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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

Agriculture is considered as a fundamental instrument for spurring growth and sustainable development, poverty reduction, and enhancing food security in developing countries like Ethiopia. However, the sector has been continually blamed for its failure to meet the growing food need of the rural population. And, it is characterized by low productivity due to technological and socioeconomic factors (Tadie et al., 2019). Mostly the farmers with the same resources are producing different amount output per hectare, because of management inefficiency inputs, limited use of modern agricultural technologies, traditional farming techniques, weak supportive and infrastructural service delivery such as extension, crop failures by climate changes, credit, marketing, road and poor agricultural policies (Tadie et al., 2019; Wang et al., 2022). Its activity is subject to a wide range of risks due to the variable economic and biophysical environment in which farming operates.

Agricultural risks arise due to uncertainty over factors determining returns to agricultural production. Uncertainty in agriculture reflects the nature of most farm production systems, which is influenced by ever-changing economic and biophysical conditions (Kiran & Umesh, 2017). Natural disasters such as droughts, floods, hurricanes, landslides, erratic rainfall, earthquakes, and many other climate change related problems often affect agricultural production and farm income in many countries. Thus, it needs an insurance service to protect smallholder farmers from those disasters (Biswakarma & Rana, 2021).

Insurance is the transfer of risk between the insured and the insurer at a cost which reduces the intensity of loss. Insurance not only reduces the uncertainty faced by the insured, but it evens out the burden of a loss especially if the loss is of large scale one (Kiran & Umesh, 2017).With agricultural insurance services, the insured party (the farmer) pays a premium to an insurer to guarantee against losses (of crops, assets, property, livestock or income) over a defined period. These losses can be caused by perils such as extreme weather events (e.g. drought and floods), the onset of pests and diseases or the death of livestock. The farmers is given a promise by the insurer to indemnify them (be paid back) in the event of a loss. While different types of agricultural insurance are available, crop insurance is the most common service offered to smallholder farmers in developing markets and it is one of the risk mitigating strategies for farmers (Raithatha & Priebe, 2020; Biswakarma & Rana, 2021).

Insurance services in developing countries can struggle to offer safety nets for such shocks. Globally its coverage, less than 20 per cent of smallholder farmers have any form of agricultural insurance 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 insurance, group insurance and index insurance 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) offered by Nyala insurance company NISCO and Dashen Bank in the Amhara region (McIntosh *et al*., 2013; Tigist, 2017, Tafesse, 2022).

Agriculture in Ethiopia is an important sector of the economy in general and it becomes livelihoods means for many small holder farmers. The, sector contributes 33 per cent to 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 between the insured and the insurer at a cost which reduces the intensity of loss. Insurance not only reduces the uncertainty faced by the insured, but it evens out the burden of a loss especially if the loss is of large scale one (Belaynesh, 2014; Tigist, 2017).

Besides, Crop failure occurred due to biological and uncontrolled natural factors. The most cause of Natural factors are an avoidable such as rainfall (drought or excess rainfall), flood, 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.

Different studies have been performed by some scholars to examine the main determinants of households willingness 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 business characteristics influence a producer's decision to use the risk management tool and employed the double-hurdle model to investigate 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, the rest of the paper is organized as follows: Section 2 provides methodology section that describes data type, sample size determination and model specification and estimation used in the study. Section 3 presents result and discussion of the study and finally, section 4 presents the conclusion and recommendation.

2. Methodology

2.1. Research Design and approach

A research design is a strategy for answering your research question using empirical data. It is essentially a statement of the object of the inquiry and the strategies for collecting the evidences, analyzing the evidences and reports the findings (Singh, 2006). In other words, the research design sets the procedure on the required data, the methods to be applied to collect and analyze this data, and how all of this is going to answer the research question (Neuman, 2014).Regarding this, the main objective of the study is this study tries to examine the Determinants of Farmer's Willingness to Pay for Crop Insurance in Ankober Woreda, North Shewa Zone, Amhara Region, Ethiopia. Thus, the study used explanatory research design and approaches to answer its research questions. The study also used primary data at specific 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 Ethiopian highlands and located at 172 km north of Addis Ababa, the Ethiopian capital, and 42 km to the east of Debre Berhan town (the north Shewa Zone capital). Ankober District is bordered in the north by Tarmaber District, south by Asagirt District and west by Basona worana District of Amhara Region. The eastern part shares its border with Gachine Special District of the Afar Region. 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 prominent for most of 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 main administrative center of the District is located at Gorabela/Ankober town that has historical significance as it has been the seat of the Ethiopian emperors from 1270 for centuries Inthewereda, 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 indigenous people inhabiting the area belong to the Amhara ethnic group.

They speak Amharic language, the national language of Ethiopia. The District has a total population of 83,260 (42,180 men and 41,080 women) of whom only 6,272 (7.5%) are urban inhabitants (AWFPO, 2012; Lulekal et al., 2014; AWFPO, 2020).

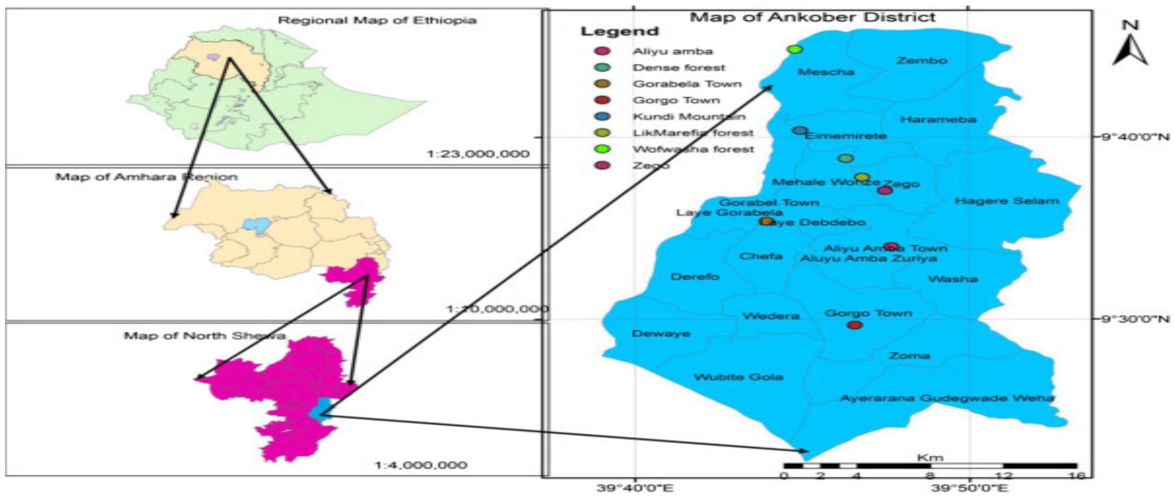

FIGURE 1: MAP OF THE STUDY AREA

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 selected 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).

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

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 rural persons who live together under the responsibilities of the head and eat from the same pot.
- ✓ **Kebele:** the lowest administrative body in Ethiopia, which comprises a population of at least 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	Aliyuambazuri ya	5729	1244	(250/6909)*1244=45
	Total	***34952***	***6909***	***250 farm hhs***

Source; Own computation, 2021

2.4. Data Sources and Collection

This study used both primary and secondary data sources. 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 obtained from different studies conducted and information documented at various levels of Central Statistical Agency, Ankober district agriculture office and other related administration office in the study area. The data set contained detailed information on households' demographic characteristics, farm characteristics, input utilization, output produced and institutional related variables. The primary data was collected from randomly selected sample farmers from the selected kebeles administrations. Data collection was done using a semi structured questionnaire. A semi structured interview schedule includes 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.s in the production of crops in year 2019/20 using cross section data in the study areas.

Besides, the values which are generated through this hypothetical market are treated as estimates of the value of new good. 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. The enumerators were given a brief explanation and training on how to gather information according to the interview schedule before they embarked on data collection. There was continuous supervision during data collection. Individual interviews with key informants from farmers, development agents, concerned agricultural professionals and administration offices at all levels were also conducted.

2.5. Methods of Data Analysis

The data was analyzed by using both 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'salpha 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). Some studies also offered indications of alpha having a threshold or cut-off as an acceptable, sufficient or satisfactory level when normally Cronbach's alpha test result ≥0.70 or >0.70(Singh, 2006).Therefore, the value of Cronbach'salpha orreliability 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 estimate willingness to pay (WTP). Single bounded dichotomous choice CV method was use only one dichotomous question is asked with a threshold amount and the respondent is expected to answer either 'yes' or 'no' to that amount. In this format, each respondent is asked once whether he/she would be willing to pay a specified bid amount. The single-bound format is incentive and compatible theoretically and has the advantage of making the responses easy since it is similar to 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, another next question followed to elicit a maximum or minimum value. Hence, 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 employed 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 appropriate when we assume the random components of response variables follow binomial distribution and when most variables have categorical responses. It is suited when the dependent variable is dichotomous and of the type that have a yes or no response.

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

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

For ease of exposition, we write as:

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

It is easy to verify that as Z_i ranges from -∞ to +∞, P_i ranges between 0and 1 and that P_i is nonlinearly related to Z_i(i.e., X_i), thus satisfying the two requirements considered earlier. 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:

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

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.

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

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:

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

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 we cannot determine the effect of independent variable on dependent variable 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, the term multicollinearity indicates to the linear relationships among the independent variables. Collinearity indicates two variables that are close perfect linear combinations of one another. It occurs when the regression model includes several variables that are significantly correlated not only with the dependent variable but also to each other. Thus, the study used two methods to check this problem. These are *Variance Inflation Factor (vif)* for association among the continuous explanatory variables and *Contingency Coefficients (cc)* for dummy or discrete variables. In the case of heteroskedasticity, it is assumed that the variance of error terms should be constant and also independent of each other. If this assumption is not fulfilled then heteroscedasticity is said to be present. 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. Results And Discussion

3.1. Descriptive analysis

The study used descriptive and inferential statistics for analysis part of the study. The study used continuous and dummy variables for its descriptive analyses. For the continuous variable, consider the mean value of the variables and standard deviation, which is a measure of dispersion or spread of variable(s), whereas for dummy variables, we used the frequency count for their number and percentages. 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 mean age of the respondent was found to be 41.72 with the minimum 20 and the maximum 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 who doesn't have access to extension services 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 check if the selected model is performed well by using STATA 11.2 software package before regression of the logit model. The technique of variance inflation factor (VIF) was employed to detect multi-collinearity among continuous variables. The test result shows all continuous variables used in the model have its vif result less than 10 which is mean of vif 1.54. Therefore, 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 main determinants of farmer's willingness to pay for crop insurance by logit model and the marginal effect of method used to estimate the explanatory variables on dependent variables., From the regression output, age of farmer's, farmer's education level, TLU, Credit access, Amounts of income from crop production, saving habit, Awareness for Crop Insurance and Information access for crop insurance 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 are statistically insignificant variables or have no impact 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 indicates that as farmers age increases, there is more likely to purchase crop insurance than with younger one. It means that, if household age increases by one more age, keeping other variables constant, the probability of willing to pay for crop insurance increase 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. This result is consistent with 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 education level is positive and statistically significant at 1% probability level. It shows that farmer's with higher education level are more willing to pay for crop insurance than farmers with lower level of education. It means that, if farmers with transition from one education category to the next of educational levelcategory 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 similar to the works of (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 unit, keeping other variables 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, keeping other variables 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. It means that, if household Annual Crop Income increases by 1000ETB, keeping other variables constant, and the probability 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 similar with the finding 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, keeping other variables 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 in the study area. 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 changes from non, keeping other variables constant, and the probability of willingness to pay for crop insurance increases 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, keeping other variables constant, and the probability of willingness to pay for crop insurance increases/changes 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 1%, ** significance at 5%, * significance at 10%, Standard error is in bracket.

Source: Own Computation, 2021.

4. Conclusion And Recommendation

In Ethiopia as developing countries, crop failures are common in different parts of 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 Ankoberwereda, 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. Besides, the result showed that the maximum mean willingness to pay (WTP) for crop insurance in the study area is272.449ETB (6.054$) /season / 0.25ha or Timad and their WTP ranges from minimum 0 ETB to maximum 3000 ETB/ha/per season.

From study findings, 15 explanatory variables which included in logit regression model for regression, nine variables have shown key determinant factors farmer's willingness to pay crop insurance in the study area. Accordingly, age of farmer's, farmer's education level, TLU, Credit access, Amounts of income from crop production, saving habit, Awareness for Crop Insurance and Information access for crop insurance are statistically significant variables to 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 are statistically insignificant variables or are not impact factors for farmer's willingness to pay for crop insurance in the study area.

Therefore, based up on the major findings of the study, the following specific areas of interventions to farmers' willingness to pay 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. Also try to practice other types of insurance programs apart from this study program which pays the producers their cost of production when the risk occurs should be investigated to determine their feasibility and acceptability by farmers. 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

ExtensionSe rves	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

AwarenessAy i	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