

Smallholders Livestock Keepers Breeding Choice and Its Implication on Poverty Reduction in Tanzania

Felician Andrew Kitole (✉ felicianandrew@gmail.com)

Mzumbe University <https://orcid.org/0000-0002-3596-5350>

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Abstract

The paper examines forces behind smallholder livestock keepers' decision towards breeding choices by widening the choices between improved dairy and beef cattle and traditional breeds and its implication in poverty reduction in Tanzania. The study has utilized the Tanzania household panel data survey of 2017/18 entailing all 27 mainland regions by focusing on the smallholder livestock keepers. The study shows that majority of smallholder livestock keepers are residing in rural areas constituting 85.87% with the sector being dominated by males owning 76.665 of entire livestock. However, the traditional breeds are dominant forming 56.43% of entire breeds in the country followed by improved beef and dairy breeds with 40.51% and 3.06% respectively. The sector is characterized by low education whereas 55.38% of the smallholder livestock keepers have no formal education, those with primary education are 41.74% and those with higher education are just 1.03% countrywide. Moreover, the multinomial logit results showed that choices of smallholder livestock keepers on cattle breeding categories significantly depend on a residence, national zoning, income diversification (farming and business ownership), education as well as per capita income with 52.45% living below the poverty line. The study recommends that the national livestock development program and livestock master plan should reconsider poverty as the focal point of change for the sectoral development and actors.

Introduction

Few studies have been carried out in the area of smallholder livestock keepers' breeding choice with largely never discuss anything about these smallholder decisions on choices of the type of cattle to be reared and its implication in poverty reduction, this increases demands for knowledge on the discipline and methodological attributes. However, the available few studies have paid attention to livestock and poverty (Engida et al. 2015; Grace et al. 2016 and Konga, 2014) while others have focused on livestock and food security (IFAD, 2016) while few have discussed breeding preferences (Mutenje et al., 2020 and Martin-Collado, 2018)

However, Mujibi et al. (2019) highlight that nearly 40% of the entire agricultural contribution to GDP in African countries is due to livestock activities which are highly dominated by the smallholder keepers. The contribution is higher in individual countries as it ranges between 30–80%. Additionally, Sub-Saharan African countries alone constitute about 450 million smallholder livestock keepers who are engaged in mixed farming activities; and this group accounts for nearly half of the entire livestock production in the continent although the majority of these livestock keepers have remained to be poor with many more being under extremely poor situations.

Moreover, annual revenues received from the livestock sector in the East African region has reached US dollar 1 billion as receipts from exports from a total of more than 2 billion cattle (Michael et al. 2018). Nonetheless, the general livestock population in the SADC region is projected to be 529,000,000 with 75% of the livestock population being kept under a smallholder traditional farming system (SADC, 2020).

The global share of Tanzania's cattle population and production stands at 1.40% and 11% respectively (FAO, 2016). The Tanzania Livestock Survey of 2016/17 presents that cattle and goats are the leading animals kept in Tanzania with 28.401 million and 16.67 million respectively while the number of sheep and pigs being 5 million and 2 million respectively. At these figures, the recent share of livestock in the GDP has reached 7.4% with the sector being one of the slowest growing annually at the rate of 2.3%. Major constraints associated with the sector includes the types of breeding animals kept by the majority of livestock keepers which has low production and poor diseases resilience that most can not survive during hot and dry seasons as well as high mortality (Michael et

al. 2018). Despite its low contribution to the GDP and its low growth rate yet Tanzania livestock's population is ranked 3rd in Africa after Sudan and Ethiopia (Engida et al. 2015). Furthermore, 99.9% of Tanzania's livestock are kept by smallholder farmers living the contribution of a large-scale farm very insignificant (Engida et al. 2015).

Table 1
Annual increase in cattle population in Tanzania

Productions zone	2016/2017	2017/2018	2018/2019	2019/2020	2020/21	2021/2022	% Change
Traditional system							
Central	13,102,022	14,098,320	14,632,283	15,186,470	15,761,646	16,358,606	20%
Coastal and Lake	11,560,207	12,301,694	12,626,411	12,959,700	13,301,786	3,652,901	14%
Highlands	3,773,606	4,095,903	4,288,036	4,489,182	4,699,763	4,920,222	26%
Total	28,435,835	30,495,917	31,546,730	32,635,351	33,763,194	34,931,729	18%
Ranching System							
Central	12,330	12,988	13,682	14,413	15,182	15,993	30%
Coastal and Lake	19,297	19,525	19,755	19,988	20,224	20,463	6%
Highlands	41,400	46,037	51,193	56,927	63,303	70,393	70%
Total	73,027	78,550	84,630	91,328	98,709	106,848	46%
Cattle in feedlots							
Feedlots	78,111	115,878	171,905	255,020	378,323	561,242	619%
Dairy Subsector	260,293.01	315,888.3	383,357	465,236	564,603	685,191	163%
Total	338,404	431,765	555,261	720,255	942,924	1,246,432	268%
Source: Tanzania Livestock Master Plan (TLMP) 2017/2018 – 2021/2022							

Nonetheless, due to persistent income poverty among smallholder livestock keepers in Tanzania, only less than 1/3 of all family-owned livestock is vaccinated. Additionally, an average of 60% of all animals is reported to have some type of disease with only 6% of rural livestock holders can hire labour while the rest depends on the family workforce; these facts justify that livestock is highly characterized with poverty in Tanzania (Michael et al. 2018).

To enhance smallholders' livestock keepers income and food security status number of breeding programs were established in Tanzania (TLMP, 2021). However, most of the smallholder farmers have been found to choose breedings based on the production of the cattle breeds, diseases resilience and environmental adaptability most often on heat and dry season (Kearney and White, 2016).

Studies of non-breeding choices and production show that indigenous or traditional breeds have the lowest milk production (Marshall et al. 2019). However, these traditional breeds have often been crossed to produce breeds with varying (Mujibi et al. 2019). In Tanzania, the main breeds that have the largest share in terms of the number

of animals kept and beef are Shorten zebu (80%) and ankole (14%). Generally in Tanzania, the traditional breeds of cattle constitute about 94% of the entire meat produced in a country and commercialized ranches makes only 6% (TLMP, 2021).

Table 2
Traditional and Improved Cattle Productivity in Tanzania

Parameter	Traditional Cattle breed	Improved Cattle breed	Smallholder	Ideal Standard
Calving rate	30.00% - 50.00%	55% - 73%	40.00% - 50%	80.00%
Calving interval (months)	18.00 – 24.00	15.00 – 21.00	17.00 – 18.00	12.00
Age at first calving (months)	36.00 – 48.00	30.00 – 36.00	43.00 – 46.00	27.00 – 30.00
Pre weaning mortality (%)	25.00% - 40.00%	4.30%	5.00% - 6.00%	< 5.00%
Calf mortality (%)	>25.00%	3.30%	5% - 6%	<10.00%
Adult mortality (%)	8.00% - 10.00%	1.30%	<1.00%	<5.00%
Mature weight (kgs)	200 – 300	250 – 350	-	300 – 500
Lactation yield	160.0 – 250.0	2800– 3500	1500 – 2000	2500 – 3500
Lactation length	200.00	300.00	270.00 – 300.00	305.00
Source: Tanzania Livestock Master Plan 2017/2018 – 2021/2022				

Table 2 justifies that enhancing the adaptation of new breeds among smallholders livestock keepers in Tanzania will help in increasing productivity and income among smallholder livestock keepers and hence reducing poverty levels among these groups. Therefore, this paper helps to examine determinants of smallholders livestock keepers choice (decision) on the breeding type of cattle and its implication in the poverty reduction strategies in Tanzania by considering that each breed has unique characteristics in terms of production which are highly associated with the household income and wealth.

Theoretical foundation

The discrete choice model has been used in this paper as an application to the random utility theory in modelling livestock keepers utility-maximizing constraints (Mutenje et al. 2020). The basics for the random utility theory has been adopted from Lancaster Consumer Theory which explains utility that is always derived or obtained from attribute which can never be bought independently. (Lancaster, 1966). Therefore, considering that individuals value differently the quality of a commodity hence it is impossible to determine general utility rather than individual satisfaction feedback. However, these farmers are always rational towards the choice of breeding that gives them the highest utils obtained from utilizing these breeds

To show this, this paper has assumed that smallholder livestock keepers satisfaction depends on choices made from the available set of choices for breeding types of cattle (j), which later provide a general utility function that:

$$U_{ij} = V_{ij} + \epsilon_{ij}, j = 1, 2, \dots, j \dots \dots \dots 1$$

whereas, for a smallholder livestock keeper i , a one will be indifferent at U based on the cattle breeding choice j . Therefore, this theory divide utility into deterministic part (V) and an unobservable part (ϵ) and smallholder livestock keepers (consumers) are regarded as rational as they will always pick the breeds that provide them with the highest utility.

Analytical Model

In order to examine the most likely explanations for the household's utility of specific types of cattle breeds among different existing breeds, this paper uses the multinomial logit model (Maddala, 1983). The choice of the model has been based on other significant facts like the ability of the MNL to use the cumulative distribution function of the logistic distribution and it has been widely used in similar studies. Consider a regressand variable Y with only two choices (dichotomous) and with its regressor X , and therefore;

$$\pi(x) = p(Y = 1|X = x) = 1 - p(Y = 0|X = x) \dots \dots \dots .2$$

Thus simple model for logistic regression will be given by the equation;

$$\text{Logit}[\pi(x)] = \log\left(\frac{\pi(x)}{1 - \pi(x)}\right) = \alpha + \beta x \dots \dots \dots .3$$

Whereas the odds will always be given by;

$$\text{Odds} = \frac{\pi(x)}{1 - \pi(x)} \dots \dots \dots .4$$

Therefore the logarithm of the odds is called logit which is hereby given by

$$\text{Logit}[\pi(x)] = \log\left(\frac{\pi(x)}{1 - \pi(x)}\right) = \log[\exp(\alpha + \beta x)] = \alpha + \beta x \dots \dots \dots .5$$

When there are multiple cattle breeding choices the model can be extended as follows;

Let k represents the number of predictors of the binary dependent variable Y that $x_1, x_2, x_3, \dots, x_k$. Hence the model for the log of odds is given by;

$$\text{logit}[P(Y = 1)] = \alpha + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k \dots \dots \dots .6$$

With the alternatively direct expression being

$$\pi(x) = \frac{\exp(\alpha + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k)}{1 + \exp(\alpha + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k)} \dots \dots \dots .7$$

Whereby β_i represents effects explanatory variable x_i on log-odds that $Y = 1$, while controlling other explanatory variables x_k , therefore $\exp(\beta_i)$ become a multiplicative effect on odds of a unit increases on the explanatory variable x_i when all other variables x_k are constant.

Therefore, when there are n observations, p independent variables, and k categorical responses in the given function, the ideal behind constructing multinomial logit is by making one of the responses as a base outcome of which all other remaining categories will be constructed relatively to it and all responses are not ordered hence any of them can be a base outcome. To simplify these explanations, consider π_j as a multinomial probability of observations falling into j^{th} category with p explanatory variables, $x_1, x_2, x_3, \dots, x_p$

Therefore, the multiple logistic regression model is given by;

$$\log \left[\frac{\pi_j(x_i)}{\pi_k(x_i)} \right] = \alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \dots + \beta_{pj}x_{pi} \dots \dots \dots .8$$

Whereas $j = 1, 2, \dots, (k - 1), i = 1, 2, \dots, n$. However, π 's add to unity therefore the equation is reduced to;

$$\log(\pi_j(x_i)) = \frac{\exp(\alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \dots + \beta_{pj}x_{pi})}{1 + \sum_{j=1}^{k-1} \exp(\alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \dots + \beta_{pj}x_{pi})} \dots \dots \dots .9$$

For $j = 1, 2, \dots, (k - 1)$, whereas parameters will be estimated by the use of maximum likelihood.

Methods And Data

This paper has applied the statistical study design by utilizing the Tanzania Household Budget Survey 2017/18. The HBS 2017/18 covered 9,552 households, from 796 Primary Sampling Units (PSUs or EAs) drawn from the 2012 Population and Housing Census Frame. Therefore, a subsample of the livestock keepers was selected from the total population in making a good analysis in this paper.

Results And Discussion

The results of this paper have been divided into two sections descriptive and Regression results. The descriptive provide the general feature or characteristic of the small livestock keepers in Tanzania while the regression results show the detailed relationship among variables towards the rational breeding choice of the small livestock keepers in Tanzania.

Table 3: Smallholder Livestock Keepers Household Characteristics

Variables	Observation	Mean	Std. Deviation	Minimum	Maximum
Head of household age	4,671	48.7034	15.5094	17	98
Household size	4,671	5.6035	3.1992	1	38
Total Household income (monthly)	4,671	991,666.667	2,441,666.67	61,083.408	15,083,333.3
Percapita income	4,671	212.3028	523.5555	13.0771	32,362.2083
Household expenditure	4,671	329,872.5	401,226.9	5,434.524	6,920,703
Percapita expenditure	4,671	847.4566	1,030.769	13.96153	17,779.58
Total consumption	4,671	302,637.2	287,442.8	2,570.42	5,021,778
Percapita consumption	4,671	777.4879	738.453	65.17769	12,901.16

(Income, expenditure and consumption are in Tanzanian shillings)

Source: Authors' computation, 2021

Results in Table 3 explain the socioeconomic behaviours of the smallholders' livestock keepers in Tanzania of which the average age of the head of household across all smallholder livestock keepers is 48.7 years with the minimum being 17 years (in some pastoralists societies in Tanzania especially Maasai young boys marry earlier) and oldest being 98. However, the average household size is 5.6 (approximately 6 members) with the lowest household having only one member while the largest size was found to be 38 members. The average monthly income is Tshs. 991,66.667 which is equivalent to US\$ 430.0376[1] with the lowest income being Tshs. 61,083.408 which is equivalent to US\$ 26.4889.

Table 4: Distribution of Smallholder Livestock Keepers

Variables	Attributes	Frequency	Percentage
Residence	Rural	4,011	85.87%
	Urban	660	14.13%
Sex	Male	3,581	76.66%
	Female	1,090	23.34%
Land Ownership	Own land	3,461	76.71%
	Don't Own land	1,051	23.29%
Business Ownership	Don't Own a business	3,686	71.91%
	Own business	985	21.09%
Farming Participation	Yes	3,967	84.93%
	No	985	15.07%
Choice of Cattle breeds	Traditional breeds	2,636	56.43%
	Improved Beef breed	1,892	40.51%
	Improved Dairy breed	143	3.06%
Level of Schooling	No schooling	2,587	55.38%
	Some primary	492	10.53%
	Completed primary	1,411	30.21%
	Some secondary	17	0.36%
	Completed secondary	116	2.48%
	More than secondary	48	1.03%
Poverty status	Above poverty line	2,221	47.55%
	Below poverty line	2,450	52.45%
Zones in Tanzania	Lake zone	1,358	29.07%
	Western zone	438	9.38%

Central zone	376	8.05%
East Coast zone	400	8.56%
Southern Highland zone	905	19.37%
Northern Highland zone	741	15.86%
Southern zone	453	9.70%

Source: Authors' computation, 2021

The findings in Table 4 explain the distribution of smallholder livestock keepers in different socioeconomic statuses. The majority of smallholder livestock keepers 85.87% are residing in rural areas compared to 14.13% that are residing in urban areas. Livestock is largely characterized by the barbaric system as 76.66% are owned by the male head of households compared to 23.34% of the female head of households. However, the sector is characterized by people who have not attended school making up 55.38% of the entire smallholder livestock keepers.

Traditional cattle breeds are the dominant breeding category owned by the majority of the smallholder livestock keepers in Tanzania comprising 56.43% of the entire cattle while the improved dairy and beef breeds constitute just 3.06% and 40.51% respectively. On the other hand, by zoning these smallholder livestock keepers in Tanzania, the majority are residing in the lake zone (29.07%), Southern Highlands zone (19.37%), Northern Highlands zone (15.86%), Southern zone (9.70%), western zone (9.38%), East coast zone (8.56%) and central zone (8.05%)

Despite traditional breed being dominant in Tanzania yet its distribution is largely in rural areas compared to urban areas of the country. Out of all smallholder livestock keepers in rural areas, 57.09% of their livestock are traditional breeds while the improved composition is 40.06% for the improved beef breeds and 2.85% for the improved dairy breeds. In urban areas, the differences are small whereas traditional breeds are just 52.42% while the improved breeds (dairy and beef) is 47.48%.

Figure 1b shows that the Lake zone, Southern zone and Northern zone are the leading zones in the rearing of both improved beef and traditional breed cattle. The least zones are the East coast and central zone.

The majority of smallholder livestock keepers are fully committed to livestock keeping and this is justified by findings in Figure 1c that only 10.235% of the entire smallholder livestock community are engaging in farming activities while 89.765% are fully committed to livestock keeping alone.

Findings further reveal that large groups of smallholder livestock keepers in Tanzania are characterized by people with no formal education. And this is highly contributed to the fact that the majority of these smallholder livestock keepers are owning large groups of cattle that require much of the family labour hence children from these communities rarely enrolled in schools.

The majority of the smallholder livestock keepers in Tanzania are living below the poverty line meaning that the sector is highly characterized by poverty. However, the trend is increasing with the time that they are moving from a traditional breed with low productivity to highly improved breeds that have higher productivity in terms of milk and meat.

Table 5: Multinomial Logit results on Breeding Choice

VARIABLES	Panel I - Breed Choice	Panel II - Breed Choice
	Traditional breed	Improved Dairy breed
Urban	-0.154** (0.0295)	0.465** (0.1046)
Female	0.0131 (0.107)	0.509** (0.346)
Age	-0.0375 (0.00233)	0.00275 (0.0113)
Own business	-0.141* (0.0792)	0.264** (0.036)
Engage in farming	-0.0507** (0.0197)	0.666** (0.112)
Some primary	0.134** (0.046)	0.288 (0.533)
Completed primary	0.0527 (0.0774)	0.0887 (0.328)
Some secondary	0.00461 (0.516)	0.352 (10,924)
Completed secondary	0.193 (0.212)	-0.445 (0.875)
More than secondary (Higher education)	-0.276* (0.0352)	0.512** (0.298)
Unemployed	0.113 (0.185)	-0.1923** (0.0365)
Never worked	0.0524 (0.133)	0.158 (0.558)
Married	-0.0109 (0.220)	1.231 (4,213)
Percapita	-0.1966** (0.0102)	0.41405*** (0.00112)
Western zone	-0.0215 (0.118)	0.128 (0.591)

Central zone	0.0146 (0.126)	0.361 (0.527)
East coast zone	0.0303 (0.128)	0.648 (0.576)
Southern Highlands zone	-0.0945** (0.0348)	0.0691** (0.0120)
Northern Highlands zone	-0.0948** (0.0861)	0.498*** (0.210)
Southern zone	0.109 (0.121)	0.373 (0.462)
Below Poverty line	-0.108 (0.585)	-0.445** (0.173)
Observations	4,508	4,508
Pseudo R Square	0.3678	0.3678

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Additionally, the improved beef breeds cattle have been herein considered as the base outcome that will be used for the comparison on the available breeding choices. Therefore, results indicate that being in urban areas reduces chances for livestock keepers to adopt the traditional breeds compared to being in rural areas. However, results suggest that being in urban areas increases the chances for the smallholder livestock keepers to choose the improved dairy breeds significantly. Mutenje et al. (2020) and Murage and Ilatsia (2011) had similar findings and emphasized that urban livestock keepers prefer the improved cattle compared to the rural resident smallholder livestock keepers.

Surprisingly, being female head of households have been found to influence the adoption of improved dairy breed cattle significantly. These findings are concurrent to Galie et al. (2019) who uses the WELI techniques (Women Empowerment in Livestock Index) to analyze roles of gender in the livestock sector whereas results showed that when women are empowered they can tend to influence the household decision in rearing improved cattle breeds and having a higher income. On the other hand, Smallholder livestock keepers having to participate in other income-generating activities like business and farming have been found to reduce their preferences on traditional cattle breeds and enhance their preferences on the improved dairy breeds significantly compared to those who are not participating in any other income-generating activities. Moreover, these results are cemented by those of Mausch et al. (2018) and Swanepoel et al. (2010) that pastoralists' income diversification is significant in determining their preferences towards the cattle breeds.

Results further show the greater disparities in education as primary education were found to have a greater influence for smallholder livestock keepers choosing traditional cattle breeds significantly while higher education

had a positive and significant influence on choosing the improved dairy breeds. Due to high costs of improved breeds, the smallholder livestock keeper being unemployed affects choices negatively for the improved dairy breeds but have been found to have a positive relationship with the traditional breeds despite not being significant and this is contributed with the fact that traditional breeds are less costly compared to the improved breeds.

A unit increase in the smallholder livestock keepers percapita income by one Tanzanian shilling reduces the smallholder livestock keepers' preferences on traditional cattle breeds by 19.66% but increases their preferences on the improved dairy breeds by 41.405%. As income increases, the smallholder livestock keepers tend to reduce the stock of their traditional cattle and increase those of improved breeds due to the need for higher productivity and more income. Bayan and Dutta (2017) had similar results and suggested that enhancing income growth among smallholder livestock keepers increases the adoption rate for such society towards improved breeds hence programs related to the shift from low to high production in the sector should take into consideration the income aspect of these groups.

Additionally, results show that smallholder livestock keepers being in the Southern Highlands and Northern highlands zones influence their preferences on the possession of the improved dairy breeds compared to those in the Lake Zone. Nonetheless, smallholder livestock keepers being below the poverty line reduces their power to choose to rear the improved dairy cattle breeds significantly compared to smallholder livestock keepers that are above the poverty line of Tshs. 1,785 in Tanzania or US\$ 1.90 (2011 PPP) per day percapita.

Policy Recommendation

The adoption of improved livestock techniques are necessary in poverty reduction, food security and nutritional improvement not only in Tanzania but also in the entire developing world (Barret et al. 2010). A livestock sector in Tanzania similarly in most of the developing countries is characterized by poverty and low productivity, the adoption of improved cattle breeds can potentially leverage pathways to poverty reduction and enhance food security in several ways. Therefore, this paper has broadened the understanding of smallholder preferences on livestock breeding choices and therefore provides empirical evidence important on the factors affecting smallholder livestock keepers choices towards different breeding categories herein used including traditional breeds, improved dairy and beef breeds.

The findings of this paper suggest that choices of smallholder livestock keepers on the cattle breeding categories significantly depends on residence, national zoning, income diversification (farming and business ownership), education as well as per capita income. Therefore, any initiatives or policies necessary to eradicate poverty and improve productivity among these smallholder livestock keepers should take into consideration these factors that are viable in the Tanzanian context.

This paper will help policymakers in reshaping the existing Tanzania Livestock Master Plan (TLMP - 2011) and the Livestock Sector Development Programme (LSDP - 2018) to include the most important aspects in enhancing sector-specific and livelihood of the smallholder livestock keepers in Tanzania through the establishment of cheap breeding programs that are affordable to a large group of smallholder livestock keepers in different areas of the country to improve their productivity and welfare.

However, the quality and quantity of products (meat, hides and milk) determine the income that will be generated by the smallholder livestock keepers. Therefore, increasing availability of the improved cattle breeds will have impacts in those areas and enhance increased per capita income of smallholder livestock keepers and hence

overcome poverty. Therefore, the use of modern technology in enhancing productivity by widening choices of the smallholder livestock keepers is important in the general welfare of the livestock keepers and increasing national income at large.

[1] 1 US\$ = Tshs 2306

Declarations

- Funding – *Not applicable*
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- Ethics approval – *The study follows all research and academic publication procedural based on the requirements of the journal*
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- Availability of data and material – *Data and all materials will be available upon request*
- Code availability – *Codes and all materials will be available upon request*
- Authors' contribution – *Felician Andrew Kitole, is the only author of the paper who has participates throughout in the preparation of this manuscript from the initiation of the topic, development of the manuscript, analysis and its interpretation.*

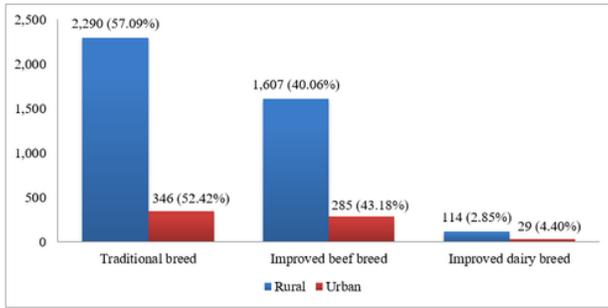
References

1. Baidoo, S. T., Yusif, H., & Anwar, U. (2017). The effect of smallholder livestock production on income of farm households in Northern Ghana. *Journal of Science and Technology (Ghana)*, 36(3), 8–19. <https://doi.org/10.4314/just.v36i3.2>.
2. Barrett, C.B., M.R. Carter and C.P. Timmer .(2010). A Century-Long Perspective on Agricultural Development. *American Journal of Agricultural Economics*, Vol. 92, (2010) pp. 447-468
3. Bayan, Baban and Dutta, Mrinal (2017). Crossbred Cattle Adoption and Its Impact on Income and Household Milk Consumption among Dairy Farmers: Empirical Evidence from Assam. *Indian Journal of Agricultural Economics*. Vol. 72 (2), 154-165 DOI: 10.22004/ag.econ.302255
4. Engida, E., Guthiga, P., & Karugia, J. (2015). The Role of Livestock in the Tanzanian Economy: Policy Analysis Using a Dynamic Computable General Equilibrium Model for Tanzania. *Research in agricultural and applied economics* <https://ageconsearch.umn.edu/record/212039>
5. Galie, A., Teufel, N., Korir, L. et al. (2019). The Women's Empowerment in Livestock Index. *Soc Indic Res* **142**, 799–825. <https://doi.org/10.1007/s11205-018-1934-z>
6. Grace D, Lindahl J, Wanyoike F, Bett B, Randolph T, Rich KM. (2017). Poor livestock keepers: ecosystem – poverty – health interactions. *Phil. Trans. R. Soc. B* 372: 20160166. <http://dx.doi.org/10.1098/rstb.2016.0166>

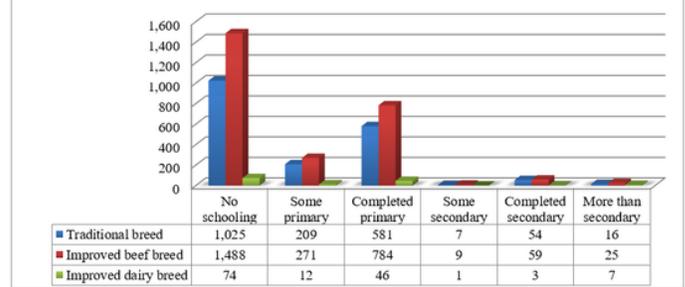
7. Hess, Stephane; Train, Kenneth (2017). Correlation and scale in mixed logit models. *Journal of Choice Modelling*, 23, 1–8. DOI: 10.1016/j.jocm.2017.03.001
8. IFAD. (2016). *Livestock and Pastoralists*. Rome, Italy: International Fund for Agricultural Development.
9. Kabunga, Nassul (2014). Adoption and Impact of Improved Cow Breeds on Household Welfare and Child Nutrition Outcomes: Empirical Evidence from Uganda. *Indian Journal of Agricultural Economics*. DOI: 10.22004/ag.econ.170517
10. Kearney L, White, J . (2016). Animal breeding benefits farmers offer food secure opportunity for mitigating climate change. *Climate Change, Agriculture and Food Security*. Accessed on 26th December 2021 from <https://ccafs.cgiar.org/news/animal-breeding-benefits-farmers-offers-food-secure-opportunity-mitigating-climate-change>
11. Konga, D. (2014). Transformation of smallholders livestock keeping into commercial livestock keeping in Rukwa southwestern Tanzania. Masters thesis. The open university of Tanzania. <http://repository.out.ac.tz/id/eprint/632>
12. Lancaster, K. J. (1966). A New Approach to Consumer Theory. *Journal of Political Economy*, 74(2), 132–157. <http://www.jstor.org/stable/1828835>
13. Marshall, K., Gibson, J. P., Mwai, O., Mwacharo, J. M., Haile, A., Getachew, T., Mrode, R., & Kemp, S. J. (2019). Livestock genomics for developing countries – African examples in practice. *Frontiers in Genetics*, 10, 297. <https://doi.org/10.3389/fgene.2019.00297>
14. Martin-Collado D, Byrne TJ, Diaz C, Amer PR. The complexity of animal breeding choice making. *J Anim Breed Genet*. (2018) 00:1–15. <https://doi.org/10.1111/jbg.12360>
15. Mausch K, Harris D, Heather E, Jones E, Yim J and Hauser M .(2018). Household aspirations for rural development through agriculture. *Outlook on Agriculture* 47, 108–115.
16. Michael, S., Mbwambo, N., Mruttu, H., Dotto, M., Ndomba, C., da Silva, M., Makusaro, F., Nandonde, S., Crispin, J. and Shapiro, B (2018). *Tanzania Livestock Sector Analysis (2016/2017–2031/2032)*. Nairobi, Kenya. ILRI. <https://hdl.handle.net/10568/100527>
17. Mujibi, F. D. N., Rao, J., Agaba, M., Nyambo, D., Cheruiyot, E. K., Kihara, A., Zhang, Y. I., & Mrode, R. (2019). Performance evaluation of highly admixed Tanzanian smallholder dairy cattle using SNP derived kinship matrix. *Frontiers in Genetics*, 10, 375. <https://doi.org/10.3389/fgene.2019.00375>
18. Murage AW and Ilatsia ED (2011). Factors that determine the use of breeding services by smallholder dairy farmers in Central Kenya. *Tropical Animal Health and Production*, 43, 199–207
19. Mutenje, M.U. Chipfupa, W. Mupangwa, I. Nyagumbo, G. Manyawu, I. Chakoma, L. Gwiriri. (2020). Understanding breeding preferences among small-scale cattle producers: implications for livestock improvement programmes, *Animal*, Volume 14, Issue 8, 2020, Pages 1757-1767, ISSN 1751-7311, <https://doi.org/10.1017/S1751731120000592>.
20. Swanepoel F, Stroebel A and Moyo S .(2010). The role of livestock in developing communities: enhancing multifunctionality. The University of the Free State and CTA, Bloemfontein, South Africa
21. Tanzania Livestock Masterplan (TLMP) 2017/2018 – 2021/2022
22. Tavirimirwa B, Mwembe R, Ngulube B, Banana N, Nyamushamba G, Ncube S and Nkomboni D. (2013). Communal cattle production in Zimbabwe: a review. *Livestock Research for Rural Development* Retrieved on 09 April 2018 from <http://www.lrrd.org/lrrd25/12/tavi25217.htm>

Figures

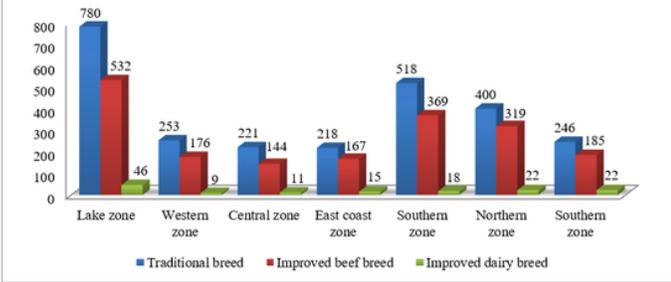
(1a) Residence



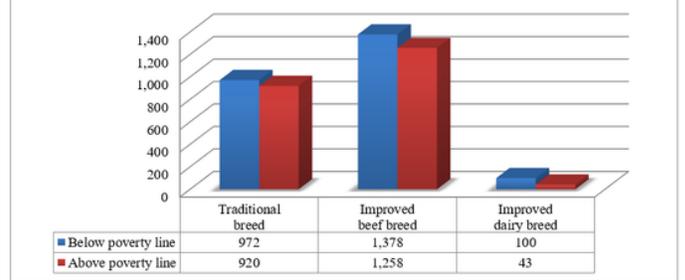
(1d) Level of education



(1b) Zones in Tanzania



(1e) Poverty status



(1c) Farming activities

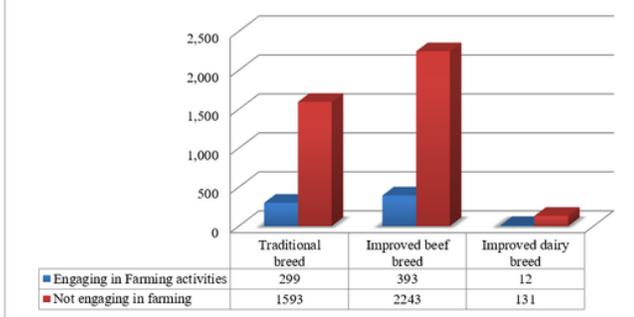


Figure 1

Dispersion of Smallholder Livestock Keepers breeding Choices across different sectors