Profitability and Competitiveness of Indigenous *Horo* Cattle Production in Ethiopia

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Abstract

The livestock sector plays an important role for livelihoods and economic security of farmers and rural communities in Sub-Saharan Africa. The sector contributes about 25 percent of total agricultural GDP and about 11 percent of national GDP of Ethiopia. However, much has not been done to improve performance of the sector, especially indigenous genetic resources that are at risk. The paper develops a Policy Analysis Matrix to examine the profitability and competitiveness of indigenous *Horo* cattle production in the Western Showa in Ethiopia. We employ multi-stage probability sampling techniques in selecting 150 farmers for interview. We then employ partial sensitivity analyses with various scenarios to assess the impacts of each policy strategy. The results show that both private and social profits from indigenous cattle production are positive; implying that indigenous *Horo* cattle production is profitable and competitive for livestock keepers in particular for the country at large. The domestic resource cost coefficient, private cost ratio, effective protection coefficient and profitability coefficient values also indicate a comparative advantage of indigenous *Horo* cattle production in the country. Policy recommendations for improved conservation, management and sustainable use of indigenous animal genetic resources are provided.

Keywords: Livestock, indigenous animal genetic resources, profitability and competitiveness, Policy Analysis Matrix, economic efficiency

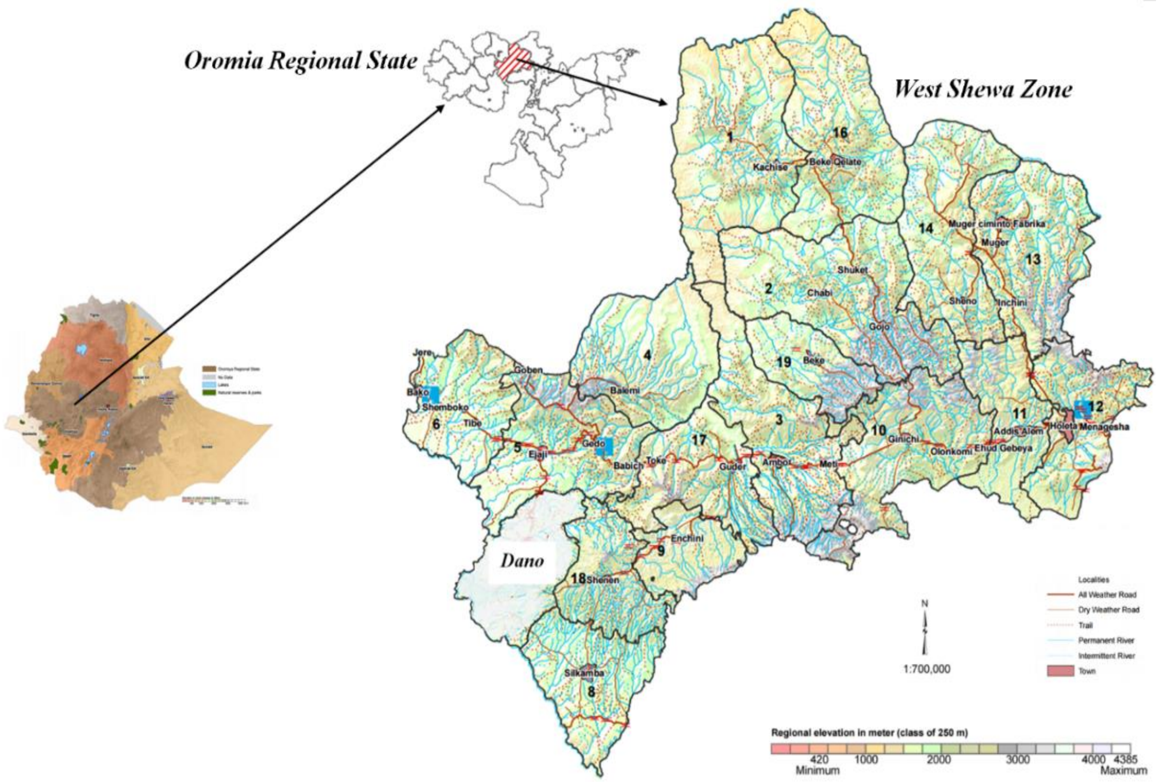
1. Introduction

The livestock sector plays a significant role in economies of Sub-Saharan African countries. It is estimated that more than 70 percent of the rural poor depend on livestock as a component of their livelihoods (FAO, 2000). Studies show that Ethiopia has the largest livestock resource among all African countries (FAO, 2011; Asresie and Zemedu, 2015) and ranks as the tenth largest livestock inventory globally (USAID, 2013). The total private holdings cattle population of the country was estimated about 53.99 million in 2013 (CSA, 2013). This subsector has significant contribution in Ethiopian economy, which ranges from draught power to livelihoods and food security (Delgado *et al.*, 1999; FAO, 2011; USAID, 2013). Empirical findings show that this subsector contributes about 11% of national GDP and 25% of total agricultural GDP with an estimate of 45% to agricultural GDP if the value of ploughing services considered (IGAD, 2013). According to National Bank of Ethiopia (NBE) (2015), the livestock subsector's contribution to the country's total export were $2,374.8 million in 2013, $2,405.08 million in 2014 and $2,387.91 million in 2015. Livestock production in the country mainly relies on indigenous animal genetic resources, however, much has not been done to improve the performance of these resources. Therefore, these resources are threatened by pressure of economic development that could be at risk of loss due to genetic erosion (IBC, 2004; Alemayehu, 2007). In addition, the subsector is characterized by inadequate feed and nutrition, widespread disease, poor health, lack of livestock policy and infrastructure (Degefe and Nega, 2000; Alemayehu, 2007; Alemayehu *et al*., 2010; FAO, 2011). With this background, the principal objective of this study is to examine profitability and competitiveness of indigenous cattle production to be able to address the potential risk of indigenous animal genetic erosion. The paper develops a Policy Analysis Matrix to examine the profitability and competitiveness of indigenous *Horo* cattle production in the Dano District of Western Showa in Ethiopia. We employ stratified probability sampling techniques in selecting 150 farmers for the interview. We then employ partial sensitivity analyses with various scenarios to assess the impacts of each policy strategy.

2. The study area

Dano District is one of the 180 districts in the Oromia Region of Ethiopia. It is located about 250 km south-west of Addis Ababa and 125 km west of the town of Ambo, the capital city of west Shewa zone of Oromia Regional State. The district is classified into three agro-ecologies: Highland, which encompasses about 5 percent of the total land size and located above 2,200 meters above sea level (>2,200 m. a. s. l.); Midland, which is about 80 percent of the total land mass and located between 1,500 and 2,200 meters above sea level (1,500 – 2,200 m. a. s. l.); and Lowland, which covers about 15 percent of the total land and located below 1,500 meters above sea level (<1,500 m. a. s. l.). The district receives on average 900-1,400 mm annual rainfall and the annual mean temperature ranges from 15°C to 30°C. It is characterized by flat and plain topographical features, which represents about 90 percent of the total land coverage followed by mountainous (8.3 percent) and Gorges (1.7 percent) topographical features (DBOA, 2006).

Figure 1: Map of the study area



Source: CSA, 2011

3. Methodology

3.1 Data collection and sampling techniques

Socioeconomic, demographic, institutional, costs and benefits data collected from sampled farmers using structured questionnaires. Experienced enumerators administered the questionnaire with close supervision. We employed stratified probability sampling techniques to select five study villages. Following, 30 farmers were selected from each village using systematic random sampling procedure. The lists of farmers were obtained from the development centers and offices of peasant associations. A total of 150 farmers were selected for interview.

3.2 Theoretical Framework of the Policy Analysis Matrix (PAM)

Monke and Pearson (1989) developed PAM, a tool that measures profitability (the difference between revenues and costs) and effects of divergences (in revenues, costs and profits due to distorting policies and market failures, see Table 1). Monke and Pearson (1989), Alemayehu (2007) and Reig-Martínez *et al*. (2008) used PAM to measure the effects of transfers caused by a particular policy and inherent economic efficiency of the system.

Table 1: Policy Analysis Matrix

Particulars	Revenues	Costs		Profits
		Tradable Input	Domestic factor	
Privet Profits	A	B	C	D[1]
Social Profits	E	F	G	H[2]
Divergences	I[3]	J[4]	K[5]	L[6]

[1] *Private Profit*, $D = A-(B+C)$
[2] *Social Profit*, $H = E-(F+G)$
[3] *Output Transfer*, $I = A-E$
[4] *Tradable Input Transfer*, $J = B-F$
[5] *Domestic Factor Transfer*, $K = C-G$
[6] *Net Transfer*, $L = D-H = I-(J+K)$

Source: Monk and Pearson, 1989 and adopted by Fang and Beghin, 2000; Zeleke, 2005; Alemayehu, 2007; Reig-Martínez *et al*., 2008

The first row of the matrix represents private *profitability* from indigenous *Horo* cattle production, which is given by:

$$D = A-(B+C)$$

Where A, B and C represent revenues, tradable input costs and domestic factor costs that obtained from livestock budgets respectively and D denotes profit in private prices.

The second row of the matrix represents *social profitability*, which is given by:

$$H = E-(F+G)$$

Where E, F and G represent revenues in social prices, tradable input costs in social prices and domestic factor costs in social prices respectively and H refers to social profit. E, F and G were estimated based on social opportunity costs of commodities produced and inputs used in indigenous cattle production.

In addition, the PAM allows us to compute *policy divergences* through disaggregating the divergences into *Output Transfer* ($I = A-E$), *Tradable Input Transfer* ($J = B-F$), *Domestic Factor Transfer* ($K = C-G$) and *Net Transfer* ($L = D-H = I-(J+K)$) in order to measure specific effects of each policy interventions, technology or market failure (Pearson *et al*., 2003). Comparison of different scenarios might also be possible through a further extension of the PAM. We might also produce a number of ratios from PAM to analyze the effects of a policy scenario, among others, selected policy distortion indicators are discussed below.

The detailed formulas of the matrix components are presented below (Fang and Beghin, 2000; Nguyen, 2002; Nguyen and Heidhues, 2004; Zeleke, 2005; Alemayehu, 2007):

$$A = \sum_{c=1}^{k} P_c T_C \qquad B = \sum_{i=1}^{n} P_i Q_i \qquad C = \sum_{j=1}^{m} W_j L_j$$

$$E = \sum_{c=1}^{k} P_c(s) T_c \qquad F = \sum_{i=1}^{n} P_i(s) Q_i \qquad G = \sum_{j=1}^{m} W_j(s) L_j$$

Where: P_i and $P_i(s)$ = prices of tradable input 'i' in private and social prices respectively

W_j and $W_j(s)$ = prices of domestic factors " j " in private and social prices respectively
P_c and $P_c(s)$ =prices of product ' c ' in private and social prices respectively
T_c = quantity of product ' c ' produced per unit of average tropical livestock unit (TLU[1]).
Q_i, and L_j = quantity of tradable input ' i ' and domestic factor ' j ' used respectively
k, n and m are number of outputs, tradable input and domestic inputs respectively

Nominal Protection Coefficient on Tradable Outputs ($NPCO$) and *Nominal Protection Coefficient on Inputs* ($NPCI$) serve as an alternative to I and J in the previous table respectively. The ratios express the divergence between livestock market price and the social price (free of any distortion).

$$NPCO = \frac{A}{E} = \frac{\sum_{c=1}^{k} P_c T_c}{\sum_{c=1}^{k} P_c(s) T_c} \qquad NPCI = \frac{B}{F} = \frac{\sum_{i=1}^{n} P_i Q_i}{\sum_{i=1}^{n} P_i(s) Q_i}$$

Private Cost Ratio (PCR) is the domestic resources required to produce additional unit of product . The ratio shows the comparative advantage of indigenous *Horo* cattle production and its private profitability. Excess profit, in excess of nominal returns to domestic resources, is indicated by PCR less than 1.

$$PCR = \frac{C}{(A-B)} = \frac{\sum_{j=1}^{m} W_j L_j}{\sum_{c=1}^{k} P_c T_c - \sum_{i=1}^{n} P_i Q_i}$$

Domestic Resource Cost Coefficient (DRC) is social return to domestic resources. It indicates whether domestic factors are utilized efficiently.

$$DRC = \frac{G}{E-F} = \frac{\sum_{j=1}^{m} W_j(s) L_j}{\sum_{c=1}^{k} P_c(s) T_c - \sum_{i=1}^{n} P_i(s) Q_i}$$

Effective Protection Coefficient (EPC) is the ratio of value added in livestock market price to social prices. This ratio compares comparative advantage of indigenous *Horo* cattle production over one another.

$$EPC = \frac{A-B}{E-F} = \frac{\sum_{c=1}^{k} P_c T_c - \sum_{i=1}^{n} P_i Q_i}{\sum_{c=1}^{k} P_c(s) T_c - \sum_{i=1}^{n} P_i(s) Q_i}$$

Subsidy Ratio to Producers (SRP) is the ratio of Net Transfer to Social Value of Revenue. The purpose of this indicator is to show the level of transfers from divergences as a

[1] Tropical livestock unit is commonly taken to be an animal of 250 kg live weights (Storck *et al*. 1991), TLU conversion factors is presented in Appendix Table 2.

proportion of the undistorted value of the system revenues.

$$SRP = \frac{L}{E}$$

Profitability Coefficient (PC) is an alternative to L and shows the extent to which private profit exceeds social profit.

$$PC = \frac{D}{H}$$

4. Results and Discussion

Estimation of shadow exchange rate (SER)[2], which is the rate that would have prevailed in the absence of any trade intervention (Gonzalese *et al.*, 1993; Shahabuddin, 2000; Lagman-Martin, 2004; Alemayehu, 2007). It is the weighted average of the demand price for foreign exchange paid by importers and the supply price of foreign exchange received by exporters (Lagman-Martin, 2004). Gittinger (1984) and Tallec and Bockel (2005) pointed out that shadow exchange rate might be considered as the opportunity cost of foreign exchange, which is given by the following equation:

$$SER = \frac{OER}{SCF}$$

Where: SER is Shadow Exchange Rate, OER is Official Exchange Rate and SCF is Standard Conversion Factor.

Lagman-Martin (2004) suggested a methodological guideline for economic analysis of projects for Asian Development Bank that adapted by Tallec and Bockel (2005), Zeleke (2005) and Alemayehu (2007), assuming distortion in domestic market prices occurred due to tariffs. The mathematical form of Standard Conversion Factor (SCF) is given by:

$$SCF = \frac{X + M}{(X - t_x) + (M + t_m)}$$

Where: X is total export value of commodities, M is total import values of commodities, t_x is total tax on exports and t_m is total tax on imports.

We estimated SCF based on data obtained from National Bank of Ethiopia (NBE) annual report (2014/15), X valued at F.O.B and M valued at C.I.F, t_x was taken as zero because proclamation No. 38/1993 and No. 287/2002 of the country canceled all export taxes. The SCF is estimated as follows:

$$SCF = \frac{3{,}019{,}300{,}000 + 16{,}500{,}000{,}000}{(3{,}019{,}300{,}000 - 0) + (16{,}500{,}000{,}000 + 2{,}673{,}657{,}880)} = 0.88$$

According to NBE (2015), the annual average OER rate of Ethiopian Birr (ETB) to US$ was 20.6688 and the SER was calculated based on Gittinger (1984):

[2] SER reflects the consumption worth of an extra unit of foreign exchange in terms of domestic currency that replaces market prices in theoretical calculations when market prices do not represent the true economic value of a particular good/service (Nguyen, 2002; Tallec and Bockel, 2005).

$$SER = \frac{OER}{SCF} = \frac{20.6688}{0.88} = 23.49 ETB / US\$$$

Decomposition of input costs: Farmers in the study area did not use any imported inputs for cattle production. We assumed some inputs such as land, labor and farm capitals as pure non-tradable cost items. As Mohanty *et al*. (2003) argued, we also assumed other inputs produced domestically and not available on the international market that include manure and animal feed[3] treated as pure non-tradable cost items. The opportunity cost of manure was computed based on Kumsa (2002). On average, a single cattle could produce 1.8 kg of feces (2.1kg dry matter in a dry season and 1.5 kg dry matter in a wet season) per day in Western Showa, Ethiopia.

Social prices of pure domestic resources: The social price of land suggested to be calculated at its highest net return on its competitive crops (Yao, 1997; Garcia *et al*, 2007). In the study area, however, specialization in the profitable crops was not observed because farmers preferred to engage in crop rotation to reduce risks. As an alternative, Ortmann (1987), Nguyen and Heidhues (2004), Zeleke (2005) and Alemayehu (2007) pointed out that market rent might be competitive and farmers could be free to make contractual agreements on land use. Accordingly, the private market rent considered as a proxy measure of the opportunity cost of land although the amount was much lower than the real rental values. Some farmers rent out their land for grazing or to grow crops in exchange for receiving part of the harvest (in kind) or in monetary values. Hence, we consider average values of formal and informal land rent values as good proxies for measuring the opportunity cost of land. The social value of labor and borrowed capital used in cattle production were estimated based on the conversion factors prepared by Ministry of Economic Development and Cooperation (MEDaC). Animal power, farm tools depreciation and manure have no conversion factors available. We adapt Zeleke (2005) and Alemayehu (2007) by assuming their social values the same as their privet values. Social prices of domestic factors estimated at their opportunity costs (see Appendix Table 1).

Social valuation of tradable and non-tradable outputs: World prices represent a government's choice to permit consumers and producers either to import or export or produce goods domestically (Monk and Pearson, 1989; Morrison and Balcombe, 2002; Mohanty *et al.*, 2003). We consider F.O.B per head as a starting point to derive social price (comparable world price) of indigenous *Horo* cattle, which was converted into local currency using shadow exchange rate. Subsequently, the price was adjusted based on transportation, handling and other transaction costs to get the export parity prices of indigenous *Horo* cattle at the farm get.

Export parity price of indigenous Horo cattle: As presented in Table 2, we calculated export parity price of indigenous *Horo* cattle at the farm gate, which usually exported in live form, based on F.O.B as a starting point. All costs such as transportation, handling and

[3] According to CSA (2013), 57.49%, 29.61%, 7.05%, 4.72%, 0.91% and 0.22% of animal feed in Ethiopia are obtained from green fodder (grazing), crop residue (straw and chaff of cereals/pulses, etc.), hay (cut and dried grass), other feed sources, industrial byproducts (oil cake) and improved feed (alfalfa) respectively.

other marketing costs incurred in the process of delivering indigenous *Horo* cattle were deducted from the F.O.B to arrive at the farm gate price. Social costs of transportation, interest paid for borrowed capital, labor costs of loading and unloading were estimated based on standard conversion factors prepared by MEDaC in 1998.

We develop revenue and cost categories in private prices based on average farm budgets, which were constructed by using average farm inputs and outputs[4] data collected from farmers at household level (see the system budget table in Appendix Table 1). The market prices of inputs and outputs were validated with District Agricultural/Rural Development Office Report, Central Statistical Agency Report and market prices of the nearest market. Few cost items such as local packaging materials, local storage, local churning device (*Ro'oo*), cleanings, ropes, overhead costs and other miscellaneous expenses were treated as pure non-tradable items. We converted all information into a common farm-level numeraire: land in a hectare, herd size in tropical livestock unit (TLU), family labor in adult/man-equivalent and a common time frame.

Table 2: Export parity price of indigenous *Horo* cattle

	Description	**Private Price**	**Social Price**
1	Exchange rate (ETB/$)	20.67	23.50
2	F.O.B ($/head)	534.67	534.67
3	F.O.B (ETB/head)	11050.99	12564.70
4	Port charge	199.47	170.99
5	Transportation	650.00	140.75
6	Feed	119.90	119.90
7	Loading and unloading	59.95	59.95
8	Overhead	70.00	70.00
9	Interest	106.57	106.57
10	Other expenses	211.00	211.00
11	Margin	3335.00	3335.00
12	Transport to the farm	93.90	57.17
13	Farm gate price (ETB per head)	6205.20	8293.37
14	Farm gate price (ETB per average cattle TLU)	33,508.06	44,784.18

Source: Survey data analysis, 2016

We measured output in average cattle TLU (5.4 Cattle TLU) numeraire and we used information extracted from the system budget table to formulate PAM[5]. Results show that both *private* and *social* profits of indigenous *Horo* cattle production to be positive at the given inputs, outputs, prices, technologies, existing government policies and market imperfections (see Table 3). This result is consistent with literature (Monk and Pearson, 1989; Perdana, 2003; Alemayehu, 2007). The PAM results also reveal that social profitability (efficiency) of indigenous *Horo* cattle production is by far larger than private profit implying that the market prices paid to farmer are less by 14,375.36 ETB per average

[4] Studies suggested to construct an input-output table (system budget table) as a first step in the PAM analysis (Perdana, 2003; Alemayehu, 2007; Reig-Martínez et al., 2008).

[5] See Appendix Table 5 for average products and average major inputs per year per household

cattle in TLU than their social value or opportunity cost. This may occur due to overvalued exchange rate, market failures, undeveloped marketing infrastructures, institutional factors at district, zonal and regional levels or other externalities[6].

Table-3: PAM for indigenous cattle production in ETB/ average cattle TLU[7]

Peculiarities	Revenue	Costs		Profit
		Tradable inputs	Domestic factors	
Private price	51470.90	0.00	9918.94	41551.96
Social price	62390.87	0.00	6463.55	55927.32
Divergence	-10919.97	0.00	3455.39	-14375.36

Source: Computed PAM results, 2016

The *Output Transfer* (I) of indigenous *Horo* cattle production is negative, which implies livestock keepers obtain less price for their animal than the world market through implicitly paying more tax on *Horo* cattle. The *Non-tradable Input Transfer* (K) is positive implying the opportunity costs of using domestic resources, mainly unskilled labor, are lower than their private values. Thus t indigenous *Horo* cattle producers are implicitly taxed for the use of domestic resources. The *Net Transfer* (L) is negative implying that the government may not pay much attention for this subsector. Like the crop production subsector, the government needs to also provide relevant inputs and output policies for this subsector.

Policy Indicators: As shown in Table 4, the *NPCO* of indigenous *Horo* cattle production, is less than one. This implies that private revenue of cattle production is reduced through the government implicitly charging farmers about 18 percent of their product. *NPCI* = 0, implies the absence of input subsidy policies and lack of institutional setup. This result suggests subsidizing indigenous livestock keepers' production costs is the only way for them to realize profits.

Table-4: Summary of Policy indicators[8]

Indicators[9]	Amount	Indicators	Amount
NPCO	0.82	EPC	0.82
NPCI	0.00	SRP	-0.23
PCR	0.19	PC	0.74
DRC	0.10		

Source: Computed from the PAM's results, 2016

DRC, which evaluate the importance of indigenous cattle production relative to the international market in relation to economic efficiency is less than 1. This result shows that

[6] Policy distortions are often introduced by decision makers that leads to inefficient use of resources (Alemayehu, 2007).

[7] PAM for indigenous cattle production per head cattle TLU in ETB is presented in Appendix Table 4.

[8] See Appendix Table 5, for policy indicators of indigenous cattle production per head cattle TLU

9 *NPCO*=Nominal Protection Coefficient on Output; *NPCI*=Nominal Protection Coefficient on Inputs; *PCR*=Private Cost Ratio; *DRC*=Domestic Resource Cost Coefficient; *EPC*=Effective Protection Coefficient; *SRP*=Subsidy Ratio to Producers; and *PC*=Profitability Coefficient.

the country has a relatively high comparative advantage in production and export of indigenous *Horo* cattle. This calls for fostering conservation and sustainable use of the sector. The *EPC* and *NPCO* are less than 1 and it's due to lack of tradable inputs and as a result, the overall impacts of existing policy influences only the output side of the market. It therefore causes a net disincentive for cattle keepers because they are being taxed instead receiving subsidies as other sub sectors do. The subsidy ratio to producers *SRP* = -0.23, implies that indigenous *Horo* cattle production is taxed 23 percent more..

Change in shadow exchange rate (SER **)**: A unit change in exchange rate, which is a key variable for cattle pricing policy (ILRI, 2004) instituted by central authority. Change in the exchange rate can affect SER , tradable inputs, cattle prices and the PAM. In this scenario, we simulated a 20 percent increase and a decrease in SER in reference to the baseline scenario. The simulation shows that comparative advantage of indigenous cattle production improves as SER . As presented in Table 5, ceteris paribus, a 20 percent increase in SER reduces the NPCO and EPC values by 17.1 percent.. This means producers are more implicitly taxed on their products as the ETB value is socially depreciated.

Table-5: Policy distortion indicators for sensitivity analysis due to change in SER

Indicators	Base line	20 percent increase	20 percent decrease
NPCO	0.82	0.68	1.05
NPCI	0.00	0.00	0.00
PCR	0.19	0.19	0.19
DRC	0.10	0.09	0.13
EPC	0.82	0.68	1.05
SRP	-0.23	-0.37	-0.02
PC	0.74	0.60	0.98

Source: Computed from PAM's simulation result, 2016

A 20 percent decrease in the current SER policy might erase the 18 percent implicit taxation in the baseline scenario and producers receiving a subsidy of about 28.ercent. This result reveals that indigenous cattle producers would be benefitting from reduced implicit taxation on their products as SER approaches OER . However, the NPCI value remains static due to an absence of tradable inputs. The DRC value decreases by 10 percent as SER increases by 20 percent, which implicitly indicates an improvement in social values added on indigenous cattle production. Conversely, the DRC value deteriorates as SER decreases by 20 percent. Likewise, the profitability coefficient decreases and increases by 18.92 and 32.43 percent for a 20 percent increases and decreases in SER respectively.

Change in the world price of indigenous cattle: Demand and supply of indigenous cattle fluctuate due to change in export prices (F.O.B) of indigenous cattle, socio-economic and institutional factors. Accordingly, we simulated impacts of change in export prices of indigenous cattle on *NPCO* , EPC , and DRC policy indicators (see Table 6).

Table-6: Policy distortion indicators for sensitivity analysis (change in the F.O.B) price

Indicators	Base line value	20 percent increase in F.O.B price	20 percent decrease in F.O.B price
NPCO	0.82	1.02	0.63
NPCI	0.00	0.00	0.00
PCR	0.19	0.16	0.25
DRC	0.10	0.10	0.10
EPC	0.82	1.02	0.63
SRP	-0.23	-0.04	-0.42
PC	0.74	0.96	0.53

Source: Computed from the PAM's simulation results, 2016

The results show an increase in *NPCO* from 0.82 to 1.02. Livestock keepers are implicitly taxed by 24.4 percent. A decreases from 0.82 to 0.63, they might be 23.17 percent subsidy. . The EPC rises as export prices of indigenous cattle increases and vice versa, a change in from 0.82 to 1.02 (23.17 percent) for a 20 percent rise in F.O.B price. This result shows that the net disincentive effect might be minimized by an increase in F.O.B price. Change in indigenous cattle export price may not affect DRC and NPCI with the existing level of technology, which suggests the same level of comparative advantage in indigenous cattle production.

Assuming tradable inputs: In this scenario, we introduced tradable inputs such as improved animal feed, veterinary services, improved cattle barn, improved management system, training, etc. We arbitrary added 50 percent of the domestic factors as tradable inputs. The corresponding private and social costs of tradable inputs might be 3,463.44 ETB and 6,719.07 ETB respectively, assuming other inputs remain constant. This simulation analysis shows that private and social profits are significantly positive with the given assumption of tradable inputs. This implies profitability of indigenous *Horo* cattle with a certain level of tradable inputs (See Table 7).

Table 7: Simulated PAM for indigenous cattle production with tradable inputs (ETB/ average Cattle TLU)

Peculiarities	Revenue	Costs		Profit
		Tradable inputs[10]	Domestic factors	
Private price	51470.90	4959.47	9918.94	36592.49
Social price	62390.87	3231.78	6463.55	52695.55
Divergence	-10919.97	1727.70	3455.39	-16103.06

Source: Computed from the PAM's simulation results

As presented in Table 8, *NPCO* <1, implies the net effect of government intervention and market distortion are not corrected through effective policies. NPCI >1, shows the overall impacts of government intervention (delivering tradable inputs). This impacts the input and

[10] Assume tradable input = 50% of privet and social domestic costs

output markets by creating an incentive to producers in the form of higher private prices relative to the baseline scenario.

Table 8: Policy distortion indicators for sensitivity analysis with tradable inputs

Indicators	Base line value	With assumed tradable inputs
NPCO	0.82	0.82
NPCI	0.00	1.53
PCR	0.19	0.21
DRC	0.10	0.11
EPC	0.82	0.79
SRP	-0.23	-0.26
PC	0.74	0.69

Source: Computed from the PAM's simulation results, 2016

The EPC <1,indicates input tariff creates a positive transfer. DRC <1, indigenous cattle keeping found to be competitive and has a comparative advantage with the assumed tradable inputs.

Change in cost of domestic inputs: We examined impacts of change in domestic inputs prices on policy indicators, ceteris paribus (see Table 9). The simulation shows that change in the cost of domestic inputs doesn't have a direct impacts on *NPCO* , NPCI and EPC with the given level of technology. However, DRC shows a slight change but less than one, which implies that indigenous *Horo* cattle production remains economically efficient with a 20 percent increase in domestic inputs, ceteris paribus.

Table 9: Sensitivity of PAM's indicators for change in domestic input costs (in private and social prices)

Indicators	Base line value	20 percent increase	20 percent decrease
NPCO	0.82	0.82	0.82
NPCI	0.00	0.00	0.00
PCR	0.19	0.23	0.15
DRC	0.10	0.12	0.08
EPC	0.82	0.82	0.82

Source: Computed from the PAM's simulation results, 2016

Change in average cattle TLU: Change in average indigenous *Horo* cattle size in TLU was found not to impact NPCI and DRC, ceteris paribus (see Table 10). However, *NPCO* changes from 0.82 to 0.93 (13.41%) for a 20 percent increase due to relative variation between private and social revenues and vice-versa. This simulation results indicate producers are slightly taxed on their products. This might be due to increasing social revenue than private revenue. The PAM simulation results also show a 20 percent increase in TLU size leads to a decrease in PCR but increases EPC, ceteris paribus.

Table 10: Sensitivity of PAM's indicators for change in average cattle in TLU equivalent

Indicators	Base line value	20 percent increase	20 percent decrease
NPCO	0.82	0.93	0.72
NPCI	0.00	0.00	0.00
PCR	0.19	0.17	0.22
DRC	0.10	0.10	0.10
EPC	0.82	0.93	0.72

Source: Computed from the PAM's simulation results, 2016

5. Conclusion and policy implications

The study shows that indigenous cattle production is profitable with the existing level of technology, market distortion and absence of effective policies. This study recommends the following set of policy tools:

1. There is a need to provide technical support concerning animal feeds, drugs, and health services; market information system; and subsidize producers to conserve and maximize socioeconomic benefits of indigenous cattle resources.
2. There is a need to formulate appropriate inputs and outputs policies and strategies to measure economic performance, policy outcomes, incentives, government revenue and expenditure.
3. Greater concern to technologies that improve indigenous cattle production quantity and quality should be given to meet export standards.
4. Promote public awareness about the contribution of indigenous cattle towards food security, better nutrition, poverty alleviation and livelihood improvement.

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Appendix Tables

Appendix Table 1: System Budget Table of indigenous *Horo* cattle production in private and social prices (ETB[11]/average cattle TLU).

Item	Private Price	Social Price
Revenue		
Main products		
Cattle	33508.06	44784.18
Butter	4545.55	4545.55
Milk	8100.00	8100.00
Cheese	1272.84	1272.84
Draft animal	2730.45	2374.30
Total main products	*50156.90*	*61076.87*
Byproduct		
Manure	1314.00	1314.00
Total revenue	**50,005.72**	**58,888.01**
Domestic Costs		
Animal feed	3080.91	3080.91
Farm tools	210.29	210.29
Storage	45.31	45.31
Shelter for cattle	395.60	395.60
Milk processing	309.20	309.20
Interest	106.57	106.57
Medication	269.37	269.37
Other expenses	46.25	46.25
Total domestic costs	*4463.50*	*4463.50*
Family labor	3310.45	1400.06
Hired labor	1800.00	150.00
Total labor costs	*5110.45*	*1550.06*
Land	345.00	450.00
Total domestic cost	**6926.88**	**5736.82**

Source: Survey data analysis, 2016

Appendix Table 2: TLU conversion factors

Animal Category	Total TLU	Animal Category	Total TLU
Calf	0.25	Donkey (adult)	0.70
Weaned calf	0.34	Donkey (young)	0.35
Heifer	0.75	Camel	1.25
Cow and ox	1.00	Sheep and goats (adult)	0.13
Pigs	0.20	Sheep and goats (young)	0.06
Horse	1.10	Chicken	0.013

Source: Storck *et al*. 1991

[11] Exchange rate (ETB/$) = 20.67

Appendix Table 3: Average yield and average major inputs used per year per household

Particulars	Amount
Yield	
Products	
Main product	
Average Cattle in TLU equivalent (in number)	5.4
Butter (in Kg) per cattle per year	8.6
Milk (in litter) per cattle per year	120
Cheese (in litter) per cattle per year	12.7
Draft animal (in hour) per cattle per 0.125 ha	96
Byproduct	
Manure (in kg) per cattle per year	657
Material inputs	
Animal feed (in ETB) per cattle per year	570.54
Farm tools (in ETB) per average CTLU per year	210.29
Storage (in ETB) per average CTLU per year	45.31
Shelter for cattle (in ETB) per average CTLU	395.60
Milk product processing (in ETB) per cattle year	57.26
Interest (ETB) per average CTLU	106.57
Labor	
Man-days family labor (in hour) per average CTLU equivalent per year	601.9
Hired labor per year in ETB per average cattle TLU	300
Land (in ha) used for average CTLU	0.384

Source: Computed based on survey data, 2016

Appendix Table 4: PAM for indigenous cattle production per head cattle TLU in ETB

		Costs		
Peculiarities	Revenue	Tradable inputs	Domestic factors	Profit
Private price	9531.65	0.00	2773.08	6758.57
Social price	13488.48	0.00	3953.18	9535.30
Divergence	-3956.83	0.00	-1180.10	-2776.73

Source: Computed PAM results, 2016

Appendix Table 5: Summary of PAM indicators per head cattle TLU

Indicators	**Amount**
NPCO	0.71
NPCI	0.00
PCR	0.29
DRC	0.29
EPC	0.71
SRP	-0.21
PC	0.71

Source: Computed PAM results, 2016