systems indicate that in the NC region, cattle production is more extensive, whereas in SC region is primarily semi-intensive or intensive.

Central Vietnam has the highest cattle population of Vietnam with over 42% of total population (GSO, 2018). Mixed crop-livestock is a type of agricultural systems in Central Vietnam, therefore feeds for cattle are very abundant, and these findings are similar to those reported by Dung *et al.* (2013). The rice straw is the most important roughage feed for the ruminants in the tropic countries (Wanapat, 2009; Chanthakhoun *et al.*, 2012). In the present study, most households in Central Vietnam predominantly used rice straw for cattle. However, the biggest limitation of rice straw is its low energy, crude protein, and minerals contents. Therefore, improving the nutritional value of rice straw by using either physical or chemical treatments with or without concentrate supplementation is required (Wanapat 1999, 2009). The present study showed that the farmer fed roughages feed to cattle supplemented with concentrates such as cassava meal (66.7%), rice bran (61.7%), maize meal (28.9%), and commercial feed (35%). Concentrate types were mixed then mixed with water before being offered for cattle.

In Vietnam, the demand for beef production is increasing in recent years. This condition creates an opportunity for smallholder farmers in the Central region where cattle fattening activity is quickly developing (Dung *et al.*, 2013). However, there are many obstacles that need to be solved to be able to realize the opportunity, especially feeding system for fattening cattle (Dung *et al.*, 2013). The protein levels in diets in the present study were higher than those in the study of Dung *et al.* (2013) who documented that crude protein levels in diet (DM basis) for fattening cattle in Central Vietnam was 8.37%-9.82%. This result is also higher than that reported by Ngoan & Giang (2008) that protein level in diet for cattle at finishing period in Quang Ngai province- a province in Central region, was 9.9%. The ADG in the present study was similar to that reported by Dung *et al.* (2013), however lower than those observed in the previous studies (Ba *et al.*, 2008; Dung *et al.*, 2011). This difference may be due to the limited supply of concentrate level and protein proportion in the diet fed to fattening cattle was too low (Ba *et al.*, 2008). Dung *et al.* (2013b) concluded that 16% crude protein in the concentrate and the concentrate level at 2.2% of live weight are recommended for fattening cattle in Vietnam. Furthermore, the present study confirmed that cattle performance was higher in the region where the concentrate level and protein supply were higher. Increasing the concentrate feed and protein level in the diets for cattle during the fattening period is a solution that must be noted in cattle production in Central Vietnam, especially in the NC region.

In Vietnam, poor cattle nutrition and husbandry contribute to a long and variable calving interval (CI) and calving to conception intervals (CCI) (Parsons *et al.*, 2013; Dung *et al.*, 2015). Phung (2009) concludes that long CCIs may be linked with post-partum anestrus in cattle, which in turn may be associated more with factors such as nutrition and husbandry than genetic differences. In the present study, there are significant differences in mean calving interval between NC and SC regions that were shorter in SC region compared to

in NC region. This might be due to the shorter calving to conception interval (CCI) in SC region than in NC region. These results indicate that cows reproduction performances in SC region are higher than those in NC region. Improving reproductive performance with the target of shorter calving interval is also a noticeable point in cattle production in Central Vietnam.

There were numerous constraints identified to cattle production in surveyed households, including diseases, lack of good quality feed sources, breeds, knowledge, lack of capital, and labor. These constraints require immediate actions to improve livestock system in Central Vietnam.

CONCLUSION

Smallholder cattle production in Central Vietnam is small-scale and still mainly extensive or semi-intensive. There are numerous constraints to cattle production in surveyed households including diseases, lack of good quality feed sources, breeds, knowledge, lack of capital, and labor which need to be solved to improve cattle production systems in the near future, especially when shifting towards semi-intensive and/or intensive cattle production systems. To achieve sustainable cattle development, extensive production systems should be considered to shift to semi-intensive or intensive production systems. Other parallel solutions are to increase cut and carry grass area, to increase the proportion of crossbred cattle by applying AI technique to increase the amount of concentrate supplementation and the protein level in the diet for fattening cattle.

CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organizations related to the material discussed in the manuscript.

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