Farm types for beef production and their economic success in a mountainous province of northern Vietnam

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A B S T R A C T

The objective of this study was to compare the management and economic success of beef production by three types of farm in northwestern Vietnam. The potential of household farms to supply beef for the market and their competition with large farms were examined.

The fieldwork was done in 2007 on 73 farms consisting of 58 small mixed farms (small farms), 10 medium mixed farms (medium farms) and 5 specialised large-scale beef farms (large farms) in Son La province. The three types of farm differed in ethnicity (Thai, H'mong, and Kinh), remoteness (lowland, highland), production objectives (subsistence, market output), degree of specialization (mixed farm, specialised beef farm) and integration of production (single farmers, cooperative). Data on biological productivity, inputs and outputs, and the social contribution of cattle production were collected by household and key person interviews, participatory rural appraisal tools and cattle body measurements. Economic values were derived by assessment of market or replacement costs. Quantitative data analysis was done with linear models (PROC GLM) in the SAS software (version 9.1).

Lowland small farms had higher costs for cattle production than the highland farms (0.8 Mill. VND head -1 year -1 compared with 0.02 Mill. VND head -1 year -1, respectively). The large farms had high production costs, with an average of 2.5–3.6 Mill. VND head -1 year -1. Cattle brought high benefits of non-cash values to the households. The total revenue from cattle was in the range 4.5–11.5 Mill. VND head -1 year -1, which depended on the use of non-market functions of cattle on the household farm. The value of net benefit/kg live weight (LW) of lowland small farms with an average of 39,000 VND/kg LW was significantly higher than that of the medium and small farms in the highlands (26,000 VND/kg LW). However, the small farms kept fewer cattle than the medium farms (average of 2–4 cattle/farm compared with 9 cattle/farm, respectively) because of forage and labour shortages and have no option to further develop cattle production. Keeping larger numbers of cattle based on available natural pasture brought high benefit from stock value as farm liquidity to only the medium farms. This was the most promising type of farm for future development of beef production, given its actual success and the availability of underutilised resources. Large-scale farms suffered high economic losses of 0.3–1.4 Mill. VND cat- tle -1 year -1 due to the lack of professional management, high feed costs and low animal performance, and showed no potential for developing cattle production.

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1. Introduction

About 90% of all domestic cattle in Vietnam are kept on household farms (Department of Animal Husbandry, 2006). Beef production is increasing steadily: 160,000 tons in 2006 represented an increase of 12% compared with 2005 and of 70% compared with 2000 (GSO, 2007). However, beef is only 5% of the total meat production of the country, and the national demand is not met. High-quality beef needs to be imported for restaurants and supermar-
and crop production. It is hypothesised that cattle management, output and contributions of cattle to the farm and economic success differ between the large and the small to medium farms and within the latter. This study was designed to evaluate beef production of three farm types (small mixed farms, medium mixed farms with a higher number of cattle due to the availability of pastures in the forests, and large-scale farms specializing in beef production), attributing differences in their economic success to explanatory variables. Thus, possibilities for household farms to supply beef for the market by utilizing the local resources should be investigated. Huyen et al. (2006) reported that the function of large ruminants in smallholder mixed farming systems in the Son La province depends on three main factors: (1) remoteness in terms of road access and distance from a major town, (2) the altitude of the area, which influences the production systems through natural conditions; and (3) the ethnic background of the farmers. Besides these factors, the impact of farm organization (individual versus cooperative) and the production objective (subsistence versus market-oriented) on the success of beef production were addressed in this study.

2. Materials and methods

2.1. Study area, villages and farms

The fieldwork was conducted in Son La province in northwestern Vietnam. The province has a total area of 1.4 Mill. ha with 18% agricultural land, and a total population of 1 Mill. people (Son La Statistical Year Book, 2006). The population includes 12 ethnic groups: Thai (55%), Kinh (18%), H’mong (12%), Muong (8%) and others (7%) (Son La DARD, 1999). The GDP per capita is USD 261.3, considerably lower than the Vietnamese average of US$ 630.5 (Son La Statistical Year Book, 2006; GSO, 2007).

A list of the communes, in which smallholder cattle production with an average of 1–2 cattle per farm is prevalent, was obtained from staff members of the Veterinary Services of two districts, and one commune in each district was selected randomly. Villages were selected after consultation with the community offices. For selection of a highland H’mong village (small farm), a village was targeted that had access to natural pastures where more than 12 cattle-keepers would participate in the interviews.

With the assistance of the head of the village, who knew the different households in detail, a total of 15 cattle-keepers per village were selected for household interviews, except for one village (Giao), where all of the 13 cattle-keepers were interviewed. The selection criterion was that the household kept cattle and was willing to participate in the study. Similarly, communes in the remote highlands were identified in which groups of farmers had established cattle farms (medium farms) in the forest near natural pastures on hilltops outside the village. One village (Nam) with 10 cattle farms was selected and introduced by the community office. To select large farms, the established beef enterprises in the northern provinces were identified through discussions with key persons in the National Institute of Animal Husbandry, and Son La was identified as a province with six specialized beef farms. After an initial visit, five of the six farms agreed to be interviewed. A total of 73 farms were selected with differences between zones of altitude and remoteness as associated with poverty, and differences of ethnicity between farmers, as well as differences of organisation and specialization of the farms (Table 1).

2.2. Methods

Fieldwork was conducted May–October 2007. Data were collected for both small and medium farms, applying household interviews with structured questionnaires, key person interviews and participatory rural appraisal (PRA) tools. The interviews used open-ended questions that were focused on socio-economic data on the households, cropping, livestock husbandry, the main inputs in and outputs from cropping and animal production, cattle production management, the reproductive performance of cattle, and utilization of crop and animal products. Farmers were asked to remember and provide information for the previous 12 months, and information about cattle influx and off-take, for the previous 3 years.

Cattle were categorized by sex and age: cows (heifers ≥ 18 month; reproducing cows); bulls (male cattle ≥ 18 months); and calves (males and females ≤ 18 months). Altogether, 163 cattle (85 males and 78 females) up to 4 years old were measured and body weight was estimated by applying the formula given by Thien (1981):

$$W = P^2*290$$

where W is body weight (in kg), P is girth (in m; a measuring tape was laid obliquely between the forelimbs and over the withers), Z is the longitudinal circumference (in m) of the trunk (a measuring tape was laid over the shoulder joints and points of the buttocks). Noi et al. (1992) used this formula and compared it to other methods to identify the most suitable approximation of body weight from measurements of crossbreds between exotic bulls and Yellow cows. The deviation of the estimated weight of 161 cattle compared to their actual weight as measured by scales was 6.5 ± 17.5 kg (mean ± SD). This formula is widely used for estimating the weight of Yellow cattle and its hybrids.

The economic success of cattle production was evaluated by assessing the gross margin (GM) and the net benefit (NB) with:

$$GM (\text{Mill. VND farm}^{-1} \text{ year}^{-1}) = \text{total cash revenue} – \text{total variable cash cost}$$

$$NB (\text{Mill. VND farm}^{-1} \text{ year}^{-1}) = (\text{total cash revenue} - \text{non-cash value}) – \text{total variable cost}$$

For large farms, GM and NB were also expressed per cattle kept on the farm (GM/cattle and NB/cattle). Cash revenue was the only revenue from selling animals. The cash variable costs included labour cost, feed purchased, annual animal health care, and other outgoings. The non-cash benefits included the value of restocked animals per year. Data were calculated based on information for the previous 12 months. The GM and NB of small and medium farms were expressed also per kg live weight (LW) kept per farm at the time of the interview (GM and NB/kg LW) as described (Lemke, 2006; Lemke et al., 2007). The cost and revenue components are summarized in Table 2.

The value of the stock and the non-market value of cattle slaughtered or given away by household farms were based on the number, age, and sex of the cattle. Dressing percentages of older calves and cows were estimated as 40% and those of bulls as 54% of the live weight according to Ly et al. (1999). The value of cattle as beef was estimated as the carcass weight (in kg) times 60,000 VND (farmers' information).

The value of draught, transport and manure from cattle was obtained from household interviews. Farmers without draught animals could exchange one man-day for one draught animal-day. The non-market benefit from draught was derived from total working days per year multiplied by 25,000 VND (the monetary value of a man-day). The non-market benefit of manure was derived from the total cattle manure used for crops multiplied by 1200 VND (the monetary value of 1 kg of phosphate or bio-fertiliser equalling the value of 1 kg of cattle manure according to the farmers). A
draught animal with a cart could take about 300–400 kg of manure or crops from the farm to the field; a draught animal could be used for transport twice per day for a distance of 2–3 km. Farmers without cattle in the lowland villages could rent small vehicles at a common price of 20,000 VND for transporting about 400 kg of crops over a distance of about 2 km. The non-market benefit from transport was derived from total days using cattle for transport multiplied by two times 20,000 VND (farmers’ information). The currency used in this study was the Vietnamese Dong, assuming an exchange rate of 1 US$ = 16,000 VND (in 2005–2007).

Quantitative data analysis was done with linear models (PROC GLM) in SAS software version 9.1 (SAS Institute Inc., Cary, NC, USA). Normal distribution and the homogeneity of the variance of the residuals were tested, and data were transformed before analysis if necessary. Least-square means (LSM) were estimated and compared pair-wise by the Scheffe method for multiple tests of unbalanced data. A number of discrete quantitative variables were analysed by the non-parametric Kruskal–Wallis test. In the case of large farms, because of sparse data, only arithmetic means and standard deviations, together with minima and maxima were reported.

The GM/farm, NB/farm, GM/kg LW, and NB/kg LW from cattle production on small mixed and medium farms were analysed using a multiple linear model. The region (altitude and remoteness), type of farm, ethnic group and number of cattle were used as explanatory variables. The model is:

\[ Y_i = \alpha + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \epsilon_i \]

where \( y_i \) is the observation of the \( i \)th farm, \( \alpha \) is the intercept, \( \beta_1, \beta_2, \beta_3, \beta_4 \) are regression coefficients, \( x_{1i} \) is the region (\( \{ 1 \) for lowlands near towns and \( i = 2 \) for highlands far from towns), \( x_{2i} \) is the type of farm (\( \{ 1 \) for small farms and \( i = 2 \) for medium farms), \( x_{3i} \) is the ethnic group (\( \{ 1 \) for H’mong and \( \{ 2 \) for Thai), \( x_{4i} \) is the number of cattle kept and \( \epsilon_i \) is the error term.

During the statistical analysis, non-significant effects were removed from the generalised linear models by hierarchical model selection. The interactions between different factors were tested, and non-significant interactions were removed from the model. If there was no interaction, the correlation between factors was tested. If the correlation was highly significant (\( P < 0.0001 \)), it was regarded as sufficient to have just one of the factors in the model. The importance of the main factors was assessed on the basis of the coefficient of determination (CD or \( R^2 \)) for different models. The model information obtained with the reduced models is shown in Results.

Within the highland region, the two villages had different types of farm (small and medium), that were targeted for comparison in this study. Therefore, in the case of significant differences between zones, the full model:

\[ y_{ij} = \alpha + \beta_i x_{1i} + \beta_j x_{2j} + \epsilon_{ij} \]

was applied for GM/farm, NB/farm, GM/kg LW, and NB/kg LW from cattle production under the effect of farm type and number of cattle. In this model, \( y_{ij} \) is the observation of the \( j \)th farm from the \( i \)th village, \( \alpha \) is the effect of the \( i \)th village, \( \beta_i \) is the regression slope for the \( i \)th village, \( x_{2j} \) is the number of cattle corresponding to \( y_{ij} \), \( x_{1i} \) is the number of cattle kept and \( \epsilon_{ij} \) is the random deviation from the regression line for \( y_{ij} \), which is assumed to follow a normal distribution with a mean of zero.

The model:

\[ y_{ij} = \alpha + \beta_i x_{1i} + \epsilon_{ij} \]

was applied to the data for herd size, total cash income, crop share in total cash income, total land area, and the costs and benefits from

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**Table 1**
Number of farmers interviewed and animals recorded according to farm type and other sample selection criteria.

<table>
<thead>
<tr>
<th>District</th>
<th>Small mixed farm</th>
<th>Medium mixed farm</th>
<th>Large-scale farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mai Son</td>
<td>Yen Chau</td>
<td>Mai Son Son La town, Thuan Chau</td>
<td></td>
</tr>
<tr>
<td>Thai, H’mong</td>
<td>H’mong</td>
<td>Thai, Kinh, Thai</td>
<td></td>
</tr>
<tr>
<td>Cu Pe, Him, Ruong Thong</td>
<td>Giao, Nam</td>
<td>Intermediate highland, Lowland, highland</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near town lowland</td>
<td>Remote highland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Region according to poverty index*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>13</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1–9</td>
<td>3–21</td>
<td></td>
</tr>
<tr>
<td>Total analysed cattle</td>
<td>161</td>
<td>91</td>
<td>1755</td>
</tr>
</tbody>
</table>

* Region according to poverty index: (1) region with a good communication system and infrastructure facilities; (2) intermediate region; and (3) remote poor and isolated border highlands with special difficulties of communication and education.

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**Table 2**
Costs and revenue components of cattle production in small mixed and medium farms.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total revenues</td>
<td>Including cash revenue and non-cash values</td>
</tr>
<tr>
<td>Non-cash values</td>
<td>Including stock value, and values of applying cattle manure as fertiliser for crops, using cattle for draught and transport, slaughtered cattle, and cattle given as gifts in 1 year.</td>
</tr>
<tr>
<td>Annual cash revenue</td>
<td>One-third of cash revenue from selling cattle assessed for a 3-year period.</td>
</tr>
<tr>
<td>Variable costs</td>
<td>Including variable cash costs and feed opportunity costs*</td>
</tr>
<tr>
<td>Variable costs/animal</td>
<td>Including costs for restocking, purchased feeds, health care, and others (AI and purchased ropes)</td>
</tr>
<tr>
<td>Restocking cost</td>
<td>Total variable costs divided by number of cattle kept on the farm</td>
</tr>
<tr>
<td>Feed opportunity costs</td>
<td>Average annual cost of cattle in the previous 3 years</td>
</tr>
</tbody>
</table>

Following Lemke (2006) and Lemke et al. (2007).

* Labour opportunity costs were not considered, as children and elderly people, who were mainly responsible for tending and cutting-and-carrying grass, were considered to have no possibility of alternative off-farm income.

* Other farm-produced feeds (such as elephant grass, banana stems, maize leaves, rice bran, and rice straws) were neglected because they have no market value.
cattle production in the villages. In this model, $y_{ij}$ is the observation of the $j$th farm of the $i$th village, $\mu$ is the overall mean, $\alpha_i$ is the effect of the $i$th village ($i = 1$ for Cu Pe; $i = 2$ for Rung Thong; $i = 3$ for Hiem, $i = 4$ for Giao, and $i = 5$ for Nam), and $e_{ij}$ is the error term.

3. Results

3.1. Livestock keeping and socio-economic characteristics of the farms

Table 3 gives an overview of ethnicity, location and state of livestock production for small and medium farms. In Cu Pe village, owing to the limited supply of fodder, labour and capital, farmers were able to keep an average of only 1–2 cattle or water buffaloes. Rung Thong village was facing the problem of a lack of water resources. Cattle were regarded as more advantageous than buffalo, with 70% of the total number of farms keeping cattle, while only one out of the 60 farms kept buffaloes. In Hiem village, almost all farms kept buffaloes for draught, while 30% of the total number of farmers, who had both capital and labour, were raising cattle mainly for breeding. In Giao and Nam villages, more farmers kept buffaloes than cattle for draught. The difference in the numbers of farmers between the two types of farm was highly significant ($\chi^2 = 11.9; P < 0.001$). In general, farms in the highlands with access to pasture had larger herds than farms in the lowlands.

Farmers in all villages had a similar area of land and a similar family size (Table 3). Although farmers in Rung Thong village had no area for growing paddy rice, they had a higher cash income than the others from a larger share of their total cash income derived from cropping maize. In contrast, farmers in the other villages had paddy rice areas to grow rice for subsistence.

Table 4 gives the general characteristics and herd composition of five large farms, which were established with financial help from the province (30% of the total farmland value). Originally, the aim was to supply cattle to new residents for the development of small and medium farms. In Cu Pe village, ownership of large farms was carried out at the farm gate. The price was based on agreement between both sides. Cattle were evaluated for draught ability or fertility on the basis of their physical appearance. The price was based on the estimation of the beef yield at an average age of 12.9 ± 3.6 years ($n = 17$); bulls were culled according to their working capacity at an average age of 7.8 ± 2.6 years ($n = 12$). The average age at sale was 22.7 ± 11.6 years ($n = 18$) for breeding females and 32.6 ± 18.0 ($n = 36$) for males sold for breeding or draught. Only 12% of 68 offspring sold were sold for beef, at an average age of 25.5 months, with a range of 12–48 months. Selling and buying cattle on small and medium farms was carried out at the farm gate. The price was based on agreement between both sides. Cattle were evaluated for draught ability or fertility on the basis of their physical appearance. The price was based on the estimation of the beef yield from the live animals when cattle were sold as beef.

In large-scale farms, calves were weaned after 6 months. Male calves were sold at the age of 0.5–1.5 years. Weak and thin cows

3.2. Cattle production management

3.2.1. Cattle management

Table 5 summarises the production management of the different types of farm. On small farms, any animal unsuitable for draught or breeding was sold and replaced. On both, small and medium farms, calves were suckled for 1 year, when the cow had the next calf. Non-breeding animals were not castrated for fattening on any of the farms in this study.

There was no significant difference between the ages of breeding/draught animals bought and sold in the investigated villages. There was a slight difference between the ages of male and female cattle that were sold ($P < 0.05$). Cows on the small and medium farms were kept as long as they could produce calves and culled at an average age of 12.9 ± 3.6 years ($n = 17$); bulls were culled according to their working capacity at an average age of 7.8 ± 2.6 years ($n = 12$). The average age at sale was 22.7 ± 11.6 years ($n = 18$) for breeding females and 32.6 ± 18.0 ($n = 36$) for males sold for breeding or draught. Only 12% of 68 offspring sold were sold for beef, at an average age of 25.5 months, with a range of 12–48 months. Selling and buying cattle on small and medium farms was carried out at the farm gate. The price was based on agreement between both sides. Cattle were evaluated for draught ability or fertility on the basis of their physical appearance. The price was based on the estimation of the beef yield from the live animals when cattle were sold as beef.

In large-scale farms, calves were weaned after 6 months. Male calves were sold at the age of 0.5–1.5 years. Weak and thin cows

Table 3

<table>
<thead>
<tr>
<th>Villages</th>
<th>Cu Pe Thai</th>
<th>Hiem H’mong</th>
<th>Rung Thong H’mong</th>
<th>Giao H’mong</th>
<th>Nam Thai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Near town, lowland</td>
<td>Remote highland</td>
<td>Intermediate highland</td>
<td>Highland</td>
<td>Lowland</td>
</tr>
<tr>
<td>Total households</td>
<td>72</td>
<td>60</td>
<td>37</td>
<td>83</td>
<td>31</td>
</tr>
<tr>
<td>Cattle keepers (%hh)</td>
<td>25</td>
<td>70</td>
<td>35</td>
<td>31</td>
<td>60</td>
</tr>
<tr>
<td>Cattle/farm (range)</td>
<td>1–4</td>
<td>1–3</td>
<td>1–7</td>
<td>1–21</td>
<td>1–21</td>
</tr>
<tr>
<td>Buffalo keepers (%hh)</td>
<td>27</td>
<td>17</td>
<td>81</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Buffalo/farm (range)</td>
<td>1–3</td>
<td>1–6</td>
<td>1</td>
<td>1–7</td>
<td>1–4</td>
</tr>
<tr>
<td>Pig keepers (%hh)</td>
<td>83</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>Pigs/farm (range)</td>
<td>3–10</td>
<td>2–6</td>
<td>3–20</td>
<td>2–30</td>
<td>2–15</td>
</tr>
<tr>
<td>Sows/farm (range)</td>
<td>1–3</td>
<td>1–2</td>
<td>1–3</td>
<td>1–2</td>
<td>1–2</td>
</tr>
<tr>
<td>Poultry* keepers (%hh)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Poultry/farm (range)</td>
<td>3–50</td>
<td>5–50</td>
<td>3–100</td>
<td>4–70</td>
<td>10–120</td>
</tr>
<tr>
<td>Goat keepers (%hh)</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Goats/farm (range)</td>
<td>1–23</td>
<td>2–25</td>
<td>2–3</td>
<td>3–60</td>
<td>3–60</td>
</tr>
</tbody>
</table>

Characteristics of smallholder mixed farms (LSM ± s.e.)

| Farms (n) | 15 | 15 | 15 | 15 | 10 |
| Farm type | Small | Medium |
| Farm size (n) | 5.5 ± 0.5 | 6.1 ± 0.5 | 5.9 ± 0.5 | 7.6 ± 0.5 | 6.4 ± 0.6 |
| Land holding (ha hh$^{-1}$) | 3.0 ± 0.3 | 2.0 ± 0.3 | 2.4 ± 0.3 | 2.0 ± 0.3 | 1.9 ± 0.4 |
| Total cash income (Mill. VND farm$^{-1}$ year$^{-1}$) | 19.9 ± 3.4* | 19.3 ± 3.4a | 48.1 ± 3.4a | 13.4 ± 3.6a | 12.9 ± 4.1a |
| Share of cropping in total cash income (%) | 85.4 ± 13.5* | 91.2 ± 13.5a | 99.3 ± 13.5a | 59.5 ± 14.5a | 64.6 ± 16.5a |
| Cattle herd size (n) | 2.2 ± 0.8b | 3.3 ± 0.8b | 1.7 ± 0.8b | 4.2 ± 0.9b | 9.1 ± 1.0b |

*a* Poultry: chicken, duck, Muscovy duck.
aged 7 years or more, and cows that had not calved within 2–3 years were culled. At the time of culling, traders came to the farms to buy the culled animals and male calves.

### 3.2.2. Breeding management

On the small and medium farms, cattle mated freely at pasture. Artificial insemination (AI) was used only in the Cu Pe village to produce crossbreeds of Laisind × Yellow cattle. Bulls were regarded as both breeding and draught animals. The selection criteria were similar in all of the investigated villages. A bull was regarded as a good draught animal if it had a long body, long legs and a long tail, well-developed chest and rump, and hooves of equal size. A cow was regarded as a good breeding animal if it had a long body, long legs and a long tail, well-developed chest and rump, four large teats, large udders, a large nose and long horns. The Yellow bulls were used for mating for the first time at the age of 2.7 years (range 1.5–3.5 years). The average age of cows at first calving was 3.0 years on small farms and 3.3 years on medium farms.

On large farms of the enlarged herd type, hormonal synchronisation and AI were used in addition to natural mating. Therefore, the reproduction rate of cows on this type of farm was higher (60–70% year−1) than that on farms of the maintained herd type (40–43% year−1). The age at first mating of bulls was 2–3 years (key person interviews), and they were culled after 7 years. The reproduction rate of cows on this type of farm was higher (60–70% year−1) than that on farms of the maintained herd type (40–43% year−1). The age at first mating of bulls was 2–3 years (key person interviews), and they were culled after 7 years. The reproduction rate of cows on this type of farm was higher

### 3.2.3. Feeding management

Feed resources for cattle in the lowland villages included natural grass along field edges and crop by-products. In the dry season, some farm-produced products were used for cattle. Maize meal and/or rice bran were used as additional high-quality feed for cattle on ploughing days. Family labour was used for tending the animals and performing the cut-and-carry of forage. In the highland villages, cattle grazed on communal pastures, and no crop by-product was used as feed. On medium farms, cattle were released to common pastures freely during the day and they went back to the farms at night. Farmers were jointly responsible for the security on these outposts, but the cattle were considered as the property of individual farmers. On small H’mong farms, cattle were released to the pastures during both day and night without providing shelter. Due to the geographical conditions (very steep hillsides with pastures at the top and villages at the bottom), it was not possible to bring the animals home at night. Also, due to the impracticable site, farmers visited the cattle only every 3 or 5 days and supplied them with salt. All large farms had limited pastures and grew elephant grass in the rainy season (Table 4). They had to collect and buy crop by-products such as maize stove and rice straw from the surrounding region to store for the dry season, in addition to making silage from the elephant grass. In general, the major feed components in the rainy season were fresh grass with additional concentrate and maize meal and in the dry season, fresh grass was replaced by dry straw and silage made from grass and maize stove. All large

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### Table 4

Cattle herd size and composition of large farms at the time of interview, by farm.

<table>
<thead>
<tr>
<th>Farm 1</th>
<th>Farm 2</th>
<th>Farm 3</th>
<th>Farm 4</th>
<th>Farm 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
<td>Foundation year</td>
<td>Farm type</td>
<td>Total herd size (n)</td>
<td>Cows and heifers (n)</td>
</tr>
<tr>
<td>Mai Son</td>
<td>2004</td>
<td>Enlarged herd</td>
<td>510</td>
<td>250</td>
</tr>
<tr>
<td>Thuan Chau</td>
<td>2003</td>
<td>Maintained herd</td>
<td>650</td>
<td>300</td>
</tr>
<tr>
<td>Mai Son</td>
<td>2003</td>
<td></td>
<td>377</td>
<td>250</td>
</tr>
<tr>
<td>Mai Son</td>
<td>2004</td>
<td></td>
<td>125</td>
<td>250</td>
</tr>
<tr>
<td>Son La</td>
<td>2005</td>
<td></td>
<td>35</td>
<td>37</td>
</tr>
</tbody>
</table>

Data obtained by key person interviews.

a Farm type: Enlarged herd, farms enlarging their herd; Maintained herd, farms maintaining size of herd.

b Drought Mas., Drought Master.

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### Table 5

Cattle production management, by farm type, location and ethnic group. Source: PRA tools and key person interviews.

<table>
<thead>
<tr>
<th>Location Ethnic group</th>
<th>Breeding</th>
<th>Feeding</th>
<th>Type of feeds</th>
<th>Housing</th>
<th>Health management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland Thai</td>
<td>Natural mating (AI)</td>
<td>Tended/Cut-and-carry</td>
<td>Natural grass; growing elephant grass; crop by-products (rice straw, maize leaves and stems, rice bran, sugar-cane tops); cassava, banana stems, pumpkin</td>
<td>Stables/under stilted houses or stilted maize store sheds, simple structure</td>
<td>Vaccination programme of Veterinary Department/responsibility of village veterinarians</td>
</tr>
<tr>
<td>Lowland H’mong</td>
<td>Natural mating</td>
<td>Free ranging on communal pasture</td>
<td>Natural grass</td>
<td>No shelter</td>
<td></td>
</tr>
<tr>
<td>Highland H’mong</td>
<td>Natural mating</td>
<td>Free ranging on communal pasture</td>
<td>Natural grass</td>
<td>Small huts in the forest, poor structure</td>
<td></td>
</tr>
<tr>
<td>Highland Thai</td>
<td>Natural mating</td>
<td>Stall feeding and ranging</td>
<td>Fresh elephant grass; silage feeds (maize stems and sugar-cane tops and elephant grass); dry rice straw; additional concentrate feed (maize meal and premix)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High land/lowland Kinh</td>
<td>Stall feeding</td>
<td>Stall feeding</td>
<td>Fresh elephant grass; silage feeds (maize stems and sugar-cane tops and elephant grass); dry rice straw; additional concentrate feed (maize meal and premix)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowland Kinh</td>
<td>Stall feeding</td>
<td>Stall feeding</td>
<td>Fresh elephant grass; silage feeds (maize stems and sugar-cane tops and elephant grass); dry rice straw; additional concentrate feed (maize meal and premix)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

farms reduced both the quality and the quantity of feed rations in the dry season. From the beginning of 2007, the large farms made contracts with the small farms in the region to raise cattle. This practice was regarded as an emergency short-term solution to reduce feeding costs while these farms were requesting permission from the province to use more land to extend their area of pasture.

3.2.4. Housing management

Cattle housing was very simple on the small and medium farms (Table 5). Cattle could be kept with buffaloes on small farms, and cattle were kept with other ruminants on medium farms. All farmers kept calves and adult animals together. On all large farms, cattle were kept in purpose-built housing with supplies of feed and drinking water, and the animals were separated into different groups according to sex and age.

3.2.5. Veterinary management

On all farms, cattle were vaccinated against foot and mouth disease, bovine pasteurellosis, and anthrax, following the vaccination program of the Veterinary Department. Anthelmintics were given only when animals showed signs of parasite infestation.

3.3. Socio-economic contributions of cattle to the farm

Small farms in the lowlands near towns kept cattle mainly for draught and manure, and a few were kept for breeding. Culled cows and bulls as well as animals unsuitable for draught or with poor reproductive success were sold as beef. Offspring were sold when the family needed capital. Cattle brought high non-market benefits to small farms in the lowlands through providing draught and transport power. In Hiem village, cattle were used frequently to carry grass from the forests or upland fields to the farms. In Rung Thong village, farmers used cattle more often for carrying water from water resources outside the commune. Cattle manure was used as fertiliser by most of the small farms in the lowlands, but by few farmers in the highlands. On small and medium farms in the highlands, cattle were considered mainly as savings and were used as a gift or the heritage of farmers for the marriage of their children. In large farms, a high number of female offspring calf remained on the farm for replacement, whereas male offspring and culled animals were mainly sold as veal and beef for cash. Successful breeding animals were not sold.

3.4. Economic success of cattle production

3.4.1. Costs and revenues of cattle production

The total cost of small lowland farms (an average of 1.2 Mill. VND farm-1 year-1, with 0.8 Mill. VND head-1 year-1) were higher than that of highland farms (0.1 Mill. VND farm-1 year-1, with 0.02 Mill. VND head-1 year-1). Inputs for cattle production on small and medium highland farms were low, with no significant difference between the types of farm. The higher costs for farmers in the lowland were mainly the result of buying new or replacement draught animals. Large-scale farms had much higher costs for keeping cattle compared to the household farms, with an average of 2.5–3.6 Mill. VND head-1 year-1.

In general, total revenue from cattle production on household farms was considerable: average of 4.5 Mill. VND cattle-1 year-1 for the highland farms, and 11.5 Mill. VND cattle-1 year-1 for the lowland farms. Stock value made the main contribution to the returns from cattle production on the medium and small farms in the highlands (90% of total revenues). Transport services and manure from cattle brought non-market revenues as large as the stock value to the farms in the lowlands. All the large farms suffered losses from rearing cattle, with an average annual revenue of 1.4–2.4 Mill. VND head-1 year-1, always lower than annual costs.

3.4.2. Economic success

Multiple linear models showed no effect on GM or GM/kg LW of village, region, type of farm, ethnicity or number of cattle. Both GM and GM/kg LW were significantly different between farms, those that sold cattle and those that did not sell cattle in the previous three years (see Table 6).

NB was significantly affected by the number of cattle and the interaction of number of cattle with region ($F = 57.6; P < 0.0001$; $DF_{\text{model}} = 3$; $DF_{\text{error}} = 64$; $R^2 = 73\%$). Cattle production brought a greater NB for farmers in the lowlands compared with farmers in the highlands. This is attributable to the non-market benefits from draught power and manure in crop production. NB/kg LW was affected by region. The NB/kg LW of the small farms in the lowland region was higher than that of the small and medium farms in the highland region (Table 7).

In the highlands, the net benefit from one animal on medium farms was slightly lower than that on small farms because more young calves were present on the medium farms. Nevertheless, there was no significant difference in NB/kg LW between the medium and small farms in the highland region ($P > 0.05$). Medium farms had a higher NB than small farms only when they had more cattle. Small farms in the highland region raised fewer than 10 cattle because of the limited availability of pastures and the poor investment in cattle keeping. Only medium farms that raised more than 10 cattle could obtain a higher NB than small farms in the highland region.

The large farms showed negative results for GM and NB as well as GM/cattle and NB/cattle (Table 8). Although farms of the enlarged herd type had higher variable costs for raising large herds, they gained a higher share of NB from progeny per year. The farms of the enlarged herd type had a smaller annual loss and a smaller loss per animal than those from the maintained farm type (167 compared to 278 Mill. VND farm-1 year-1 and 0.3 compared to 1.4 Mill. VND cattle-1 year-1).

4. Discussion

4.1. Cattle farm type and management

It was found that there was no market orientation for beef production in small and medium farms, the traditional types of mixed farm. Generally, management of cattle production on the small and medium farms in this study was similar to the extensive management systems practiced by other smallholder ruminant keepers in Vietnam (e.g. Doyle et al., 2008; Eguierta et al., 2002; Gibson, 1997; Huyen et al., 2006) and in neighbouring countries such as Thailand, Laos, Cambodia, China and Indonesia (e.g. Harding et al., 2007; Hunter et al., 2008; Na-Chiangmai, 2002; Rachmat et al., 1992; Windsor et al., 2008). The small farms were mainly arable, with cattle as a complementary activity and having to live

Table 6

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Farm with cattle sold</th>
<th>Farm with no cattle sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>Mean</td>
<td>n</td>
</tr>
<tr>
<td>GM ($\times 10^4$ VND farm-1 year-1)</td>
<td>39</td>
<td>1455.3</td>
</tr>
<tr>
<td>GM/kg LW ($\times 10^4$ VND kg-1 farm-1 year-1)</td>
<td>39</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Difference between farm groups at $\chi^2 = 32.3$ and $P < 0.0001$ for GM; $\chi^2 = 32.8$ and $P < 0.0001$ for GM/kg LW (Kruskal–Wallis test).
on scarce fodder resources. Due to the limited land area and fodder availability, the number of cattle per household in the lowlands was less than five. This agrees with Tung et al. (2007), who reported herd sizes for beef cattle in northwestern Vietnam at 3.4 animals per farm. They found that nearly 50% of households kept fewer than three cattle, followed by households that kept three to five (41%) and a few households that kept between six and ten (8%). The medium farms were located in an area with vast natural pastures in the forest and with family labour available to manage the livestock. The availability of feed resources for cattle was a major factor affecting herd size and cattle management on household farms. This result is in contrast to the report by Millar and Phatakoun (2008) in Laos, where the main factor for variation in farmer attitudes to livestock was ethnicity in the uplands, and the tendency to intensification. The large farms, in spite of considerable governmental subsidy during their establishment, could not cope with the high expenditure for feed necessary because of limitations in pasture area and the consequent shortage of feed resources, especially during the winter, leading to a stagnation of output. Winter and Doyle (2008) stated lack of knowledge and resources for managing exotic cattle as a constraint for smallholders. In this study, the large farms could not overcome this constraint; in addition, they were not able to gain access to markets for the high-quality beef that is in great demand within the country, as claimed by Hall et al. (2006) and Perkins (2002).

### 4.2. Social contribution of cattle production

The contributions of cattle to the farms in the present study were different between different types of farm according to their major purpose of keeping cattle. Social-cultural values and farm security were major contributions of cattle production on the small and medium farms. In contrast, cattle production was simply regarded as an income-generating activity on the large farms. The large non-market values of cattle on the small farms were due to keeping cattle for self-sufficiency in draught, transport and fertilizer. A large contribution of non-cash value from stock on the medium farms was through keeping cattle as savings. Raising cattle as savings and maintaining the farm security by providing emergency finance has been reported for other developing countries in the tropics (e.g. Dovie et al., 2006; Harding et al., 2007; Mapiyea et al., 2009; Schwalbach et al., 2001; Siegmund-Schultze et al., 2007; Strobel et al., 2008; Vongsamphanh et al., 2005). According to Devendra and Chantalakhana (2002), the social and cultural value of livestock sometimes exceeds the value of their economic output.

#### 4.3. Economic success of cattle production

The results of this study showed that the NB from cattle on small and medium farms increased with increased herd size. Therefore, the NB of small farms in the lowland region was low compared with that of medium and small farms in the highland regions, which could keep more animals based on the available forage from natural pastures. Phung (2001) reported that a low-input system with the advantage of available natural pasture in the mountainous areas of central Vietnam created favourable conditions for an increase in the number of cattle, resulting in an increase in farm income. Mapiyea et al. (2009) reported that the number of cattle on household farms in South Africa increased with feed availability on the pastures. Hall et al. (2006) concluded that, for keeping large ruminants in Vietnam, medium farms with more than 3–10 animals are the most economically efficient and most competitive in the market, provided that land is available.

The large farms in this study are far from economically efficient. Similarly, beef cattle enterprises in the Czech Republic could not operate without government subsidy, as reported by Wolfová et al. (2004). The subsidies were fixed at a level assumed to balance the economic loss of the evaluated systems. The large farms in the present study were far from achieving their production goals to meet the demand for breeding animals and for high-quality beef for the market because of inadequate feed resources and poor management.

The present study agrees with the findings reported by Huyen et al. (2006) that smallholder cattle production was affected by the region, which was regarded as a combined effect of remoteness and altitude and partially confounded with ethnicity. In addition, the present study shows that farm organization also affected the success of cattle keeping; cooperatives of medium farms could make use of natural pasture for extending cattle production better than individual small farms. The large-scale farms that specialised in keeping beef cattle did not show any advantage in breeding animals for beef supply to the market compared with household mixed farms. Only household farms could exploit the range of benefits from cattle production to strengthen self-sufficiency of their livelihoods, while cattle production did not bring economic benefits to the large-scale farms.

#### 4.4. Implications for national policies

In some regions of Vietnam where markets are available for live beef cattle, the animals are routinely fattened on smallholder farms, for example, in Nghe An provinces (Liem, 2000) and in central Vietnam (Doyle et al., 2008), and this has been reported for neighbouring countries, such as Indonesia (Lisson et al., 2008), Thailand (Na-Chiangmai, 2002), Cambodia and Laos (Harding et al., 2007). In contrast, markets or market chains for beef cattle in the study region have not yet developed. Buying and selling were not regular practices for any of the three farm types in the study region. These activities occurred only occasionally at the farm gate and were of minor importance to the farmers compared to the non-market values of cattle. Winter and Doyle (2008) stated that farmers will not change what they do currently and will probably invest only limited resources if there is no strong market demand for their produce.

Unlike the situation in other southern and southeastern Asian countries, like India, the Philippines and Thailand, where competition for markets occurs between small and large producers, with limited market access for the small producers (Delgado et al., 2008), this type of competition was not observed between different

### Table 7

Net benefit/kg live weight (NB/kg LW) in the investigated villages, by region.

<table>
<thead>
<tr>
<th>Region</th>
<th>Farm (n)</th>
<th>NB/kg LW (000VND)</th>
<th>LSM</th>
<th>s.e.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highland</td>
<td>23</td>
<td>26&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Lowland</td>
<td>45</td>
<td>39&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

LSM in the column with different superscripts differ significantly at P < 0.0001. (F = 38.7; P < 0.0001; D<sub>FM</sub> = 1; D<sub>FV</sub> = 66; R<sup>2</sup> = 37%).

### Table 8

Gross margin (GM)/farm and net benefit (NB)/farm, GM/cattle and NB/cattle from cattle production of large-scale farms, by type (in Mill. VND).

<table>
<thead>
<tr>
<th></th>
<th>Enlarged (n = 2)</th>
<th>Maintained (n = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Min.-Max.</td>
<td>Mean Min.-Max.</td>
</tr>
<tr>
<td>GM</td>
<td>-1085 (-1375&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-1085 (-1375&lt;sup&gt;a&lt;/sup&gt;)</td>
</tr>
<tr>
<td>GM/cattle</td>
<td>-1.8 (-2.1&lt;sup&gt;a&lt;/sup&gt;)</td>
<td>-2.6 (-3.4&lt;sup&gt;a&lt;/sup&gt;)</td>
</tr>
<tr>
<td>NB</td>
<td>-167 (-259&lt;sup&gt;a&lt;/sup&gt;)</td>
<td>-278 (-531&lt;sup&gt;a&lt;/sup&gt;)</td>
</tr>
<tr>
<td>NB/cattle</td>
<td>-0.3 (-0.4&lt;sup&gt;a&lt;/sup&gt;)</td>
<td>-1.4 (-1.4&lt;sup&gt;a&lt;/sup&gt;)</td>
</tr>
</tbody>
</table>

<sup>a</sup> LSM in the column with different superscripts differ significantly at P < 0.0001. (F = 38.7; P < 0.0001; D<sub>FM</sub> = 1; D<sub>FV</sub> = 66; R<sup>2</sup> = 37%).
types of farm in the present study. This study found that, although none of the farm types was a regular supplier of beef or breeding animals, there was a tendency for access to different markets, as follows: small mixed farms joining the market for draught animals and partly attending the beef market; medium mixed farms tending to be major beef suppliers for the standard quality beef market at low-input level and to provide breeding cattle for small farms; and well managed large-scale farms with access to low-cost feed connecting to high-quality beef markets providing beef for restaurants and supermarkets in the cities. However, without promotion of market access, none of these types of farm will have a chance of developing beef cattle production.

According to the Decision No., 167/2001/QĐ-TTg, the government encourages the establishment and organization of market places as well as the support of investors for beef cattle production, particularly in regions of comparative advantages (Department of Animal Husbandry, 2006). However, the comparative advantages in the study region are limited and the support of investors with capital alone will not lead to sustainable farm types while the constraint of feed resource availability is not overcome and farms lack professional management. In the present study, cooperative groups of medium farms were established to make use of the available feed resources and to save labour costs. The formation of cooperatives of smallholdings, as suggested by Lapar et al. (2003) for small-holding pig production, could provide an opportunity for connecting smallholders to beef markets and stimulate the development of beef markets in the region. However, the development of such cooperatives requires support by the government, at least in the initial phase, and premium markets may be accessed only through high-quality production with strict quality control (Lapar et al., 2003).

5. Conclusions and recommendations

The extension and intensification of cattle production in the lowland small mixed farms is severely restricted by forage availability and labour shortage. The most promising type of farm for profitable beef production in the study region was the medium mixed farm, where the farmers could increase their cattle production on the basis of available fodder resources from pastures with a consequent limited use of supplemental feed. The problems of feed shortage and low feed quality necessitate improvements of the current feeding practices and grazing management to increase the efficiency of cattle production in the mountainous zone (Phung, 2001; Olson, 2005) and further research is needed to identify locally adoptable solutions. Efforts to improve feeding, however, must be rewarded by new marketing possibilities, which remain to be established. Cooperative organization of short food supply chains as proposed for pig production in the same region by Herold et al. (in press) could be an appropriate solution for marketing a defined meat quality from younger animals, further contributing to the shortening of production cycles. The formation of farmer groups, which has enabled medium farms to reduce labour costs for cattle keeping, could be developed favourably towards cooperative beef marketing. Research on optimising feeding, breeding, management and marketing for this type of farm could support its further development. However, without governmental support and regulatory interventions concerning marketing and health as well as infrastructure improvement and provision of services for farmers, this development will not take place. The development of beef production on the medium farm seems to be the most promising option to enhance the live beef supply from the region. Beef cattle production can develop to a major income-generating activity of these farms without overstraining the available resources. In contrast, the prospects for further development of large farms towards productivity and economic efficiency seem to be severely limited.

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