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MODELING KEY DETERMINANTS OF THE HOUSEHOLD FOOD SECURITY IN RWANDA: PROBIT REGRESSION APPROACH

[1]NDAKAZA Jean Napoleon, [2]Dr. Joseph K. Mung'atu, [3]Dr. NDENGO Marcel, [4]HAGENIMANA Felix, [5]GASHEJA Christophe, [6]HARERIMANA jean de Dieu

Faculty of applied sciences, Department of statistics and actuarial sciences, Jomo Kenyatta University of Agriculture and Technology, Kigali, Rwanda

Abstract: **Rwanda runs the risk of slowing further progress toward the achievement of MDG-1 to eradicate extreme hunger and poverty. Thus there was needed to understand factors that influence and determine food security in Rwanda. A probit regression procedure was employed on household cross sectional data surveyed by WFP Comprehensive Food Security and Vulnerability Analysis and Nutrition Survey 2012 in a joint initiative between the Rwandan National Institute of Statistics and the Ministry of Agriculture and Animal Resources. The backward elimination and stepwise methods determined automatically which variables to keep or drop from the model. Of the seven variables fitted in the model; Sex of household head and Education level of household head as demographic determinants of household food security and Size of land, Access to nearest market, Livestock ownership and climatic adaptation as the economic determinants of household food security were found to be statistically significant. Marginal effects showed that households with education level of head of household and households owning livestock were more likely to be food secure than their counterparts. Correctly classified of 75.72% And the area under the receiver operating characteristic (ROC) curve of 0.71 indicated that the model was correctly specified. These results have policy implications for Food Security Status of Households in developing countries like Rwanda.**

Keywords: **Probit, food security, Rwanda.**

1. INTRODUCTION

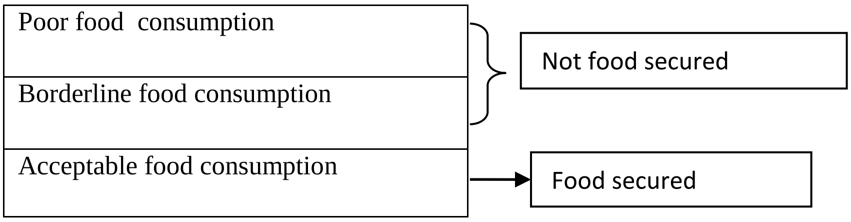
Rwanda runs the risk of slowing further progress toward the achievement of MDG-1 to eradicate extreme hunger and poverty. The CFSVA and Nutrition Survey 2012 household questionnaire asked whether households had enough food or money to buy food during the last 12 months, and if they did not, they were labeled as having 'food access issues'. In total, almost half of all households do not have food access issues (49%). A fifth of all households reported seasonal food access problems, 17% acute and 14% chronic problems, adding up to a total of 51% of all households reporting some type of difficulty in accessing food in the 12 months preceding the survey (CFSVA and Nutrition Survey, 2012). The realization that society's poor remain at the forefront of food insecurity is the reason why this research focus on understanding the situation behind the food security at household level .Insufficient research had been done in relation to the situation of food security at household level in Rwanda. Most of the research has tended to concentrate on key global issues at the policy maker level, without much due consideration for how the citizens are struggling out a living. Although Rwanda is the most densely populated country in Africa, with 57% of Rwandans live below poverty line and 37% line in extreme poverty which tend to affect all people, the poor are most susceptible to diseases, and malnutrition due to their limited access to resources, which results in them struggling daily to make ends meet. (CFSVA and Nutrition Survey, 2012).This study also aims at contributing to the evaluation of policy effectiveness approach as well as the results of this study will be largely generic and can be applied elsewhere.

2. LITERATURE REVIEW

2.1 Dependent variables: The household food security:

According to the World Food Summit organized in Rome in 1996, food security exists when all people, at all times, have physical and economic access to sufficient, safe, nutritious food to meet their dietary needs and food preferences for an active life. (FAO, 1996).

To identify key determinants of household food security (HFS) we first computed a dichotomous variable indicating whether the household is food secure or not.



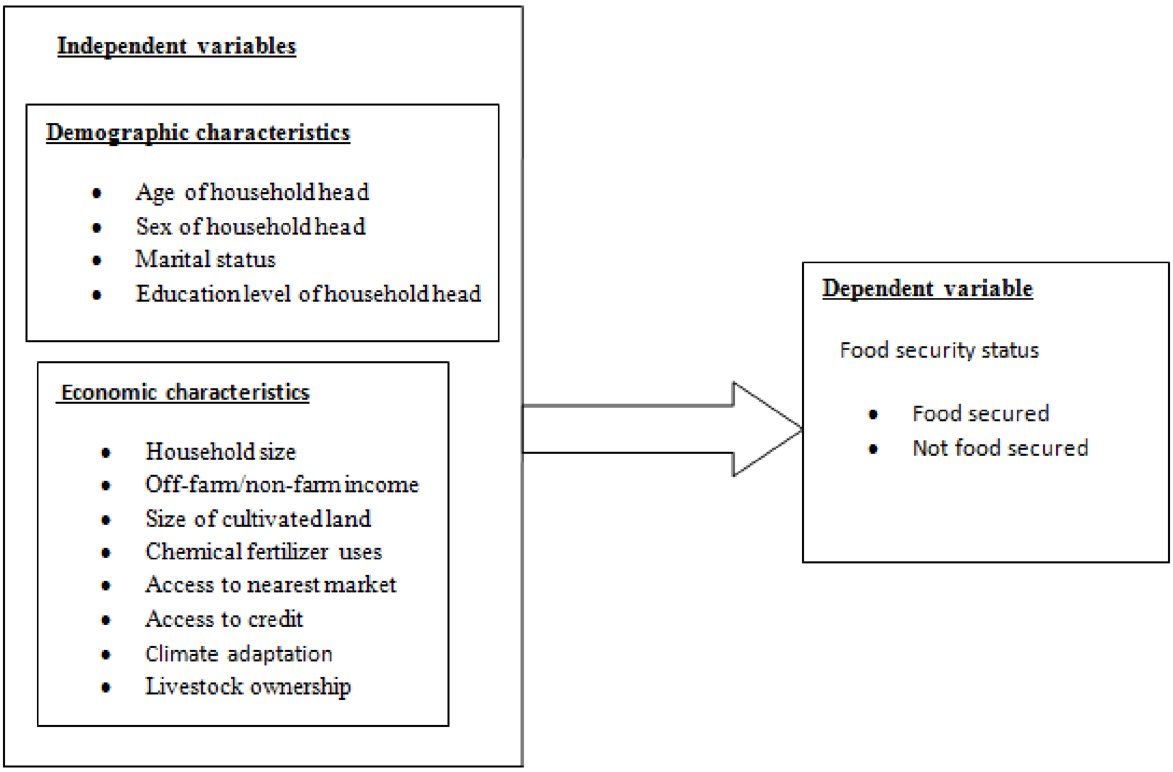
$$HFS = \begin{cases} 1, & \text{if household is food secured} \\ 0, & \text{if household is not food secured} \end{cases}$$

Where HFS denotes household food security status.

Using the Food Consumption Score (FCS), a tool developed by WFP, is commonly used as a proxy indicator for access to food. It is a weighted score based on dietary diversity, food frequency and the nutritional importance of food groups consumed. Data to use may be collected on the number of days in the last 7 days a household ate specific food items. A seven day recall period is used to make the FCS as precise as possible and reduce recall bias. The FCS of a household is calculated by multiplying the frequency of foods consumed in the last seven days with the weighting of each food group. The weighting of food groups has been determined by WFP according to the nutrition density of the food group. (FAO, 2008).

2.2 Independent variables:

The following explanatory variables are hypothesized to have an influence on household food security



Source: Author

Figure 1: Conceptual framework

3. RESEARCH METHODOLOGY

3.1 Probit Regression:

3.1.1 Definition:

Probit regression is a mathematical modeling approach that can be used to describe the relationship of several independent variables to a dichotomous dependent variable, Probit regression, also called a probit model, is used to model dichotomous or binary outcome variables. In the probit model, the inverse standard normal distribution of the probability is modeled as a linear combination of the predictors.

The Probit model constrains the estimated probabilities to be between 0 and 1, and relaxes the constraint that the effect of independent variables is constant across different predicted values of the dependent variable. The probit model assumes an S-shaped response curve such that in each tail of the curve the dependent variable, $\Pr(Y_i = 1)$, responds slowly to changes in the independent variables, while towards the middle of the curve, i.e., towards the point where Pr(Yi = 1) is closest to 0.5, the dependent variable responds more swiftly to changes in the independent variables .The probit model assumes that while we only observe the values of 0 and 1 for the variable Y , there is a latent, unobserved continuous variable Y^* that determines the valueof Y . We assume that Y^*can be specified as follows:

$$Y^* = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki} + u_i \quad (1)$$

$$\begin{cases} Y = 1 & if \quad Y^* > 0 \\ Y_i = 0 & \text{otherwise} \end{cases}$$

where $x_1, x_2, \ldots, x_n$ represent vectors of random variables, and u_i represents a random disturbance term.

Now from equation (1),

$$\Pr(Y_i = 1|\, x_i) = \Pr(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki} + u_i > 0) \quad (2)$$

Rearranging terms,

$$\Pr(Y_i = 1|\, x_i) = \Pr(u_i > -(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki})) \quad (3)$$

$$= 1 - \Pr(u_i < -(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki}))$$

$$= 1 - \Phi(-(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki})) \quad (4)$$

where Φ is the cumulative density function of the variable u_i. If we make the usual assumption that u_i is normally distributed, we have:

$$\Pr(Y_i = 1|\, \mathrm{x_i}) = 1 - \Phi(-(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki}))$$

$$= 1 - \Phi(-X_i\beta)$$

$$= \Phi(X_i\beta) \quad (5)$$

Where Φ represents the cumulative normal distribution function.

Taking the inverse of Φ we obtain:

$$\Phi^{-1}(p_i) = \Sigma\, \beta_k x_{ki} \quad (6)$$

Which is the probit model.

Using maximum likelihood techniques we can compute estimates of the coefficients (βs) and their corresponding standard errors that are asymptotically efficient. However, these estimates cannot be interpreted in the same manner that normal regression coefficients.

These coefficients give the impact of the independent variables on the latent variable Y^*, not Y itself. To transfer Y^* into a probability estimate for Y we compute the cumulative normal of Y^*. Because of this transformation there is no linear relationship between the coefficients and $\Pr(Y_i = 1)$. Hence the change in $\Pr(Y_i = 1)$ caused by a given change in X_{ij} will depend upon the value of all of the other Xs and their corresponding coefficients, or more precisely on the value of the sum $X_i\beta$, as well as the change in X_{ij}.

3.1.2 Maximum Likelihood Estimation of Probit Models:

Joint density: $f(y|x,\beta) = \prod \Phi(x_i\beta)^{y_i}[1-\Phi(x_i\beta)]^{(1-y_i)}$ (7)

$$\prod \Phi_i^{y_i}(1-\Phi_i)^{1-y_i}$$

Log likelihood function: $lnL = \sum y_i ln\Phi_i + (1-y_i)ln(1-\Phi_i)$ (8)

The principle of maximum likelihood: Which value of β maximizes the probability of observing the given sample?

$$\frac{\partial lnL}{\partial \beta} = \sum\left[\frac{y_i\emptyset_i}{\Phi_i} + \frac{(1-y_i)(-\emptyset_i)}{1-\Phi_i}\right]x_i \quad (9)$$

$$= \sum\left[\frac{y_i-\Phi_i}{\Phi_i(1-\Phi_i)}\emptyset_i\right]x_i \quad (10)$$

$$\frac{\partial lnL}{\partial \beta} = 0 \iff \sum\left[\frac{y_i-\Phi_i}{\Phi_i(1-\Phi_i)}\emptyset_i\right]x_i = 0 \quad (11)$$

Maximizing L can be computationally intense, but with today's computers it's usually not a big problem.

3.1.3 Marginal Effects in Probit:

The marginal impact of changing a variable is not constant. Another way of saying the same thing is that in the probit model

$$y = \Phi(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki}) \quad (12)$$

$$\frac{\partial y}{\partial x_i} = \beta_i \emptyset(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki}) \quad (13)$$

Since Φ is the normal cdf, ∅ the derivative, is the normal pdf. This derivate should tell us the marginal effect of increases in x on the probability of taking the action. But note that it depends not only on β_i, it depends on x as well. In other words, the marginal probability effect of changes in x depends on x itself. Well, in a way, it has to. If it were constant, we would have a linear probability

3.1.4 Goodness of fit (Receiver Operating Characteristic Curves):

Receiver operating characteristic (ROC) curves are useful for assessing the accuracy of predictions. Given a classifier and an instance, there are four possible outcomes. If the instance is positive and it is classified as positive, it is counted as a true positive; if it is classified as negative, it is counted as a false negative. If the instance is negative and it is classified as negative, it is counted as a true negative; if it is classified as positive, it is counted as a false positive. Given a classifier and a set of instances (the test set), a two-by-two confusion matrix (also called a contingency table) can be constructed representing the dispositions of the set of instances. This matrix forms the basis for many common metrics.(Da et al., 2013).While the ROC curve contains most of the information about the accuracy of a continuous predictor, it is sometimes desirable to produce quantitative summary measures of the ROC curve. The most commonly used such measure by far is the area under the ROC curve (AUC). In an empirical ROC curve this is usually estimated by the trapezoidal rule, that is by forming trapezoids using the observed points as corners, computing the areas of these trapezoids and then adding them up. This may be quite an effort for a curve with many possible thresholds. Accuracy is measured by the area under the ROC curve. An area of 1 represents a perfect test; an area of .5 represents a worthless test. (Da et al., 2013) .

4. DATA ANALYSIS AND RESULTS

4.1 Householder Food security statuses in Rwanda:

This analysis evaluates the food security status of the households based on the Food Consumption Score

Table 4.1: Food security status

HH food security	**n**	**Percent**
Food insecure	2,183	29.1
Food secure	5,310	70.9
Total	7,493	100.0

Among 7,493 respondents, 29.13% were food unsecured almost a third of all interviewed

4.2 Bivariate associations between covariates and HFS in Rwanda

Bivariate analysis was conducted to identify among the expected predictors of household Food security in Rwanda which individually contributes to the occurrence of household Food security in the country. A chi-square test for association was used with the specified threshold (α=0.05).

Table 4.2: Bivariate analysis

	Food unsecured %	food secured %	p-value
Head household's age			0.183*
15-24	33.20	66.80	
25-34	27.46	72.54	
35-44	28.98	71.02	
45+	29.70	70.30	
Head of household's marriage status			0.001
Married/union	26.67	73.33	
Divorced/separated/widowed	34.54	65.46	
Head of Household's education level			0.000
no school	35.37	64.63	
Primary	27.44	72.56	
Secondary	16.35	83.65	
vocation school	22.94	77.06	
University	7.41	92.59	
Sex of head of household			0.000
male	26.72	73.28	
Female	35.11	64.89	
Size of household			0.003
1-3	30.04	69.96	
4-6	30.16	69.84	
7-10	26.01	73.99	
10+	19.57	80.43	
Household land size			0.000
no land	26.98	73.02	
0 to 0.49 ha	35.39	64.61	
0.5 to 1.99 ha	21.33	78.67	
2 to 5 ha	13.51	86.49	
more than 5 ha	11.11	88.89	more than 5 ha
	Food unsecured %	Food secured %	p-value
Chemical fertilizer uses			0.000
none	31.30	68.70	
one of fertilizer or insecticides	28.40	71.60	
both	20.88	79.12	
Climate adaptation			0.008
No	27.63	72.37	
Yes	30.42	69.58	
Livestock ownership			0.000
0-1	32.05	67.95	
1.001-3	18.34	81.66	

3.001-6	8.48	91.52	
6+	7.50	92.50	
Access to credit			0.112*
no	29.06	70.94	
yes	39.22	60.78	
Estimated time from village to the market			0.000
1-60min	26.67	73.33	
1h-2h	31.91	68.09	
2h+	36.83	63.17	
off farm incomes			0.109*
No	29.97	70.03	
Yes	28.27	71.73	

*Not statistically significant at $p < 0.05$

According to the table 4.5, among variables with demographic characteristics, Sex of household head with $p - value = 0.001$, Marital status with $p - value = 0.000$ and Education level of household head with $p - value = 0.000$,were found individually strongly associated with house hold food security. Only age of household head was not associated with household food security with the p-value $= 0.183$. And the variables with economic characteristics, Size of household with p-value $= 0.003$, Household land size with p-value $= 0.000$, Household farm land p-value $= 0.000$, Climate adaptation with p-value $= 0.008$, Livestock ownership with p-value $= 0.000$ and Estimated time from village to the market with p-value $= 0.000$ were found associated with household food security. But Access to credit and off farm incomes with p-value 0.112 and p-value 0.109 respectively are not significantly associated with HFS thus we drop them.

4.3 Multicollinearity screening:

Table 4.3: Multicolinearity among covariates

	hh_age	hh_mar	hh_edu	hh_sex	hh_size	hh_landsiz	hh_fert	hh_nearmar~t	acc_credit	Clim_adapt	Liv_Owners	off_farm
hh_age	1.000											
hh_mart	-0.082	1.000										
hh_edu	0.131	-0.023	1.000									
hh_sex	-0.094	-0.835*	0.084	1.000								
hh_size	-0.259	0.199	-0.102	-0.014	1.000							
hh_landsiz	-0.084	0.007	0.059	0.029	-0.029	1.000						
h_fert	-0.007	0.068	0.002	-0.020	-0.028	-0.318	1.000					
hh_nearm	0.054	0.020	0.083	-0.006	0.013	-0.002	-0.010	1.000				
acc_credit	0.017	-0.014	0.010	0.000	-0.022	-0.020	-0.010	-0.019	1.000			
Clim_adapt	0.030	-0.002	0.026	-0.010	0.011	-0.028	-0.108	-0.025	-0.000	1.000		
LivOwners	-0.079	-0.005	-0.083	0.032	-0.105	-0.264	-0.070	0.038	0.009	0.002	1.000	
off_farm	0.129	0.000	-0.128	0.030	-0.108	0.144	0.088	0.081	-0.007	0.032	0.030	1.000

(* shows $|r| > 0.5$ which means that they are correlated)

Table 4.3 provides the test for Multi-co linearity among covariates. We are testing if there is a correlation of at least one independent variable with a combination of the other independent variables. Here the Pearson's R correlation coefficient is used. Correlations of $|r| > 0.5$ are considered to be collinear.

The test shows us that house holder sex and house holder marital status are linearly correlated with $r = -0.835$. This means that house holder sex and house holder marital status will explain the same on the outcome in the probit model, Thus to produce parsimonious (efficient), to avoid that we remove one variable of collinear pairs. To remove one variable we need judgment of which to remove. By using a chi-square test for association between house holder sex, house holder marital status and house holder food security we found the p-values p-value=0.000 and p-value = 0.001 respectively, This suggest that we drop house holder marital status and keep householder sex.

4.4 Full Model:

All the covariates identified by binary probit regression analysis to be associated with the outcome was going to be considered in multiple probit regression model. First we are going to run a full mode by incorporating all significant covariates.

Table 4.4: Full model

Iteration 0: log likelihood = -4520.8707
Iteration 1: log likelihood = -4343.0663
Iteration 2: log likelihood = -4341.8773
Iteration 3: log likelihood = -4341.8772

Probit regression — Number of obs = 7493; LR chi2(8) = 357.99; Prob > chi2 = 0.0000; Pseudo R2 = 0.0396

Log likelihood = -4341.8772

HFS	Coef.	Std. Err.	z	P>|z|	95% Conf. Limite	
					Lower	Upper
hh_edu	0.2005852	0.0221215	9.07	<0.001	0.157228	0.2439425
hh_sex	-0.1390661	0.0360204	-3.86	<0.001	-0.209665	-0.068467
hh_size	-0. 0511744	0.0229816	-2.23	0.026	-0.096217	-0.0061314
hh_landsiz	0. 1329123	0.0244252	5.44	<0.001	0.085039	0.1807848
h_fert	0. 0382354	0.0281773	1.36	0.175*	-0.016991	0.0934618
Clim_adapt	0.0920009	0. 0316492	2.91	<0.004	0.0299697	0.154032
Liv_Ownership	0. 3419413	0. 039064	8.75	<0.001	0.265377	0.4185054
hh_nearmarket	- 0.1446266	0.0227455	-6.36	<0.001	-0.189207	-0.1000462
_cons	0. 3582298	0.0961176	3.73	<0.001	0.169843	0.5466168

* Not significant at 5%

The result of probit regression is presented in Table 4.4. The result shows that the model was suitable for explaining the determinants of the food security status of farm household. Only one variable were not significant at 5% level among eight variables included in the model.

Chemical fertilizer uses (h_fert) when tested as a univariate model, is statistically significant with household food security but it's not significant when included in the multivariate analysis

4.5 Reduced Model:

The coefficients of stepwise regression model begin with full model

Table 4.5 Reduced model

p = 0.1020 >= 0.0500 removing h_fert

Source	SS	Df	MS		
Model	67.2057955	7	9.60082793		Number of obs = 7493
Residual	1479.80208	7485	0.197702348		F(7, 7485) = 48.56
Total	1547.00787	7492	0.20648797		Prob > F = 0.0000
					Adj R-squared = 0.0425
					Root MSE = 0.44464

HFS	Coef.	Std. Err.	z	P>|z|	95% Conf. Limite	
					Lower	Upper
hh_edu	0.0613091	0.0068479	8.95	<0.001	0.0478853	0.0747328
hh_sex	-0.0517348	0.0120493	-4.29	<0.001	-0.075354	-0.0281148
hh_size	-0.0159256	0.0075198	-2.12	0.036	-.0306666	-0.0011846
hh_landsiz	0.0456867	0.0073159	6.24	<0.001	0.0313455	0.060028
hh_nearmarket_2	-0.0480903	-0.0076309	-6.30	<0.001	-0.063049	-0.0331317
Clim_adapt	0.0279286	0.0103623	2.70	0.007	0.0076156	0.0482416
Liv_Ownership	0.0913302	0.0110789	8.24	<0.001	0.069612	0.1130479
_cons	0.676839	0.0309913	21.84	<0.001	0.616087	0.7375908

The overall model is significant since the $-value\ is\ < 0.001$.

$$\Pr(\text{HFS} = 1) = \Phi\,(\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i})$$

The β_i refer to the coefficient of being food secured and X_{ki} are factors determining food security status which are Head of Household's education level(hh_edu), Sex of head of household (hh_sex), Size of household (hh_size), household land size (hh_landsiz) , Estimated time from village to the near market (hh_nearmarket_2),Climate adaptation

(Clim_adapt), and Livestock ownership (Liv_Ownership). We can insert these into probit regression equation as was done in multiple regression. This was arrived at using a forward stepwise selection method.

$$\Pr(\mathrm{HFS}=1)=\Phi\left[\,0.6768+0.061(\mathrm{hh}-\mathrm{edu}\ )-0.0517(\mathrm{hh}-\mathrm{sex}\ )-0.0159(\mathrm{hh}_{\mathrm{size}})+0.04568(\mathrm{hh}-\mathrm{landsiz}\,)-0.0481\left(\mathrm{hh}_{\mathrm{nearmarket}_2}\right)+0.0279\left(\mathrm{Clim}_{\mathrm{adapt}}\right)+0.091\left(\mathrm{Liv}_{\mathrm{Ownership}}\right)\right] \quad (13)$$

With Φ the cumulative normal distribution.

4.6 Marginal Effects Results:

Marginal effects were computed to estimate partial effects show the quantitative effects (predicted probability) that the significant variables have on the food security status among households under study.

Table 4.6: Average marginal effects

Average marginal effects Number of obs = 7493
Model VCE : OIM
Expression : Pr(HFS), predict()
dy/dx w.r.t. : hh_edu hh_sex hh_size hh_landsiz Clim_adapt Liv_Ownership hh_nearmarket_2

HFS	Delta-method				95% Conf. interval	
	dy/dx	Std. Err.	z	P>|z|	Lower	Upper
hh_edu	0.0658416	0.0071798	9.17	<0.001	0.0517694	0.0799138
hh_sex	-0.0467257	0.0117981	-3.96	<0.001	-0.0698496	-0.0236019
hh_size	-0.016439	0.0075516	-2.18	0.029	-0.0312398	-0.0016382
hh_landsiz	0.0475385	0.0074927	6.34	<0.001	0.0328531	0.0622239
Clim_adapt	0.0287944	0.0103433	2.78	0.005	0.0085219	0.0490669
Liv_Ownership	0.1141512	0.0126681	9.01	<0.001	0.0893221	0.1389802
hh_nearmarket	-0.0471576	0.0126681	-6.35	<0.001	-0.0617068	-0.0326085

The marginal effects are used here (instead of the coefficients) as they denote the marginal changes of the dependent variables as a result of changes in the respective explanatory variables. Taking in account that the signs of the marginal effects are the same as those of the respective coefficients of the explanatory variables. Table 4.6 shows that If education level of head of household increased by one unit, household is 6.5% more likely to be food secured. The marginal effects as predicted probability when head of householder sex changes by unit has no meaning but it showed that it is statistically significant

The marginal effects results review that each additional household member increases the probability of a household being food insecure by 1.6%. If household land size increases by a hectare, household is 4.7% more likely to be food secured.The results in table 4.8 showed that the chances of households which practice climate adaptation being food secure are 2.8 % higher than their non-practicing. If ownership of a beast for (cow) increases, household is 11.5% more likely to be food secured. If the time to reach the nearest market increases by one hour, household is 4.7% less likely to be food secured

4.7 Probit model for HFS, goodness-of-fit test:

Correctly classified 75.72% and the area under the receiver operating characteristic (ROC) curve of 0.71 indicating that the model was correctly specified (The area under an ROC curve can be interpreted like an R^2)

5. CONCLUSION AND RECOMMENDATION

The aim of the study was to determine the demographic determinants of household food security, the economic determinants of household food security and model the food security dynamics in Rwanda. Based on the empirical evidence from the analysis, it can be concluded that demographic determinants of household food security in Rwanda are Sex of household head and Education level of household head. Sex of household head contribute to the household food security decrease significantly at 1% level and Education level of head of household has a positive coefficient and it was significant at 1% this means increases in educational attainment have an important impact on rising the probability of a household to be food secured. The economic determinants of household food security are Household size, Size of land, Access to nearest market, Livestock ownership and climatic adaptation. Household size has a negative coefficient which was significant at 5% level. Hence, increase in household size would lead to decrease in the food security status of the household others are significantly positive affecting household food security at 1% level. Age of household head, Access to credit, Off-farm/non-farm income, Chemical fertilizer application by the household were found to be statistically insignificant in determining the food security status of households in Rwanda. The results have several policy implications. They show that large households are more vulnerable to food insecurity indicating the need for policy makers to promote family planning since the notion that more children means more responsibility seems not to hold. Government and other organizations involved should intensify their efforts in order to increase climate change adaptation. Irrigation and marshland uses should be given a priority, because rural households follow subsistence agricultural activities that solely depend on rain. Livestock is a productive asset on the farm, playing an important role in providing household food security. Manure can be utilized through composting as a very cost-effective fertilizer and soil conditioner, revitalizing soil quality, the program of the one cow per poor household (GIRINKA) were initiated by the Government in order to improve the livelihood of the beneficiaries who had no cows . Cows enabled people to fight against malnutrition and to generate incomes .Therefore that program must be strengthened and remove all barriers to the implementation. Furthermore, interventions should be designed to address these and other factors influencing the household food security acquisition. As for future research recommendations, due to time constraints this study did not cover all predictors of HFS in Rwanda, we only used cross sectional data surveyed by WFP Comprehensive Food Security and Vulnerability Analysis and Nutrition Survey 2012 and limited on those factors collected by the survey. Thus further studies would explore deeply all other factor that did not covered by the current study.

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