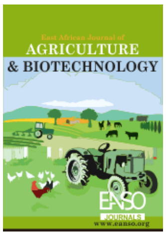

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Original Article

Investigating the Direct and Indirect Drivers of Land Use and Land Cover Change from Agriculture to Acacia Plantations in Banja District, Awi Zone, Ethiopia

Engidayehu Melaku[1], Asabeneh Alemayehu[1] & Kassa Chanie[1]*

[1] Ethiopian Forestry Development, Bahir Dar Center, P. O. Box. 2128 Bahir Dar, Ethiopia.
* Author for Correspondence ORCID ID: https://orcid.org/0009-0008-2935-1986; Email: melakuengidayehu@gmail.com

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ABSTRACT

Understanding the drivers of the land use land cover change is essential for development of appropriate land use system. The study conducted in north-western Ethiopia Banja district aimed to identify the direct and indirect drivers behind the LULC changes that had occurred. The study uses multistage sampling technique to draw 145 randomly selected households. Both primary and secondary data sources were used for this purpose. Descriptive statics and DPSIR ranking index model used to analyse data from household surveys to rank drivers of land use change from agricultural land to Acacia plantations or forestland. Decline of soil infertility for crop production, use of tree for income generation and increase of demand for forest products were identified as direct drivers of LULC, whereas high cost of agricultural input, soil erosion and land degradation and lack of technology to improve agricultural practice, were indirect drivers of LULC from agriculture to Acacia plantation. The result of binary logistics regression shows that total land holding, annual income, and the distance from residence to woodlot are statistically significant variables that influence positively farmers' decisions to change their farmland to Acacia plantations, whereas households' educational status negatively influences farmers' decisions to change their farmland to plantation land. Due to land use change from agricultural to plantation forest currently farmers, face lack of cropland, decreased crop production and shortage of animal fodder. On the contrary, they perceived that improvement of soil fertility, reduced land for grazing and biodiversity. Then it is to recommend that the concerned body should promote appropriate land use policy centred on major drivers of land use system from agricultural to forestland.

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INTRODUCTION

The interaction between humans and nature has recently led to LULC changes worldwide (Garg et al., 2019). LULC change is a dynamic and complex process that can be caused by many interacting processes, ranging from various natural to socioeconomic factors (Hailu et al., 2020). LULC change is enhanced by human activities and natural processes (Gedefaw et al., 2020). Drivers that accelerate LULC changes can be social, economic, or environmental and can have positive or negative impacts on the planetary system (Benavidez-Silva et al., 2021). Studies concluded that the main driver of land cover change are people's responses to economic opportunities facilitated by institutional factors (Lambin et al., 2003). In developing countries, such as Africa, most of the populations are engaged in agriculture (both commercial and subsistence farming) and charcoal production as a source of income (Zulu and Richardson, 2013). In Ethiopia, the expansion of agricultural land into forestland, logging, charcoal production, and fuel wood harvesting were the main drivers of LULC change (Bekere et al., 2023). Drivers for land use/land cover dynamics are multiple and complex in space and time, requiring more investigation in Ethiopia (Dibaba et al., 2020). Land use and land cover change has been occurred in Ethiopia for centuries (Bewket and Abebe, 2013).

Based on the review of several studies conducted between the years 1996 to 2009 (Asfaw et al., 2013), it was estimated that the expansion of eucalyptus planting started around the year 2000. (Bewket, 2002, Sewnet, 2016) (Gedefaw et al., 2020) conveyed the continuous increase of forest cover in the highlands of Ethiopia due to *Eucalyptus* and *Acacia* plantations. (Ridder, 2007) reported the increased forest coverage of Ethiopia by 0.8% per year from 2005 to 2010 due to Eucalyptus and other plantations. In Ethiopia, fertile croplands have been converted to plantation wood lots each year for two main reasons; its attractive economic return with minimal labour and capital inputs, and fear of crop yield reduction at the adjacent or neighbouring eucalyptus woodlots to crop farms (Yitaferu et al., 2013). Land-use changes from farmland to *Acacia decureens* plantations are being actively implemented in the high lands of northwestern Ethiopia (Endalew and Anteneh, 2023). Expanding small-scale acacia plantations in the country, especially in the Amhara region, show that forest plantations are accepted as an attractive business for smallholder farmers both at the regional and district level (Endalew and Anteneh, 2023).

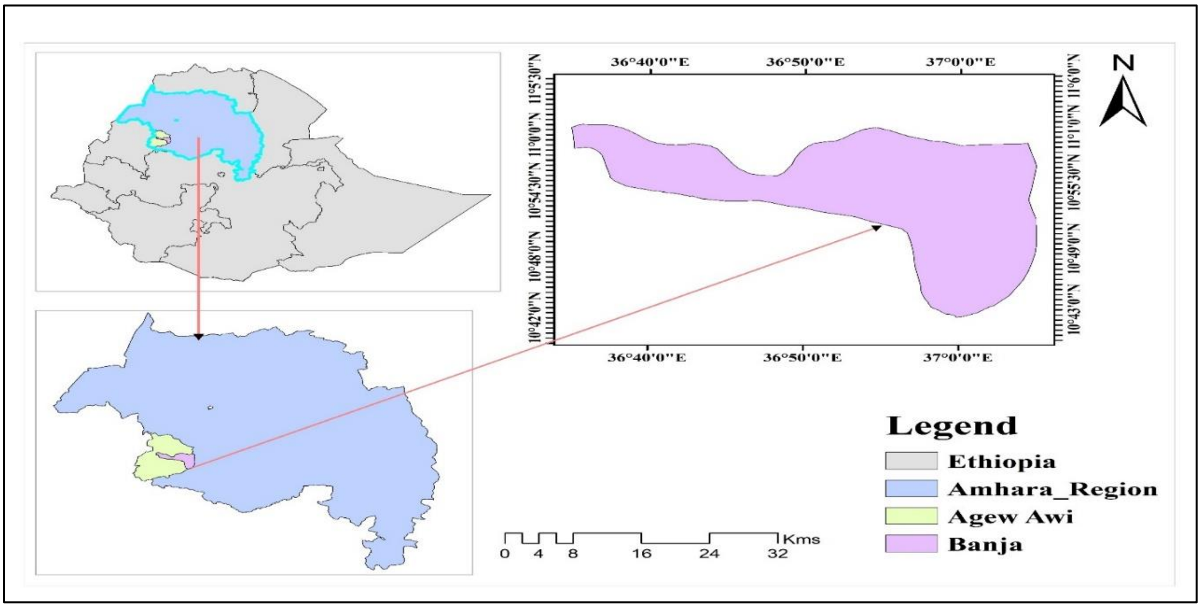
The conversion of agricultural lands to forest land has become a viable option for smallholders to diversify and increase their household income resulting in improved livelihood (Addis et al., 2016). As stated by (Jaleta et al., 2016) land use land cover change is a significant driver of environmental changes at different scale This change brings several direct and indirect social, economic and ecosystem service impacts. To minimize the negative there is a need to understand drivers of the change and the associated impacts on social and economic welfare of the community as well as on ecosystem service. In addition, ecosystem services assessment and analysis of the governance framework under the current scenario would be crucial. Knowledge of land use and land cover change, both on a local and wider scale is crucial for decision-making in relation to a wide range of issues, such as for reversing land degradation, deforestation, and climate change. Improving the understanding of LULC dynamics can lead to the projection of future LULC and to more appropriate policy interventions for achieving better land management. Thus, the objective of this paper is to investigate the direct and indirect drivers of land use and land cover change from agriculture to acacia plantations. It also explores the factors that determine farmer's decision to convert their farmland to planation forests (*Acacia decureens*).

METHODOLOGY

Distribution of Study Area

The study was conducted in Amhara Regional State, at Banja district, in the Northwest parts of Ethiopia. It is located 447 Km far from Addis Ababa and 122 Km to the north of regional city. The estimated total population of the district is estimated at about 315,271, with 5% in towns and 95% in rural areas (187,213 are females and 128,058 are males). It has 25 rural and 1 urban kebeles and the total area of district is estimated at 47,915.8 ha and constitute of 80% of the area is highland, the rest 20% is middle highland (Mengstu et al., 2023).

Figure 1: Map of the study area: own construction using Arc GIS10.8



Sampling and Sample Size Determination

The study used multistage stage sampling procedure (both a purposive and random sampling techniques) in the selection of the study site and the sample households, respectively. Primarily, potential district known for land use changes from agriculture to forest was selected purposively. The selection of the potential district was based on activity and in consultation with the district agricultural and natural resource as well as land administration officer. After the district is selected, four (4) potential kebeles were selected purposively based on the extent of land use changes for each case. Then households from each selected kebeles were selected randomly and allocated proportionally for sample size determinations. To select the sample household the study used the formula developed by (Yamane, 1973) and Out of 2023 population size, 145 sample frames were taken in the district.

$$n = \frac{N}{1+N(e)^2}$$

Where, n is sample size of housing units (household heads); e is the precision level and N=Total population size of the selected district, then

$$n = \frac{2013}{1+2013(0.08)^2} = 145$$

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Data Collection Method

For this study, both primary and secondary data were used. There were different techniques to collect primary data. This includes in-depth interviews, key informant interviews, direct field observation, and focused group discussions. The household surveys were carried out to collect both qualitative and quantitative data. A key informant (KI) who had a broad knowledge of the crop production and farming practices of acacia plantations in the area was given priority for selection. Totally, 12 KI interviews were conducted with agricultural experts and one District expert, and three farmers who have expertise about in agricultural crop farming and use of acacia plantation were contacted. Four focus group discussions, one at each centre of village level, with a group of 10 farmers using men's, women's, and youth groups, were conducted. The discussion was focused on the status of acacia, reasons behind expansion of acacia woodlots by converting agricultural land, and opportunities and challenges for acacia production and management.

Secondary data were collected from published and unpublished source (Banja district Environment, Forest and Wildlife Protection and Development Office) to gather information about forest plantation, especially acacia and the cause of land use change and the determinants of households' decision to change land use from crop land acacia plantation.

Data Analysis Method

The collected data was analysed through both descriptive statistics and econometric model. The descriptive statistics such as percentages and frequencies and descriptive-statistics analysis was used to describe socioeconomic variables of the households and summarize their responses and ranking of drivers of land use change for each land use changes.

In addition to Drivers, Pressure, State Impact Response (**DPSIR**) model ranking the drivers of land use change perceived by respondents was computed with the principle of weighted average using the ranking index adopted by (Abdullahi et al., 2013) and (Solomon et al., 2017).

$$Index = \frac{R_n C_1 + R_{n-1} C_2 \cdots + R_1 C_n}{\sum R_n C_1 + R_{n-1} C_2 \cdots + R_1 C_n}$$

Where, R_n = value given for the least-ranked level (for example, if the least rank is the 10^{th}, then

$R_n = 10$, $R_n - 1 = 9$, $R_1 = 1$;

C_n = counts of the least ranked level (in the above example, the count of the10^{th} rank = C_n, and the count of the 1^{st} rank = C_1).

Conceptual Framework of Drivers, Pressure, State Impact Response (DPSIR)

Understanding the causes (drivers and pressure) of change and their interaction is very crucial to manage land use change in a sustainable way. To understand this causes of change the model; the DPSIR framework will be used. The DPSIR framework was developed by the Organization for Economic Co-operation and Development and has been used widely by international agencies like, UNEP (Gabrielsen and Bosch, 2003). DPSIR framework used to understand the interrelating factors that alter the environment and as such offer not only a means to address the drivers and the state of the conditions (Aliero et al., 2017). The drivers can be human activities that exert pressure on the environment (Ivanova et al., 2012). The driving forces on the environment, such as land cover change causes pressures (Gedefaw et al., 2020). If the cover of the land changes interms of its constitutes it is said to be state or condition. Based on the pressure exerted, the state of land cover could be altered. Impacts are changes in land use that affect human well-being (Gedefaw et al., 2020). Responses are the reactions of humans to perceived change of land use. At different stage responses might be taken, such as policy and local measurements for remediation (Pullanikkatil et al., 2016). Responses can address the pressures or attempt to maintain or improve the state of the land use (Gedefaw et al., 2020). The (DPSIR) model is a proper tool to assess cause-effect relationships between interacting

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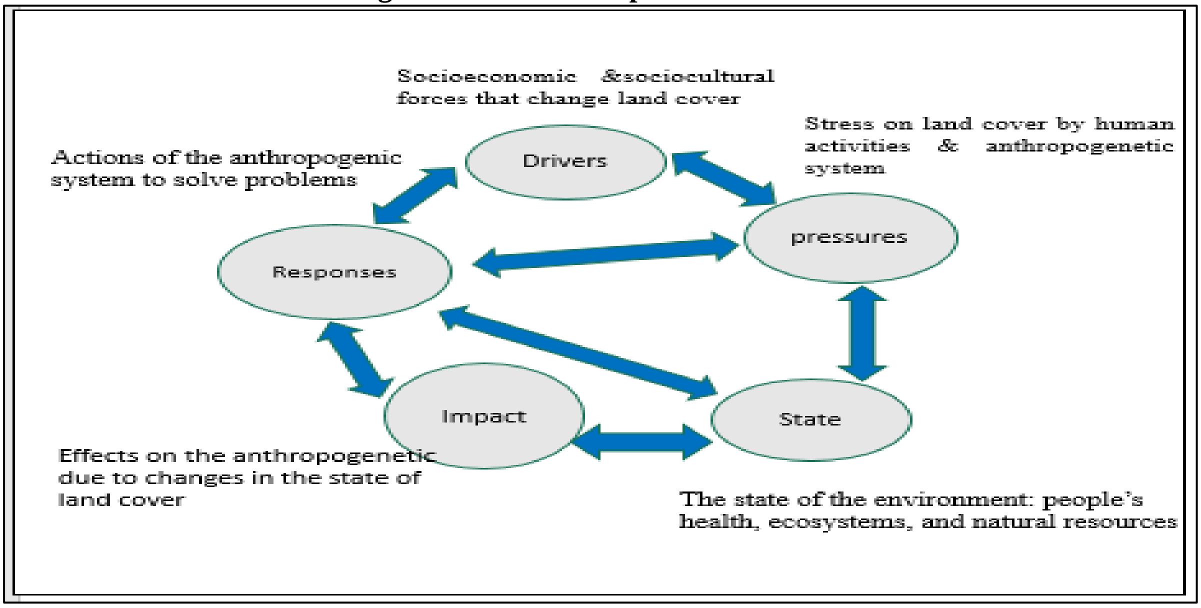
components of social, economic, and environmental systems, like: Drivers of land use change; Pressures on the land use change; State or condition of land due to the changing situations/conditions; Impacts on population, economy, ecosystems, and/or environment to the land use change; and Response of the society to the land use change.

Figure 2 below shows how human activity exerts pressure on the land resources and, consequently, changes the state of the environment or land. Changes in impacts over time can result in people modifying their response to those impacts (Gabrielsen and Bosch, 2003).

Figure 2: The DPSIR (Drivers, Pressure, State, Impact, and Response) conceptual framework indicators for land cover changes with their descriptions



(Adapted from UNEP, 2007 and European Environment Agency, 2003).

Binary logistic Regression

Binary Logistic Regression or commonly abbreviated as BLR is a regression model that formulated to predict and explain phenomena (dependent variables) that are binary (dichotomous) using all data types as independent variables (GÜNERİ and DURMUŞ, 2020). The logit model was employed to understand factors that influence farmers' decisions to change their farmlands to Accacia plantation or forestland. Binary characteristics in the dependent variable produce a type of data that consists only two category values, in this case such as decision to land use changing or not changing. These two category values have a 0 or 1 probability of occurrence. Households who have changed ≥ 0.25 ha of their cropland to *Accacia decurrens* were taken as decide to convert, and the rest were taken as not decide to convert their cropland to *Accacia decurrens*. (Y=1 for decide to change and Y = 0 for not decide to change). The independent variables considered were household family size, sex, age, education status, total land holding, livestock holding, annual income and the distance from the residence to woodlot area. For limited dependent variable, binary logistic regression function is specified as follows (Handavu et al., 2019).

$$P_i = E(Y = 1|X_i) = \left(\frac{1}{1+exp^{(\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} \ldots\ldots + \beta_k X_{ki})}}\right)$$

$$P_i = \left(\frac{1}{1+exp^{(-Z_i)}}\right) \quad (1)$$

Where, Z_i is general linear regression model and

$$Z_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} \ldots\ldots + \beta_k X_{ki}$$

P_i is the probability that a household decides to change farmlands to forest.

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$$\boldsymbol{P_i} = \left(\frac{1}{1+exp^{(-Z_i)}}\right)$$

The probability that a household do not change to forest land (1-Pi), is specified as the following.

$$(\boldsymbol{1-P_i}) = (\boldsymbol{1} - \left(\frac{1}{1+exp^{(-Z_i)}}\right)) \quad (2)$$

$$\frac{P_i}{1-P_i} \quad (3)$$

Equation 3 shows the odds ratio of a household decision to land use change from farmland to forestland.

Taking the natural logarithm of the equation 3 according to "e" base the logit model Li is expressed as

$$Li = Logit\ (\boldsymbol{P_i}) = ln\ \left(\frac{P_i}{1-P_i}\right) = \boldsymbol{\beta_0} + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} \dots\dots + \beta_k X_{ki}$$

Where X_1, X_2, and X3… are the independent variables,

K represents, the number of the independent variables and i represents respondents either decide to change (Y = 1) or not decide (Y = 0)

Table 1: Summary of independent variables and hypothesized to influence farmers' decision

Variable	Measurement	Description	Expected sign
Sex	Categorical	1 if the respondent is male, 0 if female	+
Age	Continuous	Respondent age in years	-
Family size	Continuous	Number of persons in the household	+
Education	Continuous	Respondent's level of education attended in years	+
Total land holding size	Continuous	Landholding size in hectares	+
TLU	Continuous	Livestock holding in tropical livestock unit (TLU)	-
Households total annual income	Continuous	Households' annual income (ETB)	+
Distance to the nearest woodlot	Continuous	Distance travelled to the forest in km	+

RESULT AND DISCUSSION

Households Sampled Characteristics

Table 2 shows demographic and socioeconomic characteristics of the surveyed households. Out of 145-sampled households interviewed, concerning family size, households who decide to change were found to be 4.9 per family while not to decide to change were found to be 5 per family on average. The sample respondent's ages ranged from 20 to 67 with mean age of 42.2 years. The minimum and maximum years of schooling for respondents decide to change their land were 0 and 10 years, while the respondents not to decide to change have a minimum of 0 and a maximum of 11 years of schooling. The mean land holding for respondents decide to change was 1.64 ha with maximum and minimum of 3.5 and 0 ha, respectively. The corresponding figure for respondents not to decide to change was 1.52 ha with maximum and minimum of 3.0 and 0 ha, respectively. Thus, respondents who were not to decide to change their land to *Accacia decurrens* had a limited land area than participants. It indicates that farmers with large land holding sizes are more likely to participate in the change of their agricultural land to *Accacia decurrens* than those farmers who have smaller land holding size. Households who were decide to change found to own more livestock than their counterparts. It was observed that the mean of respondents decides to change had livestock holding 9.5. Tropical Livestock Units (TLU), while not to decide to change had 8.2 TLU. It indicates as farmers own large livestock units, the chance to decide to change their cropland into *Accacia decurrens* become increases. It is because livestock ownership enables (oxen) for the plantation of *Accacia decurrens*. In the study area, Accacia de, planted after plowing the land with

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oxen. Moreover, as farmers own large livestock populations, the availability of financial income in the household from the sale of livestock, especially bulls for meat, small ruminants, and chickens, increases, which in turn leads decide to invest Accacia plantation. Concerning to annual income, households who decide to change earn minimum and maximum of 4200.00 and 320,800.00 Ethiopian Birr (ETB) respectively. On the other hand, households who were not to decide had minimum 3100.00 and maximum of 197,430.00 ETB annually from crop and livestock production, and other source of income. The result indicates that respondents who were decide to change had more Kms than counter parts as seen in the *Table 2*. It means that farmers who had more Kms are more likely to decide to change their agricultural land into *Accacia decurrens* than counter parts.

Table 2: Household characteristics of sample respondents

Land use decision	Parameters	Family size	Age	Educational status	Land holding size	TLU	Annual income	Distance from resident to woodlot
Not to decide to change crop land to *Acacia decurrens*	Mean	5	39.1	4.6	1.52	8.2	89814.9	3.6
	Min	1	20	0	0	0	3100	0
	Max	13	65	11	3	24	197430	20
Decides to change crop land to *Acacia decurrens*	Mean	4.9	44.1	3.6	1.64	9.5	85955.8	3.3
	Min	1	25	0	0	0	4100	0
	Max	11	67	10	3.5	23	320,800	30
Total	Mean	4.9	42.2	4.0069	1.59	9.05	87419.64	3.45
	Min	1	20	0	0	0	3100	0
	Max	13	67	11	3.5	24	320,800	30

As stated by (Ababa, 2019), *Acacia decurrens* is one of the most popular species in Awi zone and Accacia woodlot is a parcel of land devoted to accacia plantations and has size of ≥ 0.125 hectares (Nigussie et al., 2017). However, for the interest of this study, farmers who had Accacia woodlot size of ≥ 0.25 ha were considered as participants and decides to change their cropland to *Accacia decurrens*. As observed in the tabele (3), of the total 145 sample respondents interviewed, 90 (62.1%) were found to be participants (decide to change) of agricultural land to *Accacia decurrens* plantation while 55 (37.9%) were non-participants (not to decide) to change their agricultural land.

Table 3: Number of households to land use decision

Land use decision	Frequency	Percent
Decide to change (Y=1)	90	62.1
Not to decide to change (Y = 0)	55	37.9

Households who decide to change their land have allocated the high coverage of their land on average 0.9031 ha with a maximum range of 3 ha to *Accacia decurrens*. On the other hand, respondents who were not to decide to change their cropland have allocated on average 0.0023 ha of *Accacia decurrens* and maximum of 0.13 ha of land *Table 4*.

Table 4: Households land use decision on Accacia plantation size ≥0.25 ha

Land use decision	Mean	Std. Deviation	Minimum	Maximum
decides to change	0.9031	0.59895	0	3
not to decide to change	0.0023	0.01685	0	0.13
Total	0.5614	0.64359	0	3

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Households Land Acquisition

Majority of the respondents acquire their land through the formal land allocation procedure by government (40%), inherited from parents (26.2%), bought (15.2%), others got land in the form of gift from (7.6%) and the rest 9% acquire their land in the other forms *Table 5*.

Farming Practice and Crop Production

Results on the main farming practices showed that local communities engage in three (3) major practices namely: potato farming, wheat farming, and teff farming respectively holds the first, the second, and the third largest crops produced in the district *Table 6*.

Table 5: land acquisition system

If yes, how did you get it?	Freq.	Percent
Bought	22	15.2
Inherited	38	26.2
Donation/gift	11	7.6
Given by local leader	3	2.1
Given by the government	58	40
Others	13	9
Total	145	100

Table 6: Households crop production in the study area

Crops produced in Quintal	N	Minimum	Maximum	Mean
Total Maize production	145	0	8	0.3759
Total wheat production	145	0	16	2.696
Total teff production	145	0	10	1.6
Total potato production	145	0	100	7.58
Total Haricot bean production	145	0	5	0.552

Crop Production and Land Use Land Cover Change

From sampled households surveyed 95% of respondent's reply that crop production has changed in the last ten years. Out of total sampled household's majority of respondents (87.6%) replied that crop production has decreased, but 11.7% reply that crop production has increased in in the last ten farming years *Table 7*.

Forest versus Land Use Land Cover Change

Forest plantation is spreading in the previous ten years. As presented in (*Table 8)* below 67.6%, 27.6%, and 4.8% of respondents answered the forest cover change is increased, decreased, and stayed the same, respectively. In the last ten years, afforestation has increased by 70.34% and Smallholder farmers are main actors of the plantation forest development in the district

Table 7: Change of crop production in last ten years

Characteristics	Parameter	Frequency	Percent
Has crop production changed in the last 10 years	Yes	139	95.9
	no	6	4.1
If yes what is the direction of change	Increased	17	11.7
	Decrease	127	87.6
	Stayed the same	1	0.7

Table 8: Change of forest coverage in the last ten years

Characteristics	Parameter	Frequency	Percent
How has the forest cover changed in your community over the past 10 years	Increased	98	67.6
	Decrease	40	27.6
	No change	7	4.8
Do you think that there is an increased in the rate of afforestation in the last 10 years	Yes	102	70.34
	No	43	29.66

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Data Analysis Using DPSIR

Drivers of LULC from Agriculture to Forest (Accacia decureens)

Based on farmers' perception, experts' opinion and personal field observation, influential drivers that contributed to LULC were identified in the study area. As stated by the expression of natural resource experts, the soil of the study district was mainly acidic, poor in fertility and degraded before starting plantation forest due to soil erosion and over exploitation of agricultural lands for crop production. Similar to that of different highland areas of Ethiopia, poor agricultural practices, free grazing, and deforestation have resulted in severe soil erosion and land degradation (Endalew and Anteneh, 2023). As elaborated by Geist and Lambin (Geist and Lambin, 2002) these drivers fall within the broader classes of social, economic, environmental, policy/institutional and technological factors. Directs drivers such as decline in soil fertility for crop production, use of tree for income generation, and increase of demand for forest products were identified as first, second, and third drivers of LULC from agricultural land to acacia plantation, respectively (*Table 9*). This result is associated with findings of (Derbe et al., 2018) indicated that the main issue for farmers converting their cropland to plantation forestry was its economic potential which can generate a better return. Similarly, a study in northwestern highlands of Ethiopia indicated that the desirable price of forest products over crop was the major causes for plantation to generate a better income (Molla et al., 2023).

High cost of agricultural input, soil erosion and land degradation, and lack of technology to improve agricultural practice, ranked in the first, second, and third indirect /proximate drivers of LULC (*Table 10*). This finding is in agreement with the study of (Gedefaw et al., 2020) which showed that occurrence of high wood demand and reduced farm size were the drivers of land use land cover change. This finding is supported by the study of (Endalew and Anteneh, 2023) that increasing the actual and potential income generation from the tree-based land-use system, declining agricultural land productivity for crop cultivations, job opportunities, and soil erosion and land degradation were major divers of land use system to change farmland to forest land. The decline soil fertility or agricultural productivity dissatisfies the household's food consumption in the study area. This study is supported by (Ariti et al., 2019, Chanie and Abewa, 2021) where, soil degradation and land fragmentation are the cause for decline of crop production and tends to change cultivated lands to forest land. AS stated by (Belayneh et al., 2020), reduction of cultivated lands, with a parallel expansion of forest lands. *Table 9* and *10* documents direct and indirect the drivers of land cover change as perceived and reported by household farmers respectively.

Table 9: Direct drivers of LULC by the respondents in the survey

	No respondents per rank							
LULC direct drivers	**1**	**2**	**3**	**4**	**5**	**Weight**	**index**	**Rank**
Decline soil fertility, crop production	125	12	5	2	0	692	0.194	1
Extreme weather events	13	12	14	17	38	227	0.064	8
Increase of demand for forest products	49	32	21	15	9	475	0.133	3
Use of tree for income generation	62	47	20	2	3	565	0.158	2
Biological property of species	44	17	6	10	17	343	0.096	4
Absence of natural forest in surrounding area	22	16	19	27	20	305	0.085	6
Farmland fragmentation	28	14	13	10	15	270	0.076	7
Households' educational status	14	18	11	13	16	217	0.061	9
Households' future income expectation	28	19	10	13	33	305	0.085	5
Labour intensity	12	13	5	8	28	171	0.048	10

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Table 10: Indirect /Proximate/ drivers of LULC by the respondents in the survey

LULC indirect direct drivers	No respondents per rank							
	1	2	3	4	5	Weight	index	Rank
Unemployment	28	20	12	11	36	314	0.092	7
High cost of agricultural input	75	42	7	5	1	575	0.169	1
Lack of technology to improve agricultural practice	35	39	16	13	10	415	0.122	3
Increase in price of wood products	53	15	20	5	15	410	0.121	4
Allelophatic effect	41	13	4	14	30	327	0.096	5
Lack of access to inputs and price raise	30	18	17	10	22	315	0.093	6
Social and demographic change(migration)	33	13	10	6	21	280	0.082	9
Soil erosion, land degradation	64	17	10	11	9	449	0.132	2
Increase of market accessibility	37	9	8	13	19	290	0.085	8
Other indirect drivers of LULC	1	4	1	1	1	27	0.008	10

Source, 2023 own computation

Pressure Exerted Land Use Land Cover Change from Agriculture to *Acacia decureens*

The pressures exerted due to LULC from agriculture to forestland as perceived by household farmers were decrease in crop production (86.9%), lack of crop residue for livestock fodder (66.9%), food insecurity (65.5%), and overgrazing of land (65.5%) were major problems of land use change from agriculture to forest. The table below shows how the respondents selected the variables frequently and the pressure exerted due to LULC. This study is consistent with findings of (Gedefaw et al., 2020), which showed that the occurrence of, overgrazing of land, demand for agricultural land, soil moisture change and high wood demand were the drivers of land use land cover change (*Table 11*).

Table 11: Pressure exerted due to LULC from agriculture to *Accacia decurrens*

Pressure exerted	Frequency	Percent
Overgrazing of land	95	65.5
Decreased crop production	126	86.9
Soil moisture change	89	61.4
Food insecurity	95	65.5
Lack of crop residue for livestock feed	97	66.9
Other	5	3.4

State of Land Use land Cover Change from Agriculture to *Accacia decureens*

Based on the frequency of respondents, the current states or the conditions were constituted (observed) due LULC by households. There is an improvement in soil fertility (84.1%), biodiversity (68.3%), and water quality (62.8%) whereas shortage of cropland (76.6%) and grazing land (73.8%) for livestock are negatively observed (*Table 12*).

Table 12: State perceived by households due to of LULC from agriculture to *Acacia decureens*

States Occurred due to LULC	Frequency	Percent
Reduced land for agriculture	111	76.6
Increased land fragmentation	50	34.5
Reduced land for grazing	107	73.8
Soil fertility improved	122	84.1
Biodiversity improved	99	68.3
Water quality improved	91	62.8
Change of land scape	86	59.3

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Impact of Land Use Land Cover Change from Agriculture to *Acacia decureens*

Studies have reported that significant environmental and economic impacts caused land cover changes in the highlands of Ethiopia (Gedefaw et al., 2020). Impacts are changes in land use system that affects human well-being. As the result in *Table 13* below shows that scarcity of land for agriculture, reduced crop production, and lack of fodder for animals were the impacts due to land use system from agriculture to forest.

Table 13: The impact of LULC as perceived by households

Impact of LULC from agriculture to forest	Frequency	Percent
Increased rural to urban migration	58	40
Scarcity of land for agriculture	121	83.4
Reduced crop production	117	80
Reduced fodder for animals	107	73.8
Difficult to revert plantation land back to crop farmland	62	42.8
Others	2	1.4

Farmers Response for Land Use System from Agriculture to *Acacia decureens*

Respondents in the study area respond that diversification of livelihood (64.83%), implementing appropriate land use system (58.62%), raising of farmers awareness (53.1%), applying agricultural intensification (52.41%), and planting multipurpose trees (46.9%) are some of major responses that applied to land use land cover change *Table 14*.

Table 14: Households response to land use land cover change.

Response	Freq.	Percent
Planting multipurpose tress	86	46.9
Implementing appropriate land use system	85	58.62
Raising farmers awareness	77	53.1
Diversification of livelihood (income generating activities and employment opportunities)	94	64.83
Agricultural intensification	76	52.41
Developing specific policies	63	43.45
Enforcement of law regulations	65	44.83
Use of renewable energy	40	27.59
Other response towards the change	4	2.7

Factors Influencing Farmers' Decision to Change Agricultural Land to *Accacia decureens*

The binary logistic regression model examined that the relationship between the dependent and the main socioeconomic independent variables (Song and Tan, 2022). The logit model was used to examine factors that influence farmers' decisions to convert their crop land to Accacia plantation forest. The dependent variable is dichotomous/binary (decide to convert and not decide to convert). A household that has converted $\geq$ 0.25 ha of cropland to Accacia plantation is said to be decide to convert ($Y = 1$ for decide to convert and $Y = 0$ for not decide to convert). The independent variables considered were household's family size, sex, age, educational status, total land holding, livestock holding, annual income and the distance from the residence to woodlot area.

The result of binary logistics regression in the *Table 15*, below shows that household's educational status, total land holding, annual income, and the distance from residence to woodlot are statistically significant variables that influence farmers' decisions to change their agricultural land to their Accacia plantation. Educational status of household shows that as the number of an educated population increases, they are more likely to decrease the conversion of farmland to planation land by 0.83 ($p=0.01$). It is expected that education levels are associated with

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low dependence on forests for livelihoods and this is mainly because education provides a wider range of employment opportunities in other sectors of the economy. This confirms with findings of (Adhikari et al., 2004, Mamo et al., 2007, Tugume et al., 2017).

Households total land holding revealed that single or a hectare increase of land holding tends 1.439 times more likely to change his/her farmland to planation land than others having small farm size (p=0.064). This finding revealed that households who have a better land size are more likely to decide to change farmlands to plantation land than households having smaller area of land are. Because when households have large total land size, the probability of allocating land for plantation land increases. This study is supported by (Mengstu et al., 2023) indicated that total land size was positively correlated with highland bamboo expansion.

Households' total annual income has positive influence of households' decision to change the farmland to forestland; a household having better annual income is 1 time more likely to change farmland to planation land (p=0.053). The result shows that the income from trees and tree products was positively associated and significantly affected the households' decision to plant Accacia trees. This study is in line with previous study of (Abate and Yohannes, 2021) which showed that total income of household heads was positively associated and significantly influenced the households' decision to change crop land to plantation forest.

Distance from the residence to woodlot has positive influence of household's decision to change farmland to forestland. As distance to nearly woodlot increases a farmer is 1.146 times more likely to change agricultural land to plantation land (p=.004). The finding revealed that households who walked long distances are more likely to decide to change their farmlands to plantation land.

Table 15: Binary logistic regression result for factors influencing farmers' decision to change farmland to *Acacia decureens*

Independent variables	B	S.E.	Wald	df	Sig.	Exp (B)
Household Family size	0.07	0.103	0.458	1	0.498	1.072
Sex of Household member	-0.246	1.292	0.036	1	0.849	0.782
Age of household member	0.013	0.019	0.446	1	0.504	1.103
Education of household member	-0.187	0.073	6.62	1	.010 **	0.83
Total land holding	0.364	0.197	3.42	1	.064***	1.439
Households' total livestock production unit	0.05	0.38	0.021	1	0.884	1.005
Households total annual income in (ETB)	0	0	3.758	1	.053***	1
Distance from your residence to woodlot	0.136	0.048	8.081	1	.004***	1.146
Constant	-2.511	1.789	1.971	1	.060***	0.81

**** Significant at 1%, ** significant at 5%, * significant at 10*

Source, 2023 own computation

CONCLUSION

The study aimed to explore and understand direct and indirect drivers of LULC in the Banja district. Majority of the respondents acquire their land through the formal land allocation procedure by government and average land holding size of the sample household in the district is about 1.59 ha with minimum zero and maximum size of 3.5ha. The average woodlot plantation size in the district is about 0.2852ha. Potato farming, wheat and teff farming respectively holds the first, the second, and the third largest crops produced in the district. Households receive mean annual income of ETB 87419. Decline soil fertility for crop production, Use of tree for income generation and increase of demand for forest products were identified as direct drivers of LULC. Households also replied that high cost of agricultural input, soil erosion, and land degradation and lack of technology to improve agricultural practice are the major indirect/proximate drivers of LULC from agriculture to Accacia Forest in the district. The result of binary logistics regression shows that total land holding, annual income, and the

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distance from residence to woodlot are statistically significant variables and influences positively farmers' decisions to change their farmland to Accacia land, whereas household's educational status negatively influence farmers' decisions to change their farmland to plantation land. The main state (conditions) was observed due to land use change from agriculture to Accacia forestland. Households perceived that improvement of soil fertility, reduced land for grazing and biodiversity were improved, but the significant environmental and economic impacts currently; they face lack of cropland, decreased crop production, shortage of animal fodder. Diversification of livelihood (income generating activities and employment opportunities) planting multipurpose trees, implementing appropriate and use system and raising farmer's awareness were stated as a solution to avert improper land use system. Thus, it is good recommended that the concerned body should promote appropriate land use policy centred on major drivers of land use system from agriculture to plantation forest.

DATA AVAILABILITY

The data sets generated and analysed to support this finding are available from the relevant author.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Authors' contribution

All authors read and approved the final manuscripts.

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