Drivers Behind Adoption Of Cassava Brown Streak Disease Control Measures In Rwanda

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Abstract: Cassava Brown Streak Disease (CBSD) continues to spread and its effect on productivity remains at high level losses (50- 100 %) in Sub-Saharan Africa. However, there is little knowledge about the drivers of adoption on CBSD control measures in Rwanda. Thus, this study investigated the drivers to adopt CBSD control measures in Rwanda during 2015-2016 agricultural seasons. A total of 152 households were randomly sampled in Bugesera and Ruhango districts where cassava demonstration plots are established. A multi stage sampling techniques was used. A structured questionnaire was used to collect data from respondents. Logistic regression analysis was employed to estimate drivers behind adoption of CBSD control measures. The key factors that influenced adoption of CBSD control measures was farm size, farmer's experience, access to credit, period of plantation, access to demonstration plot. In order to increase adoption of CBSD control measures policy makers and implementers in Rwanda should improve farmers' social economic and Insistutional characteristics, sensitize and mobilize farmers on the importance of adopting the CBSD control measures.

Key words: Cassava brown streak virus, Control measures, logit model, Smallholder farmers, Bugesera and Ruhango District, Rwanda

Introduction

Cassava *(Manihot Esculenta Crantz*) plays a significant role in people's lives, it is now grown throughout Sub-Saharan Africa and is considered second in importance to maize as a human staple food, accounting for more than 200 calories per day per person. In this regard, estimates show that about 160 million people or 40 per cent of the population of Sub-Saharan Africa consume cassava as a staple food and its demand increases with high population growth rates. Except for South America and Thailand, cassava is increasingly being grown for industrial use. In Africa it is largely grown for human consumption (Montagnac, Davis, & Tanumihardjo, 2009). Hence, cassava remains one of the dominant starchy staples in the diet of people in Sub-Saharan Africa and is grown in many countries though its cultivation is concentrated in humid tropics.

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It is now becoming a more important crop for both food and for cashincome to the rural areas (Patil, Legg, Kanju, & Fauquet, 2015). Despite the economic and social importance of cassava in both Africa and Rwanda, its productivity is severely constrained to both biotic and a biotic factors. Cassava Mosaic Disease (CMD) and Cassava Brown Streak Disease (CBSD) have become the most viral diseases which cause many losses in cassava production. CMD resistant varieties are now released, but CBSD resistant varieties still remain fewer as varieties which are resistant to CMD are susceptible to CBSD (Masiga et al., 2014). This disease is becoming a bigger challenge in SSA. The rapid spread of CBSD is being linked to the super- abundance of the whiteflies (*Bemisia tabacci*) and use of infected planting materials. In Africa, 9.6 million hectares of cassava are affected by the disease (Asche, Guttormsen, & Tveteras, 2008).It was reported in Rwanda in 2009 in three Districts (Muhanga, Bugesera and Nyagatare) out of the 17 surveyed. In 2012, the spread of disease reached 9 districts out 16. The high incidence of disease was reported in Ruhango (91%) and Bugesera (>60%). Due to the incidence of CBSD, technical strategies to reduce the rate of this disease have to be taken into account (Masiga et al., 2014).Previous studies have identified a number of control measures which have been developed to reduce CBSD incidence and severity, and maintain cassava productivity. However farmers rate of adoption has been reported to be disappointing, therefore it is against this background that this study aims to investigate the drivers behind adoption of CBSD control measures. The main objective is to determine the factors influencing the adoption of CBSD control measures in Bugesera and Ruhango districts of Rwanda.

Methodology

This study adopted cross section survey research design. Household surveys with structured questionnaires, were methods adopted for the primary data collection. Relevant secondary data were obtained from different publications, books, journals, newspaper articles, dissertations, year-end reports and others. A structured questionnaire (closed as well as open ended) were developed in order to retrieve the quantitative and qualitative information, pre-testing survey was done, descriptive and econometric methods of analysis were used for this study.

Study area

Two Districts Ruhango and Bugesera were chosen based on the fact that they are the ones where cassava is widely grown and there is high incidence of Cassava brown streak disease. The limits with Ruhango District at the Southern Province and Bugesera at the Eastern Province .Ruhango district have Nine (9) Sectors. From these sectors the whole district has fifty -nine (59) cells and five hundred thirty- three 533 villages. It covers an area of 626.8 square kilometers. Its relief, alternate seasons, vegetation give a smooth climate for its population. Agriculture is the main economic activity and source of income where cassava contributes 79.7%. Bugesera District, it is one of seven Districts of the Eastern Province in Rwanda. It covers a total surface area of 1337 Km². The district is composed of 15 Sectors, 72 Cells and 581 Villages with a total Population of 363,339 people, where 177,404 are males and 185,935 are females (Urimubenshi et al., 2015).

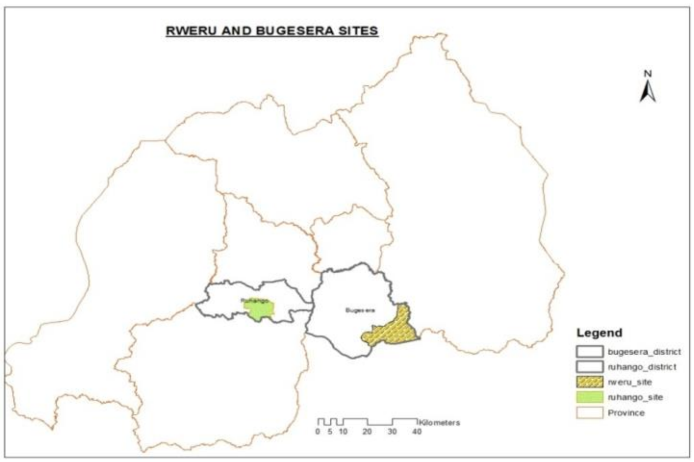

Figure 1: *Showing map of study area*

Target Population

Out of 224 only 152 cassava farmers were selected research focuses on influence of cassava brown streak disease control measures on cassava production in Ruhango and Bugesera Districts of Rwanda**.** Target population of this study focused on adopters against non adopters.

Table 1. *Sampling frame*

Sectors	Villages	Total number of cassava farmers	Number of sample selected		Total sample
			Adopt ers	Non-adopters	
Rweru	Nimba	65	35	30	65
Ruhango	Musamu	87	52	35	87
Total		152	87	65	**152**

Sampling techniques

In the second stage, stratified sampling will be used to divide the sample household farmers into strata of adopters and non adopters. A two-stage cluster sampling will be used to sample the cells in each sampled sector. The first sampling stage involves the selection of a predetermined number of clusters (cells) per sector. A simple random sampling technique will be used in the sampling of the district. Farmers will be having equal chances of selection. The list of total household heads in the selected sectors will be obtained from the sector offices.

Research Instruments

Both qualitative and quantitative methods have been used by the researcher using survey questionnaire. The questionnaire will contain three sections first section will contain contents related to level of awareness of CSBD. The second section will include factors influencing adoption and third section will contain information related effect of CSBD measures on production. Focus group was conducted to provide qualitative information related to adoption of CBSD.

Measurement of variables

Age: Age is a continuous variable measured in years, old age can be an indicator of better experience, greater resources, and enhanced authority that may influence adoption of new varieties positively (Sarkis et al., 2010).

Education: This is a continuous variable measured in number of years spent in school, findings in technology adoption studies, indicate that education improves the analytical ability of the decision makers, hence positively influencing participation (Sarkis et al., 2010).It is hypothesized that education has a positive influence on adoption of CBSD control measures.

Gender: This is a dummy may have a significant influence on some technologies and not on others. For instance, a study on adoption of technology found that, gender had a significant and positive influence on adoption of improved cassava production in Nigeria. It is perceived that male-headed households are more likely to participate in adoption of new agriculture technologies than the female-headed households (Sarkis et al., 2010).

Household size**:** This was measured on number of house members the family owns. The effect of on technology adoption could be positive or negative. Adoption of technology depends on whether the household has a higher ratio of members who contribute to farm work (implying more labor, hence more time for participation) or the household has a higher consumer-worker ratio (raising the need for more labor for production, hence reducing time available for participation (Sarkis et al., 2010).

Farm size**:** Farm size was simple measured in land owned (Mignouna, Manyong, Rusike, Mutabazi, & Senkondo, 2011)**.** It was hypothesized to influence adoption positively Uaiene, Arndt, and Masters (2009), suggests that social network effects are important for individual decisions, and that, in the particular context of agricultural innovations, farmers share information and learn from each other. It was dummy variable hypothesized to influence adoption positively. Institutional factors: Include farmers' access to extension services, credit, market, farmers' organization and mass media (Kaguongo, Ortmann, Wale, Darroch, & Low, 2012).Extension services are reflected by the number of extension contacts either through farm visits made or training sessions received prior to and during production season influence crop productivity (Anyiro & Oriaku, 2011). Access to credit: This has been stated to motivate technology adoption. It also stimulates the adoption of risky technologies through relaxation of the liquidity constraint as well as through the boosting of household 'risk bearing ability. This is because with an option of borrowing, a household can do away with risk reducing but inefficient income diversification strategies and concentrate on more risky but efficient investments (Anyiro & Oriaku, 2011). Farmers' organization: Helps them to participate in group activities, as they may tend to share ideas on profitable enterprises and adopt them as well as engage in market activities of inputs acquisition or selling of produce and thereby improve their profits. Consequently, organized farmer groups are promoted as useful avenues for increasing farmer productivity and for the implementation of food security and other development projects (Masunga, 2014). Use of resistant or tolerant varieties: This was measured on wheather a famer uses the variety or not, (Mc Quaid et al, 2016)**.** This could influence adoption positively. Use of disease free planting materials: This was measured on wheather a famer knows about the planting material or not (Birhanu, 2015).This could influence adoption positively. Early planting and early harvesting: This was measured on wheather a farmer knows about the harvesting periods or not. This could influence adoption positively (http://www.agriguide.org/index.php ret reviewed on 25/10/2016). Field hygiene**:** This was measured on weather a farmer knows about the field hygiene or not (Legg et al., 2011).This was hyposized to influence adoption positively.

Validity and reliability

The questionnaire to be used in this study was pre-tested among small holder farmers in the same study. Piloting on 10% sample members was conducted to test for validity and reliability of the data prior to the actual study, to ensure validity, the researcher consulted the university supervisor to proof read the questionnaire and advice on any necessary changes. This ensured validity and reliability.

Data collection techniques

A structured questionnaire was be used to capture data from individuals (small holder farmers), designed with the assistance of a statistician and comprising mostly closed-open-ended questions that will make it easier to analyze the data. Key informant interview and focus group discussion guided was developed in order to assist the facilitator of the key informant interviews in collecting relevant information from respondents.

Data analysis

The data was exported to SPSS version 20 and STATA version 13, for analysis. The data analysis was incorporated both descriptive and econometric analysis. Descriptive analysis was used to describe the percentages and frequencies on social economic profile of respondents and Logit regression analysis was used to estimate factors that are independently associated with adoption of CSBD. This was for independent variables that have p -values of less than 0.05 in their relationship with the dependent variable in bivariate analysis.

Application of Logit model

Logit model or Probit Model and Linear Probability Model and those are for dichotomous models. Linear Probability Model is inefficient due to the fact that the possibilities of the responses are un truncated, that is, the values lie beyond 0 and 1 in violation of probability concept. Logit and Probit Model take the graphical form of cumulative distribution functions (Onubuogu & Esiobu, 2014).The Logit model uses (OLS) Ordinary Least Square or the Weighted Least Square (WLS) for group data but it is difficult to apply in individual data. It is preferred to probit when the sample size is as large as the application of probit model for analysis involves complex integration. Logit model is difficult to apply in individual data except with computer programmes that uses (ML) a non-linear maximum likelihood estimation (Masozera & Alavalapati, 2004). Analysis for the logistic regression model assumes the outcome variable is a categorical variable. It is common practice to assume that the outcome variable, denoted as Y, is a dichotomous variable having either a success or failure as the outcome. Let Y_i represent response variable, x_i represent covariates that mainly factors affecting farmers to adopt CBSD control measures grouped into the Socio-economic and institutional factors (farmer experience, education, ages ,gender ,land size, extension services ,training, technology transfer), we get :

$$P(Y_i = 1) = \pi_i = \frac{exp(\beta_0 + \beta_i X_i)}{1 + exp(\beta_0 + \beta_i X_i)} \quad \text{……………..(1)}$$

The probability that a farmer will adopt at least one CBSD control measure was postulated as a function of some socioeconomic and institutional factors. Following Pindyck and Rubinfeld (1998), the cumulative logistic probability model which is estimated is econometrically specified as:

$$\text{Pi} = \text{F(Zi)} = \text{F(Y)} = \textstyle\sum_i \beta_i X_i = \frac{1}{1 + e^{-zi}} \quad \text{……..(2)}$$

Where Pi is the observed response for the i^{th} observation of the response variable P.It is the probability that a farmer will adopt at least one CBSD control measure or not. Given Xi; Pi =1 for an adopter (i.e. farmers who adopt at least one CBSD control measure) and Pi = 0 for a non-adopter (i.e. farmers who do not adopt CBSD control measure); e denotes the base of natural logarithms, which is approximately equal to 2.718; Xi represents the explanatory/ independent variables, associated with the i^{th} individual, which determine the probability of adoption (P);λi and γ are parameters to be estimated. The function, F may take the form of a normal, logistic or probability function. Zi is the Cumulative density function of Pi (probability that a farmer will adopt at least one CBSD control measure)

$$1 - Pi = \frac{1}{1 + e^{-zi}} \qquad \text{...(3)}$$

Logit model could be written in terms of the odds and log of odds, which enables one to understand the interpretation of the coefficients. The odds ratio implies the ratio of the probability (Pi) that a farmer adopts, to the probability (1-Pi) that the farmer is a non-adopter.

$$Zi = \sum_{i=1}^{n} \beta_i X_i + \mu i \qquad \text{..(4)}$$

Results and discussion

Socio-demographic profile of the respondents

The point differentiation has also been observed on the side of quantitative variables by the use of t- test for independence so as to compare the fluctuation between adopters and non-adopters. Apart from the mean age which has been talked about in the previous paragraph, the study revealed significant difference under the following points: household Size, farm Size (in hectares), area with cassava cultivation and amount of production (P-values <5%).The findings proved the insignificancy of the difference on the side of farm experience in farming cassava although the mean difference is about 4 years and more (McKay, 2015).

Table 2.*Demographic profiles o respondents*

Variables	**Adopters**	**Non-Adopters**	**P-value**
Mean Age	87(52.49)	65(48.42)	3.815(0.107)
Household Size	87(5.47)	65(4.83)	0.810 (0.047) **
Farm Size (in hectares)	87(2.8218)	65(1.8600)	0.96176 (0.023) **
Farm Experience (Years)	87(29.76)	65(25.57)	4.189(0. 106)
Area with cassava cultivation	87(0.4411)	65(0.3149)	12.20 (0.037) **
Amount of Production	87 (2478.56)	65(159.95)	2009.071 (0.000)**

Factors influencing the adoption of CBSD control measures

The result of the study revealed that factors influenced the adoption of CBSD control measures by farmers in the study area are shown in Table 4.5. The findings of the study revealed that that farm size as an indicator of economic resources influenced adoption of CBSD control measures. Farm size positively influenced adoption (Mignouna et al, 2011). The study findings in table 4.5 indicate that experience is significant to adoption of CBSD control measures at 95% confidence interval meaning that as experience in farming increases adoption increases. In Rwandan context and agriculture production experience means ability to increase production and if a farmer is less experienced production can decrease, the results of the study are consistent with findings (Masunga, 2014). Access to credit influenced adoption of CBSD control measures. The results of the study revealed the relationship between access to credit and adoption of CBSD control measures. In Rwandan context credit accessibility stimulates the adoption of risky technologies through relaxation of the liquidity constraint as well as through the boosting of household's-risk bearing ability with an option of borrowing, a household can do away with risk reducing but inefficient income diversification strategies and concentrate on more risky but efficient investments. The findings of the study are in line with (Kaguongo, Ortmann, Wale, Darroch, & Low, 2012). The institutional factors such as demonstration plots and period of plantation influenced adoption of CBSD control measures. The relationship between farmers' access to extension services and adoption has been repeatedly reported as positive and significant by many authors. Extension services are reflected by the number of extension contacts either through farm visits made or training sessions received prior to and during production season influence crop productivity. In Rwandan case, poor adoption of this CBSD control measures in attribution to instutional factors can be explained by lack of enough of extension services to deliver these services. The findings of the study are in line (Anyiro & Oriaku, 2011). Based all on the findings of the study, the hypothesis that socio economic and institutional factors does not influence adoption of CBSD rejected.

Table 3.*Factors influencing adoption*

Adoption Status	Coefficients	SE	Z	P>|z|
Gender of Household head	0.696091	0.403023	1.73	0.084
Age of household head	-0.025800	0.020957	-1.23	0.218
Marital Status	0.117140	0.267912	0.44	0.662
Education level	-0.108760	0.14607	-0.74	0.457
Household size	0.043723	0.057680	0.76	0.448
Membership in Groups	0.941248	0.630609	1.49	0.136
Agricultural extension	0.444253	0.336276	1.32	0.186
Demonstration Plots	0.627040	0.316887	1.98	0.048*
Farmer's experience	0.040429	0.019714	2.05	0.040*
Farm size	0.487786	0.076341	2.89	0.013*
Access to credit	0.857057	0.301305	2.84	0.004*
Access to training	0.788460	0.529205	1.49	0.136
Period of Plantation	0.412364	0.128126	3.22	0.001*
Area of Cassava plantation	-0.044760	0.086677	-0.52	0.606
Constant	-2.494790	1.021677	-2.44	0.015

Significant at P<5%

Conclusion and Recommendations

It was concluded that household size, Farm size, contact with extension and feedback from extension, access to demonstration plots were factors that influenced adoption of CBSD control measures in the study area. The study recommends that the government and other relevant stakeholders help in the improvement of farmers' such as extension services, trainings and land ownership amongst others so as to enhance adoption of CBSD control measures. Further research needs to be done to assess the efficiency and effectiveness of methods, tools and techniques used by government institution regarding cassava plantation in order to sustain the increase of cassava productivity.

STATEMENT OF NO COMPETING INTERESTS

We, the authors hereby declare that there are no competing interest in this research and publication.

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