# ECONOMIC EFFICIENCY IN BEEF CATTLE PRODUCTION UNDER DIFERENT SYSTEMS AT WESTERN HIGHLAND OF VIETNAM

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## ABSTRACT

The objective of this research was to investigate the economic efficiency of beef cattle production according to three various systems in Western Highland of Vietnam. Three systems were applied as traditional grazing system (TGS), semi-intensive system (SIS) and nomadical grazing system (NGS).

Total of 1,160 cattle, out of which 512 cows, 20 breeding bulls, 628 growing calves (0-24 months old) were observed for data collection from January 2017 to June 2020 of 58 households in Gia-Lai and Dak-Lak provinces. Input expenditures for cattle production were comprised of crude feed, concentration and minerals, health care, breeding and additional expenses. Outputs were comprised of compost and calfsellings. Procedures of basic statistics and one-way ANOVA in MINITAB16 were applied for analyzing inputs, outputs and revenue per household and cow.

The results indicated that by household, the highest total output was 133.64 million Vietnam Dongs (mVND)/household/year and found in NGS, the lowest total output was of TGS with 84.75 mVND/household/year; the annual total output of SIS was 91.10 mVND/household/year. The differences between them were statistically significant ($P<0.05$). Whereas, the annual revenues per cow including labourcost and gross investment, excluding labour cost and gross investment interest were usually the highest estimates in SIS: 13.37 mVND/cow/year (including labour cost and gross investment); 10.05 mVND/cow/year (excluding labour cost); 8.30 mVND/cow/year (excluding labour cost and gross investment interest).

The SIS has shown the best choice for beef cattle production. It should be taken into account for extension in Western Highland of Vietnam.

**Keywords:** *Beef cattle, beef production system, economic efficiency.*

## INTRODUCTION

The various beef production systems may result in diverse impacts: Some system could sustain biodiversity and reduce gas emission, but the other systems may get more dominant efficiency in feed conversion, conservation of natively rare cattle races. And thus, from environmental viewpoint, it is necessary to thoroughly consider for determination of the best system (Galka, 2004; Bragaglio et al., 2018; Bragaglio et al., 2020). Fattening system in finishing period requires lower land and emits lower global greenhouse gas for each beef kg (Bragaglio et al., 2018; Capper, 2012; Nguyen et al., 2010; Peters et al., 2010). Grazing system of ruminants utilizes pasturelands and pastoral zones those are not proper for crop production, in the mean while it converts forage into protein sources for human without controlling competition of the feed resouces for ruminants –human food (de Vries et al., 2015; Wilkinson, 2011). Therefore, the determination of the suitable beef cattle production system would bring about both economic efficiency and reduction of environmental pollution.

Western Highland of Vietnam is anarea of low population density with abundant arable land, and a potential zone for intensive grass cultivation and ruminant development. Herein, cattle are mainly nourished in several ethnic minority groups. Due to the influences of productive costum, distinctively aboriginal cultures, geographic characteristics and climates in Western Highland, as well as social-economic developments and science-technologies applied in beef cattle production, resulted in three major sytems of beef cattle production such as: (1) Cattle are

traditionally grazed in conventional pasturelands or grasslands (Traditional grazing system - TGS); (2) Cattle are normally grazed in pastures or grasslands and supplemented with concentration and roughage at housing (Semi-intensive system -SIS); (3) Cattle are nomadically grazed in natural pastures or grasslands (Nomadic grazing system - NGS). In order to deal with economic efficiency of beef manufacture, it is necessary imperative to select and encourage to extend some beef system, which would be suitable for beef production in Western Highland based on creterions of food security and hygienic standards. The promotion of the best system would also be solution to maintain and amend the traditional activities of multiple minor-ethnic communities are commonly residing in Western Highland of Vietnam.

## MATERIALS AND METHODS

### Cattle and materials

Total of 1,160 cattle, out of which, 512 cows, 20 breeding bulls, 628 calves and heifers from birth to 24 months old; were local cattle or crossbreds of local race, Lai Sind and Red Brahman or Drought Master breeds; raised in 58 households at districts: KrongPa, Ayunpa of Gia-Lai province and Eakar, M'Drak, KrongPac districts of Dak-Lak province. Roughage and feed-stuffs, comprised of forage, fodders, rice straw, concentrate, minerals. Records were gathered and collected from January 2017 to June 2020.

### Methods

#### *Investigation, choosing households*

After investigation from 152 households, 58 households were selected and assigned into three systems. The households chosen were the farmers keeping reproductive cattle (Local cows, Lai Sind cows, Brahman or Drought Master bulls) and selling commercial calves (Local cattle, Brahman or Drought Master crossbreds, Lai Sind), with more than 10 years experienced in cattle production and maintained, according to 3 distinctive systems as following. Reproductive herd sizes of Households were sustained and kept constant during investigation.

*Traditional grazing system (TGS):* Cattle were traditionally grazed, released into pastures or grasslands in the mornings and returned the stalls in the late afternoons or evenings.

*Semi-intensive system – SIS:* Cattle were traditionally grazed, released into pastures or grasslands in the mornings and returned the stalls in the late afternoons or evenings. They were additionally supplemented forage, roughage, fodder or concentrate at the stalls in the morning before grazing or evening after returing.

*Nomadical grazing system (NGS):* Cattle were rotationally grazed in natural grasslands or carpets in the forests, they were rested or stayed overnight in the temporary shelters, after several days, ruminants were moved into other areas.

Table 1a. Structure breeding herds according to three beef cattle production systems

| Systems | Households | Local cows | Lai Sind cows | All |
|---|---|---|---|---|
| SIS | 15 | 23 | 77 | 100 |
| TGS | 29 | 84 | 153 | 237 |
| NGS | 14 | 49 | 126 | 175 |
| All | **58** | **156** | **356** | **512** |

***Data collection***

Documents for recording were set in accordance with actual situations in cattle production from households (Inputs comprised offeed cost (expenditures and expenses of feed resouces), breeding cost, housing costs, health cares and medicines; Outputs contained: Calfsellings and compost sales). Technicains or veterinarians periodically visited monthly or every fortnight by visitings and mobilephones. Data of productive and reproductive traits were directly collected at the herds, and data related to management and expenditure were collected on interviewing households and herdmans with questionnaires.

*The productive or reproductive traits of the herds*

Cows, bulls, calveswere individually observed and recorded:

Reproductive females or bulls: age at first service, body weight, calving intervals, utilizing lifetime in the herds, selling price of calves, culled cows, old bulls or compost disposals were directly collected from the herds, households' notebooks and herdmans.

Calves: Birth weight, 6, 12, 18, 24 months old and weight at selling, price per live weight kg.

Weight of calves and cows or bulls at recording or at selling were determined by technical measurements at selling timepoints.

*Feed costs*

Roughage: comprised of forage and fodder, rice straw, expenditure for green forage production and conservation, payments for collecting and buying fodder, rice straw, grass seed, water irrigation, fertilizer, labours for caltivation, …

Concentrate: maize powder, rice bran, cassava chips or powder, commercially industrial concentration, …

Additive supplements: Licking mineral block, complex of vitamins, mixed minerals, …

*Expenditure for veterinary medicine*

Medicine for treatment and prevention, spraying drugs to disinfect cattle barns and confinement, vaccines, helminthiases, internally and externally parasitic diseases.

Costs for veterinary advisements and renting veterinarians.

*Other expenditures: estimated depreciation for a year.*

Cattle barn depreciation: estimated for a year.

Machinery depreciation: estimated for a year: green feed slicer, water pump, ventilator, bicycles, motorbikes used for cattle husbandry.

Miscellaneous expenditure: Canvases for barns, temporary shelters, electrical wires, cords for controlling cattle.

The costs of fuels, electric power and commercial water service.

*Breeding cost*

The cost for produce a calf, was estimated as sum of cow depreciation and insemination to produce a calf for a reproductive cow.

Cow depreciation for a calf ($E_1$): estimated based on selling price of culling cow, the price of

buying a breeding cow, number of calves for a cow's reproductive lifetime, cow's live body weight, was estimated as followed:

$$E_1 = \frac{(B_1 - S_1) \times W_{Cows}}{ncalf_1}$$

Where: $E_1$ is the depreciation of a cow to produce a calf;

$B_1$ is the price of buying the reproductive cow at the investigation;

$S_1$ is the price of selling the culled cow at the investigation;

$W_{Cows}$ is the live weight of the culled cow;

$ncalf_1$ is number of calves produced for a cow's reproductive lifetime (Table 1c).

Expenditure for insemination to produce a calf, was estimated as followed ($E_2$)

The calf, born from artificial insemination, was estimated as price and number of insemination to produce a calf.

The calf, born from natural mating in households used stud bulls, was estimated as followed.

$$E_2 = \frac{(B_2 - S_2) \times W_{Bulls}}{ncalf_2}$$

Where: $E_2$ is the expenditure to produce a calf;

$B_2$ is the price of buying a stud bull;

$S_2$ is the price of selling a culled stud bull;

$W_{Bulls}$ is the live body weight of the stud bull;

$ncalf_2$ is number of calves produced of stud bull's reproductive lifetime in the herd.

Breeding cost to produce the calves of a reproductive cow was estimated as followed:

$$E_i = \frac{E_{1i} + E_{2i}}{CI_i}$$

Where: $E_i$ is breeding expenditure to produce the claves in a year of $i^{th}$ cow in the herd of the hoder;

$CI_i$ is calving interval of $i^{th}$ cow (in year).

*Labour expenditure.*

Labour expenditure was estimated based on Decision No. 38/2013/QD-UBND, December 17th, 2013 of the People's Committee of Dak-Lak province.

*Investment capital interest.*

Expenditure for investment capital interest: estimated as annual investment interest of the hoder, applied according to the bank interest for agricultural production, was applied as 7%/year, on October, 2019. Investment capital was comprised of the worth of reproductive cow herd and total input.

Total input was comprised of feed, veterinary medicine, breeding cost, other miscellaneous expenditure.

The worth of reproductive cow herd was estimated based on the live body weight of individual cows and the current selling price of breeding cows at household.

**Method for data analyses**

***Total input (estimated in a year)***

*Total input was estimated by the households and in a year, as followed:*

$$TI = FE + CE + VE + BE + OE$$

Where:

TI: is total input by household and in a year;

FE: is expenditure for forage, roughage, fodder, conserved feed;

CE: is expenditure for concentrate and additive minerals;

VE: is expenditure for veterinary medicine;

BE: is breeding cost to produce the calves a year;

OE: is other miscellaneous expenditure.

*Total input was estimated by cow head of the households and in a year, was estimated as followed:*

$$TI_{(RC)} = \frac{TI}{N}$$

Where:

TI: is total input of the household and in a year;

$TI_{(RC)}$: is total expenditure by cow head of the household;

N is reproductive cow number of the household.

***Total output (estimated in a year)***

*Total output by household*

Total output of the household was comprised of selling calves and compost disposal, was estimated as followed:

$$TO = ACS + ACD$$

Where:

TO: is total output of the hold in a year

ACS: is amount of calf selling in a year

ACD: is amount of compost disposal in a year

ACS: is amount of calf selling in a year and was estimated as followed

$$ACS = \sum_{i=1}^{n} \frac{CS_i}{CI_i}$$

Where:

ACS: is amount of calf selling in a year of the household in a year:

$CS_i$: is amount of calf selling from $i^{th}$ cow of the household in a year:

$CI_i$: is calving interval of $i^{th}$ reproductive cow (in year)

n: is reproductive cow number in the households

*Total output by cow head in the household*

$$TO_{(RC)} = \frac{TO}{N}$$

Where:

TO: is total output of the household

$TO_{RC}$: is amount of output by reproductive cow head in the household

N is reproductive cow number in the household

***Revenue***

*Revenue per year by household:*

Households' annual revenues were estimated according to 3 types: the raw revenue, excluding labour, excluding labour and total investment interest.

$$RR_{(Holder)} = TO - TI$$

$$NR_{(H-L)} = TO - TI - LC$$

$$NR_{(H-LE-TII)} = TO - TI - LC - TII$$

Where:

$RR_{(Household)}$: is the raw revenue per year by household;

$NR_{(H-L)}$: is the net revenue per year by household after subtracting labour cost;

$NR_{(H-L-TII)}$: is the net revenue per year by household after subtracting labour cost and total investment interest;

TO: is the total output per year by household;

TI: is the total input per year by household;

LE: is labour expenditure or labour cost;

TII: is the total investment interest.

*Annual revenue by reproductive cow in the household.*

Annual revenues by reproductive cow of the household were also estimated according 3 types: The raw revenue, the revenue after subtracting labour cost, the revenue after subtracting labour cost and total investment interest.

$$RCR_{(RC)} = \frac{TO - TI}{N}$$

$$RCR_{(RC-LC)} = \frac{TO - TI - LC}{N}$$

$$RCR_{(RC-LC-TII)} = \frac{TO - TI - LC - TII}{N}$$

Where:

$RCR_{(RC)}$: is the revenue by reproductive cow of the household;

$RCR_{(RC-LC)}$: is the revenue by reproductive cow of the household after subtracting labour cost;

$RCR_{(RC-LC-TII)}$: is the revenue by reproductive cow of the household after subtracting labour cost and total investment interest;

TO: is the total output by year of the household;

TI: is the total input by year of the household;

N: is number of reproductive cows of the household.

Table 1b. Basic statistic parameters in the herds according to three beef cattleproduction systems at the time on October 2019

| Parameters | Systems | N (Households) | Mean±SE | Min | Max |
|---|---|---|---|---|---|
| Duration for grazing per day (hours) | SIS | 15 | 7:51±0:19 | 4:59 | 10:00 |
| | TGS | 29 | 7:39±0:08 | 7:00 | 9:30 |
| | NGS | 14 | All day time | All day time | All day time |
| Total heads per holder (cattle head) | SIS | 15 | 15.47±1.61 | 8 | 32 |
| | TGS | 29 | 18.83±0.81 | 13 | 35 |
| | NGS | 14 | 27.29±1.17 | 20 | 36 |
| Reproductive cows per household (cattle head) | SIS | 15 | 6.67±0.73 | 3 | 14 |
| | TGS | 29 | 8.17±0.43 | 5 | 15 |
| | NGS | 14 | 12.50±0.77 | 9 | 21 |
| Heifers (cattle head) | SIS | 14 | 2.93±0.27 | 1 | 4 |
| | TGS | 29 | 3.03±0.21 | 1 | 5 |
| | NGS | 13 | 3.92±0.18 | 3 | 5 |
| Calves (cattle head) | SIS | 15 | 6.00±0.76 | 2 | 14 |
| | TGS | 29 | 7.41±0.36 | 4 | 14 |
| | NGS | 14 | 10.21±0.79 | 6 | 15 |

*Notes: SIS: Semi-intensive system; TGS: Traditional grazing system; NGS: Nomadic grazing system.*

*Sources: Data from investigation 10, 2019*.

Table 2. Basic statistic parameters in the herds according to nomadic grazing systems

| **Parameters** | **N** (Households) | **Mean±SE** | **Min** | **Max** |
|---|---|---|---|---|
| Duration for grazing at one pasture or grassland of the households (Days) | 14 | 29.86±8.54 | 5 | 90 |
| Number of pastures or grasslands for annual movement of the households (Pastures, grasslands) | 14 | 5.86±0.33 | 4 | 8 |

*Sources: Data from investigation 10, 2019*.

Table 3. Parameters were fitted into the model for estimation of revenue

| **Parameters** | **Breed groups** | **N** (Heads) | **The actual values at investigation of the households** | **The applied values were fitted into the model** |
|---|---|---|---|---|
| The age at calf selling of the households (Old month) | *Local cattle* | 47 | 23.40±1.21 | 23 |
| | *Brahman and Drought Master crossbreds* | 91 | 9.15±0.56 | 9 |
| | *Lai Sind* | 42 | 18.39±1.20 | 18 |
| The price for calf selling (1000 VND/kg live weight) | *Local cattle* | 47 | 53.48±1.87 | 53 |
| | *Brahman and Drought Master crossbreds* | 91 | 73.41±1.69 | 73 |
| | *Lai Sind* | 40 | 54.89±1.68 | 55 |
| The price for selling culled cows and bulls (1000 VDN/kg live weight) | *Local cattle* | 43 | 44.41±1.57 | 44 |
| | *Brahman and Drought Master crossbreds* | 59 | 53.34±1.19 | 53 |
| | *Lai Sind* | 60 | 45.04±1.44 | 45 |
| Number of calves produced of the lifetime for a reproductive cow (Calves) | *Local cattle* | 43 | 7.09±0.42 | 7 |
| | *Brahman and Drought Master crossbreds* | 61 | 6.19±0.25 | 6 |
| | *Lai Sind* | 59 | 7.14±0.33 | 7 |
| Survival rate of calves until selling | SIS | 15 (Households) | 96.53±0.27 | 95.53 |
| | TGS | 29 (Households) | 95.55±0.18 | 95.55 |
| | NGS | 14 (Households) | 95.43±0.33 | 95.43 |
| Labour cost[1] (Applied | Number of | Animals | 30 | 30 |

| Parameters | Breed groups | N (Heads) | The actual values at investigation of the households | The applied values were fitted into the model |
|---|---|---|---|---|
| for 3 systems).<br>1 labour per day (232,000 VND) | reproductive cows/1 labour<br>Number of breeding bulls/1 labour | Animals | 6 | 6 |
| | Number of growing calves/1 labour | Animals | 50 | 50 |

*Notes: SIS: Semi-intensive system; TGS: Traditional grazing system; NGS: Nomadic grazing system.[1] based on Decision No. 38/2013/QD-UBND, December 17th, 2013 of the People's Committee of Dak-Lak province*

To compute the basic statistic parameters, the descriptive statistics procedure was used; to analyze the effects of different production systems on the revenues by household, by reproductive cow, Proc GLM in MINITAB16 was applied with following model:

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where: μ - is overall mean;

$Y_{ij}$ -is the observation: Total output, total input, the revenue were estimated by household, by reproductive cow of the household per year in the levels: by household, by reproductive cow after subtracting labour cost, total investment capital interestofj$^{th}$cow or household; at i$^{th}$ system;

$S_i$–is the fixed effect of i$^{th}$ system (i=3: Semi-intensive system; Traditional grazing system – TGS; Nomadic grazing system);

$e_{ij}$ is residual errors assumed that normally distributed with zero mean and $\sigma^2$ variance - $N(0,\sigma^2_e)$.

## RESULTS AND DISCUSSION

### Outputs

The results of this investigation showed that total output of household consisted of annual amount of calf and compost selling (Table 4). Total output of households produced according to NGS was the highest amount, in total of 14 households investigated, the average total output was of 148.92 mVND/household/year; consecutively, was in SIS, with 15 households and average annual total output per holer was of 130.70 mVND/household/year; the lowest total output was found in TGS, in 29 households, the average annual total output was of 91.39 mVND per household. This considerable difference was due to scale and number of cow heads kept in systems. The NGS possessed the largest scale of 12.5 reproductive cows/household, TGZ got the scale of 8.17 reproductive cow/household and SIS got the average scale of 6.67 reproductive cow per household.

Table 4. The estimated total output by household in different systems

| Output | Systems | N *(Households)* | Mean±SE *(mVND)* | Min | Max |
|---|---|---|---|---|---|
| Calf selling | SIS | 15 | 113.00±13.40 | 43.20 | 237.50 |
| | TGS | 29 | 83.57±4.76 | 48.15 | 150.75 |
| | NGS | 14 | 141.68±8.29 | 85.30 | 197.70 |
| Compost disposal | SIS | 15 | 17.65±3.51 | 7.68 | 60.00 |
| | TGS | 29 | 7.82±1.33 | 1.00 | 24.00 |
| | NGS | 14 | 7.24±1.66 | 2.00 | 18.00 |
| ***Total output*** | ***SIS*** | ***15*** | ***130.70±16.30*** | ***50.90*** | ***297.50*** |
| | ***TGS*** | ***29*** | ***91.39±5.44*** | ***52.98*** | ***155.75*** |
| | ***NGS*** | ***14*** | ***148.92±9.12*** | ***87.30*** | ***207.70*** |

*Notes: SIS: Semi-intensive system; TGS: Traditional grazing system; NGS: Nomadic grazing system.*

Total outputs by reproductive cow of the household ($TO_{RC}$) were shown in Table 5. The households in SIS got the highest $TO_{RC}$, averaged 19.31 mVND per reproductive cow per year, significantly higher than $TO_{RC}$ of the hodersin the other systems ($P<0.05$); 12.25 mVND/cow/year in TGS and 12.11 mVND in NGS. $TO_{RC}$ of the households in TGS and NGS were not significantly different ($P>0.05$). $TO_{RC}$ in SIS got the highest value, resulted from higher amounts of calf selling and compost disposal than the other systems. The output amount from calf selling in SIS got the average of 16.75 mVND/reproductive cow per year, which was significantly higher than output amounts from two other systems ($P<0.05$); 10.33 mVND/cow/year and 11.53 mVND/cow/year, respectively in TGS and NGS. Similarly, output amount by reproductive cow from compost disposal was the highest value in SIS, average 2.56 mVND/cow/year, it was significantly higher than output amounts from two other systems ($P<0.05$).

Table 5. Estimated total output by reproductive cows of the households in different systems in a year

| Items | Systems | n (holds) | Mean ±SE *(mVND/reproductive cow/year* | Min | Max |
|---|---|---|---|---|---|
| Calf selling | SIS | 15 | $16.75±0.53^{a}$ | 14.21 | 20.09 |
| | TGS | 29 | $10.33±0.38^{b}$ | 6.02 | 15.89 |
| | NGS | 14 | $11.53±0.55^{b}$ | 8.56 | 17.97 |
| Compost disposal | SIS | 15 | $2.56±0.20^{a}$ | 1.09 | 4.50 |
| | TGS | 29 | $0.92±0.14^{b}$ | 0.15 | 3.00 |
| | NGS | 14 | $0.58±0.20^{b}$ | 0.14 | 1.50 |
| ***Total output*** | ***SIS*** | ***15*** | ***$19.31±0.60^{a}$*** | ***16.31*** | ***23.08*** |
| | ***TGS*** | ***29*** | ***$11.25±0.43^{b}$*** | ***6.71*** | ***16.77*** |
| | ***NGS*** | ***14*** | ***$12.11±0.62^{b}$*** | ***8.79*** | ***18.88*** |

*Notes: SIS: Semi-intensive system; TGS: Traditional grazing system; NGS: Nomadic grazing system.*

**Expenditures**

*Expenditure estimated by hold*

Table 6. Total input and expenditure estimated by household in different systems in a year

| Items of expenditure | Systems | N (Holds) | Mean (mVND/hold/year) | SE | Min | Max |
|---|---|---|---|---|---|---|
| Roughage[1] | SIS | 15 | 4.30 | 0.77 | 0.95 | 12.00 |
| | TGS | 28 | 0.77 | 0.10 | 0.15 | 1.99 |
| | NGS | 14 | 1.70 | 1.16 | 0.09 | 16.60 |
| Concentrate and minerals[2] | SIS | 15 | 19.38 | 3.49 | 7.55 | 60.80 |
| | TGS | 4 | 0.76 | 0.52 | 0.19 | 2.31 |
| | NGS | 4 | 5.27 | 3.00 | 0.51 | 14.04 |
| Veterinary care | SIS | 15 | 1.81 | 0.28 | 0.60 | 3.20 |
| | TGS | 12 | 1.19 | 0.41 | 0.05 | 5.00 |
| | NGS | 4 | 2.75 | 0.75 | 2.00 | 5.00 |
| Other miscellaneous expenditures | SIS | 15 | 4.32 | 0.42 | 2.75 | 7.80 |
| | TGS | 29 | 1.15 | 0.18 | 0.15 | 3.87 |
| | NGS | 14 | 1.47 | 0.41 | 0.30 | 4.50 |
| ***Input amount excluding breeding cost*** | ***SIS*** | ***15*** | ***29.81*** | ***4.35*** | ***13.48*** | ***83.60*** |
| | ***TGS*** | ***29*** | ***2.49*** | ***0.43*** | ***0.50*** | ***7.91*** |
| | ***NGS*** | ***14*** | ***5.46*** | ***2.62*** | ***0.45*** | ***36.53*** |
| ***Breeding cost amount*** | ***SIS*** | ***15*** | ***9.76*** | ***1.23*** | ***4.20*** | ***24.25*** |
| | ***TGS*** | ***29*** | ***4.25*** | ***0.51*** | ***1.36*** | ***12.52*** |
| | ***NGS*** | ***14*** | ***9.82*** | ***1.23*** | ***4.24*** | ***19.10*** |
| **Basic total input in a year** | **SIS** | **15** | **39.57** | **5.50** | **17.69** | **107.85** |
| | **TGS** | **29** | **6.74** | **0.87** | **2.01** | **19.68** |
| | **NGS** | **14** | **15.28** | **3.56** | **5.02** | **52.44** |
| Total worth of reproductive cow herd of the hold | SIS | 15 | 128.50 | 17.40 | 54.10 | 332.60 |
| | TGS | 29 | 99.54 | 7.51 | 44.10 | 226.75 |
| | NGS | 14 | 185.20 | 16.60 | 99.40 | 297.70 |
| **Total investment capital of the hold** | **SIS** | **15** | **168.10** | **22.70** | **71.70** | **440.40** |
| | **TGS** | **29** | **106.28** | **8.23** | **47.65** | **244.34** |
| | **NGS** | **14** | **200.50** | **19.00** | **104.50** | **323.50** |
| Bank lending interest of total investment capital (7%/year) | SIS | 15 | 11.77 | 1.59 | 5.02 | 30.83 |
| | TGS | 29 | 7.44 | 0.58 | 3.34 | 17.10 |
| | NGS | 14 | 14.03 | 1.33 | 7.31 | 22.64 |
| Labour expenditure[3] | SIS | 15 | 22.54 | 2.89 | 9.72 | 49.79 |
| | TGS | 29 | 38.13 | 3.25 | 19.44 | 88.33 |
| | NGS | 14 | 65.07 | 5.42 | 35.64 | 121.69 |

*Notes: SIS: Semi-intensive system; TGS: Traditional grazing system; NGS: Nomadic grazing system; [1]the feed included green forage, fodder, hay, conserved roughage; [2]concentrations, macro and micro minerals including licking mineral block; [3]based on Decision No. 38/2013/QD-UBND, December 17th, 2013 of the People's Committee of Dak-Lak province.*

Basic total input of the holds in different systems was indicated in Table 6. Generally, the households raised their cattle in SIS got higher expenditures than two other systems. Especially, the highest expenditure was for concentrations, averaged each household in

SIS paid 19.38 mVND/household/year. Otherwise, the results showed that input amount excluding breeding expenditure was the maximum in SIS (29.81 millionsVND/hold/year), and then in NGS (5.46 mVND/hold/year), the lowest value was in TGS (2.49 millions/hold/year). But for breeding cost, the amounts of SIS and NGS were resembled, 9.76 and 9.82 mVND/hold/year, respectively. Whereas, breeding cost in TGS was much lower than SIS and NGS, 4.25 mVND/hold/year. Similarly, the results showed that the holds in SIS got the highest basic total input, average annual basic total input of these holds was of 39.57 mVND/hold/year, the maximum was 107.85 mVND, the lowest value was 17.69 mVND/household/year; consecutively, holds in NGS got the average basic total input was 15.28 mVND/hold/year; the lowest basic total input, was found in the hold of TGS, was of 6.74 mVND/hold/year. Besides, in respect of total investment capital of the hold, NGS exposed the value of 200.50 mVND/hold/year, which was much higher than the values of SIS (168.10 mVND/hold/year) and TGS (106.28 mVND/hold/year. The reason for that is reproductive cow number in NGS was much higher than in SIS and TGS (was shown in Table 1).

*Expenditure estimated by reproductive cow in the households*

Basic total input estimated by reproductive cow per year was shown in Table 7. The average of basic input amount excluding breeding cost for SIS was 4.48 mVND/reproductive cow/year, significantly higher than in TGS of 0.33 mVND and in NGS of 0.46 million ($p<0.05$). Breeding cost amount of SIS was 1.45 mVND/reproductive cow/year, also significantly higher than in TGS of 0.54 mVND and in NGS of 0.80 mVND ($p<0.05$). Annually, the holds in SIS got average basic total input of5.94 mVND per reproductive cow, was much higher than in TGS of 0.87 mVND and NGS of 1.25 mVND ($p<0.05$). The difference between TGS and NGS was not statistically significant ($p>0.05$).

Otherwise, the results exposed more that the reproductive cow in three system got the average worths as 19.03 mVND; 12.30 mVND and 14.96 mVND, respectively in SIS; TGS and NGS ($p<0.05$). On the other hand, the annual average investment capital per reproductive cow was 24.97 mVND in SIS; which was almost 1.5 folds compared to investment capital in NGS (16.22 mVND), and nearly twice compared to TGS (13.17 mVND). The difference of investment capital/reproductive cow/year among them was statistically significant ($p<0.05$).

Similarly, average expense for bank interest of investment capital by reproductive cow per year was 1.75 mVND in SIS, significantly higher than the expense of TGS (0.92 mVND) and the expense of NGS (1.14 mVND). However, the difference of expense between TGS and NGS was not significant ($p>0.05$).

Besides, labour expenditure for cattle nourishment and management was the lowest value (6.65 mVND); and highest in NGS (10.39 mVND); labour expenditure of TGS was 9.08 mVND; the difference among them was significant ($p<0.05$).

Table 7. Total input and expenditure estimated by reproductive cow head in different systems in a year

| Items of expenditures | Systems | N | Mean±SE | Min | Max |
|---|---|---|---|---|---|

| | | | *(mVND)* | | |
|---|---|---|---|---|---|
| Basic input amount excluding breeding cost | SIS | 15 | 4.48±0.21[a] | 2.55 | 8.15 |
| | TGS | 29 | 0.33±0.15[b] | 0.07 | 1.32 |
| | NGS | 14 | 0.46±0.22[b] | 0.04 | 3.32 |
| Breeding cost amount | SIS | 15 | 1.45±0.09[a] | 1.21 | 1.76 |
| | TGS | 29 | 0.54±0.06[b] | 0.20 | 1.56 |
| | NGS | 14 | 0.80±0.09[b] | 0.42 | 1.59 |
| Total basic input in a year | SIS | 15 | 5.94±0.26[a] | 3.78 | 9.88 |
| | TGS | 29 | 0.87±0.19[b] | 0.32 | 2.50 |
| | NGS | 14 | 1.25±0.27[b] | 0.46 | 4.77 |
| The average worth of reproductive cow of the holds | SIS | 15 | 19.03±072[a] | 14.17 | 23.75 |
| | TGS | 29 | 12.30±078[b] | 8.40 | 23.31 |
| | NGS | 14 | 14.96±120[b] | 9.24 | 23.74 |
| The average investment capital/ reproductive cow of the hold | SIS | 15 | 24.97±0.92[a] | 17.96 | 31.46 |
| | TGS | 29 | 13.17±0.89[b] | 8.73 | 25.77 |
| | NGS | 14 | 16.22±1.43[b] | 9.70 | 26.13 |
| Bank lending interest of investment capital/ reproductive cow (7%/year) | SIS | 15 | 1.75±0.08[a] | 1.26 | 2.20 |
| | TGS | 29 | 0.92±0.06[b] | 0.61 | 1.80 |
| | NGS | 14 | 1.14±0.09[b] | 0.68 | 1.83 |
| Labour expenditure/reproductive cow[3] | SIS | 15 | 6.65±0.50[a] | 6.48 | 9.05 |
| | TGS | 29 | 9.08±0.36[b] | 6.48 | 14.41 |
| | NGS | 14 | 10.39±0.52[b] | 6.48 | 13.51 |

*Notes: Notes: SIS: Semi-intensive system; TGS: Traditional grazing system; NGS: Nomadic grazing system; [3] based on Decision No. 38/2013/QD-UBND, December 17th, 2013 of the People's Committee of Dak-Lak province.*

**The revevues**

The revenues per year were estimated by different levels of three beef cattle production systems shown in Table 8.

*The revenue was estimated by household*

The results showed that NGS's annual average revenue wasthe highest value of 133.64 mVND per household; subsequently, the annual revenue in SIS was 91.10 mVND/household;

the revenue of households in TGS was the lowest value of 84.75 mVND; the difference among them was statistically significant (P<0.05).

After subtracting labour expenditure, the annual revenue by household was equivalently approximate between SIS and NGS, 68.57 mVND and 68.55 mVND, respectively; these revenues were all significantly higher than the revenue by household of TGS with 46.61 mVND (p<0.05).

Table 8. The revenues were estimated by household and by reproductive cow in different beef production systems per year

| Revenues | Levels | Systems | N | Mean ± SE | Min | Max |
|---|---|---|---|---|---|---|
| | | | *(Households)* | *(mVND)* | | |
| By household | Basic revenue | SIS | 15 | 91.10±11.50[a] | 33.2 | 189.6 |
| | | TGS | 29 | 84.75±5.08[a] | 50.63 | 148.15 |
| | | NGS | 14 | 133.64±6.75[b] | 82.29 | 175 |
| | Basic revenue (Subtract labour expenditure)[1] | SIS | 15 | 68.55±8.97[a] | 23.51 | 144.28 |
| | | TGS | 29 | 46.61±3.60[b] | 7.01 | 88.55 |
| | | NGS | 14 | 68.57±8.05[a] | 16.58 | 119.61 |
| | Basic revenue (Subtract labour expenditure and Bank interest of total investment capital) | SIS | 15 | 56.79±7.67[a] | 18.49 | 113.45 |
| | | TGS | 29 | 39.17±3.23[b] | -1.66 | 74.12 |
| | | NGS | 14 | 54.53±7.05[a] | 8.46 | 101.36 |
| By cow | Basic revenue | SIS | 15 | 13.37±0.52[a] | 11.06 | 17.8 |
| | | TGS | 29 | 10.39±0.32[b] | 6.33 | 14.31 |
| | | NGS | 14 | 10.86±0.50[b] | 8.33 | 14.11 |
| | Basic revenue (Subtract labour expenditure) | SIS | 15 | 10.05±0.52[a] | 7.82 | 14.56 |
| | | TGS | 29 | 5.86±0.41[b] | 0.64 | 11.07 |
| | | NGS | 14 | 5.64±0.72[b] | 1.51 | 10.87 |
| | Basic revenue (Subtract labour expenditure and Bank interest of total investment capital) | SIS | 15 | 8.30±0.52[a] | 6.16 | 12.8 |
| | | TGS | 29 | 4.94±0.37[b] | -0.15 | 9.27 |
| | | NGS | 14 | 4.51±0.64[b] | 0.77 | 9.21 |

*Notes: SIS: Semi-intensive system; TGS: Traditional grazing system; NGS: Nomadic grazing system; [1] based on Decision No. 38/2013/QD-UBND, December 17th, 2013 of the People's Committee of Dak-Lak province*

After subtracting labour cost and total investment capital, the revenue by household in SIS was the highest value of 56.79 mVND/household/year; which was higher than the revenue in NGS of 54.53 mVND/household/year (P<0.05). Both the estimated revenues of SIS and NGS were significantly higher than the revenue of TGS (P<0.05) (39.17 mVND/household/year).

*The revenue was estimated by reproductive cow*

The annual basic revenue for a reproductive cow in the households was estimated as the highest value of 13.37 mVND/cow/year in SIS; subsequently, in NGS, the annual average revenue for a reproductive cow was estimated as 10.86 mVND; the lowest annual revenue by reproductive cow was estimated as 10.39 mVND. The differences among them were statistically significant ($p<0.05$).

After subtracting labour cost, the annual basic revenue by reproductive cow was highest value of 10.05 mVND and found in SIS; that was statistically higher than the revenues in TGS and NGS ($P<0.05$). The annual revenues by reproductive cow of TGS and NGS were similarly equivalent; 5.68 millions/cow and 5.64 mVND, respectively in NGS; the revenues for these do not significantly differ ($P>0.05$).

After subtracting labour cost and bank interest of total investment capital; the annual revenue by reproductive cow was stimated as the maximum of 8.30 m VND and was found in SIS, that was significantly higher than the revenue from two other systems ($P<0.05$). The annual revenue by reproductive cow from households in NGS was 4.94 mVND; but in TGS this value was estimated as 4.51 mVND, therefore the differences between them was not statistically apparent significance ($P>0.05$).

**General discussions**

Requirement for manufacturing high quality beef product, so cattle breeding needs to be considerably improved. indigenous cattle and lowly-produced breeds are gradually substituted by Brahman, Dought Master crossbreds or other high-yielding beef breeds, and these crossbreds would not be proper for normal grazing system as well as in nomadic grazing system. It is necessary to develop intensive grassland or cultivate high-yielding grass species, mixture of concentrate. And thus, semi-intensive system would be gradually prevailed, and substitute TGS and NGS in near future. Otherwise, the results from this research indicated that SIS dominated in economic efficiency versus two other systems from basic revenue by reproductive cow after subtracting labour cost, bank interest of total investment capital. In Western Highland, TGSand NGS applied more indigenous cattleand Brahman or Drought Master bulls. In the meanwhile, households in SIS applied more Red Sindhy crossbred reproductive cows and Brahman or Drought Master bulls.The efficiency of beef cattle production in different models was also mentioned by some reserachers in Daklak province, that was quite similar to these findings, the beef production model applied technical advances brought about more revenue the traditional model about 60%; the revenue of Zebu crossbreds was higher than local cattle from 25 to 30% (Truong La, 2018).

Beef cattle production system may be partitioned on many different manners depends on characteristics and categorizations (Steinfeld and Mäki-Hokkonen,1995). Furthermore, so as to assure getting revenue, the beef production systems all need to be intervened from government to support the input expenditure (Wolfová et al., 2004). In this research, SIS gave the highest economic efficiency, which was quite similar to findings from some other researchers. Bragaglio et al. (2020) indicated that environmental impact of local and intensive beef cattle system in term of environment (global warming, acidization, soil nourishment) was considerably decreased when accompanying service were included into the system. Whereas, land occupation not changed due to high absolute value and needs to allow keeping ruminants on grassland.

Ogino et al. (2016) showed that intensive beef cattle system got lower greenhouse gas emission, but considerable impact on energy consumption and acidification compared with extensive system. Two these aystems do not affect soil eutrophication.

And thus, it needs to encourage and develop beef cattle via SIS, to take advantage of natural grass resources as an available potential in Western Highland. Furthermore, it is necessary to cultivate intensive pastures of high quality grass species, increase households'economic efficiency, enhance the quality of beef commodity and assure beef cattle development coming into stablity and sustainability for this region.

## CONCLUSIONS

Net basic revenues obtained in a year for a reproductive cow in Semi-Intensive System, Traditional Grazing System and in Nomadic Grazing Systemwere 8.30 mVND; 4.94 mVND and 4.51 mVND, respectively.

Beef cattle production was applied according to semi-intensive system brought about the highest economic efficiency and it should be extended in Western Highland of Vietnam.

### Conflict of Interest

The authors declare that there are no conflicts of interest.

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