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Determinants of smallholder commercialization of livestock: A case study from Tigray, Ethiopia

Gebrekiros Hagos Belay[1], Kebede Abrha Mengstu[2], Hassen Mehammedberhan Kahsay[1], Gholamhossein Hosseininia[3], Ahsen Işık Özgüven[4], Ants-Hannes Viira[5] and Hossein Azadi[6,7,8]*

Abstract: In several developing countries, including Ethiopia, the change from a subsistence-oriented production system to a market-oriented production system as a means of raising smallholder incomes and mitigating growing rural deprivation has been at the center of the agenda. Therefore, the purpose of this analysis was to evaluate the determinants of smallholder livestock commercialization in Tigray, Ethiopia. One hundred and eighty-three households were selected using a simple random sampling technique. The data were gathered through a structured survey. The data obtained were evaluated using econometric models of both concise and Heckman two-step collections. The results of the binary probit model revealed that in the decision to sell, household head education level, family size, distance from the nearest market center, and the total livestock ownership played a significant role. Heckman second-step selection estimation indicated that the education level of the household head, the extension agents' visit, the total livestock owned and the owned land size significantly affected the level of commercialization measures. The findings of this study will contribute to enhancing the efficient utilization of the existing limited farmland. In this study, smallholder farmers' access to the agricultural markets with higher value is seen as a critical opportunity to improve and diversify the livelihoods of lower-income farm households. As a result, better market participation is required to connect smallholder farmers to markets and increase demand for livestock products and income generation. The findings of this study may help in the development of appropriate policy intervention mechanisms to promote smallholder livestock commercialization in Ethiopia.

Subjects: Environmental Sciences; Forestry; Agriculture and Food

Keywords: Subsistence-oriented production; Two-step Heckman pattern; Binary probit model; Rural communities; Level of commercialization

PUBLIC INTEREST STATEMENT

Commercialization of smallholder livestock production is not new—it is an ongoing process where smallholders move from subsistence farming into market-oriented production. The change in priority from household consumption to production for the market is a difficult transformation against traditional farming. However, this transformation is already happening at different regions and this process can be enhanced by studying the commercialization management. It should not be ignored that livestock farming will provide smallholders with more income and security than the traditional production system. Therefore, smallholders need to invest capital and labour in more productive livestock systems with higher quality products and more efficient incorporation into the value chain. In this context, the current study investigated the determinants of smallholder commercialization of livestock in Tigray, Ethiopia as a country with traditional farming sector.

1. Introduction

The growing demand from developed countries for livestock goods provides incentives to players in the supply chain to minimize the poverty of rural households (Benin et al., 2003; Erenstein & Thorpe, 2010; Ochieng et al., 2020; Ogutu et al., 2020; Omondi et al., 2017). The surge in market volumes, led by income and population development, and by urbanization, often includes diversification and enhanced competition for standard attributes (Goswami et al., 2016; Jiang et al., 2019; Lutta et al., 2020; Pedron et al.; Rehman et al., 2017). This scenario offers, possibly, the biggest chance for the smallholders in Africa to profitably raise livestock production that in many countries provides the lion's share of all food products including agricultural products such as milk, meat, and eggs (Reist et al., 2007). However, it also poses growing restrictions for the smallholder farming group, as the bulk of customers, i.e., the metropolitan populace, are being progressively distant in relation to the areas of food production. Consumer needs and perceptions about food tastes, price, and variety are therefore dramatically different from those of the rural communities that manufacture the product. Therefore, the smallholders will need to respond to consumers' requirements instead of selling the odd surplus for their household use resulted from the conventional food supply. To meet this double demand in developed countries, livestock farming needs to become even more competitive and effective, i.e., higher output per animal in the farmland (Forabosco et al., 2017; Hatab et al., 2019; Tibesigwa et al., 2017).

Livestock are rarely sold in developing countries given that they perform essential livelihood functions in rural households, which include providing human needs, such as drought strength, manure, social needs, and providing households with financial and food protection (Godber & Wall, 2014). Sales are often driven by the needs of the farmer for cash, rather than by the characteristics of demand or the condition of the market. Forced procurement was also an effective tactic to address scarcity during the dry season (Gebremedhin et al., 2009).

Agricultural marketing relates to the cycle of growing the share of agricultural output sold by the producers (Chindime et al., 2017; DeLong et al., 2019; Pradhan et al., 2017; Rosairo et al., 2012). The commercialization of farming as a function of agricultural transition is more about whether or not a cash crop is present in a development network to any degree. This can occur in a variety of ways including the increased demand excess on the export side of manufacturing or the decreased utilization of purchased products on the supply side. Marketing is the outcome of farm households' parallel decision-making activities in development and marketing (Matsuda et al., 2018).

Ethiopia is one of the countries in Sub-Saharan Africa that has modernized its economy and established poverty alleviation strategies. Agricultural production is the center of the Ethiopian economy, contributing to 45.4 percent of gross domestic product (GDP), 83.9 percent of all production of the nation, and 80 percent of total workers. Ethiopia is one of the few African countries that successfully achieved the comprehensive African Agricultural Growth Plan for the African Union (CAADP) goals of 10 percent growth in public expenditure in agriculture by 2008 and 6 percent rise in agricultural production by 2015 (FAO, 2016).

Furthermore, smallholders plow more than 96 percent of the overall agricultural property, even though a typical smallholder cultivates less than one hectare of arable land and absorbs more than 65 percent of the total family production (FAO, 2015). Market presence of smallholder family farms is limited in several elements of the country (measured either in terms of per capita market share, the degree of farm production supplied to markets, or the purpose for their profit) (Gwiriri et al., 2019). Thus, the commercialization of smallholder farms is now seen needed by the government as the point of focus for the nation's agricultural production (FAO, 2017; Nasir et al., 2017). Furthermore, encouraging the commercialization of agricultural output is the pillar of Ethiopia's rural growth and poverty mitigation policies, as well as several other developing countries (World Bank, 2007).

Indeed, commercialization complements the ties between agricultural sector's input and production aspects. Marketing includes business alignment (demand-oriented decision on agricultural output mainly centered on consumer alerts) and market engagement (price-related commodity and the usage of purchased inputs) (Nasir et al., 2017). Business transition in subsistence agriculture is an important road to economic development and change for vast numbers in rising farming-dependent nations. Policymakers in Ethiopia and elsewhere regard agricultural marketing as an integral part of the economy's cycle of agricultural modernization, specialization, and institutional change toward faster and more productive development. Nonetheless, the modern world characterized by population increase, employment, urbanization, policy changes, technology, regional interconnectivity, restructuring of the food sector, and climate change calls for the transformation of agriculture, and marketing will accomplish this aim through shifting the existing development practices from high subsistence to highly market-oriented ones (Bengtsson et al., 2018; Rabbi et al., 2019). This is because marketing is seen as a future engine of sustainability and economic growth for the least developed countries (Krammer, 2017; Pradhan et al., 2017; Rabbi et al., 2019).

While small-scale cattle farmers are claimed to be able to adapt rationally to markets, there are those who are actively engaged in the marketing of livestock (Amunyela & Moyo, 2019; Mezgebe et al., 2017). The gaps in the priorities and attitudes of livestock farmers impede the development of successful livestock policies aimed at improving the livelihoods of poor cattle farmers (Bettencourt et al., 2015; FAO, 2016). There is therefore a need to emphasize that efforts to improve the rural livestock production and the market supply of quality live animals understand the objectives, perceptions and experience of livestock keepers (Dominguez-Salas et al., 2019; Salmon et al., 2018).

Therefore, the investigators are interested in examining the determinants of smallholder commercialization and the extent of commercialization among livestock producers to provide results and policy implications which can be applied by stakeholders. Smallholder farmers are recognized as an important opportunity to enhance the livelihoods of low-income farm households and reduce rural poverty overall by accessing the markets for value-added agricultural produce. As far as we know, there is little evidence of marketing factors for smallholder farmers in developing countries, especially in Ethiopia. In order to increase demand for livestock products and provide opportunities for generating revenue, improvements in marketing are therefore necessary in order to link smallholder farmers to markets. Thus, empirical studies are therefore crucial in determining commodities and locational and socio-economic factors that trigger the marketing process. Focusing on the theoretical novelty, the findings of this study would provide practical insights towards designing appropriate policy intervention mechanisms to enhance smallholder commercialization of livestock in Ethiopia. This study is also novel in terms of methodological aspects as it applies Binary probit model to evaluate the market-entry decision of a household and its specification. The log-likelihood method was also used to measure the parameters and is maximized to produce the estimates of parameters and subsequent marginal effects. The result of this study will be beneficial to policy makers and smallholder farmers dealing with the commercialization of livestock. The governments of developing countries recently attempted to encourage development and export diversification away from conventional commodities to boost economic development, to expand work prospects, and to reduce rural deprivation (Iizuka & Gebreeyesus, 2017). Consequently, in the current policy setting in Ethiopia and in its Plan for Growth and Transformation (PGT) initiated between 2010 and 2015, the government is aiming to stimulate the growth and export of high-value agricultural products in order to improve productivity in the state, regional, and international markets (Okereke et al., 2019).

While Ethiopia has the highest livestock population and a favorable climate for livestock development (due to its varied agro-climatic conditions), over time, the share of overall agricultural gross production in the sector is gradually decreasing and the proportion of crops is rising. This may be due to the lack of proper government concern in the livestock sector, as all the strategic

goods covered by Plan for Accelerated and Sustained Development to End Poverty (PASDEP) include crops, and none of the components of livestock units (despite its high production potential in the country) have been prioritized by the Ethiopian government policies (Wubneh, 2018).

A variety of research-utilizing household data have sought to explain the factors that influence smallholder decisions regarding investing in livestock markets (Hagos et al., 2019; Kyaw et al., 2018; Musemwa et al., 2010; Nwafor et al., 2020). A literature review shows contradictory proof of factors impacting the marketing of livestock markets, such as environmental, political, human, and institutional influences. The actual marketing limitations require small densities of the rural population (Willy et al., 2019), remoteness from the major metropolitan business centers, and weak road networks, resulting in high travel costs (Tarekegn et al., 2017). Improved road networks and marketing infrastructure such as holding facilities may encourage farmers' commercialization in livestock markets (Sehar, 2018), though the effects in some country studies are not significant (Muzzo & Provenza, 2018). For example, in a study by Zuwarimwe and Mbaai (2015), they proved that smallholder farmers' involvement in the livestock markets is affected by a variety of main factors: dynamics of development and distribution, acquisition costs, human resources, marketing system, and entrepreneurial mindset of smallholder farmers. In order to increase the market participation of smallholder farmers, a proactive extension program is required and policy recommendations will concentrate on enhancing the knowledge flows, livestock marketing systems, and the growth of smallholder farmers' human capital. If these issues are tackled, more smallholder farmers would be able to invest in the livestock markets.

In Tigray, particularly the southern zone has good potential for livestock. Given such opportunities for development and the value of livestock for both the nation and the research field, there has been little study on the role and nature of smallholder livestock marketing and the consequences of challenge-taking decision-making. In view of the importance of agricultural commercialization in Ethiopia's agriculture and rural growth policies, where Tigray is not an exception, and its theoretically significant and beneficial effect on agricultural production, poverty reduction in rural areas, and food and nutrition welfare, it is necessary to consider the factors influencing the marketing decision of smallholders and the degree of Tigray's commercialization. There is little empirical data to the best of our knowledge on factors regulating the commercialization of smallholder livestock in Ethiopia, especially in Tigray. Improvements in market commercialization are therefore required to connect small-scale farmers with market opportunities to increase demand for livestock and generate income. Therefore, an important study such as this was essential to recognize factors activating the marketing cycle, and the results of this study will provide some insight into the creation of effective policy action frameworks to promote small-scale livestock marketing, both in the study region and in the country at large. The general objective of this analysis was therefore to examine the socio-economic determinants of marketing among Tigray livestock producers by addressing basic objectives below: 1) exploring factors which decide the marketing decision of smallholder farmers in the livestock sector, 2) analyzing the determinants for the level of marketing in the research region among the participants in the smallholder livestock industry, and 3) identifying the challenges facing commercialization among smallholder livestock producers.

2. Literature review
Agriculture is considered to be a key source of employment, livelihoods, and environmental resources in low-income countries. However, in the long-term, subsistence farming cannot be a feasible practice to ensure adequate food security and healthcare for the household; therefore, since the 1980s, marketing was seen as a way out of poverty and as a tool for increasing the standard of food for poor agricultural households in low-income countries (Linderhof et al., 2019; Ogutu et al., 2017). To date, marketing promotion has been targeted towards poor farming households' agricultural production. There are two explanations that this partnership will be reexamined. Firstly, marketing can be seen from the food system viewpoint, which implies that various elements of the food system as described in earlier studies (Ingram, 2011) can help with

marketing. From the farmer's viewpoint, marketing is not limited to either improved demand for yields or cash crop growth. Second, not all low- and middle-income countries have detailed surveys accessible to measure the effects of marketing on farm households (Linderhof et al., 2019). Although the degree of involvement in the production sector lies at the core of most concepts of agricultural marketing, some literature discusses other aspects of marketing. Three additional measurements are briefly mentioned here. Firstly, this is the degree of business participation. When farmers are more industrialized, they continue to depend less on inputs and services from mixed agricultural systems provided by themselves and then focus increasingly on markets to source their inputs and services. So we could define commercialization on the input side as: ICI = value of market-acquired inputs/value of agricultural output (Leavy et al., 2008).

Secondly, it is noted that, as farms are more commercialized, they become largely reliant on hired labor, with family labor more concentrated on supervisory and management duties. This may be related to freeing up certain resources elsewhere in the economy for the jobs of the family. When agricultural production is increasingly business-oriented rather than a matter of subsistence, some family members can opt to work in other professions, with the remaining members bringing in employees to conduct the required tasks (Leavy et al., 2008; Singh, 2019). Thirdly, some commercialization writing illustrates the value added to the benefit motive within the farm sector as a predictor of marketing (Leavy et al., 2008). Indeed, agricultural marketing means more than marketing of agricultural production; it means that decisions on product choice and input use are based on the principles of maximizing the profit. Agricultural market reorientation happens with both the main staple cereals and the cash crops in the so-called strong demand (Carletto et al., 2017; Ogutu et al., 2017; Singh, 2019).

On the other hand, marketing is fundamental to the systemic transition cycle since greater input market alignment raises the demand for manufactured products and technologies necessary for growth, improves consumer welfare by work development and improved labor efficiency, and enables the shift of surplus in the form of food, labor, and capital from the agricultural sector to other sectors (Pingali et al., 2019). Smallholder marketing is also a key aspect of the social transition cycle that most growth economists find to be the primary road through a semi-sustainable farming community to a more dynamic and food-secure environment with higher general living standards as the systemic transformation cycle starts with broad-based agricultural production, allowing millions of smallholder farmers to build up buying power (Jayne et al., 2011), which can also be related to benefits and challenges. As Pingali (2001) states in his research, the commercialization of agriculture is the effects of industrial development and urbanization. The promotion of agricultural systems helps to strengthen the business orientation, replace non-traded products with imported inputs, and worsen the industrialized agriculture systems. The negative and positive effects on the base of natural resources can be caused by agricultural marketing. In Low- and Middle-Income Countries (LMICs), livestock production is critical for improving human livelihoods and survival (Herrero et al., 2013, 2014; Lam et al., 2019; Salmon et al., 2018). Up to one billion smallholders are reported to be sponsored by livestock worldwide, and several million more are employed by retail chains in the sector (Herrero et al., 2009). Livestock production is growing dramatically (Alexandratos & Bruinsma, 2012; WHO, 2003). Smallholders are primarily liable for significant amounts of livestock production (FAO, 2015; IFAD, 2015; World Bank, 2007) and there is room for expanded development by reducing the proposed yield gaps (Mayberry et al., 2017; Van Ittersum et al., 2016). Nonetheless, smallholders are likely to continue to play a significant role in fulfilling the above-mentioned demand amid more consolidated systems, with differing degrees of participation and intensification (Herrero et al., 2014; Staal et al., 2009; Thornton, 2010).

However, there is now widespread recognition that livestock production plays a major role in human-induced negative impacts on the ecosystem including land use change, water shortages and depletion, greenhouse gas emissions and biodiversity loss (Rivera-Ferre et al., 2016). Despite cumulatively large numbers of livestock and low output levels, smallholders are required to

contribute significantly to these impacts (Herrero et al., 2013). Increased demand for livestock products, combined with normal market processes, is expected to have a significant impact on global environmental impacts (O'Mara, 2011). The concept of sustainable intensification (SI) has been around for some time in acknowledgment (increasing crop development without any environmental impact) (Cook et al., 2015). SI's initial focus on environmentally friendly manufacturing has been criticized in recent years for failing to comprehend the true nature of food production systems, including social and economic aspects (Cook et al., 2015). To improve the efficiency of SI activities, it is proposed that political, economic, and social indicators and perspectives be included; these aspects are currently being adjusted (Smith et al. 2016; Värnik et al., 2017).

According to what was said, and despite the benefits, risks and opportunities of the commercialization of agricultural sector, especially livestock, understanding the reasons why smallholder farmers in Tigray, Ethiopia and other developing countries do not actively participate in livestock markets may help policy makers come up with innovations to deal with the problem and help reduce poverty among the rural farm households. The summary of these studies related to smallholder commercialization of livestock is illustrated in Table 1.

3. Methodology of the study

3.1. Study area
The research was carried out in the Endamehoni District of northern Ethiopia (Figure 1). Endamehoni is one of Ethiopia's woredas in the Tigray region. Endamehoni is bordered on the south by Ofla, on the west by the Amhara Region, on the north by Alaje, and on the east by Raya Azebo (it is part of the Debubawi Zone). The district has an approximate overall population of 84,726, of which 2,985 (3.5 percent) are urban dwellers (Gebreegziabher & Tsegay, 2015). A rise of 36.90 percent has been seen relative to the 1994 survey, of which 42.052 are males and 42.687 are females, and 2.986 or 3.52 percent live in urban areas. Endamehoni has a population density of 37.04 people per Km^2, which is lower than the National District's 53.91 people per Km^2. This woreda had a total of 18,816 households, with an average of 4.50 people per household and 18,371 housing units. This is comprised of 18 "Tabias" (district local administrative units) and 70 sub-Tabias. The district sits at an altitude ranging from 1700 to 3488 masl. The rainfall is bimodal; it rains in the season of Kremt (June–September and the season of Belg (January–March). Temperatures vary between 6°C and 32°C. Agricultural development, especially combined cultivation, is the base of people's livelihoods in the district and it is rainfed, depending on the Belg and Kremt rains. The primary food crops are wheat and barley, while minor food crops are sorghum, teff, corn, and faba bean. Pulses are the most important cash crops. The primary forages are forest pastures, cereal straws, and Cactus (locally known as Beles). The primary types of livestock are horses, pigs, and goats (Gebreegziabher & Tsegay, 2015). Throughout this woreda, a 2001 CSA census enumeration interviewed 17,400 farmers who held an average of 0.44 hectares of land. For the 7,658 hectares for private property surveyed, 91.1 percent were in farmland, 0.34 percent in woodland, 2.79 percent in fallow ground, 0.61 percent in forestry, and 5.14 percent in other uses. In this woreda, 64.73 percent of the land under cultivation is for cereals, 23.77 percent for peas, and 11.5 percent for oilseeds and vegetables. 54 hectares of land are used for gesho; there is no field for fruit trees. 65.43 percent of farmers raised both crops and livestock, although only 32.51 percent developed crops, and only 2.07 percent raised livestock. In this woreda, land ownership is divided among 89.07 percent who own their property and 10.19 percent who lease them.

3.2. Data collection and analysis
The researchers used data from a household survey that was obtained from the woreda throughout 2015. This qualitative and quantitative information was gathered from secondary and primary sources. The Supplementary Details important for this analysis were obtained from the Agriculture Zonal Office, Woreda Agriculture Office, National Statistics System (CSA), and reported and undisclosed sources. Using a standardized questionnaire under the guidance of this report, well-trained enumerators had collected primary data from sample smallholder livestock farmers. The

Table 1. Studies related to smallholder commercialization of livestock		
Refrences	**Findings**	**Topic**
Linderhof et al. (2019)	- Considering agriculture to be a key source of employment, livelihoods, and environmental resources in low-income countries. - Marketing was considered as a way out of poverty and as a tool to increase the standard of food for poor agricultural households in low-income countries.	"Agricultural commercialization and food security"
Ogutu et al. (2017)	Identifying the commercialization of smallholder agriculture as an essential pathway towards rural economic growth.	"Agricultural commercialization and nutrition"
Ingram (2011)	- Marketing promotion has been targeted towards poor farming households' agricultural production. - Marketing can be seen from the food system viewpoint, which implies that various elements of the food system can help with marketing.	"Food-systems approach to researching food security"
Leavy et al. (2008)	- The most degree of involvement in the production sector lies at the core of agricultural marketing. - When farmers are more industrialized, they continue to depend less on inputs and services from mixed agricultural systems provided by themselves and then focus increasingly on markets to source their inputs and services.	"Commercialization's in agriculture"
Carletto et al. (2017)	The transition from subsistence to commercial agriculture is the key for economic growth.	"Agricultural commercialization and nutrition revisited"
Singh (2019)	Agricultural commercialization means more than the marketing of agricultural output; it means the product choice and input use decisions are based on the principles of profit maximization.	"Re-organising agricultural markets"
Pingali et al. (2019)	Marketing is fundamental to the systemic transition cycle since greater input market alignment raises the demand for manufactured products and technologies necessary for growth.	"Commercialization and diversification"
Jayne et al. (2011)	Smallholder marketing is a key aspect of the social transition cycle that most growth economists find to be the primary road through a semi-sustainable farming community to a more dynamic and food-secure environment with higher general living standards.	"Agricultural commercialization, rural transformation and poverty reduction"
Pingali (2001)	The promotion of agricultural systems contributes to greater business orientation, the gradual substitution of non-traded products for imported inputs, and the deterioration of industrialized farm systems.	"Environmental consequences of agricultural commercialization"
Herrero et al. (2013)	The negative and positive repercussions on the natural resources can be caused by agricultural marketing. The livelihoods and survival of people on low and medium incomes are important for livestock production countries.	"Roles of livestock in developing countries"
Sojasi Gheidari et al. (2016)	The status of social capital was higher than other aspects of livelihood capitals. Then the physical, economic, institutional, and human capitals were placed, respectively.	"Livelihood capitals in rural areas"
Alexandratos and Bruinsma (2012)	It is necessary for developing countries to invest in agriculture and rural production, thereby providing advantageous opportunities for the poor so that they can switch from subsistence farming to market-oriented.	"World agriculture towards 2030/2050"
FAO (2015)	Many smallholder farmers depend on agriculture as a source of food and income in developing countries.	"Economic lives of smallholder farmers"
IFAD (2015)	Socio-economic variables such as age, household size, degree of education, grain and livestock producers, field scale, and access to education influence the decision to engage in processing agricultural products.	"Smallholder livestock development"
World Bank (2007)	Business transition in subsistence agriculture is an important road to economic development and change for vast numbers in rising farming-dependent nations.	"Agriculture for development"
Mayberry et al. (2017)	Livestock production is growing dramatically. Smallholders are primarily liable for significant amounts of livestock production and there is room for expanded development with proposed yield gaps.	"Milk yields and increasing production"
Van Ittersum et al. (2016)	Improving market access is not only important for rural economic growth, but also for improving the sensitivity of smallholder agriculture to diet.	"Sub-Saharan Africa food security"
Staal et al. (2009)	The commercialization of smallholder agriculture is widely seen as an essential pathway towards rural economic growth.	"Strategic investment in livestock development"

(Continued)

cogent · food & agriculture

Table 1. (*Continued*)		
Refrences	**Findings**	**Topic**
Thornton (2010)	Increased system participation and intensification in smallholder businesses are expected to continue to play an important role in the meetings of this demand.	"Livestock production"
Rivera-Ferre et al. (2016)	The rapid growth and demand in the livestock sector has led to unexpected and major environmental and livelihood implications, especially in the context of climate change.	"Climate change debate in the livestock sector"
O'Mara (2011)	The increasing demand for livestock products, confronted with market processes as normal, is projected to significantly increase the global environmental impacts.	"Livestock contributions to global greenhouse gas emissions"
Cook et al. (2015)	The concept of sustainable intensification (SI) has been around for some time in acknowledgment. In recent years, SI's initial focus on environmentally friendly manufacturing has been criticized for not understanding the true nature of food production systems, including the social and economic aspects.	"Sustainable intensification revisited"

Figure 1. Map of the study area.

questionnaire, which comprises open and close-ended queries, was designed and pre-tested to ensure accuracy and reliability and to allow for the same overall development, in accordance with the study's goals. Selecting survey households had been accompanied by a two-stage sampling process. In the first point, livestock holders were identified in partnership with leaders, woreda agricultural office experts were involved, and four sites were randomly selected (Tabias). Throughout the second stage, households that keep livestock were selected by the respective Tabias's production agents. The list of households holding livestock was collected from official records in selected Tabias, and 186 farm households were randomly selected from the specified (listed) livestock-holding households out of the total target classes. The sample sizes in each Tabias were calculated using the Probability Proportional to Size (PPS) method, which took into account the size of the identified livestock households. The data collected from the livestock keepers in the study field was analyzed using two methods of data analysis: descriptive statistics and econometric models. Descriptive figures such as ratio, mean contrast, cross tabulation, chi-square, and standard deviations may be used in the data review. The econometric model will be used to measure the characteristics of

the family, capital endowments, customer access, and systemic variables speculated to evaluate the decision of smallholder farmers to participate (or not) in export markets and the degree of commercialization. The two-step Heckman model was implemented to evaluate livestock marketing determinants in terms of marketing outputs. This model consists of a two-step estimation method. Probit model has been used in the first stage to investigate variables controlling consumers' buying decisions, which are alluded to in this analysis as a marketing decision.

3.2.1. Probit model: default

The probit model to evaluate the market-entry decision of a household and its specification, as set out by Wooldridge (2002), and the brand approach can be described as follows:

$Y* = Z'\alpha + \varepsilon_1$

$Y = 1$ *if* $Y* > 0$

$Y = 0$ *if* $Y* \leq 0$

Where,

$Y*$ = Latent (unobservable) element that reflects a separate decision by farmers whether or not to compete in the livestock market

Z' = Independent vector variables speculated to impact farmers' marketing choices

α = The matrix of the parameters to be determined in order to measure the effect of the explanatory variables on the decision of the farmer to participate

$E\varepsilon_1$ = Distributed error of the mean (0) and regular ÿ1 variance, which collect all unknown variables

Y = Related vector which is equal to 1 if farmers engage in the livestock market and 0 if not

Although the calculation of the probit parameter does not indicate how much a single variable increases or reduces the likelihood of the sale, the residual effects of independent variables on the likelihood of participation of the livestock farmer have been considered. The residual impact was determined for the constant independent variables by multiplying the variance estimation by the normal probability density equation by keeping the specific factor variables on their mean values. The null-independent variables' residual effects have been evaluated by evaluating the probability of the outcome as the null variables take their two separate values. The following critical factors keep sample values at their mean (Franken et al., 2018; Wooldridge, 2002).

Eventually, the log-likelihood method was used to measure the parameters and is maximized to produce estimates of parameters and subsequent marginal effects.

$$Ln\ L(\tfrac{\alpha}{\gamma}, Z) = \sum_{y=1} LN(\phi(Z'\alpha)) + \sum_{y=0} \ln(1 - \phi(Z'\alpha))$$

The variables deciding the degree of marketing were developed using the second-stage Heckman selection process, based on consumer decision (Heckman, 1979). The equation for selecting Heckman has been defined as follows:

$Zi* = Wi'\alpha + \varepsilon_2$

$ZI = ZI*$ *if* $Zi* > 0$

$Zi = 0$ *if* $Zi* \leq 0$ (3)

Where,

$Zi *$ = Latent feature, reflecting the ideal or optimum marketing degree, where Zi*>0 is measured and, therefore, not observed

Zi = Commercialization rates found

Wi = Unit I covariate selection function vector which is a subset of Z

α = Classification Equation Coefficients function

π 2 = Disruption of random unit I for equation of selection

Due to unmediated variables of farmers who determine both separate and ongoing decision-making, two-stage decision-making processes are not separable, resulting in a link between method errors. If the two mistakes are associated, the predicted values of the parameters for the factors evaluating the degree of commercialization are skewed (Wooldridge, 2002).

Therefore, we need to determine a formula that can compensate for selectivity bias when calculating the marketing level determinants. To this end, Mills ratio was generated in the first phase using the expected chance values derived from the first-stage probit analysis of marketing decisions. Then we used the Mills ratio as one of the independent variables in the marketing regression stage in the second phase. Therefore, the degree of advertisement equation with sample collection bias correction is as follows:

$$V = X'\beta + \lambda \left(\frac{(\emptyset X'\beta)}{(\Phi X'\beta)} \right) + \varepsilon_3$$ Where,

Ø (.)/Φ (.) = Mills ratio

λ = Mills ratio correlation

Ø = Traditional real density likelihood function

Φ = Normal function cumulative distribution (ε)

3 = Unrelated to π 1, ÿ2, and other undefined variables. Under the null hypothesis of no set of tests, π bias does not differ significantly from zero.

V = Level of commercialization (ratio of sales to total production)

4. Results and discussion
The concise and econometric findings of the study are described here. Descriptive analyses on the characteristics of the households and their commercialization decision in livestock markets are presented and discussed in this section. The results of the econometric estimation of livestock market commercialization and level of commercialization are also presented and discussed.

4.1. Socioeconomic characteristics
As the results of Table 2 show, out of 183 households were surveyed in which 83.06 percent were commercializing their livestock while the remaining (16.94 percent) did not commercialize; they simply rear them for prestige as a way of expressing their wealth and life. It can be concluded that farmers may commercialize their livestock to obtain more profits.

Own survey, (2017)

Table 2. Commercialization		
Commercialization	**Frequency**	**Percent**
Not commercializing	31	16.94
Commercializing	152	83.06
Total	183	100.00

Table 3. Proportion of demographic and social features of households selling and not selling			
Variables	**Commercializing**	**Non-commercializing**	**Chi-square value**
Household master sex			
Women	21	6	0.428
Men	131	25	
Marital status of household head			
Single	19	1	
Married	119	25	0.355
Divorced	6	2	
Access to Market information			0.000*
No	38	24	
Yes	114	7	
Visit by extension agents			
No	56	22	0.000*
Yes	96	9	
Non-livestock commercialization			
No	24	1	0.070***
Yes	128	29	

***, **, and *: Statistically relevant at 10, 5, and 1 percent, respectively. The mean values of livestock market participants and nonparticipants' socioeconomic characteristics are given in Table 3 below.

The chi-square test is used to determine that there are substantial variations between categorical variables among both marketing and non-marketing households (Table 3). The chi-square values of household head sex and household head status of categorical variables listed in the model of livestock marketing indicate negligible variations in both groups. Male-led households dominate surveyed households, both in selling and non-commercializing. Women have traditionally been heavily involved in agriculture, while men work off-farm to supplement the household income. Married household dominate surveyed households in both commercializing and non-commercializing households. Of the surveyed households, off livestock farming groups dominate in both commercializing and non-commercializing households. This result follows the findings of Chege et al. (2015) and Ogutu et al. (2017). The chi-square values for access to market information, visit by extension agents, and categorical factors for non-livestock production included in the model for selling livestock suggest major variations in both groups. Therefore, it can be said that market access is one of the determining factors in commercializing livestock products. In other words, the more people have access to the market, the more they are willing to participate in commercialization and the more successful they will be. This finding contradicts the findings of Enete and Igbokwe (2009), as well as those of Gebremedhin and Jaleta (2010). The chi-square statistics value shows that there is a significant difference at less than 1 percent, in access to market information by a livestock market commercializing and non-commercializing household. Hence, as market information makes a difference in decision to

commercialization, any interested group can profit from this variable's best implementation; therefore, access to details is so relevant to decisions on production and marketing. This is consistent with prior results by Olwande and Mathenge (2011). The findings show that there is a statistically important gap about exposure to visits by extension officers, at less than 1 percent, between those who commercialize and non-commercializing in livestock market. Therefore, it can be said that the presence of extension agents in the field of production can be very important in encouraging people to commercialize. The finding is consistent with Gc and Hall (2020) findings. The findings indicate a substantial gap at 5 percent between those who are engaged in livestock business and those who are engaged in non-livestock business. Therefore, it can be said that non-livestock commercial activities are pioneers in advancing economic goals and achieving a successful market. It is consistent with previous findings by Gc and Hall (2020).

The value of t-statistics shows that there is no significant difference between family size and household land ownership of participants in the livestock market and non-participants. Therefore, it can be said that the land holding size of the household and family size will not affect the economy between the people involved in the commercialization process and the non-traders. This result contradicts the findings of Kyaw et al. (2018). Hence, this study can conclude that the mean educational level of household head for the commercialization of livestock was higher than non-commercializing counterparts. It reveals that there is a direct relationship between the educational level of the household and commercialization. This result is consistent with the results of Khoza et al. (2019) and Kyaw et al. (2018).

The t-statistics value shows that the mean difference in the distance from the nearest urban-center among the two groups, commercializing and non-commercializing, was statistically significant and positive (Table 4). This reveals that there is an indirect relationship between the distance from the nearest urban center and livestock commercialization. Hence, this study can conclude that the mean distance from the nearest urban center of household head for livestock commercialization was lower than non-commercialization. This means that the closer people get to urban centers, the more they will be involved in commercialization. In fact, rural and urban labor markets are connected to differing degrees by the propensity for rural-urban migration, which appears to be the most prevalent among rural households near the urban centers (and by the propensity for regular or weekly commuting in peri-urban areas). Farm incomes and non-farm employment opportunities in rural areas are both influenced by proximity to urban centers (Fafchamps, 1996; Ruben & Pender, 2004).

Variable	Mean with str.err. In criteria		t-value
	Commercializing HH	**Non-commercializing HH**	
Head of household age	41.55921	47.93548	0.0093*
Level of education of the household head	6.638158	2.741935	−0.0068
Family size	5.375	4.870968	0.2181
Distance from the nearest urban center	5.100645	7.54375	0.0472 **
Land holding size of the household	1.356908	1.459677	0.6647
Total livestock owned	17.29605	7.129032	0.0428 **

Table 4. The social and economic dimensions of both participants and non-participants in the livestock field

** and *: Statistically relevant at 5 percent and 1 percent, respectively. ** and *: statistically significant at 5 percent and 1 percent respectively.

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Table 5. Level of commercialization in number of livestock from visit by extension service						
Variable	Obs	Mean	Std. Err	Std. Dev	[95 percent Conf. Interval]	
Not-visited	78	0.7179487	0512821	4,529,108	6,158,331	.8200643
visited	105	0.9142,857	0274505	2,812,843	8,598,503	.9687212
combined	183	0.8306,011	0278045	376,133	7,757,404	8,854,618
diff		−.196337	054458		−.3037912	−.0888827
		t = −3.6053			Pr(|T| > |t|) = 0.0004	

The t-statistics value shows that mean difference in Total livestock owned among commercializing and non-commercializing households was statistically significant and positive. Hence, this study can conclude that the mean livestock owned by the household head for livestock commercializing was higher than non-commercializing. This reveals that there is a direct relationship between the number of livestock owned and commercialization. This might be due to the fact that the high amount of livestock owned will either be difficult to feed or result in a surplus of livestock left out of consumption and service, which motivates them to commercialize them. This finding is consistent with other studies (e.g., Da Cruz, 2003).

The t-statistics value shows that the mean difference in livestock commercialization among extension service recipients and non-recipients was statistically significant and negative. Hence, this study can conclude that the mean livestock commercialization of extension service recipients was higher than non-recipients of extension services. This reveals that there is a direct relationship between extension service recipients and livestock commercialization (Table 5).

4.2. Econometric analysis

4.2.1. Livestock commercialization
Livestock were produced for a way of life, prestige, consumption, and commercialization in the study area. Various variables are believed to assess the extent of marketing of livestock by measured households of livestock owners. The analysis used the inflation factor for variance to test the linearity of multicollinearity across continuous variables. According to the test results, there was an average Vif (tolerance) of 1.93 which is below 10 and tolerable (multicollinearity linearity was not a serious problem). As a result, all the variables in the list were considered for the model analysis.

4.2.1.1. Heckman analyses. The econometric analysis for the Heckman two-step estimation procedures was performed using Stata version 12. The probit estimate predicts each household's likelihood of marketing decision on the livestock market; in the second stage, it analyzes the determinants of the level of livestock marketing. Kyaw et al. (2018) proposed utilizing the preference variable which is expected to have a significant effect on the marketing judgment, but not the sum of promotion in the preferential equation which helps to accurately estimate the inverse Mills ratio. This work has also used distance as selection variables in the probit model/marketing equation, which has been shown to affect the decision on the marketing of livestock but has no major effect on the amount of marketing in order to correctly estimate the lambda (inverse Mills ratio).

4.2.1.2. Livestock commercialization decision. The model output reports the estimation result of variables that are expected to determine livestock commercialization by households (Table 6). Head of household employment, size of family, the ability to drive to the nearest market center, and gross held livestock were found to determine the probability of livestock commercialization decision.

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Table 6. First stage probit evaluation effects of variables influencing the likelihood of a model decision on the marketing of livestock			
Variable	**Coefficient**	**Marginal effect** $\frac{\partial P(y=1/x)}{\partial x}$	**p>/z/**
Household age	−0.03(0.02)	−0.000721	0.232
Household education	0.081(0.12)	0.00456(.000458)	0.045**
Household sex	1.4738(5.5765)	0.7365(0.00134)	0.245
Family size	0.4542(0.159)	0.0839 (.01091)	0.002*
Distance	−0.521(0.059)	−0.00925(0.00678)	0.042 *
Visit by extension agents	0.725(0.0623)	0.00346(.00235)	0.134
Total livestock owned	0.09851 (.04523)	0.02365(0.01452)	0.000*
Market information	0.423(0.241) (.02458)	0.00452(.00367)	0.137
Owned land size	0.4281 (.00045)	0.02451(.00489)	0.112
Constant	12.6521(15.756)		

No. of observations = 183, LR chi^2 (9) = 138, Pseudo R^2 = 0.62.12. The values in parenthesis are robust standard errors. * * and *: 5 percent and 1 percent statistically important, respectively.

Level of education of the household head: As expected, households with literate heads have higher livestock commercialization. Literacy of head increases the proportion of output sold by about 8.1 percent on average for the population of the study.

Family size: The measure is statistically important at a point of importance of less than 1 percent. As predicted, the predictor has a positive impact on the marketing decision likelihood. The optimistic and important association suggests that because livestock rearing is a labor-intensive practice, greater family size offers more labor for efficiently undertaking livestock maintenance in processing and management operations, which in effect raises the level of contribution to improved potential for decision to sell livestock. The marginal impact of the variable often emphasizes that the likelihood of marketing decision of the household rises by 45.42 percent for each individual in a family.

Total livestock owned: The total livestock owned is linked positively and statistically to the livestock market commercialization decision. The marginal impact of the equation indicates that one livestock in the household leads to a 9.8 percent increase in the livestock market commercialization decision because many in number could result in a high surplus of livestock left from consumption and/or way of life which can increase the motivation of households to sell the extra in the livestock market.

Distance: As predicted, the gap to the closest business center had a detrimental influence on the marketing decision and was statistically relevant at a point of less than 5 percent. This could be due to the reason that their decision will be diverted to simply consumptions or way of life than selling and buying new ones.

The negative relationship suggests that the farther a household is from the nearest livestock market, the more difficult and expensive it will be to get involved in the business. The marginal effect also confirms that increasing the distance between the livestock market and the livestock farm owner by one kilometer reduces the likelihood of commercialization in the livestock market by 5.21 percent.

4.2.1.3. Heckman selection model. Performance of the Heckman second-stage collection calculation for household degree commercialization in livestock market in terms of sales amount of

livestock (cow, ox, sheep, and goat) is presented in Table 7. Maximum joint fit parameter is estimated for the second stage. Heckman selection model was calculated on the basis of the Wald chi-square method. The chi-square analysis, which apply a reasonable degree of independence, indicates that the overall success of the second stage of Heckman selection model is statistically significant with a likelihood of less than 1 percent. This means that the Heckman selection model's variables explained the degree of the marketing of livestock sales. Four explanatory variables in Heckman's second-stage selection model, including household head education, extension agent visits, overall livestock held, and held land area, had a significant impact on the amount of livestock marketing.

Household level of education: The household head's schooling degree has a favorable impact on the livestock marketing which is statistically relevant at a chance degree of less than 10 percent. The positive and important relationship suggests that schooling strengthens the capacity of livestock households to process relevant development and market-specific knowledge, which in effect boosts the bargaining role. The assumption is that household head's degree of schooling more certainly raises the probability of business involvement. The probable reason for this is that the farmers' standard knowledge raises the know-how of farmers, awareness, and experience in agricultural development. This condition lets farmers get higher production, which contributes to more market participants. The model production shows that one structured year of schooling contributes the livestock household to a 30.6 percent rise in the amount of livestock sales' selling. This finding is aligned with the favorable association that Mekonnen and Worku (2011) noticed between access to education and business outlet preference.

Total livestock owned: Total livestock ownership is strongly linked and statistically important to marketing point. It suggests a spike in ceteris paribus livestock volume per household, which results in a 42.35 percent increase in the level of commercialization. This is because the stock of livestock would result in a high surplus left from the way of life and own consumption which can increase the involvement of farmers in livestock market. The result is consistent with that of Motbainor and Taye (2019).

Table 7. Second stage results of Heckman selection estimate for livestock marketing level			
Variable	**Coefficient**	**Standard error**	**p>/z/**
Household head age	−0.00452	0.00896	0.214
Education degree of household head	0.30670	1.37423	0.0672**
Household master sex	−0.18756	0.15876	0.423
Family size	1.2831	0.5939	0.365
Distance from the nearest center	−1.08752	0.265590	0.412
Transportation access to market center	0.34761	0.34672	0.856
Visit by extension agents	0.7856	0.50636	0.076***
Total livestock owned	0.4235	0.72562	0.002*
Access to market information	6.8945	5.37214	0.986
Previous year's price	0.42765	0.34756	0.147
Owned land size	.8965	0.2006	0.006*
Lambda	−0.4509	0.401	0.129

Censored observations = 112, uncensored observations = 71, wald chi2 (11) = 84.35 *, Rho = −4.9562, sigma = 2.2352.
***, **, and *: 10, 5, and 1 percent statistically important, respectively.

Visit by extension agents: The model result shows that extension services given by the respective office to the head of the household had a strong and important impact on the degree of livestock marketing of the households studied. The strong and significant interaction between the two variables reveals instead of additional service, and training, operation, and distribution of the respective officers could increase the household head's capacity to produce and manage the livestock and access necessary information on market, production, and management of the livestock, thereby growing the possibility of targeting the livestock sector at the household level. The coefficient also confirms that when the household gets visited by extension agents (access to extension service increases by one unit), the probability of household head's level of livestock commercialization increases by 78.56. This finding is not compatible with that of (Pingali et al., 2019), according to which, exposure to extension service has been correlated with the amount of potato marketing adversely and substantially.

Owned land size in hectare: Land area has a favorable impact on livestock marketing rates and was shown to be important at a chance level of 1 percent. The positive relationship between the variables demonstrates that each additional hectare of land provides an opportunity to generate livestock food and a rearing area that will lead to a rise in livestock per household and thus lead to an improvement in the sale of livestock. Farmers with broad scale land plots, on the other side, will grow more animals and implement modern technology for surplus growth, which thus promotes consumer supply. The equation further shows that if the property held by the household decreases by one hectare, the risk of the livestock marketing amount of the household head further rises by 89.65 percent. This result is compatible with that of (Pingali et al., 2019) who postulated that land management is explicitly connected to the potential to produce a marketable surplus.

Lambda: The correction factor of the Lambda (Inverse Mills Ratio) or selectivity bias has a negative yet statistically negligible effect on livestock marketing according to the model production. This finding indicates that there seem to be no non-observed variables that may influence both the probability of decision to sell livestock and therefore the amount of marketing. Nevertheless, the negative sign of the Inverse Mills Ratio suggests that non-observed factors occur and negatively influence both the marketing decision and marketing power.

Table 8 reveals the challenges that households had been facing during their livestock rearing and marketing. Among the challenges they rated, lack of marketing infrastructure, shortage in pastoral land, and livestock diseases took the lions share. This could mean that they did not get post rear of livestock sometimes. Moreover, did not also received the same price of livestock in the previous year. Besides, their rearing seems traditional hence their livestock will be easily vulnerable to disease and death as well.

Table 8. Households' perceptions towards challenges in livestock commercialization	
Variable	**Observation**
Water scarcity	71
Drought	14
Shortage in pastoral land	171
Livestock diseases	154
Lack of marketing infrastructure	174
Problem of roads	86
Others	Not mentioned

5. Conclusion

In several developing countries, including Ethiopia, the change from a subsistence-oriented production system to a market-oriented production system as a means of raising smallholder incomes and growing rural deprivation has been at the center of the agenda. To aid maintain healthy wages and safe livelihoods, it is therefore imperative to improve the decision to market by the smallholder as well as the level of marketing. Endamehoni district is one of northern Ethiopia's future livestock growing regions. Nevertheless, livestock productivity and market participation are limited. This analysis, then, was undertaken with the objective of livestock market commercialization in endamohoni area (woreda), Northern Ethiopia.

The strategy of encouraging the export of livestock products has been widely positive today, but studies will also concentrate on enhancing the productivity of smallholders manufacturing livestock products for the local market, both in order to satisfy the growing demand for livestock products and also in order to improve the industry to face the challenges of globalization. Livestock is an essential source of income for the majority of Ethiopian farmers, especially those in northern regions; thus, its production has significant consequences for poverty reduction and income distribution. Livestock development offers the ability to capture higher value added per hectare than crop-based farming, especially in the sense of an agrarian system characterized by very small farms. There are productivity improvements in both crop and livestock output to be achieved by their growth in an integrated framework. The evidence shows that livestock may act as a significant growth factor in supplying farm households with a large proportion of cash income, which in turn can have powerful multiplier effects on local economies. In the livestock sector in Ethiopia, there are many problems related to commercialization and economies of scale. These revolve around the differing rates of size between small- and large-scale farmers, high production costs and supply exposure, restricted business prospects, and livestock production commercialization.

Regarding households' perceptions towards challenges in livestock commercialization, there were several challenges that the households had to deal with including water scarcity, drought, shortage in pastoral land, livestock diseases, lack of marketing infrastructure, and the problem of roads. To address policy implications, it can be suggested that to mitigate climate change impacts (water scarcity and drought), the implementation of water infrastructure (e.g., pumping, dams, wells, etc.) will aid households to boost productivity. Considering shortage in pastoral land, it can be suggested that higher commercialization will probably lead structural changes, where some farms exit and other will expand their land area on their account and become more commercial at the end. To mitigate livestock diseases, extension services could play a critical role. Extension services must consider farmers' perspectives, improve their knowledge base, involve them in participatory learning processes, and empower women, who are often the ones who look after the livestock in order to be effective. Finally, to address the challenges linked to markets and road, the relevant infrastructure by state should be improved toward promoting more productive and sustainable livestock management.

Growth of the livestock industry depends on certain economies of scale in processing and feed production. Nevertheless, the bulk of livestock production in Ethiopia is carried out by small-scale farmers. The hope is that greater cooperation between the commercial sector and smallholder farmers will offer major benefits to the rural community and mitigate poverty. The challenge is how smallholder producers' production systems can be integrated with those of big businesses. The most successful means of supporting the livestock sector is by selecting the most commercialized product and producers. Evidence has demonstrated that even small-scale farmers are extremely market-oriented and that small-scale expert farmers may be as effective as the larger ones. Thanks to the lack of returns on volume in livestock processing, small-scale output is not inherently an obstacle to the sector's performance, given that development is of a specific and

commercialized form and not a form of subsistence. This finding is limited to this (Ethiopia) region because the story may differ in other parts of the world.

The absence of economies of scale in livestock processing does not mean that one form of scale alone is optimum. Optimum size relies on several specific variables related to local service requirements, promotion, technological connectivity, and environmental conditions. In reality, the industry may profit from different output sizes because they are tailored to specific local conditions. The ideal output rate varies as the circumstances shift over time. The key point to remember here is that small as well as big specialists and industrial suppliers will contribute to the sector's growth and output. Finally, policies can be taken as an alternative to enhance the efficient utilization of the existing limited farmland. Improving the income of farmers from the sale of livestock products is a great necessity for smallholder farmers. Adequate availability of inputs to raise farm income for livestock in rural areas may also be emphasized as a policy option to improve market access to products.

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Author statement
Authors are active in the fields of business and economics, social and life sciences, human geography, agricultural marketing, and agricultural entrepreneurship and technologies, that all have strong link with the main topic of the study. The findings of this study contribute to the development of appropriate policy intervention mechanisms to promote agricultural sciences and technologies in the field of livestock commercialization. This study strengthens the ties between agricultural inputs and production aspects. Accordingly, the results of this study will be beneficial to policy makers and smallholder farmers dealing with the commercialization of livestock.

Declaration of interest
We have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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