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Research Article

Determinants of Farmers' Willingness to Pay for Crop Insurance in Ankober Woreda, North Shewa Zone, Amhara Region, Ethiopia

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Abstract

This study examines the Determinants of Farmers' Willingness to Pay for Crop Insurance in Ankober Woreda, North Shewa Zone, Amhara Region, Ethiopia. The study used cross-sectional data from 245 randomly selected farm households from seven Ankober kebeles. It used binary Logit model to identify the main determinants of farmers' willingness for crop insurance. The result showed that the maximum mean willingness to pay (WTP) for crop insurance in the study area is 272.5ETB (6.054$)/season / 0.25hectar and their WTP ranges from 0 ETB to 3000 ETB/ha/per season. From empirical findings, 15 explanatory variables are used in logit regression model; nine variables have shown key determinants for farmer's willingness to pay for crop insurance in the study area. Accordingly, age of farmer's, farmer's education level, TLU, Credit access, income from crop production, saving habit, Awareness for Crop Insurance and Information access are statistically significant variables that determines farmers' willingness to pay crop insurance in the study area at 1% and 5% significant level. Thus, the policy makers should work on providing education and training, expansion of credit deliver institutions, encouraging saving habit, accessing more information for crop insurance schemes and different activities for knowing crop insurance implementation in the study area.

Keywords: Ankober, Binary logit, crop insurance, Willingness to Pay

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1. Introduction

In under developed nations like Ethiopia, the role of Agricultural sector is great in stimulating the growth and sustainable development, poverty alleviation, and enhancing food security. Nevertheless, the sector has been unable to satisfy the growing food need of the rural population. This is because of the low productivity of the farmers due to lack of technological advancement and socioeconomic factors (Tadie et al., 2019). The production and productivity per hectare is vary from farmers to farmers because of amount of inputs used, the application of modern agricultural technologies, sticking on traditional farming techniques, the support and infrastructural service delivery such as extension, crop failures by climate changes, access to credit, access to market, access to road and poor agricultural policies (Tadie et al., 2019; Wang et al., 2022). Agriculture by its nature is exposed to different type of uncertainties because of the dynamic economic and biophysical environment of where the farming activities are operating.

The risk associated with agriculture derived from the factors that determine the output of agricultural production. In agriculture, uncertainty is a common phenomenon which reflects the dynamic nature of farm production, that affected by the dynamic economic and biophysical conditions (Kiran & Umesh, 2017). The natural catastrophes like drought, flood, hurricane, landslide, erratic rainfall, earthquake, and other problems caused by climatic change are seriously harming the agricultural production and its income in many countries. Thus, it needs an insurance service to protect smallholder farmers from those disasters (Biswakarma & Rana, 2021).

Insurance is a mechanism of sharing or transferring a risk from one individual or organization (insured) to the organization (insurer) who agrees to compensate the lost property of the insured. It reduces the risk of uncertainty faced by the insured, and also shared the burden of a loss specifically if the loss is in large scale (Kiran & Umesh, 2017). In the agreement of the insurance services, the insured party (the farmer) expected to pays a premium to an insurer (the insurance company) to get the promised compensation of loss of property or farming production with in specified period of time. When the losses occurs caused by natural disaster or perils such as extreme weather events (e.g. drought and floods), the onset of pests and diseases or the death of livestock. In such conditions, the farmers are given a promise to reimburse or paid in monetary values. Now a days there are various types of agricultural insurance are available, but the most common type of insurance preferable to smallholder farmers in developing market is a crop insurance which is one of the risk sharing mechanism used by farmers (Raithatha & Priebe, 2020; Biswakarma & Rana, 2021).

The global insurance coverage towards agricultural sector is not this much attractive, however in developing nations it could be the worst. Globally its coverage, only 20 % of the smallholder farmers have access to agricultural related insurances in general, 33% in Latin American, 22 percent in Asia countries and 3% for Sub-Saharan Africa countries in specific manners (Raithatha & Priebe 2020). In Ethiopia crop insurance has no long historical institution practice rather traditional way of coping mechanism of crop failure farmers were victims on crop failure caused by natural hazards like: flood and land slide, droughts, excess or heavy rains, pests and diseases often threaten crop production. But, in recent time the country shows a demand of a special interest on introduction of index-based insurance. The cases of individual insurances, group insurances and index insurances practice represented different sessions in the country. In Ethiopia a recent time insurance pilot projects, start to implement increasing by Interlinking Insurance with Credit in Agriculture (EPIICA) provided by Nyala insurance company and Dashen Bank in the Amhara region (Tigist, 2017; McIntosh *et al*., 2013; Tafesse, 2022).

In Ethiopia, agriculture is an important economic sector in general and it becomes livelihoods means for many small holder farmers. The, sector contributes 33% of the gross domestic product (GDP), 76% of the export earnings and contributes66% for employment opportunities in Ethiopia (Tafesse, 2022). These small holder farmers are highly exposed to the adverse effects of climate change mainly reflected in shortage of rainfall (drought) in Africa continent and the crop insurance status is at its infant stage (Ashenafi, 2016; Amar, 2020). Crop failure occurred due to a natural factor that are beyond farmers control such as excess rainfall, drought, flood, hails and other weather variables (temperature, sunlight, wind), pest infestation, disease, soil fertility reduction and other. This large exposure and uncertainty affect the actual and potential crop yields. The crop failure in Ethiopia cause more related with natural rainfall distribution pattern that is high risk occurred when weather disorder high. These risks directly affect farmers' income as well as consumption. So, insurance is a method of sharing losses from farmers to insurance company paying the expected insurance premium to get compensation at the time of loss. The contribution of insurance is to reduce the uncertainty the insured might face and also avoid any psychological burden of loss when the insured have large scale properties (Belaynesh, 2014; Tigist, 2017).

Besides, Crop failure occurred due to biological and uncontrolled natural factors. The most cause of Natural factors are an avoidable; these are rainfall (shortage or excess rainfall), floods, hails, other weather variables (temperature, sunlight, wind), pest infestation, disease, soil fertility reduction and etc. According to Woreda agricultural office yearly report (2018G.c), crop failures status is at a higher stage which is mostly caused by pests, excess rainfall, disease, flood and landslide and drought this make

farmer vulnerable and risky farming practice support gain only alternative were government emergency aid and asset losses without this there is no any financial institutions that responsible for crop failures risks share.

Various studies have been conducted by some scholars to examine the main factors that affect the willingness of households to pay for crop insurance in developing countries (Ali, 2013; Ellis, 2017; Kiran & Umesh, 2017; Ntukamazina, et al., 2017; Fonta et al., 2018; Mutaqin & Usam, 2019; Carrer et al., 2020; Essossinam et al., 2020; Gulseven, 2020; Biswakarma & Rana, 2021: Ngango et al., 2022); Wang et al., 2022). From their finding, the variables of family size, off-farm income, credit usage, Oxen, Insurance premium, fertilizer application, credit service, frequency of extension contact, plots of land, are the main determinants of household's willingness to pay crop insurance in their study areas. Some of the studies looked how farmers and the nature of business determine their decision of using risk management tools and applied the double-hurdle model to examine the farmers' WTP for crop insurance in Ghana Kenya, Nepal and India.

In Ethiopia, few studies have been conducted to see household's willingness to pay crop insurance in different study areas and regions. From those studies (McIntosha et al., 2013; Belaynesh, 2014; Mebrahtu, 2014; Teshome & Bogale, 2015; Ashenafi, 2016; Tigist, 2017; Amar 2020) are some studies for willingness for crop insurance in different aspects. From their findings households willingness to pay crop insurances are determined by many factors: demographic, socioeconomic, environmental, institutional and physical factors are the main determinants factor for farmers 'willing to pay crop insurance. Thus, many of the above-mentioned studies used index-based crop insurance (particularly weather index crop insurance) and none of them used crop yield or amount insurance. None of them showed the study did not consider the main challenges for improving crop insurance coverage and used very few explanatory variables for their works.

Therefore, many more empirical studies need to be performed by using a large number of sample sizes with big study area coverage, it needs assess farmers WTP that influence the farmer decision to buy crop insurance. And, consider many more explanatory variables in the model, and incorporate the descriptive study with the inferential statistics model to examine the issue in detail for the study area. Thus, WTP can be determined by institutional and socio economic characteristics like education, age, household size, income, crop diversification, insurance awareness, Initial bid amount, land tenure, off-farm income, credit access, saving money, access to information, for studying of willingness for crop insurances.

Lastly, to address these issues, the study tried to address the following two questions: what are the main factors affecting Farmers' Willingness to Pay for Crop Insurance in the study area? And what are the major challenges encountered for farmers to get Crop insurance scheme in AnkoberWoreda, North Shewa Zone, Amhara Region, Ethiopia. Finally, this paper is consists of four sections: section one deals with highlighting the background of the study, section two provides methodology section that describes data type, sample size determination and model specification and estimation used in the study. Section three present and discuss the result and section four presents the conclusion and recommendation.

2. Methodology

2.1. Research Design and approach

A research design is a blue print of a study which shows how the study going to respond to the research questions using empirical data. It is used to sets the procedure define the required data, the methods of collection and analyzing the data, and how these all activities organized to effectively answer the research question (Neuman, 2014). Regarding this, the main purpose of the study is to examine the factors that affect the Willingness of Farmers to Pay for Crop Insurance in the study area. Thus, an explanatory research design was applied to answer its research questions. The study also used primary data within a specified period of time to address the objectives of the study.

2.2. Description of the Study Area

Ankober wereda or Distrcit is located at 9° 22' 0"- 9° 45' 0" N and 039° 40' 0"- 039° 53' 0" E in north Shewa Zone of Amhara National Regional State, north-central Ethiopia. The District is perched on the eastern escarpment of the highlands of Ethiopia and found at the distance of 172 km in the north from Addis Ababa, the capital city of country, and 42 km to the east of Debre Berhan town (the north Shewa Zone capital). The District is shared border with Tarmaber District in the north, Asagirt District in the south and Basona worana District in the west from Amhara Region and with Gachine Special District of the Afar Region in the eastern. Elevation in Ankober District ranges from 1300 meter above sea level near Addis Alem area to 3700 meter above sea level at Kundi Mountain. The land topography characters of district were categorized by mountains, sloping and low land and this topography were covered the area 75%, 17% and 8% respectively. The district average annual temperature was range from 18-26^{0}c. Its annual rainfall in the District ranges 1000 to 1400 mm and cold temperature is common throughout the year. The district weather conditions were dividing by 3 agro ecological zones: Dega, WenyaDega and Kola which cover the area 12%, 53% and 35% respectively (AWFPO, 2012; Lulekal et al., 2014).

The District's administrative center is located at historical town of Gorabela or Ankober which

has been the political center of the Ethiopian monarchs for centuries since 1270. In the wereda, 19 rural kebeles and 4 small urban kebeles and 23 total kebeles are there. The district total coverage area is 78,700 square kilometers. The native people who are living in the area are part of the Amhara ethnic group. The people are using the Amharic language, which is the official language of the country. The total number of district's population is 83,260 (42,180 men and 41,080 women) out of this figure only 7.5 % of the population (6,272) is urban inhabitants (AWFPO, 2012; Lulekal et al., 2014; AWFPO, 2020).

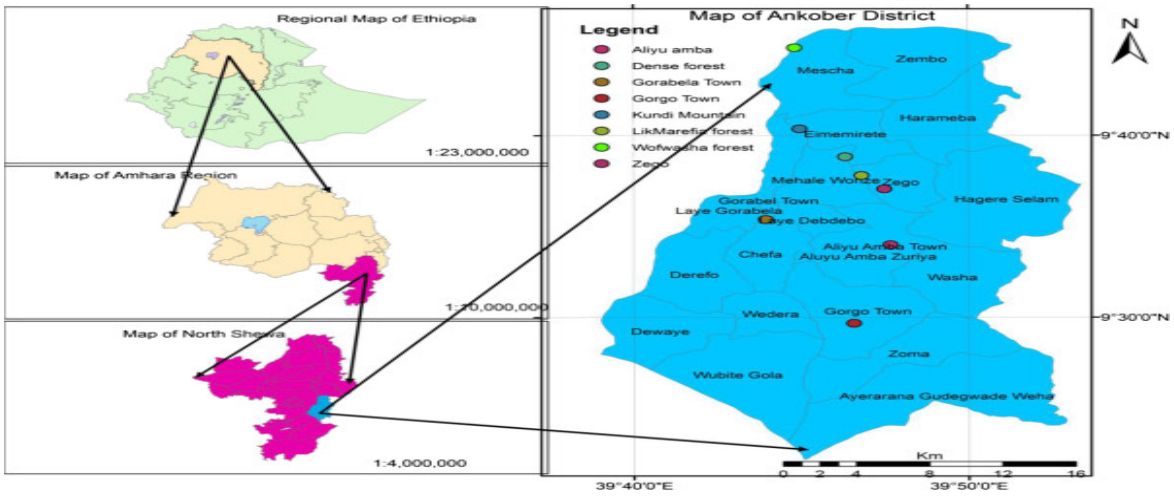

FIGURE 1: MAP OF THE STUDY AREA

Source: Adopted from Lulekal et al., 2014.

2.3. Sampling Technique and Estimation

The target group of this study is rural farmers that live in Ankober District. The district is organized in to 23 administrative kebeles. From those administrative, 4kebeles are urban and exercises non-farming economic system. On the other hand, 19 kebeles are rural and farmers who engage their economic activities that depend on agricultural practice particularly on crop production (Wheat, Barley, Teff and Maize). The district categorized to three Agro-Ecological zones: Dega, Weyna- dega and Kola. Multistage sampling technique was employed to select respondentsfor study. In the first stage, purposively Ankober wereda was purposively selected from three Agro-Ecological zones: Lay Gorebela and chefa from Dega: Haramba, GorguZuria and MahlWonz from Weyna- dega andZoma and AliyuambaZuria from Kola Agro-Ecological zones were randomly selected in the second stage. Lastly, crop producer farmers were chosen by using simple random sampling technique.

To collect the primary data from farm households, seven enumerators were used including the researchers. The selection was based on their ability to communicate using Amharic, their educational level which is at least twelve and above grades and prior exposure in data collection. Enumerators were

trained on the interview discipline, program and process of conducting the survey and interview.

To figure out the study sample size and obtain good representation to ensure a valid generalization, the study use minimum sample size formula stated as follows: The research assumes that crop failure incidence rate in the study area by using minimum sample size formula. Let p value = is crop failure incidence rate in the area which is equal to 82% (AWFPO, 2020). The two-tailed critical value at 95% confidence interval Z is (1.96) and α/2 is marginal error between the sample and population size (0.05).The study used minimum sample size formula to estimates its sample size (Dawson, 2009).

$$\mathbf{n} = \frac{\mathbf{z2} * \mathbf{p} * \mathbf{q}}{\boldsymbol{\alpha}\mathbf{2}}$$

Where; n= Sample size

Z^2 = Standard normal value usually taken as 1.96 for a 95 percent confidence interval

α^2 = Marginal error

p or q =Indicate that the degree of variability

Based on the above information the minimum sample size of the study can be estimated by

z =95%=1.96

p = the proportion of household that are victims of crop failure or percentage cover of incidence 0.82,

q = 1-p =0.18 the proportion of household that are not victims of crop failure and

α^2= acceptance error =100%-95%=5%=0.05.

Then the sample size n will be =?

$$n = \frac{z^2 * p * q}{\alpha^2} = \frac{[1.96]^2 0.82[1-0.82]}{(0.0025)} = 227$$

n = 227 plus 10% of contingency (23) =250 Farm Households

Table 1: population Number and distribution for AnkoberWereda(District)

19 Rural kebeles								
Agro-ecological Division								
Dega/5kebele	HHs	Popn	Weynadega/9	HHs	Popn	Kola/5ke	HHs	Popn
Laygorebela	843	4031	***Haramba***	1073	6050	***Zoma***	799	4459
Mescha	717	3874	Deway	828	5028	Washa	621	3255
Debdebo	444	2186	Derefo	1181	5327	Wubitgol a	605	3685
Chefa	875	4118	***Gorgozuriya***	1221	6394	***Aliyuam bazuriya***	1244	5729

Ememihret	625	2683	Wedera	754	4297	Ayrara	540	3385
			Zego	595	2914			
			Mehalwon	854	4171			
			Zenbo	1023	5552			
			Hagereselam	998	5721			
5	***3504***	***16892***	***9***	***8527***	***45454***	***5***	***3809***	***20513***

NB: Highlighted in green color Kebeles are selected randomly for sampling purpose

- ✓ **A household:** a group of individuals who are living and eat together being responsible for the head of the house in rural the part of the nation.
- ✓ **Kebele:** the lowest governmental administrative structure of Ethiopia, having a minimum population size of 5000 people

Source: AWFPO, 2020.

Table 2: Total selected Sample population

No	Kebele	Total population	HHs sample population	Sample size Estimation $(\frac{n}{N} * ni)$
1	Lay gorebela	4031	843	(250/6909)*843 =31
2	Chefa	4118	875	(250/6909)*875=32
3	Haramba	6050	1073	(250/6909)*1073=39
4	Gorgozuriya	6394	1221	(250/6909)*1221=44
5	Mehalwon	4171	854	(250/6909)*854=31
6	Zoma	4459	799	(250/6909)*799=28
7	Aliyuambazuriya	5729	1244	(250/6909)*1244=45
	Total	***34952***	***6909***	***250 farm hhs***

Source; Own computation, 2021

2.4. Data Sources and Collection

Concerning the data source, both the primary and secondary sources of data have been used. The primary data collection based through open-ended and close- ended questionnaires that can be address for the households and other concerned body. The secondary data was collected from various previous studies and report and documented from Central Statistical Agency, Ankober district agriculture office and other related administration office in the study area. In the data set full information of the demographic characteristic of households, the nature of farm, input utilization, total produced output and institutional related variables. Whereas concerning the primary data, it was collected from farmers by random selection of sample from purposely selected kebeles administrations. Data collection was done using a semi structured questionnaire. A semi structured interview was undertaken to collect a detailed

information about land coverage of crop production, the amount of output obtained from that plots, credit access, amounts of saving, TLU(Tropical Livestock Unit), Crop diversification, etc. in the production of crops in year 2019/20 using cross section data in the study areas.

Besides, the value of the new good was estimated from the value which was generated through this hypothetical market. The study used 250 ETB (5.5$) per 0.25 hectare as premium payment for the crop insurance and this is taken from the initial premium amount as a base. In order to secure relevant data collection, the researcher provides brief explanation and training on how to gather information to the enumerators before they embarked on data collection. In addition to this, there was a continuous supervision during data collection. A key informant interviews were conducted with farmers, concerned agricultural professionals, development agents, and administration offices at all levels.

2.5. Methods of Data Analysis

Once the data have been collected, it was analyzed using a descriptive and econometric model. The descriptive part of the study helped us to describe different variables by using statistical analysis such as mean, standard deviation, tables, graphs, and percentage. In the econometric part, the study used binary logit model for analyzing the basic determinants and status of farmer WTP for crop insurance. Besides, the study employed reliability test by Cronbach's alpha test. it important instrument for reliability and internal consistency on the other hand Cronbach's alpha is one of the most widely used measures of reliability test in the social and behavioral sciences research. From different books found that alpha values calculated to determine quantities interpretations of the significance of the values in relation to what was being measured form of reliability or internal consistency. Many scholars agreed that a threshold or cut-off point, when the Cronbach's alpha test result is ≥0.70 or >0.70, it is acceptable and satisfactory level of reliability (Singh, 2006).Therefore, the value of Cronbach's alpha or reliability test ranges from 0.7568 to 0.8044 and total test scale result ***show 0.79***, thus, the study accepts its instrument or questionnaire for final survey.

2.6. Model Specification and Estimation

The study used a Single bound dichotomous choice formats to examine the willingness to pay (WTP). A Single bounded dichotomous choice CV method was used and only one dichotomous question was asked with a threshold amount which can respond in either 'yes' or 'no' to that amount. This format helps to identify whether the respondents have a willing to pay the specified bid amount by is asking each of them once. The single-bound format is theoretically suitable because it makes the responses easy because it is more related with real purchase actions.

The single bound dichotomous choice question is like take- it or leave -it type or yes or no answer. When ask the respondent a question like are you willing to pay an amount Y? If the response is Yes or No, the next question could be requesting their maximum or minimum value. Therefore, the respondents identified two amounts that limited their maximum WTP.

Mostly uses probability model for the estimation of mean WTP is the logistic model. Thus, the study applied the Binary Logit model to determine farmer's willingness to pay for crop insurance in Ankober wereda, North shewa zone, Amhara region, Ethiopia. The binary logit model uses values to which variable have two responses. The study used to the close-ended or dichotomous types of dependent variables for the model. That means farm households are given the initial 'bid' that has 'yes' or 'no' responses to analyze their responses of WTP. This means 0 for no; 1 for yes of willingness to pay. The willingness of farmers for the crop insurance depends on their expected gains and utility, and would be willing if the expected gain obtained from participating is exceeding with their cost of participating.

The Logit model is suitable when we assume the random components of response variables follow binomial distribution and when most variables have categorical responses. More appropriate when the dependent variable is dichotomous having a yes or no response.

It can be specified as: by assuming the cumulative logistic distribution of the logitmodel

$$P_i = E(Y = 1 \mid X_i) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 X_i)}} \quad \text{---------- (1)}$$

For ease of explanation, we can write it as:

$$P_i = \frac{1}{1 + e^{-Z_i}} = \frac{e^z}{1 + e^z}$$ Where: $Zi = \beta_1 + \beta_2 X_i$---------- *(2)*

It is simple to check according to *Zi*ranges from -∞ to +∞, *Pi* ranges between 0and 1 and that *Pi* is nonlinearly related to *Zi*(i.e., *Xi*), now the two required assumptions are satisfied. But this problem is more apparent than real because (1) can be linearized, which can be shown as follows (Gujarati & Porter, 2009).

If Pi, the probability of a given farmer is willing to pay and (1 − Pi), the probability of not willing to pay: Then, we take the natural log of the odds ratio, we get:

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta_1 + \beta_2 X_i + u_i \quad \text{----------(3)}$$

L,is the log of the odds ratio, is not only linear in X, but also (from the estimation viewpoint) linear in the parameters. L is called the logit, and hence the name logit model.

$$Y_{it} = \beta_0 + \sum_{i=1}^{t} \beta_{it}\, x_{it} + \varepsilon_{it} \quad (4)$$

Where,

Yi= is the dependent variable for willingness to pay Crop Insurance

X_{it} = is the independent variable with i^{th} observation

β = is the parameter to be estimated

ε_i = is the residual

Based on the above justification, the logit model can be specifying for farm households' willingness for the crop insurance is as follows:

$$WTP = \beta_0 + \sum_{i=1}^{t} \beta_{it}\, x_{it} + \varepsilon_{it} \quad (5)$$

WTPi = response to the 'bid' which is 1 if the response is 'Yes', 0 if the response is 'No', β_0 is constant, βiis the regression parameter, ui is the error term and X_i is the explanatory variables. Therefore, this study model can be specified as:

WTP= β_0 + β_1Sex +β_2 Age + β_3 Education + β_4Family Size+β_5 TLU + β_6Off Farm Income + β_7Credit Access +β_8 Extension contact + β_9Land Size + β_{10}Annual Crop Income + β_{11}Saving habit + β_{12} Awareness for crop insurance + β_{13}Information Access+β_{14} Crop Diversification +ui----------(6)

Where: WTP: Willingness To Pay

The interpretation of logit model cannot be directly interpretable. To interpret the result we use odds ratio but still the effect of independent variables on dependent variable are not identified clearly. So the study used marginal effects (take the derivative of Y (dependent variable) with respect to X_i (that is, the rate of change of the probability with respect to independent variables.

Table 3 presents all explanatory variables with its expected sign as below

Table 3: Variables name, type, description and expected sign

No	*Variable*	*Type*	*Description of variables*	*Expected sign*
1	Sex	Dummy	Gender of HH Head: 1 if gender of the HH head is male and 0 otherwise.	+
2	Age	Continuous	Age of the HH Head	-
3	Education	Ordinal	Education level of Farm Household	+
4	Family size	Continuous	Number of family members	+
5	TLU(Tropical Livestock Unit)	Continuous	Tropical livestock unit.	-
6	Off farm income	Dummy	1 if the farmer has an off farm income and 0 otherwise	+
7	Credit access	Dummy	1 if the HH has had credit access and 0 otherwise.	+
8	Extension Contact	Dummy	1 if the HH has contact to DAs and 0 otherwise	+
9	Land size	Continuous	Land size for crop production	+
10	Annual Crop Income	Continuous	Total amounts of Income generates from Crop Production	+
11	Saving habit	Dummy	1 if the HH has had savinghabitand 0 otherwise.	+
12	Awareness for Crop Insurance	Dummy	1 if the HH has had awareness for yield crop insurance and 0 otherwise.	+
13	Information access	Dummy	1 if the HH has had information access and 0 otherwise.	+
14	Crop Diversifs	Continuous	Total amounts of crop diversification or varieties	+

Source: Own Computation, 2021

2.7. Diagnostic tests

Diagnostic tests helps to check whether there is or not a series problem in the multiple regression models before testing important variables. According to Young, (2017), in multiple regression analysis, a multicollinearity test is conducted to know whether there is a linear relationship within the independent variables or not. Collinearity indicates whether two variables have close perfect linear combinations of one another. A multicollinearity issues can arise when two or more independent variables are significantly correlated with each other. Thus, the study used two methods to check this problem. These are *Variance Inflation Factor (vif)* for association between the continuous independent variables and *Contingency Coefficients (cc)* for dummy or discrete variables. In the case of heteroskedasticity, it checked whether the variance of error terms is constant and independent of each other or not. This condition determined the

present and absence of heteroscedasticity issue. In presence of heteroscedasticity the estimates of regression coefficients not remain BLUE (Best Linear Unbiased Estimator). Thus, it can be detected by Breusch – Pagan – Godfrey Test.

3. Result and Discussion of the study

3.1. The Descriptive analysis

The study used descriptive and inferential statistics for analysis part of the study. For the descriptive analyses of the study, continuous and dummy variables are used. The mean value and standard deviation of the variables were applied to measure the central tendency and dispersion of variable(s) respectively for the continuous variable, whereas, frequency count and percentages have used for dummy variables. From study findings, A total of 250questionnaires were distributed and of which 245 (98%) filled completely and returned which is excellent, and a total of 5 are not completed and returned.Thus, this study, use a total of 245 sampled households for this study purposes. From sampled farm households, the average age (mean) of the respondent was 41.72 years with the minimum age of 20 and maximum of 75 years old. The respondent average mean family size is 4.15 with minimum of 1 and maximum of 8 family members in per household. The mean value of farm household's wealth measured in terms of TLU (Tropical livestock Unit) is 5.02, and ranges from minimum of 0 and maximum of 13.15 TLU.

The average mean of land holding size in the study area is 2.53 Timad (which is equivalent to 0.63hector) and it ranges from minimum 1 Timad(0.25ha)to maximum of 5 Timad(1.25ha) of land size. The respondent farmer annual revenue ranges from 1000ETB/year to 60000ETB/year and their mean annual income from crop production is 16741.63ETB/year. The farmer crop diversifying habit ranges from 1 to 5 kinds of crop and at least they grow 3.21 kinds of crops in one crop season. From the total sampled respondent, the maximum mean willingness to pay (WTP) premium of farmer for area yield crop insurance in the study area is 272.449ETB (6.054$) /season / 0.25ha or Timad and their WTP ranges from minimum 0 ETB to maximum 3000 ETB/ha/per season. ***NB: (1 USD is equivalent to 45 Ethiopian Birr)***

Besides, from the total respondent 188(76.73%) were male and 57 (23.27%) of the respondents were female. The households' educational level categorizes in to four educational levels that is from grade (1-4), grade (5-8), and grade (9-12) and above grade 12 it covers from the total respondent 32.24, 33.06, 28.57 and 6.12 percent respectively. From the total respondent 53(21.63%) farm households participated in off-farm activities and they have off farm income which is helpful for farmers to participate in the program, and the rest 192(78.37%) farmers has no off-farm income generating source. From the total respondent 127(51.84 %) has the opportunity to get credit service, and 118(48.16 %) of the respondents has no access to credit.

The results show that farmers who have access to agricultural extension services are 202(82.45%) and those who have not access are 43(17.55%). The study shows that, from the sampled farm households those who have saving habit are 166(67.76%) and those who haven't a habit of saving are 79(32.24 %). From the sampled farm households, those who have awareness about area yield index crop insurance were 18(7.35%) and who have not awareness were 227(92.65%). This entails that in the study area farm households have less awareness about the nature of crop insurance and that is why the study is essential, because the first thing that the farmer to have is awareness about the nature of crop insurance. From the sampled respondents, 156(63.67%) of farm households has information access about crop insurance and other related situations but the other 89(36.33%) of the respondent has no information access. Finally, the result shows that in study area from total 245 respondent 130 (53.06%) are willing to participate for crop insurance and 115(46.94%) of respondent are not willing to pay (See Appendix 1 and 2).

3.2 Determinants of Farmer's Willingness to Pay for Crop Insurance

Different post estimation diagnostic tests techniques were applied to test whether the model is best fit for STATA 11.2 software package before regression of the logit model. The variance inflation factor (VIF) was conducted to test the multi-collinearity among continuous variables. The result shows that all variables used in the model have VIF result less than 10 (or 1.54), which means that there is no multi-collinearity problem in the model. In the case of discrete explanatory variables the contingency coefficients were computed. Its result was less than 0.80 indicated there is no multi-collinarity problem (See Appendix3 and 4). The test detects the presence of heteroscedasticity (has no constant variance in εi) . The result of Breusch-Pagan test (Chi2 (1) = 1.72 with probChi2= 0.187. It showed that we fail to reject the null hypothesis of homoscedasticity or it is statistically insignificant since the *p*-value is greater than 0.05.Thus, there is no heteroscedasticity problem in the model (Appendix5).

After doing the diagnostic test and identifying the key factors that determine the willingness of farmers to pay for crop insurance by a logit model and the marginal effect of method used to estimate the independent variables on dependent variables. From the regression output, age of the farmers, educational level of the farmers, TLU, Credit access, income generated from the crop production, the farmers' habit of saving, awareness towards Crop Insurance and access to crop insurance related information are statistically significant variables farmer's willingness to pay for crop insurance in the study area at 1% and 5% significant level. On the other hand, sex, family size, off farm income, Extension contact, Land size and crop diversification variables have no significant effect on farmer's willingness to pay for crop insurance in the study area. Thus, table 4 presents

Age: The coefficient of age is positive and statistically significant at 5% probability level. The result shows that as the age of farmer increase, the chance of paying for crop insurance become higher than younger one. It means that, assuming other variables constant, as the age of farmers increase by one more year increase their willingness to pay for crop insurance by 8%. This can be due to old age needs support from different insurance schemes and the farmers become more risk adverse individuals for their crops production. The result is supported by the finding of (Ali, 2013; McIntosha et al., 2013; Teshome & Bogale, 2015; Kiran a& Umesh, 2017;Wang et al., 2022).

Education: The coefficient of farmer's educational level is positive and statistically significant at 1% probability level. It shows that the more educated the farmers are the higher the chance of willing to pay for crop insurance than lower educational leveled farmers. This means, if farmers with transition from one education category to the next of educational level category such that the education of the household head (compared with grade (0-4) which is used as a base)), grade (5-8), grade (9-12) and grade (>12), keeping other variables constant, their willingness to pay for crop insurance increases by 24 ETB on average level. This can be due to education improves more aware about the issue of area yield crop insurance and how to protect them from crop failures .This finding is supported by previous studies (Belaynesh, 2014; Amar, 2020; Carrer et al., 2020; Biswakarma & Rana, 2021; Wang et al., 2022).

TLU (Tropical Livestock Unit): The coefficient of Total Livestock Unit is positive and statistically significant at 5% probability level. The result indicates that as farmers Total Livestock Unit increases, there is more likely willingness to pay for crop insurance than with low TLU. It means that, if Total Livestock Unit increases by one more units, assuming other factors constant, and the probability of willingness to pay for crop insurance increases by 5 %. This can be due to the fact that farmers with more TLU, they have good opportunities to get more income from this livestock production and be able to more willing to purchase the crop insurances for their crop protection. The result is similar with the finding of (McIntosha et al., 2013; Teshome, & Bogale, 2015; Kiran & Umesh, 2017; Wang et al., 2022).

Credit Access: The coefficient of credit access is positive and statistically significant at 1% probability level. It shows that farmers with more credit access from MIFs and other financial service providers are more willing to pay for crop insurance than farmers with no credit access. It means that, if farmers with one more credit access, assuming other factors constant, and their willingness to pay for crop insurance increases by 33% on average level. This implies that farmer's with more access to credit and can purchase more fertilizer and improved seed for their production activities and can produce more output The result is consistent with the works of (Teshome & Bogale, 2015; Ashenafi, 2016; Essossinam et al., 2020 ;Gulseven, 2020).

Annual Crop Income: The coefficient of Annual Crop Income is negative and statistically significant at 5% probability level. The result indicates that as Annual Crop Income increases, there is less likely willing to pay for crop insurance. This means, if household Annual Crop Income increases by 1000ETB, assuming other factors constant, and the chance of willing to pay for crop insurance decreases by 0.1%. This can be due to that if the farmers with high annual income from their production; it becomes more risk taker farmers than with low income group. Thus, it leads to less willing to purchase crop insurance for their crops. This result is consistent with the works of (Ashenafi, 2016; Tigist, 2017; Kiran & Umesh, 2017; Ntukamazina et al., 2017; Fonta et al., 2018.

Saving Habit: The coefficient of saving habit is positive and statistically significant at 1% probability level. It indicates that as farmers saving habit changes from none saving, there is more likely willingness to pay for crop insurance than with no saving habit. It means that, if farmers saving habit changes from non, assuming other factors constant, and the probability of willingness to pay for crop insurance increases by 62%. This can be due to saving more money in the financial or non-financial institution leads to build more confidence to buy the crop insurance. The result is consistent with the finding of (Belaynesh, 2014; Essossinam et al., 2020; Gulseven, 2020; Biswakarma & Rana, 2021;Ngango et al.,2022).

Awareness for Crop insurance: The coefficient of Awareness for crop insurance is positive and statistically significant at 1% probability level. The result indicates that as farmers Awareness for crop insurance increases, there is more likely willingness to pay for crop insurance than with no awareness for crop insurance. It means that, if farmers Awareness for crop insurance increases, assuming other factors constant and the chance of paying for crop insurance rises by 50%. This is due to the fact that farmers who has previous information and know more about the idea make evidence based strong and significance decision as well as more demanded for willing to pay than farmers who have not awareness for crop insurance. This result is similar with the finding of (Mebrahtu, 2014; Tigist, 2017; Kiran & Umesh, 2017; Ntukamazina et al., 2017; Mutaqin & Usam, 2019; Ngango et al., 2022).

Information access: The coefficient of information access for crop insurance is positive and statistically significant at 5% probability level. The result indicates that as farmers information access for crop insurance changes, there is more likely willingness to pay for crop insurance than with no or less access. It means that, if farmer's information access for crop insurance changes from none or less accessed farmers, assuming other factors constant, and the chance of paying for crop insurance rises by 24%. This is due to the fact that farmers with more access for crop insurance, they become more familiars and willing to buy different crop insurance for their crop failures. The result is similar with the finding of

(Kiran and Umesh, 2017; Ntukamazina, et al., 2017; Tigist, 2017; Fonta et al., 2018; Mutaqin & Usam, 2019 ; Ngango et al.,2022).

Table 4.Logit Estimation out pot for Household WTP crop Insurance

Explanatory variables	***Dependent variable WTP: 1 for WTP for Crop Insurance 0, otherwise***	
	Logit output	***Marginal effects : dy/dx***
Sex	0.5755 (.5429)	0.1410 (.1285)
Age	0.3269** (0.1453)	0.0815** (0.0361)
Age square	-0.0038** (0.0016)	-0.009** (0.004)
Education	0.9860*** (0.2609)	0.2461*** (0.0651)
Family size	-0.0286 (1.6855)	-0.0071 (.0420)
TLU	0.2358** (0.1289)	0.0588** (0.0321)
Off farm income	0.1818 (0.5736)	0.0451 (0.1432)
Credit access	1.3956*** (0.5191)	0.3346*** (01151)
Extension Contact	0.2718 (0.8521)	0.0671 (0.0875)
Land size	0.3802 (0.2469)	0.0949 (0.0617)
Annual Crop Income	-0.0001** (0.0000)	-0.0001** (0.0000)
Saving Access	3.1841*** (0.6056)	0.6241*** (0.0754)
Awareness for CROP INSURANCE	2.8787*** (0.9988)	0.5022*** (0.0894)
Information access	1.0020** (0.4623)	0.2427** (0.1059)
Crop Diversifs	0.3572 (0.2533)	0.0891 (0.0632)
Constant	-15.2709*** (3.3942)	
Number of obs	245	245

LR chi2(15)	187.43	
Prob> chi2	0.0000	
Pseudo R2	0.5533	

*** Significance at 1percent, ** significance at 5percent, * significance at 10percent, Standard error is in bracket.

Source: Own Computation, 2021.

4. Conclusion And Recommendation

In Ethiopia as developing countries, crop failures are common all over the country. For this, the existence of crop insurance plays a decisive role. This study attempted to determine farmer's willingness to pay for crop insurance in Ankober wereda, North Shewa zone, Amhara region, Ethiopia. The study collected data from 245 farm households drawn randomly from five districts using structured questionnaire. The study employed both descriptive and econometric analysis to analyze the data. To assess the determinants of farmer's willingness to pay, the study employed binary logit model. The descriptive analysis showed that out of the total 245 respondents, 130 (53.06%) are willing to participate in crop insurance scheme and 115 (46.94%) of the respondents are not willing to participate in the area yield crop insurance program. The finding indicated that the maximum mean willingness to pay (WTP) for crop insurance in Ankober wereda is 272.449ETB (6.054$) /season / 0.25ha or Timad and their WTP ranges from minimum 0 ETB to maximum 3000 ETB/ha/per season.

In the study, out of 15 independent variables examined to identify the determining factors using logit regression model, only nine of them have significant determining effect on the selected farmer's willingness to pay crop insurance. Consequently, the age, the educational level, TLU, the Credit access, amounts of income from crop production, the habit of saving, awareness towards Crop Insurance and information access for crop insurance have significant effect on farmer's willingness to pay for crop insurance in Ankober wereda at 1% and 5% significant level. However, sex, family size, off farm income, Extension contact, Land size and crop diversification have not effect.

Therefore, on the bases of the major findings stated above, the following suggestion are forwarded to create the awareness and enhance the chance of buying crop insurance in the study area suggested as

- ✓ Provide different training and advisee for farmers in considering of crop insurance and other schemes,
- ✓ The government and other stake holders should have to provide more educational access to farmers

- ✓ Develop and expand the saving habit of the farmers so as to solve the problem of financial constraints.
- ✓ Expansion of credit delivery institutions at each kebele and farm level.
- ✓ Arrange for different Medias access as a source of information to create awareness and understanding about the nature of crop insurance among farm households

Finally, in the areas of future research, further studies should be investigated by put additional variable that determine farmer willingness to pay for crop insurance. On the other hand estimating percentage of total farmer production cost are important for determine crop insurance premium amount. Crop insurance estimation confirms other mechanism provides insight on a more feasible method of estimating insurance premiums and on significant variables. Moreover, other types of insurance services should have to be practiced in order to minimize all possible sources of uncertainty from farmers and make their life stable and sustainable. Hence, similar other studies need to be studied and should focus to cover unstudied areas to drive large data analysis for the zone, the region as well as in country level.

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Lists of Abbreviation

TLU: Tropical Livestock Unit

VIF: Variance Inflating Factors

Availability of Data and Materials

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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Declarations

Competing interests: The authors declare that they have no competing interests.

Appendix 1.Descriptive statics: Categorical Variables.

```
. tab1 wtp sex education offfarmy creditacs extensionserves saving awarenessayi informass
-> tabulation of wtp
```

WTP	Freq.	Percent	Cum.
0	115	46.94	46.94
1	130	53.06	100.00
Total	245	100.00	

```
-> tabulation of sex
```

Sex	Freq.	Percent	Cum.
0	57	23.27	23.27
1	188	76.73	100.00
Total	245	100.00	

```
-> tabulation of education
```

Education	Freq.	Percent	Cum.
1	79	32.24	32.24
2	81	33.06	65.31
3	70	28.57	93.88
4	15	6.12	100.00
Total	245	100.00	

```
-> tabulation of offfarmy
```

offfarmY	Freq.	Percent	Cum.
0	192	78.37	78.37
1	53	21.63	100.00
Total	245	100.00	

```
-> tabulation of creditacs
```

CreditAcs	Freq.	Percent	Cum.
0	118	48.16	48.16
1	127	51.84	100.00
Total	245	100.00	

```
-> tabulation of extensionserves
```

ExtensionServes	Freq.	Percent	Cum.
0	43	17.55	17.55
1	202	82.45	100.00
Total	245	100.00	

```
-> tabulation of saving
```

Saving	Freq.	Percent	Cum.
0	79	32.24	32.24
1	166	67.76	100.00
Total	245	100.00	

```
-> tabulation of awarenessayi
```

AwarenessAyi	Freq.	Percent	Cum.
0	227	92.65	92.65
1	18	7.35	100.00
Total	245	100.00	

```
-> tabulation of informass
```

InformAss	Freq.	Percent	Cum.
0	89	36.33	36.33
1	156	63.67	100.00
Total	245	100.00	

```
.
```

Appendix2.Descriptive statics: Continuous Variables.

```
. summarize mwtp
```

Variable	Obs	Mean	Std. Dev.	Min	Max
mwtp	245	272.449	382.2267	0	3000

```
. summarize age familysize livestock landsize annualyi cropdvsf mwtp, separator(7)
```

Variable	Obs	Mean	Std. Dev.	Min	Max
age	245	41.72245	11.58347	20	75
familysize	245	4.159184	1.526799	1	8
livestock	245	5.023714	1.976069	0	13.15
landsize	245	2.534694	1.136134	1	5
annualyi	245	16741.63	11878.52	1000	60000
cropdvsf	245	3.216327	1.08932	1	5
mwtp	245	272.449	382.2267	0	3000

Appendix 3.VIF (Varian Inflating factors) for Explanatory Variables

```
. estat vif
```

Variable	VIF	1/VIF
landsize	1.79	0.560038
annualyi	1.75	0.570634
familysize	1.45	0.691149
age	1.43	0.699268
livestock	1.42	0.701828
cropdvsf	1.42	0.702363
Mean VIF	1.54	

Appendix 4. Diagonal Matrix Or CC Test

```
. estat vce, correlation

Correlation matrix of coefficients of regress model
```

e(V)	sex	age	agsq	educat~n	family~e	livest~k	offfarmy	credit~s	extens~s	landsize	annualyi
sex	1.0000										
age	-0.0724	1.0000									
agsq	0.0295	-0.9788	1.0000								
education	-0.0901	0.0876	-0.0311	1.0000							
familysize	-0.0274	-0.2366	0.1758	0.0626	1.0000						
livestock	-0.0176	-0.0468	0.0153	-0.0927	-0.2418	1.0000					
offfarmy	0.0976	0.0118	0.0317	-0.0130	-0.0844	0.0645	1.0000				
creditacs	0.0637	0.0418	-0.0593	-0.2471	0.0938	0.0336	-0.1856	1.0000			
extensions~s	-0.1526	-0.0901	0.1172	-0.0735	0.0788	0.0500	0.0695	-0.1966	1.0000		
landsize	0.0138	-0.1023	0.0702	0.1008	0.0044	-0.1802	-0.1413	-0.1102	-0.0865	1.0000	
annualyi	0.0255	0.0902	-0.0930	-0.0528	-0.1180	-0.1437	-0.0010	-0.0831	0.0102	-0.3824	1.0000
saving	0.0155	-0.0587	0.0895	-0.0104	0.0425	-0.1244	0.0344	-0.0774	-0.3407	-0.0590	-0.1894
awarenessayi	0.0163	0.0121	-0.0015	0.0452	-0.0029	0.0400	0.1336	0.0733	-0.0215	-0.1110	-0.0729
informass	-0.0663	-0.0446	0.0646	-0.0476	-0.0128	-0.0961	-0.1445	0.0327	-0.0353	-0.0539	0.1661
cropdvsf	-0.0429	-0.0224	0.0747	-0.0215	-0.0319	-0.0084	0.2777	-0.2586	0.1095	-0.2288	-0.2173
_cons	0.0218	-0.8797	0.8197	-0.2863	0.0715	-0.0019	-0.1340	0.0524	-0.0796	0.0826	0.0087

e(V)	saving	awaren~i	inform~s	cropdvsf	_cons
saving	1.0000				
awarenessayi	0.0164	1.0000			
informass	-0.1518	-0.1556	1.0000		
cropdvsf	0.0327	0.0446	-0.1475	1.0000	
_cons	0.0325	-0.0334	0.0261	-0.2067	1.0000

Appendix 5.Hetroschedacity Test

```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of wtp

         chi2(1)      =     1.72
         Prob > chi2  =   0.1897
```

Appendix 6. Logit output

```
. logit wtp sex age agsq education familysize livestock offfarmy creditacs extensionserves landsize annualyi saving awarenessayi inf
> ormass cropdvsf

Iteration 0:   log likelihood = -169.36159
Iteration 1:   log likelihood = -77.035801
Iteration 2:   log likelihood = -75.680955
Iteration 3:   log likelihood = -75.648204
Iteration 4:   log likelihood = -75.648195
Iteration 5:   log likelihood = -75.648195

Logistic regression                             Number of obs   =        245
                                                LR chi2(15)     =     187.43
                                                Prob > chi2     =     0.0000
Log likelihood = -75.648195                     Pseudo R2       =     0.5533
```

wtp	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
sex	.575549	.5429088	1.06	0.289	-.4885327	1.639631
age	.3269017	.1453207	2.25	0.024	.0420784	.6117251
agsq	-.0038988	.0016815	-2.32	0.020	-.0071944	-.0006031
education	.9860608	.2609344	3.78	0.000	.4746387	1.497483
familysize	-.0286653	.1685965	-0.17	0.865	-.3591084	.3017778
livestock	.2358218	.128594	1.83	0.067	-.0162179	.4878615
offfarmy	.1808363	.5736414	0.32	0.753	-.9434802	1.305153
creditacs	1.395642	.5191409	2.69	0.007	.3781444	2.413139
extensions~s	.2706891	.8521524	0.32	0.751	-1.399499	1.940877
landsize	.3802782	.2469071	1.54	0.124	-.1036509	.8642073
annualyi	-.0000483	.0000237	-2.04	0.041	-.0000947	-1.96e-06
saving	3.184166	.6056791	5.26	0.000	1.997056	4.371275
awarenessayi	2.878784	.9988383	2.88	0.004	.921097	4.836471
informass	1.002078	.4623755	2.17	0.030	.0958386	1.908317
cropdvsf	.3572781	.2533728	1.41	0.159	-.1393235	.8538798
_cons	-15.27092	3.394272	-4.50	0.000	-21.92358	-8.618273

Appendix7. Marginal effects output

```
. mfx

Marginal effects after logit
      y  = Pr(wtp) (predict)
         =   .4802685
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
sex*	.1410216	.12854	1.10	0.273	-.110905	.392949		.767347
age	.0815982	.03614	2.26	0.024	.010756	.15244		41.7224
agsq	-.0009732	.00042	-2.33	0.020	-.001792	-.000154		1874.39
educat~n	.2461313	.06519	3.78	0.000	.118369	.373893		2.08571
family~e	-.0071552	.04209	-0.17	0.865	-.089643	.075332		4.15918
livest~k	.0588636	.03217	1.83	0.067	-.004185	.121912		5.02371
offfarmy*	.0451697	.1432	0.32	0.752	-.235498	.325837		.216327
credit~s*	.3345959	.11507	2.91	0.004	.109071	.560121		.518367
extens~s*	.0671035	.20875	0.32	0.748	-.342044	.476251		.82449
landsize	.0949215	.0617	1.54	0.124	-.026002	.215845		2.53469
annualyi	-.0000121	.00001	-2.04	0.042	-.000024	-4.6e-07		16741.6
saving*	.6241364	.07541	8.28	0.000	.476326	.771946		.677551
awaren~i*	.5022168	.08954	5.61	0.000	.326725	.677709		.073469
inform~s*	.2427362	.10596	2.29	0.022	.03505	.450422		.636735
cropdvsf	.0891804	.06324	1.41	0.158	-.034762	.213123		3.21633

(*) dy/dx is for discrete change of dummy variable from 0 to 1