Ghana Journal of Science, Technology and Development | Vol. 10, Issue 2, March 2025
e-ISSN: 2343-6727
DOI: https://doi.org/10.47881/474.967x

Received: July 6, 2024
Accepted: October 21, 2024

Market Potential of Forage Cultivation in Northern Ghana

Franklin Nantui Mabe[a], Bekele Hundie Kotu[b] and [1]Terry Ansah[c]

[a] Centre for Agricultural Productivity and Policy Studies, University for Development Studies, Tamale, mfnantui@uds.edu.gh
[b] International Institute of Tropical Agriculture, Tamale, B.Kotu@cgiar.org
[c] Faculty of Agriculture, Food and Consumer Sciences, University for Development Studies, Tamale, tansah@uds.edu.gh

ABSTRACT

Livestock farmers and traders in the Northern region of Ghana have challenges in getting quality and enough feed. These stem from the long dry season characterized by bushfires, monomodal rainy season, rapid residential development in peri-urban areas and usage of few opened spaces between houses for gardening. This study assessed willingness to pay for cultivated forage in Ghana by using cross-sectional data and a double-bounded dichotomous choice contingent valuation method. The factors influencing the willingness to pay bids were analysed using an interval regression model. The study revealed that 93.6% of the respondents were willing to pay for cultivated forage. The average willingness to pay amount for Pigeon pea is relatively higher than that of Napier grass. Livestock farmers had a relatively higher willingness to pay amount than their counterpart livestock traders. From the study, having a bank account, access to veterinary services, satisfaction with the livestock business, training on livestock production or marketing and the value of livestock owned increase the willingness to pay probability. The study, therefore, recommends that unlike livestock farmers, the traders should be sensitized more about the nutritive value of forage so as to raise their willingness to pay for forage. Since there are market potentials for cultivated forage, rural folks especially those in peri-urban areas should take forage cultivation as a commercial activity. Forage production should be included as a package in the rearing for food and jobs programme that the government is implementing so as to create jobs for the youth.

Keywords: Forage, willingness to pay, interval regression, livestock

INTRODUCTION

The livestock sub-sector is an important component of agriculture in Ghana. Prominent among the numerous contributions the livestock sub-sector makes to the economy of Ghana is that; it provides animal protein to humans, serves as food to enhance the food security of the country, and provides income for farmers and traders. Smallholder farmers are engaged in the production of livestock, especially small ruminants, as a critical risk-coping strategy (Adams et al., 2021). The contribution of the livestock subsector to the agricultural GDP has been increasing gradually as its recorded 5.7%, 6.0% and 6.2% in 2014, 2015 and 2016 respectively (MoFA, 2017). It is the only subsector that has enjoyed a positive growth rate for the past decade spanning from 2007 to 2016 (MoFA, 2017). The livestock sub-sector

recorded the highest growth rate of 5.5% in 2022 among the other subsectors of the agricultural sector (Ministry of Finance [MoF], 2023).

Whilst some households engage in livestock production or marketing as their primary source of occupation, others engage in it as a complementary occupation, to help create additional income sources. The general implication is that the livestock value chain is critical to the economy of Ghana and hence needs to be supported by the stakeholder agencies. The importance of livestock is clearly articulated in most Ministry of Food and Agriculture (MoFA) documents. The Rearing for Food and Jobs programme which is currently being implemented by MoFA has the objective of increasing the production of selected livestock. Also, National Medium Term Development Plan Framework has seven policy objectives of which MoFA consider the one that talks about the promotion of livestock and poultry development for food security and income generation very relevant to the economy of Ghana (MoFA, 2019).

Aside from the important role the livestock subsector of agriculture plays, there are challenges affecting its growth and transformation. Among them are poor husbandry practices and handling of livestock and poultry products, inadequate quality feed and water standards for livestock and poultry, and lack of modern housing for livestock and poultry production (MoFA, 2018). The unavailability of quality feed in the country affects the productivity of the livestock, especially during the dry season when all the grasses get dried. Sometimes, feed is an issue in some communities during wet seasons as well. Due to the cultivation of crops at homesteads or backyards in some communities, green grass available to animals is cleared for farming forcing producers to walk far away to look for forage. To prevent the livestock from destroying the crops, animals are tethered thereby compelling farmers to search for feed or use stored feed if available (Awuma, 2012). This is not uncommon in Northern Ghana where the rainy season is very short.

The major feed resources used in the Northern region are natural pastures and crop residues, with agro-industrial by-products contributing much less (MoFA, 2011; Amankwah et al., 2012; Oppong-Anane, 2010). The declining availability of natural pasture especially in peri-urban areas due to the expansion of residential infrastructure has put more pressure on the peri-urban livestock farmers to explore other sources of feed for their animals. Unlike the southern part of Ghana, Northern Ghana has a prolonged dry season making it difficult for both livestock farmers and traders to get quality fresh feed for the animals. The livestock traders sometimes rely on crop residue and grains of cereals to feed the animals. Meanwhile, forage can be one of the best alternatives. The good thing about forage is that it contains all the necessary nutrients for the proper growth of livestock.

As noted by Kumar et al (2017), the principal challenges facing agriculture in the coming decades will be how to produce enough food and forage to feed the emergent soaring global population and livestock respectively. The goods and services that rangelands provide are enormous. It is important to note that the relevance of rangeland is now pronounced as global population growth and urbanization are threatening their existence (Maczko, et al. 2011). Whilst, Latin America and the Caribbean is the leading in cultivated forage crops, Sub Sahara Africa is lacking behind in the cultivation of forage for livestock (Fugile et al., 2021). In most African countries including Ghana, natural pasture or rangelands are the main sources of forage for livestock especially the ruminants. As noted by Kauffman and Pyke (2001; Chap. 1), this rangeland is land with grasses and grasslike forbs or shrubs

as the native vegetation. Globally, 54% of the ecosystems on land are made up of rangeland (Reynolds et al. 2007; Estell et al. 2012). As part of the ecosystem, they have a provisioning function (food and fibre, wood, clean water, medicinal purposes), regulatory function (climate regulation, pollination of crops, storing of carbon, control flooding) and cultural function (inspiration, recreation, education, aesthetic) (MA, 2005). With provisioning function, forages on the natural rangeland or pasture are the source of feed for ruminants in Ghana. This is based on the kind of systems of animal rearing. In Ghana, especially the five northern regions, small and large ruminants are kept under the extensive system or the free-range system. Under this system, the animals are left to search for feed on their own. This poses several challenges.

One of the toning issues in an extensive system of rearing livestock is how to get quality feed for the animals. The rapid conversion of agricultural land to urban residential development is reducing grazing areas that used to be available for ruminants. This, according to Opong-Anane (2013), has caused an upsurge in the demand for livestock feeds to meet the feed need of the growing number of animals in urban and peri-urban areas of northern Ghana. As alluded to by Konlan et al. (2015), natural pasture is fast declining in urban areas due to the expansion of infrastructure thereby pressurizing urban livestock farmers to explore other sources of feed. The declining size of land for natural pasture is an important reason to seek alternative sources of livestock feed. Also, there are concerns about the quality of natural pasture. The nutrient such as crude protein contains in basal feeds (natural pasture, dry grass, straws and cereal crop stovers) are low in northern Ghana, particularly in the dry season (Innovation Laboratory for Small Scale Irrigation [ILSSI], 2017). As noted by Partey et al. (2018), the nutritive value of available pasture species is usually poor with low levels of crude protein.

With the above challenges, livestock farmers need alternative means of getting forage to feed the animals as some of the nutrients in the forage are not available in the grains or legumes use as feed. Aside from urbanization, the cultivation of crops around homesteads during the wet season is a common practice in northern Ghana. The few open spaces where grasses grow naturally for animals to feed on are often used for the cultivation of crops. This has been identified by Awuma (2012) as a constraint to accessing forage for livestock production in some communities hence the need to stall-feed for the animals. Backyard farming in most urban and peri-urban communities in the Northern Region of Ghana compels livestock farmers and traders to travel long distances to access natural forage.

Moreover, forage of fair nutritive value is usually scarce in the dry season due to prolonged drought, continuous overgrazing and lack of range improvement intervention (Konlan et al., 2016). As a result, highly palatable and productive perennial grasses, legumes and herbs species have been replaced by unpalatable, low-quality annual species with a drastic loss of soil fertility (Estell et al., 2014). Whilst the wet season is better, the quality of natural pasture available for ruminants is impaired during the dry season.

It has also been observed in Ghana that policy regimes over the years have supported the production of crops more than the rearing of animals. There are input subsidies for the production of crops. Apart from the limited supply of improved breeds of some selected livestock, it is difficult to identify policies or programmes aimed at managing the forage for livestock feeding and productivity improvement. This observation is better put by Konlan et al. (2015) that the policies favouring crop production over the maintenance of pasture

are gradually reducing the area of land available for grazing livestock.

The unavailability of feed is worrying since there has been an increased purchase of young market-oriented livestock, fattening them for sale. It has been established that the high demand for livestock feed by ruminant traders has motivated feed sellers to harvest naturally occurring browses and crop residues and gather agro-industrial by-products for sale (Husseini et al., 2011). During forage scarcity periods, livestock is fed on crop residues and low-quality rangeland hay. A study by Duguma et al. (2021) in Ethiopia observed that crop residues have low nutritive value due to the kind of methods of storage. Cultivated forage is one of the surest ways to deal with the unavailability of sustainable quality feed for livestock producers and traders. Meanwhile, whether or not there is a demand for cultivated forage in Ghana needs to be unraveled important to note that, the high demand for livestock feed and the positive benefit of forage cultivation are just necessary conditions. They are not sufficient conditions for one to conclude that livestock farmers or traders will be willing and able to pay for cultivated forage. It is important to know whether or not livestock producers and traders are willing and able to pay for quality forage and whether or not forage production can improve the incomes of smallholder farmers. Therefore, the general objective of the study is to assess the market potential of forage cultivation in the Northern Region of Ghana.

This study is expected to provide information for policymakers and duty bearers to incorporate forage production and range management as sustainable feed for small and large ruminants as well as an alternative livelihood for smallholder farmers. The study provides credible information to the scanty literature on the market potential of forage production in Ghana. Methodologically, the double-bounded contingent valuation approach was adopted to elicit the biding of WTP due to its ability to provide more efficient asymptotical estimates compared to the conventional single-bounded contingent valuation (Ahmed et al., 2015). Also, the study employed interval regression to analyse the determinants of livestock farmers and traders WTP due to its ability to handle interval outcome data that may be left-censored or right-censored or completely censored.

METHODOLOGY

Study area

The study was conducted in the Northern Region of Ghana. The vegetation in the region is Guinea Savanah which is suitable for agricultural production. Majority of the people in the region are farmers. Until it was divided, the region had the highest number of households (604,228) rearing livestock (GSS, 2019). Out of a total number of 31,427,025 livestock reared in Ghana, 5,422,364 representing 17.3% are from the former Northern Region making it the largest producing region in the country (GSS, 2019).

Sampling Procedure and sample size

The study used multistage sampling techniques in selecting the respondents. For the study districts, Tolon, Kumbungu, Nanton and Savelugu were purposively selected because they were already the study districts of the Africa RISING project in the Northern Region of Ghana. Tamale Metropolis was also purposively included because of its urbanized status as well as being the only metropolis within Northern Region with a regional livestock market status. Also, this was used to enable us to get livestock traders who are willing to buy cultivated forage. Also, farmers engaged by the African RISING project to produce forage were from Savelugu Municipality and hence needed to be included purposefully.

For the second stage, the communities where livestock farmers were interviewed

were purposively sampled based on their inclusion in the Africa RISING project. The purposive selection of livestock markets and meat-selling suburbs or markets were based on the fact that they have the information required to be able to assess the market potential of forage. Also, they are major markets or meet selling points in the study area.

The livestock farmers and traders were then grouped into two strata using a stratified sampling technique. The livestock farmers were randomly selected from the list of farmers who participated in the Ghana Africa RISING Baseline Evaluation Survey. This involved a stratified two-stage random sampling strategy. As explained by Tinonin et al. (2016), in the first stage, communities were randomly selected and this was followed by the second stage which involved the random selection of 20 households in each of the selected communities who participated in the Africa RISING project. Livestock traders were selected using a simple random sampling technique. With the help of the sample determination formula by Yemane (1967), 37298 livestock holding population in Northern Region, and 7% margin of error, a sample size of size 203 is considered statistically significant for this study. Therefore, data was collected from sample size of 236 livestock farmers and traders. This comprises 87 livestock traders and 149 livestock farmers.

Data Sources and Instrumentation

The study used primary data obtained from livestock farmers and traders. The data was collected with the aid of semi-structured questionnaires focusing on willingness to pay for forage. The questionnaires have both closed-ended and open-ended questions. The questionnaire contained socio-demographic characteristics, types of livestock, types of feed for livestock, willingness to pay, and personal, institutional and policy factors affecting livestock production and marketing. In collecting the data, face-to-face interviews were conducted. This was done electronically. The enumeration was done by enumerators who were recruited temporarily. The minimum qualification for the enumerators was a first degree in social science or agriculture or related field and their ability to speak the local language thus Dagbani.

The questionnaires were pre-tested and corrections were made on questions that are not clear or improperly captured. Also, the pre-testing helped the enumerators to understand and get familiar with the questions in the questionnaires. The data was collected in July and August 2021.

Frequency distribution of respondents in the study districts

Figure 1 is a 3-D multiple-column chart depicting the frequency distribution of livestock farmers and traders in the study districts. Livestock farmers were selected from all five districts except Tamale Metropolitan Assembly. This is because the area was not part of the African Rising District. The Metropolis host the regional capital city called Tamale with few farmers. The livestock farming activities are not so much pronounced as compared to other districts because of their urbanised nature. On the other hand, livestock traders were not selected from Kumbungu and Nanton Districts. These two districts do not have prominent livestock markets as compared to Savelugu Municipality, Tamale Metropolis and Tolon District. Savelugu Municipality, Tamale Metropolis and Tolon District have Savelugu, Kpatinga and Aboabo livestock markets respectively. Livestock traders, butchers, restaurant operators and final consumers from the study districts, the region and sometimes outside the districts and the region come all over to purchase livestock from these prominent markets. According to DAI (2014), the livestock marketing system involves itinerant traders, middlemen (such as livestock agents, transporters and aggregators) and butchers. It is also noted by DAI (2014) that there are two livestock

marketing systems and they are within the local northern market and in the north-south marketing systems.

Out of 236 respondents, 63.1% were livestock farmers with the remaining 36.9% being traders. The traders here include the middlemen and the butchers. Out of the 149 livestock farmers, Figure 1 shows that 43.6% came from the Savelugu Municipality. This municipality recorded the highest numbers of livestock farmers followed by Tolon district with 30.9% of the livestock farmers. The lowest percentage (8.1%) of livestock farmers interviewed were from the Nanton District. For the traders, as much as 50.6% of the respondents came from Tamale Metropolis. Whilst Tamale Metropolis recorded the highest percentage of livestock traders, the district with the least traders is Tolon as it recorded 14.9% respondents. The remaining 34.5% of the livestock traders came from the Savelugu Districts. The distribution of the respondents shows how significant livestock markets are in the various districts. The Tamale livestock market is regarded as a regional market with people coming from different parts of the country to buy live livestock or their carcass. It is a bigger market than that of Savelugu and Kpatinga in the Tolon districts. A study by Kassoh et al. (2017) identified the Tamale market as one of the major sources of livestock for traders in Ghana. Also, the Savelugu livestock market is the second most highly patronized because of the strategic location of the Municipality. It is located along the Tamale-Bolgatanga highway. The traffic on the road is high as people from the neighbouring Burkina Faso and Niger pass through to Accra and vice versa.

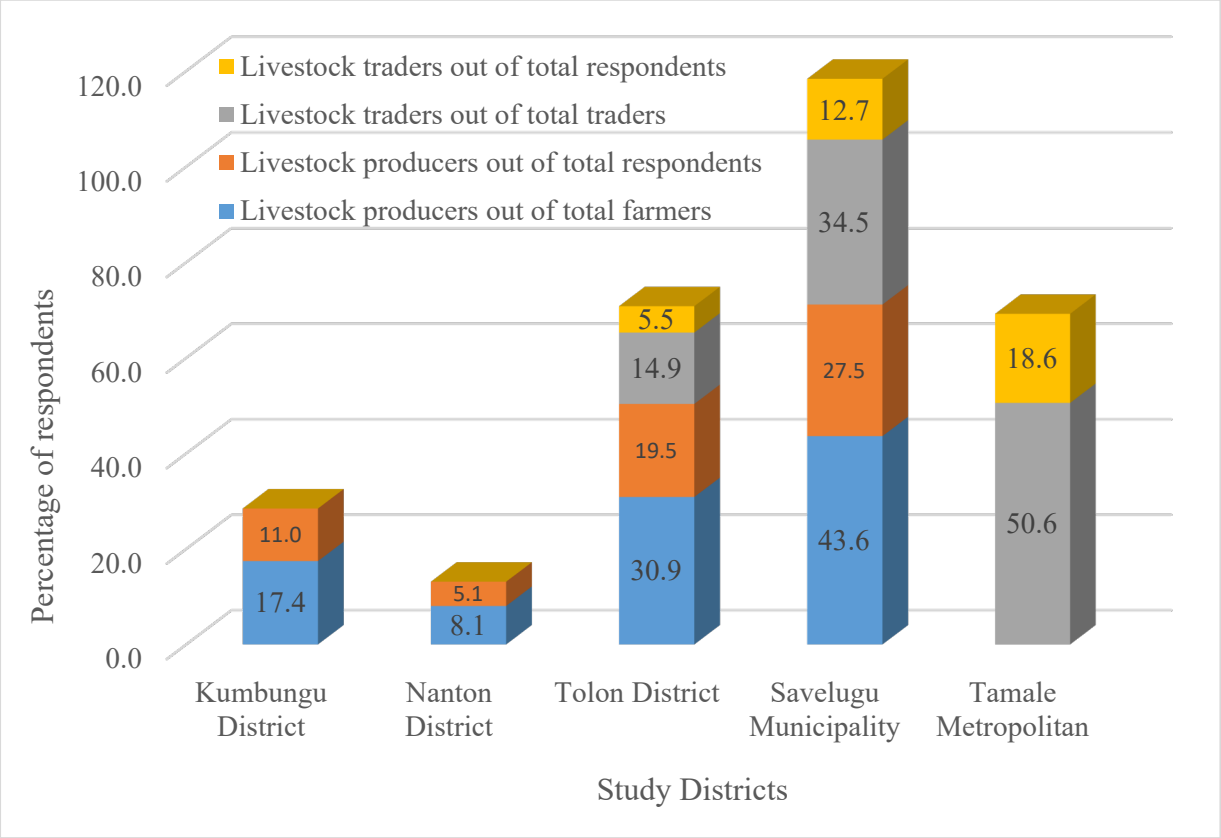


Figure 1 Percentage distribution of livestock farmers and traders in the study districts

METHODS OF DATA ANALYSIS

Estimating the Value of Forage

Forage has both use and non-use values which form the total economic value. Whilst the revealed preference approach is used to estimate the use values, the stated preference approach is used to estimate the non-use values. The use-value is the value obtained from the direct and current use of the resource. The benefit or value that livestock farmers and traders obtain from using forage to feed their animals is current and direct. However, the non-availability of cultivated forage (which has more nutritive value) in the market today calls for the use of a hypothetical market. Conceptualizing a hypothetical market to estimate the value of forage in this study falls under the contingent valuation method which is used to elicit willingness to pay for more improved and nutritive forage as compared to the conventional feed.

Theory for measuring willingness to pay

Willingness to pay (WTP) can be estimated using the contingent valuation method or the surrogate method. Since the nutritive value component of the forage is not currently available in the market, it likens the forage to non-use value and hence the use of CVM to elicit WTP. The original proponent of CVM in 1947 is Siegfried von Ciriacy-Wantrup, a German Environmental and Resource Economist. Its practical usage can be traced to Davis (1963), in a study that estimated the value that hunters and tourists place on marine wood.

The theory of consumer behaviour and the random utility maximization theory better explain the rationale behind CVM which uses WTP. The theory explains that a rational decision-maker or individual will be willing to pay a certain amount of money to be able to obtain or use an economic good if and only if the utility or satisfaction that the person will derive is higher than the utility without the good. Meanwhile, the utility cannot easily be observed and hence the use of an indirect utility function to derive WTP is much more practical. It is assumed that the livestock farmers and traders have two options of feed to purchase for the animals. These are improved and highly nutritive cultivated forage (Fa) which is made up of either Napier grass or Pigeon pea and the other kinds of feeds (Fo). A rational livestock farmer or trader is expected to choose *Fa* if only the benefit of *Fa* minus the benefit of *Fo* is greater than zero. As adapted from Liu *et al*. (2009), given the prices of feeds and income of the farmers and traders, the net indirect utility function is given as:

$$V^* = V_a(P_a, Y, Z) - V_o(P_o, Y, Z) > 0$$
$$V^* = V_a(P_a, Y, Z) - V_o(P_a - w, Y, Z) > 0$$

Where
V_a is the indirect utility derived from cultivated forage, V_o is the utility derived from other feed, P_a price of cultivated forage, P_o price of other feed, Y is the income of livestock producers or traders, Z is a vector of socioeconomics and policy variables, and w is the amount respondents are willing to pay for forage.
As a decision-maker, one compares the marginal willingness to pay with the price of the cultivated forage and increases (decreases) the demand for the forage if the marginal willingness to pay exceeds (is below) the price.

Conceptualization of a hypothetical market and the WTP elicitation methods

Since cultivated forage with more nutritive value is not readily available in the market for sale, a hypothetical market was conceptualised as described below.

Forage for this study refers to dried hay or straw or fresh edible parts of grass or crops for feeding livestock such as cattle, sheep and goats. During the dry season, it is very difficult for livestock producers and traders to get enough quality feed for their animals. Also, in the wet season, access to fodder from rangeland is often limited due to the

extensive cultivation of food crops. Additionally, the fresh grasses from natural pastures or straws of crops that animals feed on during the wet season do not contain the necessary nutrient. Sometimes, the livestock feed on some insects that are attached to these grasses or straws which have harmful effects on their health. An organisation producing fodder that contains all the necessary nutrients for the proper growth of your livestock. The fodder is available all year round. As a livestock farmer or trader desirous of getting quality feed for your animals, how will you assess your readiness to be one of the customers of this organisation?

With the contingent valuation approach, there are the open-ended elicitation approach (continuous method) and the closed-ended elicitation approach (discrete choice method). The closed-ended elicitation approach is made up of single bounded dichotomous choice and the double-bounded dichotomous choice contingent valuation methods which were developed by Hanemann et al. (1984) and Hanemann et al. (1991) respectively. The open-ended elicitation approach characterised unrealistically large or small bids. It is against this backdrop that the National Oceanic and Atmospheric Administration (NOAA) panel recommended the dichotomous choice approach for eliciting WTP for non-market goods and added some guiding principles (Arrow et al., 1993). As noted by Hanemann et al. (1991), the double-bounded contingent valuation approach provides more efficient asymptotical estimates than the conventional single-bounded contingent valuation method. Therefore, the double-bounded dichotomous choice contingent valuation method was used in this study and the elicitation procedure is described below.

To elicit the bidding, a recognizance survey was conducted to come out with a realistic market price for forage. This was done to deal with the starting point bias characterized by the double-bounded contingent valuation method. The average realistic price obtained was Gh¢30.00 per 100 kg of forage. This realistic price was used as the basis for initial WTP bids. The initial price bid was randomly assigned to livestock traders and farmers as shown in Table 1. Each initial bid is associated with a unique follow-up bid for both "Yes" and "No" responses. Assuming a Y* is the initial bid presented to a livestock farmer or trader, he or she is asked "Are you willing to pay Y* for a 100 kg bag of forage?" If the respondent responded Yes", he or she is asked a second follow-up question "Are you willing to pay 50% lower of Y* for a 100 kg bag of forage?" On the other hand, a "Yes" response to the initial question is followed with "Are you willing to pay 50% higher of Y* for a 100 kg bag of forage?". Figure 2 shows the initial bids, the questions and the responses. The bids are then as arranged as "No-No", "No-Yes", "Yes-No" and "Yes-Yes" with ordering scores of 0, 1, 2 and 3 respectively.

Table 1: Initial and follow-up bids

Initial willingness to pay bid (Gh¢)	Willingness to pay bid with "No" response (Gh¢)	Willingness to pay bid with a "Yes" response (Gh¢)
20	10	40
25	12.5	50
30	15	60
35	17.5	70
40	20	80

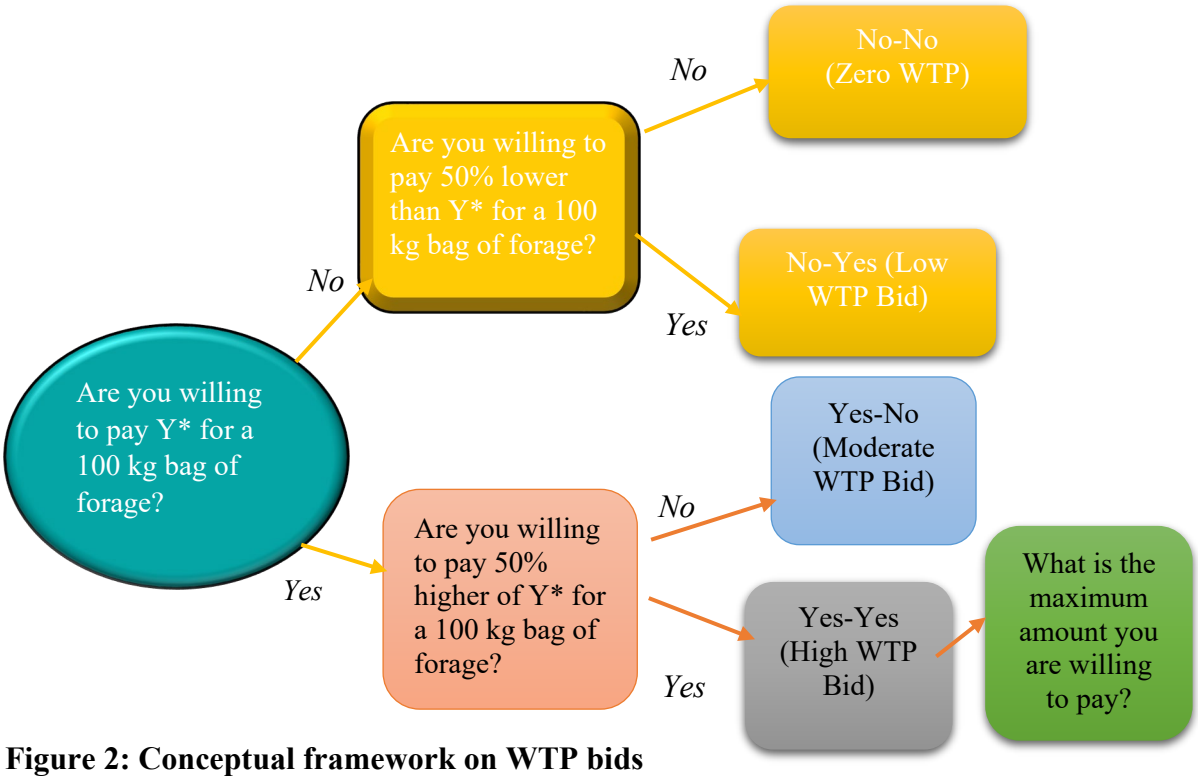


Figure 2: Conceptual framework on WTP bids

Source: Authors' conceptualization

Econometric modelling of the determinants of WTP

Modelling the determinants of WTP which is elicitation using a double-bounded contingent valuation method requires the use of appropriate econometric models. As noted by Kpade et al. (2015), data from the double-bounded contingent valuation method as in the current study can be organized as left-censored for No-No responses, right-censored for Yes-Yes responses, and interval-censored for No-Yes or Yes-No responses given by livestock farmers and traders. Considering the left-censored response (lower bound) and the right-censored response (upper bound), Cawley (2008) contends that interval regression model can be used to assess the factors influencing WTP. The WTP bid, Y^* by i^{th} respondent is related to a vector of X socioeconomic factors using the equation:

$$Y_i^* = X_i\beta + \varepsilon_i,\ \varepsilon_i \sim N(0, \delta^2) \quad (1)$$

Where X_i is the vector of explanatory variables that are expected to influence WTP bid for cultivated forage, Y_i^* is the latent WTP bid, β is a vector of the parameters to be estimated. In the current study, empirical socioeconomic factors which are expected to influence the WTP bids are age (years), occupation (1=traders, 0=farmers), household size, education (years), total livestock value (Gh¢), satisfied with livestock business (5=strongly agree; 4=agree, 3=indifferent, 2= disagree, 1=strongly disagree), cultivated forage has fewer impurities (5=strongly agree; 4=agree, 3=indifferent, 2= disagree, 1=strongly disagree), member of livestock farming or trading group (1=yes, 0=no), trained on livestock production or marketing (1=yes, 0=no), have access to veterinary services (1=yes, 0=no) and have a bank account (1=yes, 0=no).

Following Hanemann et al. (1991), WTP bid Y_i^* is unobservable but rather it is in the interval of the upper bound (WTP^L) and the lower bound (WTP^U) contingent on the successive responses to the double-bounded elicitation questions. As stated by Kpade et al. (2015), the probability of Yes-No, No-Yes, Yes-Yes and No-No responses can be respectively stated as equations 2, 3, 4 and 5 below:

$$P(WTP_i^I < maxWTP \leq WTP_i^U) \quad (2)$$

$$P(WTP_i^I > maxWTP \geq WTP_i^U) \quad (3)$$

$$P(WTP_i^I \leq maxWTP \; and \; WTP_i^U \leq maxWTP) \quad (4)$$

$$P(WTP_i^I > maxWTP \; and \; WTP_i^L > maxWTP) \quad (5)$$

Using, the maximum likelihood estimator, an interval regression model was estimated to determine the probability that the unobserved WTP for forage lies between the lower and upper WTP whilst the post-estimation command in STATA is used to predict the average WTP. The average WTP for forage is given as:

$$E(WTP) = X'\hat{\beta} \quad (6)$$

The assumptions under interval estimation are that the error term is normally distributed and the valuation functions for both initial and follow-up bids are identical. To deal with Cameron and Quiggin's (1994) assertion that if the responses to the initial bid price are biased, the identical valuation functions assumption will fail, the initial bids were randomly assigned to the respondents.

RESULTS AND DISCUSSIONS

Distribution of respondents by initial and follow-up bids

The distribution of respondents by initial and follow-up bids for 100 kg each of Napier grass and Pigeon pea is shown in Table 2. This section describes how the respondents are distributed by the bids presented to them.

Napier grass

According to the results in Table 2, out of 47 respondents who were randomly presented with an initial WTP bid of Gh¢20.00, 29.8% were not willing to pay that amount for a 100 kg bag of Napier grass. The remaining 33 respondents representing 70.2%, on the other hand, were willing to pay the Gh¢20.00 initial bid for Napier grass. A follow-up higher bid of Gh¢40.00 was then presented to the 33 respondents who said yes to the initial bid, and 16 of them representing 48.5%, were willing to pay. The remaining 17 respondents were not willing to pay a higher bid of Gh¢40.00. Further, out of the 14 respondents who were unwilling to pay the initial bid of Gh¢20.00, a lower bid of Gh¢10.00 was presented to them and 35.7% were willing to pay the said bid for Napier grass.

In addition, 47 respondents were initially presented with an opening bid of Gh¢25.00 to see whether or not they were willing to pay for 100kg of Napier grass. A good number (39 people) representing 83.0% were willing to pay for the first bid of Gh¢25.00. The 39 respondents who said yes to the initial bid of Gh¢25.00 were then asked if they would pay Gh¢50.00 for the same quantity of Napier grass and only 38.5% affirmed this WTP bid. Out of the 8 respondents who were unwilling to pay an initial bid of Gh¢25.00, 4 representing 50% were ready to pay half the initial bid of Gh¢25.00 to acquire Napier grass.

An initial bid of Gh¢30 was presented to 48 respondents, and as much as 79.2% responded in affirmative to this WTP bid. Respondents who were willing to pay the original bid were provided with a second higher follow-up bid of Gh¢60.00. and 15 representing 39.5% were still willing to pay this higher bid for the quantity of Napier

grass. A second lesser bid of Gh¢15.00 was also presented to those who were unwilling to pay the first bid of Gh¢25.00 but with 40% agreed to pay the Gh¢15.00.

Also, out of 47 respondents who were randomly presented with Gh¢35.00 initial bid, 11 representing 76.6% were willing to pay whilst 23.4% indicated that they are not ready to purchase 100Kg bag of Napier grass at such an amount. Respondents who were willing to pay the original bid were given a second higher follow-up bid of Gh¢70.00, and 44.4 % were ready to buy the forage. Meanwhile, those who were unwilling to pay the initial bid were given a second, lower bid of Gh¢17.5.00, which 63.6 % agreed to pay.

Furthermore, 47 respondents were offered a starting bid of Gh¢40.00 to assess the WTP behaviour. Nearly half of the respondents (42.6 %) said they would not pay such an amount for Napier grass, whilst the rest were okay with the amount. When those willing to pay were offered a higher bid of Gh¢80.00, 25.9% stated they would pay. When respondents who were unwilling to pay the original price of Gh¢40.00 were asked if they would pay half that amount (Gh¢20.00), 55% said yes, while the remaining 45% said no.

As shown in Table 2, when the bid price of the Napier grass forage increases to Gh¢80.00, the WTP for the forage will decrease. This is premised on the fact that as the price increases from Gh¢40.00 to Gh¢80%, the proportion of respondents willing to buy the forage decreases.

Pigeon pea

As shown in Table 2, 83.0% of the 47 respondents are willing to pay Gh¢20.00 initial bid to purchase 100Kg bag of Pigeon pea. This means more than three-quarters of the respondents are ready to pay a randomly assigned initial bid of Gh¢20.00 for a 100kg bag of Pigeon pea suggesting a potential market for the forage. When the 39 respondents were presented with the 50% increase of the initial bid, 64.1% were willing to pay that Gh¢40.00 higher follow-up bid to acquire 100 kg of Pigeon pea. Furthermore, respondents who were unwilling to pay the original bid were provided with a lower bid of Gh¢10.00, and out of the 8, 2 representing 20% were prepared to pay the lesser bid.

Table 2: Distribution of respondents by initial and follow-up bid for Napier grass

WTP bids (Gh¢)				No initial bidders		Yes initial bidders		Follow-up bid for yes initial bidders		Follow-up bid for no initial bidders	
Initial bids	Follow up higher bids for yes bidders	Follow up lower bids for no bidders	N	Freq	Per	Freq	Per	Freq	Per	Freq	Per
Napier grass											
20.00	40.00	10.00	47	14	29.8	33	70.2	16	48.5	5	35.7
25.00	50.00	12.50	47	8	17.0	39	83.0	15	38.5	4	50.0
30.00	60.00	15.00	48	10	20.8	38	79.2	15	39.5	4	40.0
35.00	70.00	17.50	47	11	23.4	36	76.6	16	44.4	7	63.6
40.00	80.00	20.00	47	20	42.6	27	57.4	7	25.9	11	55.0
Pigeon pea											
20.00	40.00	10.00	47	8	17.0	39	83.0	25	64.1	2	25.0

25.00	50.00	12.50	47	3	6.4	44	93.6	17	38.6	2	66.7
30.00	60.00	15.00	48	8	16.7	40	83.3	19	47.5	4	50.0
35.00	70.00	17.50	47	9	19.1	38	80.9	18	47.4	5	55.6
40.00	80.00	20.00	47	17	36.2	30	63.8	8	26.7	11	64.7

An initial offer of Gh¢25.00 was further presented to 47 respondents. Out of this, 93.6% were willing to pay that Gh¢25.00 initial bid for the forage with only 3 representing 6.4% not willing to pay. Respondents who agreed to pay the first bid of Gh¢25.00 were given a second higher follow-up bid of Gh¢50.00, and 17 only 38.6% said they would pay. For those unwilling to pay the first Gh¢25.00 initial bid, 66.7% were willing to pay half (Gh¢12.5.00) of the initial amount for the 100 kg Pigeon pea forage.

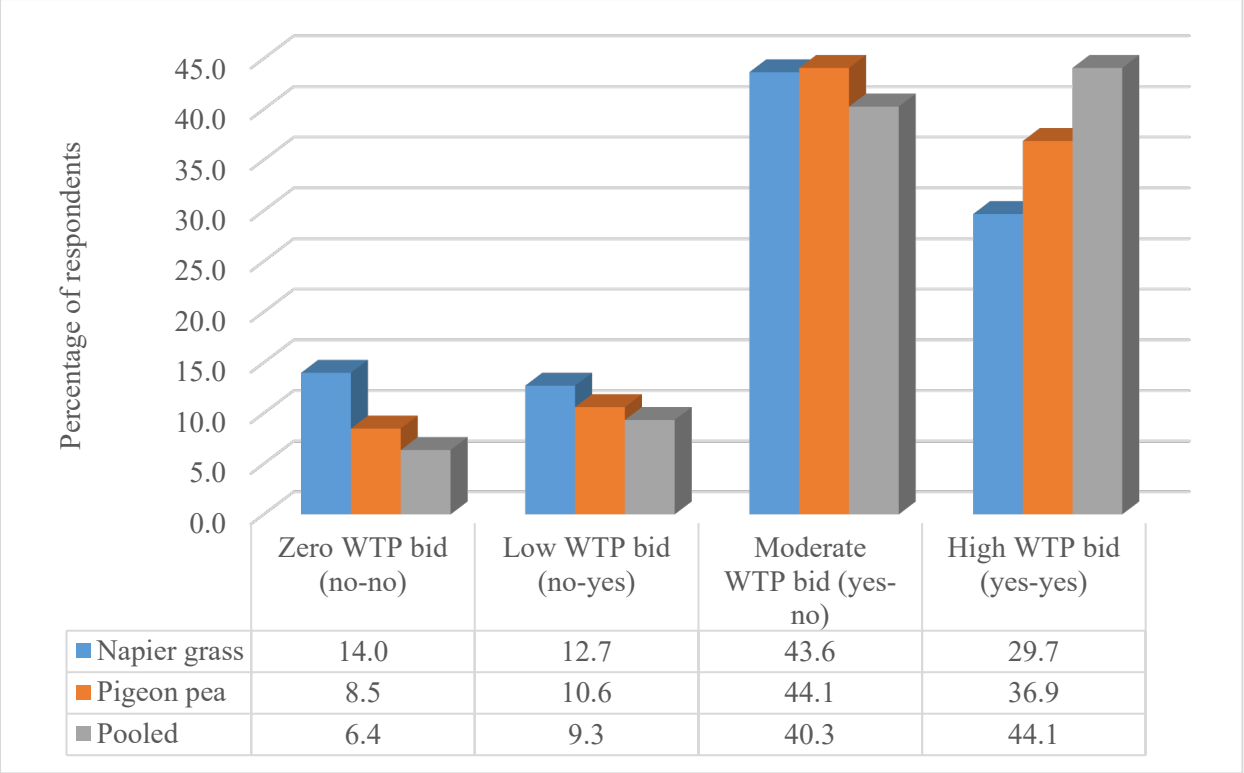
Out of 48 respondents, whilst 83.3% were willing to pay an initial bid of Gh¢30.00 for 100 kg of Pigeon pea forage, the remaining 16.7% responded no to the affirmative willingness to pay question. Of those who were willing to pay Gh¢30.00, 19 representing 47.5% were willing to pay a second higher bid of Gh¢60.00 to have access to the 100Kg Pigeon pea forage. When the initial bid of Gh¢30.00 was halved to Gh¢15.00 for those who were not willing to pay the Gh¢30.00, 50% accepted the offer.

For Gh¢35.00 initial bid, 80.9% out of 47 respondents were willing to pay whilst 19.1% were not. Of the 9 who were not willing to pay, 5 representing 55.6% were ready to pay Gh¢17.5 for the 100 kg of the Pigeon pea forage. Similarly, of 17 respondents who did not agree to pay the initial bid of Gh¢40.00, 11 representing 64.7% agreed that they are ready to offer Gh¢20.00 for the 100 kg forage of Pigeon pea.

It is clear from Table 2 that as the initial and follow-up bids for yes response increase, the percentage of respondents willing to pay for Pigeon pea forage decreases. Based on this revelation, the suppliers of Pigeon pea forage need to be careful in setting the price for the forage. When the price increases beyond a certain equilibrium level, the demand for the forage will fall.

Distribution of WTP bids

Figure 2 illustrates the distribution of WTP bids. As shown in the figure, the majority of the respondent was willing to pay the initial bid but not the subsequent higher bids. For instance, 43.6% of the respondents were willing to pay the initial bids to acquire Napier grass but not ready to pay for the subsequent higher bids. This percentage is almost half of the respondents. For other bids such as the No-No WTP bid, No-Yes WTP bid and Yes-Yes WTP bid, the recorded percentages of respondents for Napier grass are 14.0%, 12.7% and 29.7% respectively. The patterns of distribution for Pigeon pea and pooled data are similar to that of Napier grass. The Yes-Yes WTP bid recorded the highest percentage of respondents for pooled data and this is followed by the Yes-No WTP bid. Whilst 44.1% of the respondents are willing to pay for the initial, and the two successive higher follow-up bids for the pooled data, 6.4% are not willing to pay for initial bids. In a nutshell, most of the livestock producers and traders interviewed have moderate WTP bids for the two forage types.



	Zero WTP bid (no-no)	Low WTP bid (no-yes)	Moderate WTP bid (yes-no)	High WTP bid (yes-yes)
Napier grass	14.0	12.7	43.6	29.7
Pigeon pea	8.5	10.6	44.1	36.9
Pooled	6.4	9.3	40.3	44.1

Figure 2: Distribution of WTP bid scores

Difference in variables between WTP and non-WTP bidders

Table 3 presents inferential statistics which test the significant differences in variables between WTP and non-WTP bidders. The WTP bidders are livestock farmers and traders who accepted to pay at least Gh¢10.00 for 100 kg of forage. The non-WTP bidders are those who were not willing to pay just Gh¢10.00 to purchase 100Kg bag of forage. From the table, the difference between the total size of land owned by the non-WTP and WTP bidders is statistically significant at 10%. Whilst livestock producers and traders are willing to pay to own an average land size of 7.90 acres, their counterparts are not willing to pay to own an average land size of 5.76 acres. Therefore, the null hypothesis of equal size of land between these categories of respondents is rejected in favour of the alternate. Since land is an asset, we can say that those who are willing to pay are in a better position in terms of a land asset than their colleagues.

At a 5% level of significance, there is a statistically significant difference between the two groups in terms of the agreement on the benefits of cultivated forage. As WTP bidders have an average level of agreement score of 4.3 that forage increases the benefits that one derives from livestock, their counterparts have an average level of agreement score of 3.8. Note that respondents were asked to indicate the level of agreement (5=strongly agree; 4=agree, 3=indifferent, 2= disagree, 1=strongly disagree) with the statement that cultivated forage is beneficial to livestock. It is not surprising to get these results. This shows that respondents are willing to pay for forage because of the benefits. This suggests that it is important for stakeholders promoting forage usage to sensitize livestock farmers and traders to its benefits.

In addition, there is a 5% statistically significant difference between the WTP and non-WTP bidders in terms of the proportions of them who have been trained in livestock production and marketing. As shown in Table 3, whilst 46% of the non-

WTP bidders have been trained in livestock production and trading, as high as 71% of WTP bidders have been trained in the livestock business. It is expected that this kind of training will improve participants' perception of the need to upscale their business thereby incentivizing them to purchase forage for feeding their livestock. It is presumed that some of the training on livestock production and trading include entrepreneurial skills. A successful entrepreneur needs to be trained in the area where he or she is engaged. Such livestock farmers and traders will be willing to pay for forage considering the long-term benefit expected.

Likewise, more farmers who have been trained in commercial forage production are willing to pay for the purchase of forage than their counterparts. This is revealed in the t-test results shown in Table 3 as 42% of WTP bidders have been trained in the artificial production of forage whereas only 16% of non-WTP bidders were trained. It is also expected that those trained in the artificial production of forage will definitely be sensitized on its importance to livestock and hence this kind of revelation. The results in Table 3 showed that 43% of the non-WTP bidders are livestock traders whilst 57% are livestock farmers. For non-WTP bidders, 36% are livestock traders. There was no statistically significant difference in occupation between WTP-bidders and non-WTP bidders.

Table 3: Differences in variables between WTP and non-WTP bidders

Variables	**Mean**		
	Non-WTP bidders (37)	WTP bidders (199)	t-test
Age (years)	47.00	47.32	1.04
WTP bids for Napier grass	0.41	2.27	17.64***
Occupation (1=traders, 0=farmers)	0.43	0.36	0.85
Household size	12.46	11.93	0.44
Household size of males	6.59	5.89	0.86
Education (years)	2.19	2.36	0.23
Education of most educated (years)	10.62	10.55	0.11
Total land size for crops (acres)	5.59	6.61	0.86
Total land size allows for fallowing (acres)	0.12	0.61	3.24
Total land size (acres)	5.76	7.90	1.75*
Livestock value (Gh¢)	11247.57	18074.88	1.20
[a] Satisfied with livestock business	2.73	3.13	0.97
Cultivated forage is beneficial to livestock	3.76	4.25	2.14**
Cultivated forage is available in the market	2.68	3.30	-2.47**
Cultivated forage has fewer impurities	3.73	3.91	0.98
Livestock farming or trading group Membership(1=yes)	0.22	0.32	1.38
Trained in livestock production and marketing (1=yes)	0.46	0.71	2.80**
Trained forage (1=yes)	0.16	0.42	3.67***

[a] was measured as 5=strongly agree; 4=agree, 3=indifferent, 2= disagree, 1=strongly disagree

Determinants of WTP Bids

Table 4 shows the results for the three interval regression models explaining the determinants of the WTP bids for Napier grass, Pigeon pea, and the pooled. The WTP bids are the amount of money that respondents are willing to pay to purchase a 100 kg bag of forage. The Wald Chi^2 for each of the three interval regression models' results is statistically significant implying that models are well fitted for the data.

From the table, occupation, livestock production and trading business satisfaction, access to veterinary services, having a bank account, livestock value and training in livestock business significantly influence WTP for cultivated forage. Out of these six factors, only occupation and access to veterinary services are statistically significant in all three models. Occupation is statistically significant at 5% but with a negative direction of effects in Napier grass, Pigeon pea, and the pooled data results. This means that livestock farmers have a higher WTP for forage than livestock traders. Livestock farmers have about Gh¢4.00 higher WTP than their counterpart livestock traders. This confirmed the findings of Ouédraogo et al. (2022) that livestock fatteners (traders) were willing to pay less than those who were not fattening their animals (thus farmers) because they prefer purchasing concentrate to fatten the animals fast and maximise profit. This revelation is plausible because farmers keep livestock for a longer period as compared to their counterpart livestock traders or fatteners. In keeping livestock for a longer period, one expects to get more benefit from forage as compared to traders who are profit-oriented. A trader can buy livestock and sell it within one hour for profit. With this, the incentives to incur the extra cost of purchasing forage to feed the animals are limited.

Training on livestock production or marketing is 5% and 10% statistically significant in Napier grass and pooled data respectively. The positive direction of effects implies that those who have ever been trained in livestock production or marketing business have a higher WTP bid for Napier and pooled than their counterparts. It is important to note that such training comes as a package that includes how to feed and fatten the livestock for the market. As such, those who have been trained are expected to have the zeal to purchase forage to feed the animals.

Another factor that has positive significant effects on the WTP is the value of livestock owned by farmers or traders. As the value of livestock owned by a trader or a farmer increases, his or her WTP amount for Napier grass also increases. This finding is a confirmation of the findings of Negassa et al. (2015) that farmers with higher tropical livestock unit are more willing to pay for forage than their counterparts. Emuru (2012) also observed similar trend of effects as more livestock holdings increases that amount that farmers are willing to accept for improved forage seeds in Ethiopia. This revelation stems from the fact that farmers or traders who have more livestock know the challenges they face in getting quality feed for their livestock and will rather be willing to sell some of the stocks and use the money to purchase quality and nutritious forage for the animals. It is against this backdrop that Qualls et al. (2012) found that farmers are two-thirds of farmers in 12 southeastern states in U.S. are willing to switchgrass on their farms to use as feed for their animals as a against allowing the animals to grass on natural pasture.

Access to veterinary services is 10% statistically significant in each of the models. Its positive direction of effects implies that livestock farmers and traders who have access to veterinary services have higher WTP bids than those who have not

been trained. The coefficient for access to veterinary services shows that livestock farmers and traders who have access to these services have about Gh¢6 higher WTP bids than those without access to veterinary services. The positive direction of the effects of veterinary service is in synchrony with the findings of Gonfa (2015) who observed that extension service increases the likelihood of farmers WTP for improved forage seeds. Similarly, the current study findings confirmed the work of Emuru (2012) that extension contact increases the amount farmers are willing to pay for improved vetch forage seed. Livestock farmers who access veterinary services are usually well endowed and are ready to expand their business and hence the need to invest in livestock feed such as forage. The veterinary officers are expected to train livestock farmers and traders on the kind of feed to give to the animals to make them grow fast and healthy. An encounter with these officers helps such farmers or traders to get better information on animal feed. Therefore, their WTP bids will be higher than their colleagues who have no access to veterinary services. It has also been revealed that respondents who are satisfied with the livestock business have higher WTP for Napier grass and pooled data than their colleagues. This meets the a priori expectation.

Having a bank account was used as a proxy for respondents' wealth status in the regression. As shown in Table 4, livestock farmers and traders who have bank accounts have higher WTP for Pigeon pea forage than their counterparts. Those who have bank accounts may have the financial muscle to be able to purchase forage to feed the animals. It can be concluded that forage has the potential to be accepted by farmers and replace the use of household wastes, mainly cassava pellets and peels, and plantain and yam peels which farmers usually depend on as stressed by MoFA (2016). As noted by MoFA (2016) that the bulk of the feed in the extensive production systems lacks adequate nutrients for the satisfactory productivity of livestock, forage comes in handy to solve such issues.

Lastly, the post-estimation results showed that the mean WTP bids for Napier grass and Pigeon pea are Gh¢35.72 and Gh¢36.95 respectively. As expected, the mean WTP bid for Pigeon pea is slightly higher than Napier grass. This heterogeneity in WTP bids has implications for the supply of forage.

CONCLUSIONS

Livestock production is prominent in the Northern Region of Ghana. Meanwhile, the region is in the Guinea savannah agro-ecological zone with a monomodal rainfall pattern resulting in the drying of grasses from November to May. During this dry season period, ruminant livestock farmers and traders find it difficult to get enough forage to feed their animals. Also, the production of food crops in backyard gardens in the open spaces between houses during the rainy season is common in the Northern region. During this period, ruminant animals must be tethered thereby compelling livestock farmers and traders to travel far distances to cut grass for their animals. The rapid urbanisation of the region is also making it difficult for livestock farmers and traders to get feed as few peri-urban lands are being converted to residential development. The solution to this predicament for livestock farmers and traders is cultivated forage. The profitability alone is not a sufficient condition and hence the need to assess whether livestock farmers and traders are willing to purchase cultivated forage.

Cross-sectional data were collected in five districts in the Northern Region of Ghana with the help of a semi-structured questionnaire. The willingness of livestock farmers and traders to purchase forages from Napier grass and Pigeon pea for the feeding of livestock was assessed with the help of an interval regression model.

The study observed that 6.4% of the respondents are not willing to purchase forage whilst 93.6% are willing to pay for forage. Livestock farmers had a relatively higher WTP bid for forage than their counterpart livestock traders. Access to veterinary services, training on livestock production and marketing, ownership of bank accounts and the total value of livestock increase how much money respondents are willing to pay for cultivated forage. Meanwhile, livestock farmers and traders have a higher WTP bid amount for Pigeon pea than Napier grass.

The study, therefore, recommends that unlike livestock farmers, the traders should be sensitized more about the nutritive value of forage so as to raise their willingness to pay for forage. Forage production should be included as a package in the rearing for food and jobs programme that the government is implementing. Since there are market potentials for cultivated forage, rural folks especially those in peri-urban areas should take forage cultivation as a commercial activity.

It is therefore recommended that veterinary officers should concentrate their sensitization effors about the importance of using forage to feed animals on the livestock traders rather than the farmers. Also, farmers living close to urbanized cities especially regional and district capitals should be encouraged to diversify their livelihood by entering into forage cultivation and supply to the market since the market potential is available. Lastly, government should include forage production as one of the packages in rearing for food and jobs programme since it has the tendency of creating more jobs for the youth.

Table 4: Interval regression model: determinants of WTP bids

Variables	Napier grass		Pigeon pea		Pooled	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Occupation (1=livestock trader, 0 = livestock farmer)	-4.3197**	2.0008	-4.2947**	1.7935	-4.1222**	1.7420
Age (years	0.0228	0.0523	0.0419	0.0486	0.0368	0.0456
Household size	-0.0106	0.1157	0.0168	0.1198	0.0180	0.1057
Education (years)	-0.0572	0.1931	0.0650	0.1790	0.0270	0.1707
Total livestock value (Gh¢)	2.31E-05	1.72E-5	3E-05*	1.71E-05	2.43E-05	1.5E-05
Satisfy with livestock farming and trading	0.9119**	0.4148	0.4144	0.3718	0.6063*	0.3677
Food contains minimal impurities	-0.2509	0.6174	-0.4166	0.5045	-0.3164	0.4971
Membership of any livestock group	0.1556	1.7458	0.0038	1.5590	0.0282	1.5471
Trained in livestock production and trading	3.7614**	1.7173	1.6986	1.6449	2.7573*	1.5322
Access to veterinary services	6.7728**	2.9825	6.6553**	3.1787	6.7470**	2.9935
Own bank account	1.1208	1.8087	2.7304*	1.4970	1.9646	1.5243
_cons	28.8562***	5.2019	31.7863***	5.0287	29.6501***	4.9081
/lnsigma	2.2129***	0.0601	2.0890***	0.0724	2.0225***	0.0737
sigma	9.1426	0.5494	8.0772	0.5848	7.5569	0.5570
Wald chi2(11)	26.29***		21.57***		24.08***	
Log pseudolikelihood	-175.45***		-153.27***		-138.76***	
Prob > chi2	0.0059		0.0279		0.0124	
Post-estimation WTP bids	35.7066***	1.6635	36.9482***	1.6545	36.0421***	1.5057

REFERENCES

Adams, F., Ohene-Yankyera, K. and Aidoo, R. (2021). Economic benefits of livestock management in Ghana, *Agricultural and Food Economics,* 9 (17): 1-17

Ahmed, M. H., Melesse, K. A., & Terefe, A. T. (2015). Valuing soil conservation practices using contingent valuation technique: evidence from the central rift valley of Ethiopia. *Review of Agricultural and Applied Economics (RAAE)*, *18*(2), 40-50.

Amankwah, K., Klerkx, L., Oosting, S. J., Sakyi-Dawson, O., Van der Zijpp, A. and Millar, D., (2012). Diagnosing constraints to market participation of small ruminant producers in Northern Ghana: an innovation systems analysis. NJAS – *Wageningen Journal of Life Sciences,* 60:37-47

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R., and Schuman, H. (1993). Report of the NOAA panel on contingent valuation. Federal register, 58(10), 4601-4614.

Awuma, K. S. (2012). Description and diagnosis of crop-livestock systems in Ghana. Proceeding of Regional Workshop on Sustainable Intensification of Crop-Livestock Systems in Ghana for Increased Farm Productivity and Food/Nutrition Security. August 27 – 28, 2012.Tamale, Ghana.

Cameron, T. and Quiggin, J. (1994). Estimation using contingent valuation data from a dichotomous choice with follow-up questionnaire. *J. Environ. Econ. Manag.* 27, 218–234.

Cawley, J. (2008). Contingent valuation analysis of willingness to pay to reduce childhood obesity. *Econ. Hum. Biol.* 6, 281–292.

DAI (2014). Livestock Market Diagnostics Report, DFID Market Development (MADE) in Northern Ghana Programme, Development Alternatives, Inc, DAI in association with Nathan Associates London Ltd.

Davis, R. K. (1963). The value of outdoor recreation: An economic study of the maine woods. Dissertation, Harvard University; 1963.

Duguma, B. and Janssens, G. P. J. (2021). Assessment of Livestock Feed Resources and Coping Strategies with Dry Season Feed Scarcity in Mixed Crop–Livestock Farming Systems around the Gilgel Gibe Catchment, Southwest
Ethiopia. *Sustainability* 2021, *13*, 10713: 1-28.

Emuru, D. E. S. A. L. E. G. N. (2015). *Smallholder farmers' willingness to pay for improved forage seeds: The case of eastern Zone of Tigray, Ethiopia* (Doctoral dissertation, Haramaya University).

Estell, R. E., Havstad, K. M., Cibils, A. F., Fredrickson, E. L., Anderson, D. M., Schrader, T. S. and James, D. K. (2012). Increasing shrub use by livestock in a world with less grass. *Rangeland Ecology and Management,* 65: 553–562.

Estell, R. E., Haystad K. M., Cibils A. F., Anderson D. M. and Scott, T., (2014). The changing role of shrubs in rangeland-based livestock production systems: Can shrubs increase our

forage supply? *Rnagelands*, 36 (2): 25-31.

Fuglie, K., Peters, M., & Burkart, S. (2021). The extent and economic significance of cultivated forage crops in developing countries. *Frontiers in sustainable food systems*, *5*, 712136.

Gonfa, L. (2015). Farmers' willingness to pay for improved forage seed in LIVES districts of West Shewa Zone Ethiopia. A Thesis submitted to College of Agriculture and Environmental Sciences, the School of Agricultural Economics and Agribusiness, School of Graduate Studies. Haramaya University

Ghana Statistical Service (GSS) (2019). Ghana Living Standard Survey (GLSS 7). Main Report, Ghana Statistical Service, Accra

Hanemann, W. M. (1984). Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics*, 66(3), 332-341.

Hanemann, M. W., Loomis, J. B., Kanninen, B. (1991). Statistical efficiency of double-bounded dichotomous choice contingent valuation. *Am. J. Agric. Econ*. 73(4), 1255–1263.

Husseini, R., Belko, R. and Baatuuwie, N. B. (2011). A survey of browse plants trade in the Upper East region of Ghana. *Agriculture and Biology Journal of North America*. 2, 546-551

Kassoh, F. S., Abdulai, J., Nabay, O. and Bockarie, R. (2017). Determinants of Inlet Choices of Sheep and Goats Traders in Ghana: A Case Study of Kumasi and Tamale, *Journal of Agricultural Science*; 9 (7): 105 – 115.

Kauffman, J., and Pyke, D. (2001). Range ecology, global livestock influences. In Encyclopedia of biodiversity, ed. S. Levin, 33–52. San Diego: Academic

Konlan, S. P., Ayantunde, A. A., Weseh, A., Dei, H. K. and Avornyo, F. K. (2015). Opportunities and challenges of emerging livestock feed markets in northern Ghana, International Livestock Research Institute

Kpade, C. P., Mensah, E. R., Fok, M. and Ndjeunga, J. (2015). Cotton farmers' willingness to pay for pest management services in northern Benin*, Agricultural Economics,* 48 (2017) 105–114

Kumar, S. A. N. D. E. E. P., Lakhran, H. A. N. S. A., Meena, R. S., & Jangir, C. K. (2017). Current needs of sustainable food and forage production to eliminate food and forage insecurity under climate change era. *Forage Res*, *43*(3), 165-173.

Liu, J. T., Tsou, M. W. and Hammitt, J. K. (2009). Willingness to pay for weight control treatment. *Health Policy*, 91(2), 211-218.

Innovation Laboratory for Small Scale Irrigation (ILSSI) (2017). Feed the Future Innovation Laboratory for Small Scale Irrigation (ILSSI) Irrigated Fodder in Northern Ghana

MA (2005). Millennium Ecosystem Assessment (MA) synthesis report.

Washington, DC: Millennium Ecosystem Assessment

Maczko, K., Tanaka, J. A., Breckenridge, R., Hidinger, L., Heintz, H. T., Fox, W. E., Kreuter, P. U., Clifford S. Duke, C. S., Mitchell, J. E. and McCollum, D. W. (2011). Rangeland Ecosystem Goods and Services: Values and Evaluation of Opportunities for Ranchers and Land Managers. Society for Range Management, 30-36

Ministry of Finance (MoF) (2024). Budget Statement and Economic Policy of the government of Ghana for the 2024 financial year, presented to Parliament on November 15, 2023.

Ministry of Food and Agriculture (MoFA) (2018). Investing for Food and Jobs (IFJ): An Agenda for Transforming Ghana's Agriculture (2018-2021), Ministry of Food and Agriculture, Accra

MoFA (2011). Agriculture in Ghana. Facts and Figures, Statistical Research and Information Directorate (SRID), Ministry of Food and Agriculture, Accra.

MoFA (2016). Ghana livestock development policy and strategy, Ministry of Food and Agriculture, Accra

MoFA (2017). Agriculture in Ghana: Facts and Figures (2016), Statistics, Research and Information Directorate (SRID), Ministry of Food and Agriculture, Accra

MoFA (2019). Medium Term Expenditure Framework (MTEF) for 2019-2022: Programme Based Budget Estimates for 2019, Ministry of Food and Agriculture, Accra.

Negassa, A., Shapiro, B. I., Kidane, T., Abdena, A., & Hanson, J. (2015). *Ex-ante assessment of demand for improved forage seed and planting materials among Ethiopian smallholder farmers: A contingent valuation analysis*. ILRI (aka ILCA and ILRAD).

Oppong-Anane, K., (2010). Ghana livestock sector review; FAO Representation in Ghana. Accra, Ghana: 124-158.

Partey, S. T., Avornyo, F., Ouédraogo, M. and Zougmoré, R. (2018). Candidate fodder species for goat production in Northern Ghana: Findings from a participatory evaluation exercise within the climate-smart villages of Ghana

Qualls, D. J., Jensen, K. L., Clark, C. D., English, B. C., Larson, J. A., & Yen, S. T. (2012). Analysis of factors affecting willingness to produce switchgrass in the southeastern United States. *Biomass and Bioenergy*, *39*, 159-167.

Ouédraogo, A., Zampaligré, N., Mulubrhan, B., & Adesogan, A. T. (2022). Assessment of peri-urban livestock producers' willingness to pay for improved forages as cash crops. *Agronomy Journal*, *114*(1), 63-74.

Reynolds, J. F., Smith, D. M. S., Lambin, E. F., Turner, B. L., Mortimore, M., Batterbury, S. P. J., Downing, T. E., Dowlatabadi, H., Fernández, R. J., Herrick, J. E. et al. (2007). Global desertification: building a science for

dryland development. *Science,* 316: 847–851.

Tinonin, C., Azzarri, C., Haile, B., Comanescu, M., Roberts, C. and Signorelli, S. (2016). Africa RISING baseline evaluation survey (ARBES) report for Ghana. Washington, DC: International Food Policy Research Institute.

Conflict of Interest

No potential conflict of interest between authors.

Funding

This research was funded by Africa RISING) project of International Institute of Tropical Agriculture, CGIAR.

Acknowledgments:

We appreciate the support from the staff of International Institute of Tropical Agriculture, Tamale, Ghana. Our special appreciation goes to Mr. Benedict Ebito Boyubie for assisting in the inputting of the questionnaire in Kobo ToolBox. For data collection from the field, we thank the enumerators and the respondents for their contributions in diverse ways. The opinions expressed in this paper do not necessarily reflect the views of our donors or partners. The contents are the sole responsibility of the authors.

Ethical Statement

The research was conducted following the ethical standards of the International Institute of Tropical Agriculture. The objectives of the research were made known to the participants. The consent of the respondents' willingness to participate in the research were should. Those who were willing to participate in the survey were informed that they could skip any question they did not want to answer. Also, they were informed that they withdraw from the survey at any point. To ensure confidentiality, the names of the participants have not been mentioned anywhere in the manuscript.