

Article

Farmers Willingness to Participate In Voluntary Land Consolidation in Gozamin District, Ethiopia

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Received: 10 September 2019; Accepted: 10 October 2019; Published: 12 October 2019



Abstract: In many African countries and especially in the highlands of Ethiopia—the investigation site of this paper—agricultural land is highly fragmented. Small and scattered parcels impede a necessary increase in agricultural efficiency. Land consolidation is a proper tool to solve inefficiencies in agricultural production, as it enables consolidating plots based on the consent of landholders. Its major benefits are that individual farms get larger, more compact, contiguous parcels, resulting in lower cultivation efforts. This paper investigates the determinants influencing the willingness of landholder farmers to participate in voluntary land consolidation processes. The study was conducted in Gozamin District, Amhara Region, Ethiopia. The study was mainly based on survey data collected from 343 randomly selected landholder farmers. In addition, structured interviews and focus group discussions with farmers were held. The collected data were analyzed quantitatively mainly by using a logistic regression model and qualitatively by using focus group discussions and expert panels. According to the results, landholder farmers are predominantly willing to participate in voluntary land consolidation (66.8%), while a substantive fraction of farmers express unease with voluntary land consolidation. The study highlighted the following four determinants to be significant in influencing the willingness of farmers for voluntary land consolidation: (1) the exchange should preferably happen with parcels of neighbors, (2) land consolidation should lead to better arranged parcels, (3) nearness of plots to the farmstead, and (4) an expected improvement in productivity. Interestingly, the majority of farmers believes that land consolidation could reduce land use conflicts. The study provides evidence that policymakers should consider these socio-economic, legal, cultural, infrastructural, and land-related factors when designing and implementing voluntary land consolidation policies and programs.

Keywords: voluntary land consolidation; land fragmentation; maximum likelihood estimation; logistic regression model; sustainable land management; land exchange; rural development

1. Introduction

Land is a scarce resource in Ethiopia, a country whose population relies on farming as the primary source of livelihood [1]. As farming is an essential factor in the Ethiopian economy, land utilization and allocation is an important undertaking in the country [2]. Agriculture is dominating the economy in Ethiopia; it accounts for 37% of the gross domestic product (GDP), which is one of the highest shares in Sub-Saharan Africa. However, landholdings are often fragmented into small parcels; the average

total farm land area per smallholder household is 0.78 hectare, and it is likely to decline further. The average number of plots constituting a household farm is four [3]. Thus, Ethiopian smallholder agriculture is characterized by extremely small farms fragmented into several plots and cultivated in a labor-intensive manner while supporting relatively large families. Many of these farms are too small to meet subsistence needs, particularly when using traditional technology and currently available resources [4,5]. Fragmentation has led to farmers neglecting strips of land far from their houses, leading to reduced agricultural output. The impact of land fragmentation is that farming becomes more and more difficult, expensive, and labor intensive, especially against the background of an expected mechanization of the farming sector in Ethiopia [6]. Adverse effects of land fragmentation have been observed in many countries where spatially separated parcels of land hinder mechanization and increase the likelihood of disputes [6,7].

Land fragmentation is defined as a situation where farmers are cultivating two or more geographically separated plots of land by taking into account the distances between those parcels [8]. Bentley explains land fragmentation as a type of land ownership, where a single farm consists of numerous discrete parcels [9]. Problems often associated with land fragmentation are small sizes, irregular shapes, and dispersed parcels, resulting in higher efforts for cultivation [10,11]. It can be summarized that land fragmentation is not beneficial in terms of agricultural development [12,13].

The studies mentioned above tackle different aspects of land fragmentation. Land fragmentation can be considered from a cultivation perspective, taking into account agricultural production such as variety of crops, quality of soil, and water conditions. In this respect, land fragmentation can also be beneficial by providing a distribution of plots according to the variety of agricultural site qualities. It also can be seen from a land administration perspective considering the geometry (e.g., shape, area, slopes) as well as the land rights (e.g., land ownership, land tenure) [14]. Another aspect would be an environmental one, where cultivation of small parcels is more likely to provide higher biodiversity. The perspective on land fragmentation is also dependent on different stakeholders. These can be farmers, planners, land administrators, environmentalists, agro-economists, etc. Furthermore, perceptions of land fragmentation vary between countries.

In this study, the investigations were focused on Ethiopia and on the viewpoints of farmers. Thus, cultivation and land administration perspectives on land fragmentation were in the foreground.

Land fragmentation is both an indicator and the result of a (frequently problematic) land tenure structure. In some regions, land fragmentation becomes a major problem because it restricts agricultural development and reduces the opportunities for sustainable rural development. Policies to counter land fragmentation are needed for social, economic, and environmental reasons [11] (see also Table 1).

Table 1. Major reasons why policies are needed to counter land fragmentation.

Reason Type	Reason
Social	to decrease disputes amongst neighbors to develop team work
Economic	to increase production to enable self-sufficiency in food production
Environmental	to enhance soil quality to protect water availability to balance climatic condition

Source: Demetriou, D., et al. 2013. A new methodology for measuring land fragmentation.

Even if farmland fragmentation is widespread and may affect farmers' decisions, it can influence farm performance either negatively or positively. Usually, the term land fragmentation is associated with small parcel sizes, improper shapes of individual parcels, long distances of parcels from homestead, and long distances between parcels [15]. Experiences with quantifying the impact of land fragmentation on agricultural production efficiency reveals the negative association. Studies done in Nigeria show that farmers' landholdings are fragmented, small in size, non-contiguous, and interspersed. Fragmentation

of holdings had negative implications for agricultural development [16]. Also, studies in South-East China reveal that land fragmentation can be an important determinant of technical efficiency in rice production. An increase in average plot size increases rice farmers' cultivation efficiency and vice versa [17]. Another study in Nigeria reveals that land fragmentation affects production efficiency by the finding that there is a negative correlation between amount of fragmented land and yield [18]

Even though policy makers often point out the draw backs of land fragmentation, there is no consensus that fragmentation is strictly a negative phenomenon. Bentley argues that the negatives caused by fragmented land holdings are overrated and that the farmers' own views often are neglected by policy makers [9]. Bentley also documents positive aspects of land fragmentation, such as variety of soil and growing conditions reducing the risk of total crop failure. Plots spread over an area sometimes implies micro-climatic variations and multiple ecological zones. Fragmentation also facilitates crop rotation [9]. Additionally, farmers can take advantage of minor differences in local agroecology [19], as they can hedge risk through spatial dispersion [20] and improve agricultural biodiversity [9,19]. In Africa, specifically in Ghana and Rwanda, Blarel et al. found that fragmentation facilitates crop diversification [20]. Studies in Turkey show more fragmentation is positively correlated with increased yields [21].

In land fragmentation research, land consolidation is regarded as a proper measure to facilitate agricultural cultivation, rural development, and land administration [14]. Land consolidation is also seen as an important tool for improving environmental management [22,23]. Land consolidation can be defined as a land use policy tool designed to overcome the difficulties of land fragmentation [24–26]. Land consolidation means a planned rearrangement of land parcels. If done properly, land consolidation supports farmers to amalgamate their fragmented parcels. It facilitates the creation of competitive agricultural production arrangements by enabling farmers to have farms with fewer parcels that are larger and better shaped. In addition, new infrastructure can be established in the consolidated area, for example, to improve accessibility and water management. In turn, this allows farmers to introduce better farming techniques [14]. Making farming more efficient and ultimately more economically viable creates incentives to attract young people into farming and agribusiness. Land consolidation is therefore considered a worthwhile complementary investment, as it improves the efficiency of rural land use and helps to address the challenges of sustainable rural development [27,28]. In Eastern, Western, and Central European countries, high amounts of farmland have been consolidated over the past decades within different governmental frameworks of land consolidation projects. As a result, farmland fragmentation was solved to a high extent [29–32].

According to a Food and Agriculture Organization (FAO) report, a land consolidation program has to accommodate national and sub-national priorities as well as local ones. A land consolidation strategy should address issues such as [14]:

- Institutional issues: what tasks should be done at what level by which institution, and how participatory “bottom-up” involvement should be implemented;
- Financial issues: how money to support land consolidation will be sourced, and how the process can be made cost-effective;
- Legal issues: what the legal basis for implementing land consolidation will be, and how to ensure that the results are not jeopardized (e.g., by heritage);
- Capacity building: how participants can, at all levels and in all sectors, acquire knowledge and skills they need to carry out their responsibilities;
- International cooperation: how countries can gain access to the technical and the financial resources of donors.

Many studies prove the positive association between land consolidation and agricultural productivity. For instance, Asia's Green Revolution is evidence that investments to improve agricultural productivity by land consolidation and by crop intensification have been important for rural poverty reduction [33,34]. Various studies from Asia, South America, and Western, Central, and Eastern

European countries [22,29,35] document that land consolidation policies have contributed to increased agricultural productivity. However, this applies to favorable farming conditions and a certain degree of mechanization. Using household-level data, Nilsson's study found that there is a positive association between land consolidation and crop yields in Rwanda, but only among farm households with land holdings greater than one hectare, which is well above the average farm size in Ethiopia [36].

To improve the Ethiopian agricultural sector, Beyene [2] proposes land reforms in the form of land consolidation as effective and efficient mechanisms to allow the population to invest in farmland. The reforms come in the form of government directing policies that should enable the consolidation of previously fragmented parcels of land [2]. In general, there are four types of land consolidation approaches [14]. These are comprehensive, simplified, voluntary, and individual land consolidation. This article focuses on the third type, as the Ethiopian federal government encourages voluntary land consolidation, and the law states that, "In order to make small farm plots convenient for development, farmers are encouraged to voluntary exchange farmlands" [37]. In line with this law, the land regulation law in the Amhara National Regional State encourages voluntary land consolidation by exchange of land between landholder farmers [38,39]. To encourage voluntary land consolidation, the regulation, enacted in 2006, further states that the government must provide technical services and has to renew landholding certificates free of charge to land holder farmers who exchange plots [39]. However, in practice, the above-mentioned technical support is largely restricted to legal support. The Ethiopian Rural Land Administration and Use determination proclamation and regulations covering land fragmentation and voluntary land consolidation currently lack well defined and detailed procedures, e.g., how to launch and implement voluntary land consolidation schemes, controlling principles to be applied during implementation, inheritance regulations for voluntary land consolidation, and legal measures to avoid future fragmentation.

Even with the already identified positive effects, land consolidation has historically faced challenges. In Central and Eastern Europe, because of post-socialist transformation, cooperative farms now consist of numerous, small, and economically barely viable private plots with a multitude of landowners. To implement land consolidation was difficult because of land ownership and, in particular, values, legitimacy, personal identity, and emotional bonds [40]. In Taiwan, farmers objected land consolidation even when they fully recognized their benefits. Corruption and maladministration of government officials, timing of operation, cost of consolidation, and the fear of receiving low quality land in the exchange process were quoted as reasons against land consolidation [41].

Ethiopia has seen extensive land grabs sponsored by the government as part of its agricultural transformation strategy. The land grabs, involving land consolidation, have been supported by recent Ethiopian policies such as the Growth and Transformation Plan I and II, where the government aimed to transfer a total of 2.3 million hectares to large-scale commercial farming [42]. In many countries, land consolidation did not consider ecological aspects for a long time. Thus, land consolidation processes decreased biodiversity in rural areas and diminished long established habitats of animals around the villages [21,43]. Not surprisingly, in Ethiopia, the above-mentioned failures in land consolidation processes affected the willingness of farmers to participate in such procedures.

Nevertheless, Ethiopia has attempted to improve the economic and the social outcomes of farming in the country. The government, following a recognition that small-scale farmers are perennially underperforming in regard to farm output, invested in land consolidation as a mechanism to improve the fate of the country's agricultural sector. One of the challenges related to agricultural output is fragmentation of land. Thus, these challenges have promoted the willingness of the population to support voluntary land consolidation. Therefore, this study aimed to estimate the willingness of farmers for land consolidation in general and, in particular, to address the factors influencing the willingness of landholder farmers to participate in voluntary land consolidation processes. The investigations were based on interviews with a total of 343 landholder farmers in the Gozamin District, Amhara National Regional State, Ethiopia. In addition, information was gathered in focus group discussion and community consultations.

2. Study Area and Methods

2.1. Description of Study Area

For the purpose of this study, the Gozamin District was selected (Figure 1). The Gozamin District was purposively selected for this study due to:

- The variety of agro-climatic zones leading to diverse types of crop farming practices;
- The considerable degree of land fragmentation;
- The existence of sustainable natural resource management plans;
- The existence of second level land certification documents for landholders (in Gozamin district, all landholder farmers received the documents of completion of second level land certification);
- The authors' local knowledge.

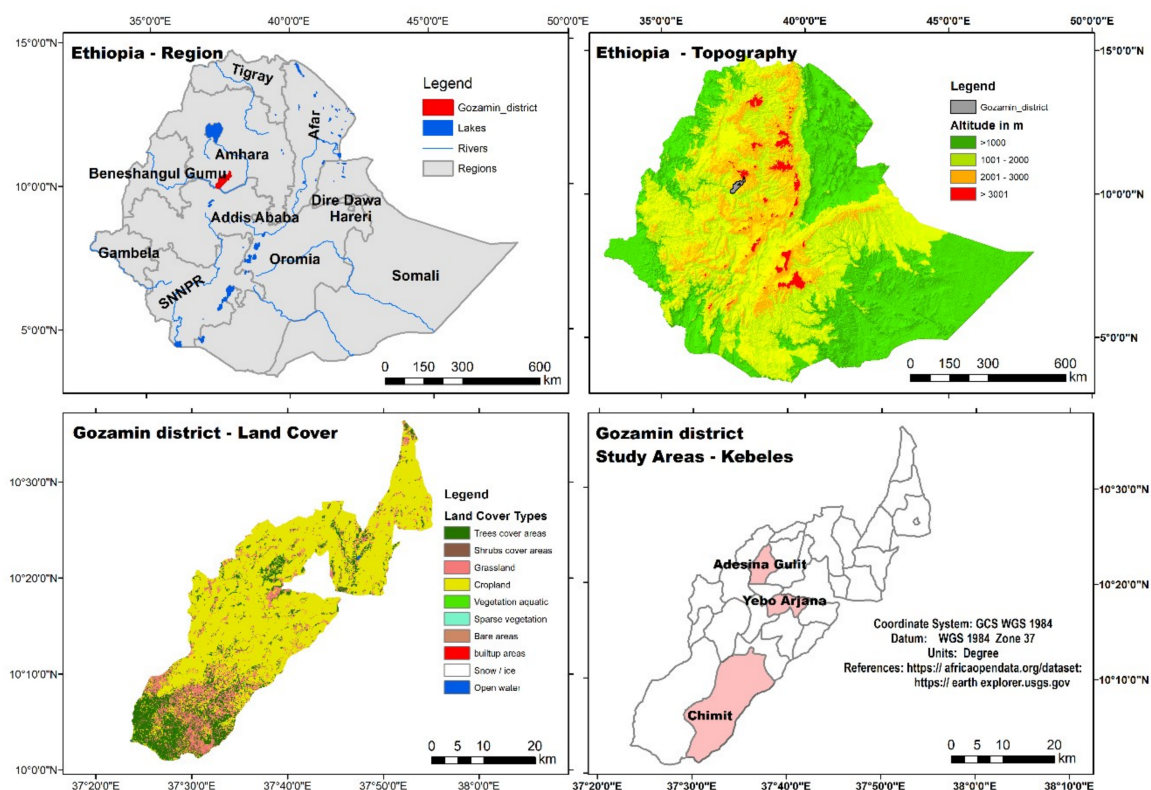


Figure 1. The study area—Gozamin District.

Gozamin district is roughly located 270 km east of the regional capital Bahir Dar and 300 km northwest from Addis Ababa. Debre Markos is the capital of the district and hosts the administrative seat of East Gojjam zone. The district contains 25 rural kebeles (municipalities) in total. Gozamin district has a total area of 1812 km². Its elevation ranges from ~ 1000 m to ~ 3200 m above sea level (m.a.s.l), i.e., the Choke Mountain range. The district is otherwise characterized by a relatively flat landscape, flood plains, and wetlands. Chemoga, Dijil, and Kulech are the major rivers in the district [44].

Gozamin District has 134,000 inhabitants with equal gender balance. The population density is 109 people per km². Sedentary, rainfed, and small scale agriculture constitutes the primary income generating activity within the Gozamin District. People primarily perform mixed cereal agriculture with farmers mainly growing teff, finger millet, sorghum, maize, barley, wheat, pulses, oil crops, vegetables, and fruits.

The ethnicity of the District population is Amhara, and Amharic is people's language [45]. Due to the high anthropogenic influence in the study area, forests have been lost. Remnant plants around holy places, inaccessible areas, left for shade trees, and on grazing lands are observed. Some of the vegetation consists of *Juniperus procera*, *Hagenia abyssinica*, *Podocarpus falcatus*, *Acacia abyssinica*, *Cordia africana*, *Ficus sycomorus*, *Erythrina brucei*, *Eucalyptus camaldulensis*, *Calpurnia aurea*, *Prunes africana*, *Carissa spinarum*, *Rosa abyssinica*, *Dombeya torrida*, and *Maytenus arbutifolia* [46].

2.2. Methodology

2.2.1. Sampling Design and Data Collection

Three kebeles of the Gozamin district were selected for the primary data collection by applying the same criteria as for the selection of the district: Chimit, Yebona Erjena, and Addisna Guilit. From 3277 landholder farmers in three selected kebeles (Table 1), 343 landholders were randomly sampled for interview (115 farmers from Chimit, 131 from Yebona Erjena, and 97 farmers from Adisna Guilit). The sample size of landholder farmers was determined based on the sample size determination equation by Cochran [47]:

$$n_0 = \frac{Z^2 \cdot p \cdot q}{d^2} \quad (1)$$

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \quad (2)$$

$$n_0 = \frac{(0.5) \cdot (0.5) \cdot (1.96)^2}{(0.05)^2} \quad (3)$$

$$n = \frac{384}{1 + \frac{384 - 1}{3277}} = 343(\text{truncatedInteger}) \quad (4)$$

where

n_0 = the desired sample size Cochran's (1977) when population is greater than 10,000;

n = number of sample size when population is less than 10,000;

Z = 95% confidence limit (1.96);

p = estimated proportion of samples with specific attribute (0.5 as cases cannot be estimated a priori);

$q = 1 - p$ (0.5);

N = total number of population (3277);

d = precision or degree of accuracy desired (0.05).

The number of landholders selected for interview from each kebele was determined proportional to the total number of landholder farmers in the kebele (rounded to integer) to guarantee an equal representation of landholder farmers' households in each kebele. The detailed information about the total landholder farmers and samples is documented in Table 2.

Table 2. Number of total landholder farmers and sample landholders of the study area.

Name of Kebele	Total Landholder Farmers	Sampled Landholder Farmers
Chimit	1100	115
Yebona Erjena	1250	131
Adisna Guilit	927	97
Total	3277	343

Sample landholder farmers were selected using the systematic random sampling technique. Sampling frames were obtained for each kebele by taking the list of all landholder farmers in

alphabetical order from the respective kebele administration offices. The sample households were drawn from each administrative unit from the list of names after a certain sampling interval (K) that was determined by dividing the total number of households by the predetermined sample size of each kebele. Next, a number was selected between one and the sampling interval (K) using the lottery method (called the random start) and was used as the first number included in the sample. Then, every K^{th} landholder head after that first random start was taken until reaching the desired sample size for each kebele administration. Systematic sampling was applied because sample units are uniformly distributed over the population [48].

In total, 343 landholder farmers' data were encoded using Statistical Package for Social Science (SPSS, version 24), and the analyses were performed with the "R" software by importing the data from SPSS.

Field data were collected from September 2018 to December 2018. Mainly primary sources were used to collect the data. The primary data were collected using household surveys (HHS), focus group discussion (FGD), and direct field observations. As mentioned before, a structured questionnaire was used for the field interviews. The questionnaire was pre-tested by administering it to selected respondents. On the basis of the results obtained from the pre-test, necessary modifications were made on the questionnaire. Six data collectors with a minimum of a college diploma in related fields of land administration were employed for data collection. Before they started enumeration, a brief explanation about the objectives of the survey and the meaning of each question was given. This briefing was also a contribution towards harmonization of the data collection. Face to face interviews were necessary, as many of the respondents were expected to be illiterate. To avoid language difficulties, two experts in the field of land administration translated the questions from English to Amharic (local language).

In order to supplement the survey with qualitative data, focus group discussions were conducted in each kebele to complement the gathered quantitative information. Participants of FGD were selected based on their knowledge and their experience in agricultural practices. These persons have lived in the kebeles for a long time and constituted the Land Administration and Certification Committee in the kebele (LACC). LACC are representatives from different social groups in the community, including elders, female-headed households, youth, and disabled persons as well as development agents and kebele managers. Nine group discussions were carried out (three in each kebele). Each FGD had 10 to 12 participants selected with the support of the "Kebele Land Administration Officer". The discussion focused on a local-level entity dealing with land-related issues as well as willingness and views of the community regarding voluntary land consolidation and other sustainable land management issues.

In addition, panels and discussion forums were organized with a total of six federal, seven regional, ten zonal, and five district experts. These experts work in rural land administration and land management offices and in other related fields. The discussion with the professionals focused on the accomplishments, the bottlenecks, and the recommendations regarding willingness and determinants of voluntary land consolidation as well as sustainable land management issues.

2.2.2. Variables Specification and Working Hypothesis

A dichotomous dependent variable was defined to specify whether a farmer was willing to accept voluntary land consolidation (WTAVLC = 1/yes) or not (WTAVLC = 0/no). The "yes/no" information about the respondents' characteristics enabled the application of binary response models such as the logit model.

The independent variables applied in the current study were hypothesized to have a relationship with the willingness to accept voluntary land consolidation. Based on the findings of previous and current studies on the adoption of land consolidation, the existing theoretical clarifications, and the authors' understandings of the status of land consolidation in the study area, 13 explanatory variables were identified. These variables, listed in Appendix A, were hypothesized to influence farmers' willingness to accept voluntary land consolidation (see Appendix A).

2.2.3. Method of Data Analysis

Farmers' decisions to adopt or reject land consolidation were influenced by socio-economic, demographic, institutional and biophysical factors, as described in Appendix A. Modeling landholder farmers' opinions to land management innovations such as land consolidation was important both theoretically and empirically.

The analysis of the relationship between the willingness and the determinants (variables) involved a mixed set of quantitative and qualitative data. Usually in such types of studies, the response (dependent) variable is dichotomous, taking on two values:

- The value 1 if the event occurs;
- The value 0 if it does not.

Estimation of this type of relationship requires the use of qualitative response models. In this regard, linear probability models (LPM) are possible alternatives. In LPM, the dichotomous dependent variable is expressed as a linear function of the explanatory variables. Although LPM can be estimated by the standard ordinary least squares (OLS) method, the results can cause several problems [49]. However, the OLS regression technique, when the dependent variable is binary (0,1), produces parameter estimates that are inefficient and in a heteroscedastic error structure. Consequently, hypothesis testing and the construction of a confidence interval become inaccurate and misleading. Likewise, a linear probability model may generate predicted values outside the 0–1 interval, which violates the basic tenets of probability.

To get rid of these problems and to produce relevant empirical outcomes, the most widely used qualitative response models are logistic regression and probit models (logit and probit models) [50]. Amemiya [50] points out that the choice between logit and probit models is difficult because of the statistical similarities between the two models. However, Maddala [51] reports that the logistic and the cumulative normal functions are very close in the mid-range, but the logistic function has slightly heavier tails than the cumulative normal function. Gujarati [52] also illustrates that the logistic and the probit formulations are quite comparable, the chief difference being that the former has slightly fatter tails, that is, the normal distribution curve approaches the axes more quickly than the logistic distribution curve.

For this study, the logistic distribution function (*logit* model) was applied, as it represents a close approximation to the cumulative normal distribution. Moreover, it is relatively simple from a mathematical point of view and lends itself to a meaningful interpretation. According to Aldrich and Nelson [49], the binomial logistic regression distribution function can be specified as:

$$p_i = \frac{e^{Z_i}}{1 + e^{Z_i}} \quad (5)$$

where p_i denotes the probability that the i^{th} landholder farmer is willing to accept voluntary land consolidation. Z_i is a linear function of m explanatory variables (X) and is expressed as:

$$Z_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \dots + \beta_m X_{mi} \quad (6)$$

where β_0 is the intercept and β_i , slope parameters to be estimated in the model. The slope gives evidence as to how the log-odds in favor of willingness to accept land consolidation change as the independent variables change.

The stimulus index Z_i also refers to the natural logarithm of the odds ratio in favor of willingness to accept voluntary land consolidation. The odds to be used can be defined as the ratio of the probability that a landholder farmer is willing to accept voluntary land consolidation (p_i) to the probability that he/she is not ($1 - p_i$).

$$\ln\left(\frac{p_i}{1 - p_i}\right) = \ln(e^{\beta_0 + \sum_{p=1}^m \beta_p X_{pi}}) \quad (7)$$

If the disturbance term U_i is taken into account, the logit model becomes:

$$Z_i = \beta_0 + \sum_{p=1}^m \beta_p X_{pi} + U_i \quad (8)$$

Hence, the above model was used in this study and was treated against potential variables assumed to affect the decision to accept voluntary land consolidation. The parameters of the model were estimated using the iterative maximum likelihood estimation (MLE) procedure. In reality, the significant explanatory variables do not all have the same level of impact on landholder farmers' decisions to accept voluntary land consolidation. The impact of each significant explanatory variable on the probability of landholder farmers' willingness to accept voluntary land consolidation was computed by keeping the dummy variables at their most frequent values (zero or one).

3. Results

3.1. General Descriptive Analysis

Of the 343 sample landholder farmers, 229 (66.8%) were found to be willing to accept voluntary land consolidation, whereas the remaining 114 (33.2%) landholder farmers were not willing to accept voluntary land consolidation. Table 3 shows that the two categories of sample landholder farmers differed in various aspects.

Table 3. Summary of dummy variables used in the logistic regression model.

Variable Name	Variable Type	Farmers Willing (%)
Educational Level	Dummy	45.2
Farm to Home Nearness	Dummy	60.6
Extension Program Participation	Dummy	73.2
Parcel Exchange	Dummy	65.9
Parcel Preference	Dummy	47.8
Knowledge	Dummy	53.6
Attitude	Dummy	57.7
Perception	Dummy	60.1
Conflict Reduction	Dummy	53.6
Tenure Security	Dummy	55.7
Trust	Dummy	53.4

Source: Model output.

The survey results (Figure 2) show that 45.2% of landholder farmers were literate. The respective percentages for willing and non-willing landholder farmers were 51.5% and 32.5%. Furthermore, 72.9% of landholder farmers who were willing to accept land consolidation voluntarily had parcels close to their home, whereas 36% of non-willing landholder farmers had parcels found near to home. Out of landholder farmers who were willing to accept land consolidation voluntarily, 80.3% had participated in extension programs. The respective percentage for the non-willing landholder farmers was 58.8%.

Results also show that 65.9% of landholder farmers required an exchange of parcels with his/her neighbor. The respective percentage was 90.4% who were willing to exchange parcels with his/her neighbor, whereas only 16.7% of non-willing landholders exchanged parcels with his/her neighbor.

Additionally, 67.2% of landholder farmers were willing to cluster their parcels, whereas only 8.8% of non-willing landholders preferred clustering, and 72.5% of willing landholder farmers had knowledge about the process of land consolidation and its regulations, whereas only 15.8% of non-willing landholder farmers had land consolidation and regulations knowledge. Results show that 71.6% of willing landholder farmers had a positive attitude. Only 29.8% of the non-willing landholder farmers had a positive attitude towards land consolidation processes.

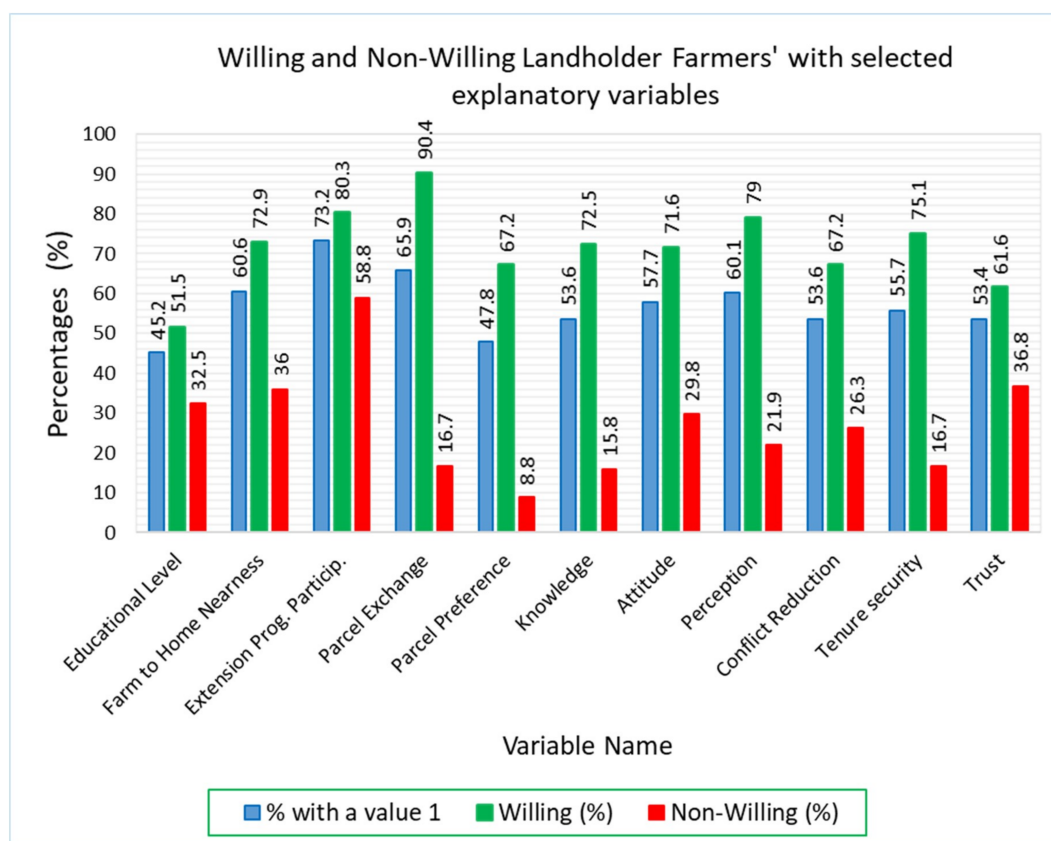


Figure 2. A bar graph showing willing and non-willing landholder farmers with selected explanatory variables.

Landholder farmers had different perceptions that land fragmentation reduces agricultural productivity. The results show that 60.1% of landholder farmers were willing to accept land consolidation voluntarily. From these, 79.0% of willing landholder farmers perceived that land fragmentation reduces agricultural productivity, whereas only 21.9% of non-willing landholder farmers did not believe that land fragmentation reduces the agricultural productivity. Moreover, 67.2% of willing landholder farmers agreed that land consolidation reduces boundary disputes, but only a few (26.3%) non-willing landholder farmers assumed that land consolidation would reduce conflicts.

In total, 75.1% of willing landholder farmers perceived that land consolidation would secure his/her land, but only 16.7% of non-willing landholder farmers perceived that land consolidation would secure his/her land. Regarding trust of landholder farmers to neighbors to exchange land, results imply that 61.6% of willing landholders trusted his/her neighbor to exchange lands, and 36.8% of non-willing landholders trusted his/her neighbor to exchange land.

A more detailed investigation (Table 4) considering the age structure of landholder farmers provided evidence that the average age of the willing landholder farmers was 48 years with 11.3 standard deviation and non-willing landholder farmers was also 48 years but with 9.8 standard deviation. The median age for willing landholder farmers was 48 years, but for non-willing landholder farmers, it was almost 47 years. The average size of farm of landholder farmers was 1.29 ha. Its standard deviation was 0.7. Willing landholder farmers had an average farm size of 1.32 ha with 0.7 standard deviation; non-willing landholder farmers had 1.23 ha, and its standard deviation was 0.8. The median of farm area for willing landholder farmers was 1.25 ha, and for non-willing landholder farmers, it was 1 ha.

Table 4. Summary of continuous variables used in the logistic regression model.

Variable Name	Age	Farm Area
Measurement Unit	Years	Hectares
Mean Value		
All	48.7	1.29
Willing	48.9	1.32
Non-willing	48.4	1.23
Median Value		
All	48.0	1.00
Willing	48.0	1.25
Non-willing	46.5	1.00
Std. Deviation		
All	10.8	0.70
Willing	11.3	0.70
Non-willing	9.8	0.80

3.2. Results of the Logistic Regression Model

The logit model was used to analyze the influencing factors of landholder farmers' willingness to accept voluntary land consolidation. The landholder farmers were either willing or not willing to accept voluntary land consolidation. Consequently, the variable willingness to accept voluntary land consolidation (WTAVLC) was used as a binary variable. Value 1 indicates the willingness of the landholder farmer in regard to voluntary land consolidation, and value 0 indicates the opposite. The logistic regression model was estimated using the iterative maximum likelihood estimation procedure. Table 5 documents the results of the model.

Table 5. Results of the logistic regression model.

Explanatory Variables Name	Estimated Coefficients	Odds Ratio	Wald Statistics	Significance Level
Age	−0.009	0.991	0.069	0.793
Educational Level	0.827	2.286	1.813	0.178
Farm Area	−0.334	0.716	0.445	0.505
Farm to Home Nearness	1.890	6.621	8.319	0.004 **
Extension Program Participation	0.404	1.498	0.312	0.576
Parcel Exchange	3.656	38.716	28.450	0.000 ***
Parcel Preference	3.233	25.361	18.999	0.000 ***
Knowledge	1.869	6.484	4.379	0.036 *
Attitude	0.455	1.577	0.533	0.466
Perception	2.203	9.054	11.786	0.001 **
Conflict Reduction	1.785	5.962	7.456	0.006 **
Tenure Security	1.333	3.794	3.042	0.081
Trust	1.238	3.448	4.043	0.044 *
Constant	−7.200	0.001	15.175	0.000
Percent correctly predicted	95.6 ^a			
Sensitivity	96.54 ^b			
Specificity	93.80 ^c			
Chi-square value	351.505 ***			
Number of cases	343			

***, **, * Significant at $p < 0.001$, $p < 0.01$, and $p < 0.05$ probability levels, respectively. ^a Based on 5050 probability classification scheme. ^b Correctly predicted willing landholder farmers. ^c Correctly predicted non-willing landholder farmers.

The model results approved the a priori hypothesis that landholder farmers' willingness to accept voluntary land consolidation was influenced by the interaction of several factors. The Chi-square value documents that the parameters included in the model were significantly different from zero at $p < 0.001$ probability level.

Another measure of goodness of fit was based on a scheme that classified the predicted value of the dependent variable (WTAVLC) as 1 if $P(i) \geq 0.5$ and as 0 otherwise. The model correctly predicted 95.6% of the observed values. The sensitivity (the number of willing landholder farmers correctly predicted by the model as willing landholder farmers) was 96.5%, while the specificity (the number of non-willing landholder farmers correctly predicted by the model as non-willing landholder farmers) was 93.8%. Therefore, the model predicted both groups accurately. The signs of all the coefficients turned out to be consistent with the a priori anticipations.

Table 5 shows the signs, the magnitudes, and the statistical significance of the estimated parameters. Of the thirteen variables hypothesized to explain landholder farmers' willingness to accept voluntary land consolidation, two were found to be significant at $p < 0.001$ (0.1%) probability level. These included landholder farmers' need to exchange parcels with the neighbors and landholder farmers' preferences for their parcels to be clustered. Table 5 also gives evidence that three variables were significant at $p < 0.01$ (1%) probability level. These variables were landholder farms' nearness to home, landholder farmers' perception that land fragmentation reduces the agricultural productivity, and landholder farmers' acceptance that land consolidation reduces boundary conflicts. Knowledge of landholder farmers and landholder farmers' trust to exchange lands with neighbors were found to be significant at $p < 0.05$ (5%) probability level.

4. Discussion

Results show that the landholder farmers who were keen to exchange parcels with neighbors had a high degree of willingness to accept voluntary land consolidation. The possible explanation is that landholder farmers exchanged their parcel to cluster the land in one place and to avoid fragmentation. This result is supported by studies in the Ukraine by Malashevskyi et al., which studied parcel exchange aimed at regrouping a significant amount of land use in order to optimize their structure and to consolidate land [53]. This hypothesis also was confirmed in the focus group discussions. Participants said that, in the study area, land exchange has long been tradition, and landholder farmers are motivated to swap the parcel with neighbors by the prospect of better access to irrigable land, facilitation of farm operations, and shorter distance to homestead. Having closer distances to main roads and town infrastructure as well as to plots of a family member in addition to having parcels with higher fertility were further reasons. Currently, the government is giving legal support to secure land use rights for those who swap parcels. During community consultations, a few landholder farmers raised issues and concerns about the risks associated with concentration of farm land in one place, such as infestation by army worm, destruction by floods, and soil fertility differences of parcels. As reasons for parcel exchange, during the expert panel, the experts noted facilitation of agricultural mechanization, better access to irrigable land, and a facilitation of cultivation on consolidated land.

Similarly, the preference to cluster parcels was strongly correlated with landholder farmers' willingness to accept voluntary land consolidation. This result also was confirmed by the discussion with selected farmers. Concentration of farmland in one place facilitates easier and more regular monitoring of the agricultural land. Aggregated plots simplify fertilization and composting. In addition, accumulated land enables the planting of permanent crops in combination with livestock fattening and easy input for transport, saves labor, improves yield due to timely operation of parcels, and facilitates agricultural mechanization. Farmers also expected that aggregated parcels would enable them to put more land under irrigation (including opportunities to intensify use of underground water for supplementary irrigation).

Plot nearness to home had a positive effect on the willingness of landholder farmers to accept land consolidation. This was considered as time taken to move from homestead to parcels as well as

from parcel to parcel. This result of the current study is supported by findings by Zeng et al. in Jiangsu province, China, which indicate that, after land consolidation, the average distance from dwellings to the plots decreases, which is also caused by an improvement of the road network [54]. Other studies worked on in Ethiopia by Paul et al. and Teshome et al. indirectly support the plot nearness to home as a positive effect with the finding that fragmentation usually increases distances from the parcel to the homestead [1,42]. In focus group discussions carried out in the current study, the landholder farmers stated their preference for parcels to be located close to their house, as transportation activities and labor forces would be reduced. The farmers also confirmed that they are able to protect and monitor parcels near the house more easily. This aims to produce higher productivity and better output.

The perception that land fragmentation can reduce productivity affected the willingness of voluntary land consolidation positively and significantly. This finding is consistent with other studies done by Nilsson et al. and Alemu et al. in Rwanda and Northern Ethiopia, respectively, which document the correlation between land fragmentation and yield reduction [36,55]. Similarly, a study done in Rwanda shows that the increase in land fragmentation is associated with a negative effect on yields [55]. Studies conducted in Rwanda by Bizoza et al. and Cioffo et al. also assure the association of positive productivity effects with land consolidation [56,57]. A Chinese study confirms that land consolidation processes (opposed to land fragmentation) enable changes of land use types with significant effects on increasing agricultural production [58]. Zeng et al. [54] confirm that land consolidation enhances grain yield capability. Qualitatively, this result was supported in the discussion with the community members. Most of the participants agreed that land fragmentation is a source for low yields, because farmers who cultivate scattered plots run a higher risk of losing their harvest to wild animals, as their plots are too far away for them to regularly monitor. They also mentioned the burden on children who carry food to family members working on distant parcels during harvesting seasons. Also, the participants emphasized the difficulty of using even small agricultural machines, such as three-wheeled multi-purpose tractors, on discontinuous plots as obstacles for agricultural mechanization. Some community members did not directly identify a negative effect of fragmentation on productivity, however, they mentioned that the additional time and effort required to manage distant parcels negatively affects productivity. A few of them considered land fragmentation as a risk spreading strategy, minimizing the risk of harvest loss by planting crops in different locations.

As expected, the determinant “perception of conflict reduction” positively and significantly influenced the willingness of landholder farmers to accept voluntary land consolidation. This finding is approved by former studies done in Turkey by Akkaya et al., which states land consolidation as an effective solution against conflicts raised by land fragmentation [59]. This also was confirmed in the focus group discussion. During community panel, landholder farmers gave evidence that, on the one hand, land fragmentation increases conflicts related to land use and, on the other hand, land consolidation minimizes land use related conflicts. On these issues, experts also confirmed that parcels concentrated in one area have reduced land related conflicts compared to parcels found in a scattered place.

The model results confirm that knowledge of landholder farmers about land consolidation had a positive and significant effect on the dependent variable. This result is confirmed by previous studies conducted by Terano et al. and Gessesse et al. in Iran and China, respectively, indicating that when farmers are aware of land consolidation, their adaptation improves significantly [60,61]. The result was supported by information gained in focus group discussion with landholder farmers. Most of them agreed that knowledge is a key element to adopting a new practice—in this case, land consolidation. In addition, participants emphasized the need for repeated events to raise awareness and clarify issues through combined use of local and scientific knowledge.

The determinant “trust of neighboring landholder farmers” was also positively and significantly related to willingness to accept land consolidation voluntarily. It is conducive to collective action such as voluntary land consolidation. This finding is in line with previous studies done by Bizoza et al., Bouma et al., and Nyangena in Rwanda and rural Kenya, respectively, which indicate that

trust constitutes an important feature of social capital assets and is a key element for successfully implementing land consolidation procedures [56,62,63]. Furthermore, capacity strengthening of local leaders, especially at village level, is required so that they are able to sensitize farmers on all aspects regarding land use and management reforms. This is likely to allow farmers to be confident in the process of voluntary land consolidation.

Tenure security of landholder farmers was positively and significantly related to the willingness to accept land consolidation voluntarily. This finding of the current study is supported by investigations done by Demetriou et al. showing that land consolidation is suitable to support land tenure security [11]. Similarly, another study by Zeng et al. in China reports that land consolidation facilitates land tenure transfer and security [54]. The focus group discussion confirmed that a concentration of parcels and consolidated plots increase the land holding capability and the security of land use rights.

Sensitivity Analysis

The above outlined explanatory variables do not equally affect the landholder farmers' willingness to accept voluntary land consolidation. To rank these variables, a "distinctive landholder farmer" can be defined using the most frequent values of the dummy variables. Accordingly, a distinctive landholder farmer:

- Has participated in an extension program (73.2%);
- Needs to exchange parcels with neighbors (65.9%);
- Has one of the parcels nearest to home (60.6%);
- Perceives that land fragmentation reduces productivity (60.1%);
- Has a positive attitude to land consolidation (57.7%);
- Perceives land consolidation as a way to secure land use rights (55.7%);
- Has awareness that land consolidation reduces boundary conflicts (53.6%);
- Trusts neighbors to exchange land (53.4%).

The probability that the distinctive landholder farmer would show interest in willingness to accept voluntary land consolidation was computed to be 0.59. However, the probability declined by 4.1% for those landholder farmers who were distinctive in all respects except that they did not have parcels near home. Similarly, the probability declined by 5.9% for those landholder farmers who were distinctive in all respects except that they did not have need to exchange parcels. Moreover, the probability of willingness to accept land consolidation decreased by 3.8% for those landholder farmers who were distinctive in all respects except that they did not perceive that land fragmentation reduces productivity. The effects of two other significant dummy variables are documented in Table 6.

Table 6. Change in probability as a result of a change in significant explanatory variables.

Description	Probability	Change in Probability	Percentage Change in Probability
A distinctive landholder farmer	0.59		
A distinctive landholder farmer but does not have parcel near home	0.57	−0.02	−4.1
A distinctive landholder farmer but does not have need to exchange parcels	0.56	−0.04	−5.9
A distinctive landholder farmer but does not perceive land fragmentation reduces productivity	0.57	−0.02	−3.8
A distinctive landholder farmer but does not have land consolidation reduce boundary conflicts	0.59	−0.01	−1.4
A distinctive landholder farmer but does not know land consolidation definition and its regulations	0.59	−0.01	−1.4

Source: Model output.

5. Conclusions

A fundamental part of any strategy towards more productive and sustainable agriculture as well as towards rural development enables farmers and food producers to utilize new methods of agricultural cultivation with higher efficiency, transparency, and competitiveness. In Ethiopia, agriculture is the foundation of the country's economy, accounting for 37% of their gross domestic product; however, it is overwhelmingly of a subsistence nature. Farmers lack the means to improve production due to the fragmentation of landholdings, the insecurity of tenure, the absence of modern agricultural technologies, and the lack of proper land management. The government's policy is to promote agriculture. One of the governmental land policies is encouraging voluntary land consolidation as a strategy tool to address the challenges of traditional agricultural practice. The current study gives evidence of a high degree of willingness by landholder farmers to accept voluntary land consolidation. Land consolidation is seen as a proper instrument to increase agricultural productivity and to improve the management of natural resources. Land consolidation is a driver for rural development and contributes essentially to the improvement of land administration systems. Land consolidation reduces land fragmentation and enables an economic cultivation of agricultural land. Finally, land consolidation is an excellent tool to improve road infrastructure and erosion management in rural areas.

In this study, a total of 13 factors hypothesized to influence the willingness of landholder farmers in regard to voluntary land consolidation were evaluated by using a logistic regression model. Findings were presented.

In focus group discussion, landholder farmers identified the following risks of voluntary land consolidation. They fear decreased cropping diversity with increased vulnerability to vermin epidemics as well as an increased risk of crop failures due to local natural disasters such as heavy rain, hail, and floods. Likewise, farmers also mentioned different soil quality, different fertility levels, and different slopes of parcels as obstacles for land consolidation. In addition to these, land scarcity, infrastructure problems, heritage law, accessibility to water resources for irrigation, and financial issues were seen as challenges that cannot be met by land consolidation procedures.

Currently, at the governmental level, there is no authority for supporting the implementation and the monitoring of land consolidation. This shows that the government does not give much attention to land consolidation. There is a lack of technical knowledge and facilities for land consolidation as well as a lack of transparent and clear regulations for voluntary land consolidation.

Despite the problems identified in the study area, many landholder farmers are willing to accept voluntary land consolidation. The conducive local environment is able to push voluntary land consolidation in a systematic manner. There are opportunities to create land consolidation projects in the study area.

Based on the investigations carried out in the study, the authors recommend the following activities for pushing land consolidation processes:

- Land exchange is a key element of land consolidation. The willingness of farmers in regard to voluntary land consolidation became evident by the quantitative and the qualitative surveys outlined in this study. It is the task of the government to facilitate legal land exchange;
- Landholder farmers are interested in aggregated and clustered parcels. Governmental authorities should provide the legal framework to enable consolidated agricultural land fragmentation while preserving environmentally important landscape structures;
- Findings of the study give evidence that landholder farmers prefer to have their parcels situated near the homestead and to have good access to their parcels. The government should enhance accessibility to farms by facilitating road networks;
- Voluntary land consolidation reduces parcel boundary disputes or conflicts. This was proven by the farmers in the survey and in the focus group discussions. Therefore, land administration offices should promote and support voluntary land consolidation to decrease conflicts arising from boundaries;

- Voluntary land consolidation improves the security of land use rights. Access to land and security of land tenure are effective ways to reduce a farmer's vulnerability, to guarantee long-term investments on land, and to conserve natural resources. The government should facilitate components of land registry and surveying of land parcels (cadaster) within land consolidation procedures.

In addition, the authors formulated some recommendations that could not be directly derived from the quantitative analysis of the study but which became obvious during the discussions with respondents:

- Land fragmentation reduces yield. Only land consolidation processes can solve land fragmentation and, as a consequence, enable improved yields. The government has to encourage landholder farmers to participate in voluntary land consolidation. This creates a favorable environment for commercializing mechanized farming and supports agriculture towards higher proficiency and more stable yields;
- In addition, the government should provide loans to landholder farmers to purchase modern technologies to improve the agricultural productivity and to make the work easier for farmers. Loans can be secured by index insurance mechanisms;
- Farmers are not always aware of the benefits of land consolidation. Therefore, land administration offices should continuously inform the rural population about the aims, the benefits, the legal framework, and the implementation of land consolidation procedures.

Land consolidation is a cornerstone for sustainable development, for the alleviation of poverty, for the improvement of rural infrastructure, for mitigated flood and erosion risks, and for an increase of agricultural productivity. Therefore, the Ethiopian government draws attention to voluntary land consolidation in practice. For this, the government has to define policies and regulations taking into consideration the different perspectives of the stakeholders, such as the Ministry of Agriculture, international development partners, policy makers, and especially landholder farmers.

The current study was among the first studies in Ethiopia to investigate the willingness of voluntary land consolidation. However, more research activities and governmental support at local, regional, and national levels are necessary to convince farmers of the benefits of land consolidation processes and to create a higher number of voluntary land consolidation projects in the study area, in the Amhara region, and in all other parts of Ethiopia. A pilot study would be a good way to demonstrate the many potential benefits of land consolidation.

Author Contributions: A.A.G. and R.M.; methodology, A.A.G. and W.S.; validation, A.A.G. and R.M.; formal analysis, A.A.G.; investigation, A.A.G. and W.S.; resources, A.A.G., W.S., and R.M.; data curation, A.A.G.; writing—original draft preparation, A.A.G.; writing—review and editing, R.M., C.A. and W.S.; visualization, A.A.G. and R.M.; supervision, R.M. and C.A.; project administration, R.M.; funding acquisition, R.M.

Funding: This research was funded by the Austrian Development Cooperation within the Austrian Partnership Programme in Higher Education and Research for Development (APPEAR). Project no. 113 "Implementation of Academic Land Administration Education in Ethiopia for Supporting Sustainable Development" (EduLAND2).

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A

Table A1. Variables specification and working hypothesis.

Variable Description	Variable	Hypothesis
Willingness to accept voluntary land consolidation	WTAVLC	A dichotomous dependent variable to specify, whether a landholder farmer is willing to accept voluntary land consolidation (WTAVLC = 1) or not (WTAVLC = 0).
Landholder farmers exchange of parcels	PARCELEXCH	These explanatory variable measures landholder farmers need to exchange parcels with other farmers involved in a land consolidation procedure. It is the hypothesis, that landholder farmers, who are interested to exchange parcels, are more likely to be willing to accept voluntary land consolidation. <i>PARCELEXCH</i> is expected to be strongly and positively associated with landholder farmers willingness to accept voluntary land consolidation. Therefore, the value is 1, if landholder farmer is willing to exchange parcels, otherwise the value is 0.
Parcel preference of landholder farmers	PARCELPREF	The hypothesis is that landholder farmers with needs to aggregate parcels are more likely to be willing to accept voluntary land consolidation. Therefore, this variable is 1, if the landholder farmer prefers to cluster parcels. If the landholder farmer prefers to have parcels scattered over the area, the value is 0.
Landholder farmers' knowledge about land consolidation	KNOWLEG	As it is hypothesized that landholder farmers being informed about land consolidation processes have a higher willingness to accept voluntary land consolidation, the variable is 1 in case the landholder farmer has some knowledge about land consolidation. Otherwise, the value is 0.
Attitude of landholder farmers	ATTITUDE	It can be assumed that landholder farmers with a generally positive attitude toward land consolidation have a higher degree of willingness to accept voluntary land consolidation. Therefore, this variable is 1 in case of a positive attitude to land consolidation processes.
Landholder farmers' perceptions of land fragmentation reducing productivity	PERCEPTI	This variable describes landholder farmers' perceptions about land fragmentation. It takes a value of 1 if a landholder farmer perceives that land fragmentation reduces agricultural productivity and 0 otherwise. It is expected that the perception variable is strongly and positively associated with landholder farmers' willingness to accept voluntary land consolidation.
Landholder farmers' nearness of farm to home	FARMHOMENEAR	This variable specifies home nearness to the parcels. It takes a value of 1 if landholder farmers prefer parcels near to home and 0 otherwise. It is hypothesized that landholder farmers who want to have their parcels near to home are more likely to be willing to accept voluntary land consolidation.

Table A1. Cont.

Variable Description	Variable	Hypothesis
Education level of landholder farmers	EDULEVE	This variable takes the value of 1 if the landholder farmer is literate and 0 otherwise. Education increases land holder farmers' abilities to get information. Thus, it is hypothesized that education has a positive effect for willingness to accept voluntary land consolidation.
Age of the household head	AGE	This variable specifies the age of the landholder farmer in years. The age of landholder farmer is also a measure of farming experience. Age and farming experience are expected to be correlated with tradition. It is hypothesized that higher age has a more negative influence toward accepting voluntary land consolidation. Young landholder farmers are normally less affected by traditions and accept changes more easily.
Farm area in hectares	FARMARE	This variable is the total area of farmland in hectares owned by the landholder farmers at the time of the survey. In the study area, large farms are owned by older landholder farmers, which are more conservative and are not so open for changes. Thus, it is hypothesized that farm size has a negative effect to accept voluntary land consolidation. Also, this variable is a continuous variable.
Landholder farmers' participation in extension program	EXTPROGPART	Ethiopian government carries out an agricultural program where farmers get specific training in how to manage the cultivation of land. It is the hypothesis of this study that landholder farmers who have participated in an extension program will also favor voluntary land consolidation. The variable is 1 if the landholder farmer has participated in an extension program and 0 otherwise.
Conflict reduction	CONFLICTRED	This variable is 1, if the landholder farmer assumes land consolidation as a tool to reduce boundary disputes and 0, if not. The conflict reduction variable is expected to be strongly and positively correlated with landholder farmers willingness to accept voluntary land consolidation.
Security of tenure	TENURESECUR	The variable describes that either the landholder farmer considers that he/she has security for using the parcel during his/her lifetime ($TENURESECURE = 1$) or not ($TENURESECURE = 0$). The hypothesis is that the existing perception of tenure security has a positive effect on the willingness to accept voluntary land consolidation.
Landholder farmers' trust in neighbor	TRUST	Trust increases landholder farmers' willingness to exchange parcels. Thus, trust is important for willingness to accept voluntary land consolidation. Therefore, the trust variable is expected to be positively associated with landholder farmer willingness to accept voluntary land consolidation. It is 1 if landholder farmer trusts his/her neighbors to exchange plots, otherwise 0.

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