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ANALYSIS OF THE DETERMINANTS OF THE ADOPTION OF AGRICULTURAL INTENSIFICATION IN BURKINA FASO.

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Summary

Essay I: ANALYSIS OF THE DETERMINANTS OF THE ADOPTION OF INTENSIFICATIONAGRICULTURAL.

Summary: The poor distribution and adoption of agricultural innovation products, in particular improved seeds, fertilizers and powdered and liquid phytosanitary treatments motivates us to identify the determining factors for the adoption of these four forms of agricultural intensification. Using data from the 2018-2019 Permanent Agricultural Survey of the Ministry of Agriculture of Burkina Faso, the study used a logit model with spline function to conduct the analysis of the determining factors. To do this, we have come to the conclusion that the determinants of the adoption of these four forms of agricultural intensification in the context of Burkina Faso are of three types. We have economic factors such as cultivated area, access to land, level of soil degradation, income-generating activities and animal ownership. Socio-demographic factors such as household head's education level, household head's sex, household head's age and household size. Institutional factors such as access to agricultural credit and membership of a farmers' organization. The results obtained could be used in public strategies aimed at increasing the rate of diffusion of innovation and improving the well-being of households in Burkina Faso. Institutional factors such as access to agricultural credit and membership of a farmers' organization. The results obtained could be used in public strategies aimed at increasing the rate of diffusion of innovation and improving the well-being of households in Burkina Faso. Institutional factors such as access to agricultural credit and membership of a farmers' organization. The results obtained could be used in public strategies aimed at increasing the rate of diffusion of innovation and improving the well-being of households in Burkina Faso.

Key words: Agricultural intensification, logit model, spline function, Burkina Faso.

JEL Codes: O33, Q12, Q18.

Introduction

The majority of populations in sub-Saharan Africa in general and in Burkina Faso in particular are rural and obtain their resources from agricultural activities by consuming a large part of their production and reselling the surplus. (Report of the United Nations General Assembly (2016) on agricultural development, food and nutrition security). For the authors Dembélé and Staatz (2010), in West Africa, the strong fluctuations in agricultural production are the most determining factors of food insecurity, not only through their effects on supply, but also on the real incomes of the rural and urban poor. In the present test, identifying the determining factors for the adoption of agricultural intensification techniques makes it possible to identify the levers on which political decision-makers can put access by conducting policies for the promotion, dissemination and popularization of agricultural intensification techniques for Burkinabe producers. In particular policies of subsidy or free distribution of improved seeds and/or chemical fertilizers. The analysis of the determining factors constitutes an axis of orientation for the political decision-makers in the achievement of the sustainable development objectives which the country has set itself through its strategic plan (2019-2023) aimed at ensuring that "small farmers, in particular those affected by recurrent climatic shocks,[1]

The general objective of this essay is to identify the determining factors in the adoption of agricultural intensification by Burkinabè producers. And this specifically consists of identifying economic factors, socio-demographic factors and institutional factors. From these specific objectives stems our following hypothesis: hypothesis 1: the determinants of the adoption of agricultural intensification in Burkina Faso are economic factors, cultivated area, access to land, level of soil degradation, income-generating activities and animal ownership; socio-demographic factors the level of education of the head of household, the sex of the head of household, the age of the head of household and the size of the household and those of an institutional nature,

This study considered four forms of agricultural intensification, including intensification through the use of improved seeds, through the use of fertilizers and through the use of powdery phytosanitary treatments and liquid phytosanitary treatments.

On the empirical level, this essay helps to identify the determining factors for the adoption of two forms of agricultural intensification, in particular the use of powdered and liquid phytosanitary treatments, which are rarely addressed by the authors as a problem in the Burkinabè context. The methodological contribution of this essay lies in the use of the logit model with spline function which is very little used to identify the determining factors of the adoption of an agricultural technology in the context of Burkina Faso.

To our knowledge, in the context of Burkina Faso, few studies have addressed the issue of analyzing the determining factors for the adoption of these four forms of agricultural intensification, especially using a methodological approach such as the logit model with spline function used in this study. Nevertheless, the author Ouédraogo (2005) had approached the question of analyzing the determining factors of agricultural intensification. But not only did

[1]World Food Programme, Executive Board Second Regular Session Rome, 26-29 November 2018. Country Strategic Plan – Burkina Faso (2019-2023).

the author not consider the same forms of agricultural intensification as the study presents, but also, he used linear programming to develop for certain types of households models allowing them to determine the optimal allocation of resources, and also the impact of promising technologies.

The remainder of this essay is organized as follows. In I) we presented the theory of the adoption of a technology, in II) the empirical approach of the determinants of the adoption of agricultural intensification, in III) the modelling, in IV) the descriptive analysis, in V) the econometric analysis and in VI) conclusion and implications of economic policies.

I. Theoretical Approach to Technology Adoption

For authors like Adesina and Zinnah, (1993); Prager and Posthumus, (2010), agricultural technology adoption theory is a multidisciplinary field that combines decision theory and innovation diffusion theory. In the literature, we encounter three paradigms, the paradigm of the diffusion of innovation which stems from the work of Ryan and Gross (1943); the economic constraint paradigm which postulates that farmers seek to maximize their utility; and the adopter perception paradigm, which allows for a certain level of subjectivity by asserting that it is the perceived need to innovate and the characteristics of the innovations' perceived attributes that determine adoption behavior (Kivlin and Fliegel, (1967); Adesina and Zinnah, (1993)). So,

$$U^* = \mathrm{X}ß + \varepsilon$$

Where ß is a vector of estimated parameters and ε is random error terms.

It is assumed that the ith farmer adopts if the expected utility of adopting the innovation is greater than 0.

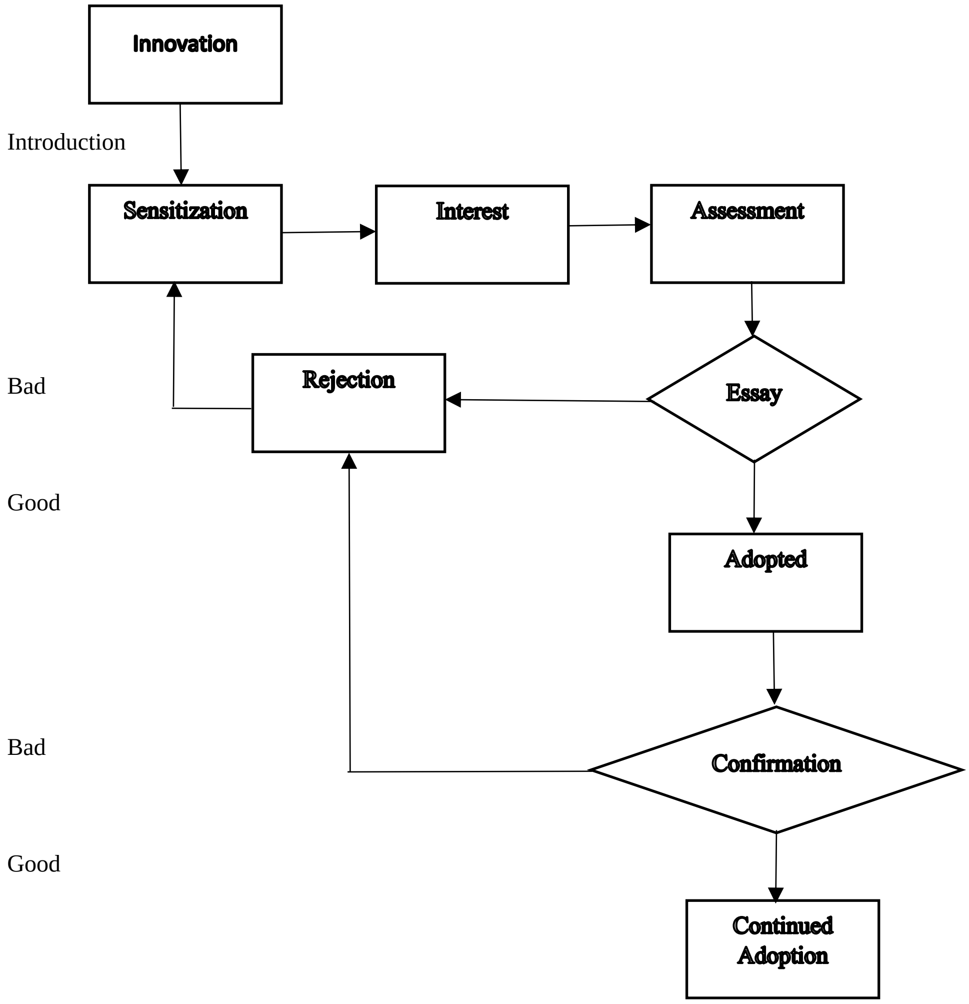
$$\mathrm{Yi} = \begin{cases} 1 \; si \; U_i^* \geq 0 \\ 0 \; sinon \end{cases}$$

where Yi is the observed adoption behavior of the farmer. There are many variations of this basic model in the literature.

In his study on the perception and adoption of agricultural technical innovations in the Banikoara cotton basin in Benin, Ichaou (2015) listed the fact that "The adoption of agricultural technical innovations is a rational behavior of the agricultural producer who gives more preference when it provides him with the most utility. This is how he makes a choice between the different chemical, organic, biological and mechanical innovations".

Thus, by referring to the microeconomic theory, we can then say that the producer decides to adopt agricultural intensification techniques if and only if this choice will provide him with more utility (expected utility in the case of the adoption of a new technology). In other words, he will choose the combination of factors of production (taking into account agricultural intensification techniques) that will allow him to obtain a high level of production (output). Indeed, the microeconomic theory stipulates that the analysis of production is done by referring to the production function which relates the output and the inputs used to obtain the final production. Then, by combining the inputs, the producer adopts the one that will allow him to obtain the highest level of output without forgetting when combining these inputs, he will take into account the techniques of agricultural intensification if he considers that this choice will allow him to increase his level of production (his level of expected utility). These producers in the analysis of the choice of their adoptions also take into account the constraint of the cost of the new technology to be adopted as well as that of the expected selling price for the producers who produce for sale. And those producing more for self-consumption take into account above all the quantity of expected output. These producers in the analysis of the choice of their adoptions also take into account the constraint of the cost of the new technology to be adopted as well as that of the expected selling price for the producers who produce for sale. And those producing more for self-consumption take into account above all the quantity of expected output. These producers in the analysis of the choice of their adoptions also take into account the constraint of the cost of the new technology to be adopted as well as that of the expected selling price for the producers who produce for sale. And those producing more for self-consumption take into account above all the quantity of expected output.

The graph below shows that introducing the innovation to farmers marks the beginning of the adoption process. Indeed, raising farmers' awareness increases their knowledge of the innovation of a technology. This will make it possible to know not only the existence, but also the operation of the innovation in question. Thus, awareness will follow from the adoption or non-adoption of the new technology by the producers.



Graph 1: Stages of the adoption of technological innovations (modification of the Mundi model)[2]

A distinction is made between observable and non-observable determining factors for the adoption of an agricultural innovation.[3]To do this, among the unobservable factors, we have farmers' risk aversion, which negatively influences the adoption of innovations on the farm and the preferences in the adoption process.[4]

[2]H Ainissyifa et al 2018 IOP Conf. Ser. : Mater. Science. Eng. 434 012247
[3]Roussy, C., Ridier, A., & Chaib, K. (2015). Adoption of innovations by farmers: role of perceptions and preferences. INRA, France.
[4]Binswanger and Sillers 1983, Marra, Pannell et al. 2003, Couture, Reynaud et al. 2010

II. Empirical approach to the determinants of the adoption of agricultural intensification

The empirical results below show the observable decision factors for the adoption of agricultural intensification techniques. On the empirical level, the authors have given abundant explanations on the question of the determinants of the adoption of new agricultural technologies. Nevertheless, there is a limit related to the methodological approach. Some studies have shown that the adoption of agricultural intensification depends on socio-demographic, institutional and economic factors. Indeed, Ouedraogo (2003); Simtowe et al., (2011); Khonj et al., (2014); Barry (2016); Ouedraogo and Dakouo (2017); Deckas et al., (2019); Yameogo et al., (2020); and Diallo; NDiaye (2021) and Olla bode et al., (2022) in their studies showed that adoption is determined by socio-demographic factors such as the age of the producer, his level of education, his gender, his experience in agricultural activity, the number of dependents and the number of women involved in the plot. The authors Ouedraogo (2003); Simtowe et al., (2011); Khonj et al, (2014); Barry (2016); Ouédraogo and Dakouo (2017), Deckas et al, (2019) and Olla bode et al., (2022) have found that it is more institutional factors such as agricultural training and supervision, access to credit, membership of a cooperative group, knowledge of varieties and contact with agricultural research which constitute the determinants of the adoption of new agricultural technologies. And for Ouedraogo (2003); Simtowe et al., (2011); Barry (2016); Ouedraogo and Dakouo (2017); Yameogo et al., (2020); Diallo and NDiaye (2021) and Olla bode et al.,

The authors below have analyzed the determinants of the adoption of the same form of agricultural intensification, in particular intensification through the use of improved seeds in the context of Tanzania, Central Africa, Zambia, Congo, Senegal and Burkina Faso. However, they used different methodological approaches. Among them, some had to use a logit model, others a probit model, and others a multivariate probit model or a sequential logit. In the context of Burkina Faso, the authors below used a logit model, a probit model and a multivariate probit model to analyze the determinants of the adoption of improved seeds.

Authors Simtowe et al., (2011) used a probit model to analyze the determinants of adoption of improved pigeon pea varieties in Tanzania. They came to the conclusion that the determining factors are distance to the agricultural office, size of landholding, ownership of livestock, access to pigeon pea seeds, education, age and gender of household head and household size.Mbétid (2013) meanwhile, to conduct his study on Central Africa, 150 rice farmers in the peri-urban area of Bangui were surveyed twice to determine the probability of adoption of the two varieties of rice (NL60[5] irrigated and N7[6]rainfed). Indeed, using the logit model, its analysis results show that variables such as the producer's experience in rice growing (Expriz), the producer's literacy level (Alpha), the supervision and training of the producer in rice growing (Enfor) had a positive impact on the probability of adoption of the Nerica varieties disseminated (NL60 in irrigated and N7 in rainfed) at the significance level of 1%. On the other hand, variables such as the producer's membership of a cooperative group, his access to agricultural credit, the number of

[5]Improved variety of irrigated Nerica rice
[6]Improved variety of upland Nerica rice

workers per agricultural holding, the area cultivated, the operating capital and the agricultural income have an insignificant impact on the probability of adoption of the varieties disseminated. To do this, in the same study, the author also used the tobit model and finds that variables such as cultivated area, agricultural income, producer literacy level, agricultural supervision and training and access to credit are the determinants of intensification by Nerica seeds, and this, at the significance level of 1%. Also, these same variables in addition to the variable experience of the producer in rice cultivation determine the intensification by chemical fertilizers. Khonj et al, (2014) in turn, in their study conducted in Eastern Zambia on the analysis of the adoption and impact of improved maize varieties on well-being used a sample of 800 households. Using the logit model, they showed that the adoption of these improved maize varieties is determined by the level of education of the head of household, household size, access to information, market information, and group membership. The author Barry (2016) used a logit model to analyze the socioeconomic and institutional determinants of the adoption of improved maize varieties in the Centre-Sud of Burkina Faso. For the author, the determining factors are age, area, membership of a peasant organization, number of cattle, distance from the market, contact with the agricultural agent, market value and good taste. Ouédraogo and Dakouo (2017) used a probit model to analyze the determinants of knowledge and adoption of NERICA varieties. These factors include male gender, level of education, experience in rice cultivation, access to credit, area under rice cultivation and contact with agricultural research. Deckas et al, (2019) in their study showed that 34.6% of farmers in the province of South Kivu in the East of the Democratic Republic of Congo adopt the improved varieties and 65.4% do not adopt these varieties. To do this, they used a probit model and they showed that membership of an organization, gender, age and seniority in the practice of cassava cultivation are the determinants of the adoption of improved varieties of cassava. And their results show that the level of education and seniority in the exploitation of cassava cultivation are factors that greatly influence the adoption of new improved varieties of cassava. Also, the other variables (membership of an organization,Using a multivariate probit model, the study conducted by the authors Yameogo et al., (2020) shows that the determinants of the adoption of improved rice varieties in lowlands in Burkina Faso are, among others, the age of the farmer, his gender, the number of dependents and the size of the farm. The authors Diallo and NDiaye (2021) in turn studied the determinants of the adoption of improved millet varieties in the Groundnut Basin of Senegal. Using a sequential logit model, these authors concluded that the determining factors are the gender of the producer, knowledge of millet varieties, payment of wages by the producer and the number of women involved in the plot.

Authors like Yabi et al., (2016) and Olla bode et al., (2022) considered the form of agricultural intensification through the use of fertilizer. Indeed, these authors found as determining factors of the adoption of fertilizer, factors of an economic order, factors of a socio-demographic order and those of an institutional order. Using logistic regression, Yabi et al., (2016) analyzed the factors that influence the adoption of soil fertility management cropping practices in Ouaké, Benin. Indeed, the results they found show that gender, the mode of tenure of the land under cultivation, membership of a group and access to mineral fertilizer positively influence the adoption of mineral fertilizer. However, variables such as the number of agricultural workers and membership of a group negatively impact the practice of agroforestry. The size of the household and the mode of tenure influence it positively. Also, the adoption of the erosion control practice is determined by the level of education, the size of the household and the social status of the producer. On the other hand, the variables sex, age, membership of a group, and access to mineral fertilizer have a negative influence on its adoption. As for the traditional practice (rotation and association of appropriate crops), it is determined positively by the variable the age of the producer and negatively by the level of education and the number of agricultural workers. The authors Olla bode et al.,

III. Modelization

To analyze the determinants of the adoption of agricultural intensification (the factors that influence adoption), we have several models. We have the probit model, the logit model and the tobit model. Indeed, the logit model and the probit model are somewhat similar except that in the first the error terms Ɛi are independent and identically distributed (iid) and follow a logistic distribution function law F(X) = 1/1+ex and in the second the error terms Ɛi are iid and follow an N law (0, 1). Also, the derivative of the distribution function of the logit model gives us the density function of the probit model.

For Cimmyt (1993), the logit model which is used in most technology adoption studies. Indeed, it was used in the study conducted by Yabi et al., (2016), Mbétid (2013), Kassie et al., (2011) and Khonje et al., (2015). According to Anley et al., (2007); Deininger and Jin (2003) the tobit model is used to model not only the adoption, but also the intensity of use of a technology, and this when we have a continuous and censored dependent variable.

As part of our study, we chose to use the logit model with spline function. This choice is due not only to the fact that the explained variable adoption of agricultural intensification is qualitative binary, but also to the fact that we have some quantitative explanatory variables whose linear relationships with the explained variable we doubt. So the development in spline function of degree 2 of these quantitative variables allowed us to identify those which have a linear relationship with the dependent variable and those which do not. Therefore after estimation, the quantitative explanatory variables whose coefficients are significant and the coefficients of their squares are not significant are considered to be linear with the dependent variable.

To estimate the parameter β of the logit model in our study, we can use the maximum likelihood method. But, in the case where all the explanatory variables are discrete, there are other estimation methods other than that of maximum likelihood (such as the asymptotic least squares method (Gouriéroux, Monfort, Trognon 1985)).

The Logit model can be presented by the following equation (1):

$Yi = Xi\,\beta + \mathcal{E}i$ (1) where Yi represents the decision to adopt the agricultural intensification techniques, Xi a vector of explanatory variables that can influence the adoption decision, β a vector of parameters associated with the explanatory variables, Ɛi the error terms which are independent and identically distributed (iid) and follow a logistic distribution function law

$F(X) = 1/1 + e^{-x}(2)$

Also, if the household adopts agricultural intensification techniques and if not.Yi $= 1$ Yi $= 0$

For Yabi et al. (2016), an innovation is adopted if and only if the combined effect of the factors reaches a value from which the decision maker agrees to adopt the innovation. If we start from the hypothesis that this effect is measured by an unobservable index that we can call I (index of the individual) and Ic the critical value of the index from which he adopts the technology. So to get the value for which the individual decides to adopt the technology we have two situations. When I is greater than or equal to Ic then he adopts the technology and the adoption variable Yi takes the value 1. And when I is less than Ic the individual does not adopt the innovation and Y is equal to 0.

The index I can be a linear combination of variables Xi which determine adoption and of coefficients βi to be estimated. Its expression is then mathematically given by: With Xi the ith independent variable explaining the adoption of the technology by the producer and βi its corresponding parameter to be estimated.$I = \sum_{i=1}^{k} \beta i \; Xi$

The probability P for the producer to adopt the innovation is then:$P = P(Y = 1)$(3)

And since the index Ic is a random variable, its cumulative probability function or distribution function F, will be given by the equation:

$P(Y = 1) = P(Ic \; \leq I) \; = \; F \; (I)$(4.1) and

(4.2)$P(Y = 0) = 1 - F(I)$

To do this, the functional form of F is determined by that of the probability density function of the random variable I. In the case of the logit model, it is a logistic function of the form:$\mathrm{F(X)} = 1/1 + e^{-x} \; = 1/1 + e^{-(\,\beta 0 \, + \, \beta i Z)}$ (5)

Referring to the theoretical model, we have the following equation:

$\mathrm{P\;(Yi\; = 1)} = 1/1 + e^{-x}$(6) and

$\mathrm{X} \; = \; \beta_0 \; + \; \beta_1 \mathrm{Age} \; + \; \beta_2 \mathrm{Educ} \; + \; \beta_3 \mathrm{Taill} + \; \beta_4 \mathrm{Appop} \; + \; \beta_5 \mathrm{Supcult} \; + \; \beta_6 \mathrm{Accredi12} + \beta_7 \mathrm{Acter} + \; \beta_8 \mathrm{Nivdeg} \; + \; \beta_9 \mathrm{Sex} \; + \; \beta_{10} \mathrm{Agr} \; + \; \beta_{11} \mathrm{Possani} \; + \; \beta 12 \; \mathrm{Resop} + \; \mathcal{E}\mathrm{i}$,(7)

With β0 a constant, the βi of the coefficients to be estimated, and Ɛi the error terms.

Starting from the general model above, we can pose the following 4 sub-models that we have estimated one after the other. By choosing to estimate separately the models of adoption of the 4 forms of agricultural intensification, we started from the hypothesis that the producer can certainly use these 4 forms of technologies but his decision to adopt them is not simultaneous because they are technologies that are not applicable at the same time on the plot necessity).

Model 1:$\mathrm{logit\;engrai} \; = \; \beta_0 \; + \; \beta_1 \mathrm{age\_cm} \; + \; \beta_2 \mathrm{educ\_cm} \; + \; \beta_3 \mathrm{TAILLE\_MEN} \; + \beta_4 \mathrm{aparopa} + \; \beta_5 \mathrm{Suptot} \; + \; \beta_6 \mathrm{accredi12} + \; \beta_7 \mathrm{Accterr} + \; \beta_8 \mathrm{Nivdeg} \; + \; \beta_9 \mathrm{sexe\_cm} \; + \beta_{10} \mathrm{agr} \; + \; \beta_{11} \mathrm{Possani} \; + \; \beta 12 \; \mathrm{respop} + \; \mathcal{E}\mathrm{i}$(7.1)

Model 2: (7.2)$\mathrm{logit\;traitphytp} \; = \; \beta_0 \; + \; \beta_1 \mathrm{age\_cm} \; + \; \beta_2 \mathrm{educ\_cm} \; + \; \beta_3 \mathrm{TAILLE\_MEN} \; + \beta_4 \mathrm{aparopa} + \; \beta_5 \mathrm{Suptot} \; + \; \beta_6 \mathrm{accredi12} + \; \beta_7 \mathrm{Accterr} + \; \beta_8 \mathrm{Nivdeg} \; + \; \beta_9 \mathrm{sexe\_cm} \; + \beta_{10} \mathrm{agr} \; + \; \beta_{11} \mathrm{Possani} \; + \; \beta 12 \; \mathrm{respop} + \; \mathcal{E}\mathrm{i}$

Model 3:$\text{logit traitphytl} = \beta_0 + \beta_1 \text{age\_cm} + \beta_2 \text{educ\_cm} + \beta_3 \text{TAILLE\_MEN} + \beta_4 \text{aparopa} + \beta_5 \text{Suptot} + \beta_6 \text{accredi12} + \beta_7 \text{Accterr} + \beta_8 \text{Nivdeg} + \beta_9 \text{sexe\_cm} + \beta_{10} \text{agr} + \beta_{11} \text{Possani} + \beta 12 \text{ respop} + \mathcal{E}i$ (7.3)

Model 4:$\text{logit semen} = \beta_0 + \beta_1 \text{age\_cm} + \beta_2 \text{educ\_cm} + \beta_3 \text{TAILLE\_MEN} + \beta_4 \text{aparopa} + \beta_5 \text{Suptot} + \beta_6 \text{accredi12} + \beta_7 \text{Accterr} + \beta_8 \text{Nivdeg} + \beta_9 \text{sexe\_cm} + \beta_{10} \text{agr} + \beta_{11} \text{Possani} + \beta 12 \text{ respop} + \mathcal{E}i$ (7.4)

A first estimation step was done before estimating the logit model. This estimation consisted of identifying the quantitative explanatory variables whose linear relationship with the explained variable is doubtful. Indeed, we proceeded to the development in spline function of degree 2 of these variables in order to obtain the quantitative explanatory variables and also their square. Then, the estimation of a logit model with spline and a simple logit were made and the two results were compared. A quantitative explanatory variable that has the coefficient of its significant square is considered a variable that does not have a linear relationship with the explained/dependent variable.

IV. Analysis of descriptive statistics

The tables below relate to the variables used for the estimations and to the results of the descriptive statistics.

Table 1: Variables used and expected signs

Variables	**Definition**	**Expected signs**
	Continuous variables	
Age	Age of head of household in years	+/-
Household size	Household size in number of people	+
Cultivated area	Cultivated area in hectares	+/-
	Dichotomous variables	
Education	Level of education of the head of household, equal to 1 if the producer has received a formal education and 0 if not	+
Peasant organization membership	Membership of a farmers' organization, equal to 1 if the producer belongs to a farmers' organization and 0 if not	+/-

Credit access	Access to agricultural credit, equal to 1 if the producer has had access to credit and 0 if not	+
Land access	Access to land or nlevel of land security, takes the value 1 if the producer is the owner and 0 if not	+
Land degradation level	Soil degradation level, measured by recovered plots, takes the value 1 if recovered plot and 0 otherwise	+
Sex	(sex of the household head, takes the value 1 if the producer is a man and 2 if a woman)	+
Income generating activities	Income-generating activity, equal to1 if the producer has an income-generating activity and 0 if not	+
Pet ownership	Possession of animals, takes the value 1 if the producer owns animals and 0 if not	+

Source :*Constructed by the author based on the empirical literature review.*

Nearly 93.58% of household heads in our sample are men with an average age of 51 and also 25.04% of them have received formal education.

One of the constraints related to the adoption of agricultural intensification techniques by the producers in the database is access to agricultural credit. Also, to finance the purchase of improved seeds, fertilizer or phytosanitary treatments, the producer resorts to at least one of the means which are among others, agricultural credit, non-agricultural income (from income-generating activities) or income from the sale of animals (for producers who own animals). Indeed, the results show us that only 24.69% of the producers in the sample had access to agricultural credit in the last twelve months. Nevertheless, on9882 producers, nearly 99.60% are animal owners, and 53.82% carry out income-generating activities.

The literature has shown that fertilizer use is below the norm in sub-Saharan African countries. Indeed, in 2019 in Burkina Faso, the producers in our sample used on average37.745 kg/ha of NPK and 17.284 kg/ha of urea. Also, we note a moderate level of adoption of agricultural intensification techniques by Burkinabè producers. To do this, 77.39%, 60.47%, 78.11% and

45.55% respectively adopted the use of fertilizers, powdered phytosanitary treatments, liquid phytosanitary treatments and improved seeds.

Table 2: Descriptive statistics

Variables	**Definition**	**Average or Percentage**	**Minimum value**	**Maximum value**
Sociodemographic characteristics of the head of household				
sex_cm	Gender of head of household	93.58%		
age_cm	Age of head of household	50,609 (13,680)	17	95
education_cm	Level of education/or education of the head of household	25.04%		
Peasant organization membership	Membership of a peasant organization	38.74%		
Farmer organization responsibility	Responsibility in the functional PO	38.43%		
Income generating activities	Income generating activity	53.82%		
Credit access	Obtaining agricultural credit in the last 12 months	24.69%		
Cultivated area	Cultivated area	6,241 (7,309)	0.01	76,928
Land access	Access to land or level of land tenure security	35.20%		
Land degradation level	Level of soil degradation, measured by recovered plots	7.34%		
Household size	Household size	13,089 (7,798)	1	59

Pet ownership	Animal ownership	99.60%		
	Dependent variables			
Fertilizer	Takes the value 1 if the producer uses the fertilizer and 0 if not	77.39%		
Powdery phytosanitary treatment	Takes the value 1 if the producer uses powdery phytosanitary treatments and 0 if not	60.47%		
Liquid phytosanitary treatment	Takes the value 1 if the producer uses liquid phytosanitary treatments and 0 if not	78.11%		
improved seeds	Takes the value 1 if the producer uses improved/selected seeds and 0 if not	45.55%		
	Agricultural intensification variables			
NPK	Quantity of NPK in Kg	37,746 (41,098)	0	289,540
Urea	Quantity of urea in kg	17,285 (22,415)	0	247,180
Burkina phosphate	Quantity of Burkina phosphate in Kg	1,429 (29,144)	0	725,628
Powdery herbicide	Amount of powdery herbicide in g	99,599 (283,569)	0	6071.924
Liquid herbicide	Amount of liquid herbicide in cl	180,338 (1082,743)	0	46511.87
Powdery fungicide	Amount of powdery fungicide in g	45,421 (245,264)	0	6681.819
Liquid fungicide	Liquid fungicide quantity in cl	39,191 (180,228)	0	5880.963
powdery rodenticide	Amount of rodenticide powder in g	10.055 (50,599)	0	1785.714
liquid rodenticide	Quantity of liquid rodenticide in cl	2,647 (27,629)	0	1114.931
Powdery multipurpose pesticide	Quantity of powdery multipurpose pesticide in g	1,712 (35,362)	0	1531,483

Liquid Multipurpose Pesticide	Quantity of liquid multipurpose pesticide in cl	1,560 (31,328)	0	1209.066
Other powdery pesticides	Quantities of other powdery pesticides in g	12.48454 (93.14217)	0	17000
Other liquid pesticides	Quantities of other liquid pesticides in cl	53,052 (119,188)	0	1588.152

Source :*Constructed by author using 2018-2019 EPA data*

V. Econometric analysis

The tables below present the results of econometric analysis of the determinants of the adoption of fertilizers, powdered phytosanitary treatments, liquid phytosanitary treatments and improved seeds. We have on the one hand the results obtained by using the logit model, and on the other hand, the results obtained by using the logit model with spline function.

Through the results in Table 3, we estimated a simple logit model and a logit model with spline function. Indeed, we made a development according to a spline of degree 2 of the quantitative explanatory variables of the adoption of fertilizer which are among others the age of the head of household, the total area cultivated by the head of household, the quantity of powdery phytosanitary treatments used, that of liquid phytosanitary treatments and the size of the household. The coefficients of the variables quantity of powdery phytosanitary treatment and quantity of liquid phytosanitary treatment used are significant, but the coefficients of their squares are not significant. So we can say that there is a linear relationship between these explanatory variables and the explained variable fertilizer adoption.

The coefficient of the quantitative explanatory variable total area is insignificant unlike its square which is significant, it is the same for the improved seed coefficient. Also, the coefficient of the household size variable and its square are not significant. So there is no linear relationship between the explanatory variables total cultivated area, household size and the explained variable adoption of fertilizer.

The results of Table 4 show us that the coefficients of the variables age, household size and use of fertilizer are significant at 1%, while the coefficients of the square of these variables are not. We can conclude at this level that there is a linear relationship between these three quantitative explanatory variables and the variable explained adoption of powdered phytosanitary treatments. On the other hand, there is no linear relationship between the explanatory variable adoption of the use of powdered phytosanitary treatments and the quantitative explanatory variable total cultivated area because the coefficient of this variable as well as the coefficient of its square are significant. In Table 5, the coefficients of the quantitative explanatory variables age, area, household size and fertilizer use as well as the square coefficients of these variables are significant at 10% and 1% respectively. So there is no linear relationship between these quantitative explanatory variables and the explained variable adoption of liquid phytosanitary treatments. For the case of the adoption of improved seeds (Table 6), there is only a linear relationship between the quantitative explanatory variable use of powdery phytosanitary treatments and the explained variable adoption of improved seeds. While there is no linear relationship between this explained variable and the quantitative explanatory variables age, area, liquid phytosanitary treatments, household size and use of fertilizer.

Regarding the estimation results of the simple logit model, the results show us that it is the variables sex, age of the head of household, his level of education, income-generating activity, access to credit in the last twelve months, cultivated area, access to land, use of liquid phytosanitary treatments and improved seeds that positively determine the adoption of fertilizer, and this, at a level of significance of 1%. These results corroborate those ofMbetid (2013) and Bessane (2010). The variables use of powdered phytosanitary treatments, household size and ownership of animals do not significantly influence the adoption of fertilizer. The logit model used to estimate the adoption of agricultural intensification through the use of fertilizer is predictable at 79.68%.

The adoption of agricultural intensification through the use of phytosanitary powder treatments is determined by gender, age, level of education, membership of the head of household in a peasant organization, access to credit, total cultivated area, household size, access to land and use of fertilizer. Indeed, the variables age, membership of a peasant organization, surface area and access to land have a positive and significant influence on the adoption of powdery phytosanitary treatments with a level of significance of 1%. This pattern is predictable at 65.05

Regarding the adoption of agricultural intensification through the use of liquid phytosanitary treatments, it is determined by gender, age, level of education of the head of household, income-generating activity, access to credit in the last twelve months, total cultivated area, household size, ownership of animals, access to land and use of fertilizers. These results are similar to those found by Bessan (2010). This model is 80.37% predictable.

The adoption of agricultural intensification by improved seeds has as determinants, the variables sex, age, level of education, income-generating activity, access to agricultural credit in the last twelve months, total area cultivated, use of powdered and liquid phytosanitary treatments, household size, ownership of animals, access to land and use of fertilizers. These resultsare in agreement with those of Mbétid (2013) and Bessane (2010). The variables sex, age, access to agricultural credit in the last twelve months, total cultivated area, use of powdered and liquid phytosanitary treatments, access to land and use of fertilizers have a positive and significant influence on the adoption of improved seeds with a level of significance of 1%. The prediction percentage of this model is 76.72%.

By analyzing the results of the four forms of agricultural intensification through the logit spline, we found that age has a negative influence on the adoption of agricultural intensification techniques. This means that the older the age, the less the heads of household adopt agricultural intensification techniques (older people practice these techniques less). Unlike the level of education which has a positive and significant influence on the adoption of the three forms of agricultural intensification. This means that the more the household head has a high level of education, the more he adopts these techniques. The same is true for the total cultivated area, the higher it is, the more the head of household adopts agricultural intensification techniques.

Owning animals, income-generating activities and access to credit have positive and significant effects on the adoption of different forms of intensification, since they are sources of financing for the purchase of agricultural inputs by rural households. Also, belonging to a farmers' organization as well as responsibility in a farmers' organization positively influences the adoption of agricultural intensification techniques. This can be explained by the fact that fertilizers and subsidized improved seeds are more accessible to household heads belonging to a farmers' organization. Household size has a small and negative effect on adoption.

The estimation results found with the Odds ratio coefficients (see tables in the appendix) show us that the adoption of the use of fertilizer, powdered and liquid phytosanitary treatments is more frequent among male heads of household, and among those who carry out income-generating activities. The adoption of fertilizer, liquid phytosanitary treatments and improved seeds is more frequent among those who have received formal education. As for the adoption of the use of improved seeds, it is more frequent among female household heads. The 4 forms of adoption are more frequent among heads of households owning animals and those having access to credit in the last 12 months.

When the age increases by one year, the probability of adopting the use of fertilizer, powdered phytosanitary treatments, liquid phytosanitary treatments and improved seeds decreases by 0.992; 0.992; 0.992 and0.991 respectively.

When the cultivated area increases by one hectare, the probability of adoption of the use of fertilizer, powdered phytosanitary treatments and liquid phytosanitary treatments increases1.058 respectively; 1.106; 1.144; and that of the adoption of improved seeds decreases by 0.948.

Table 3: Determinants of fertilizer adoption

Variable explained	**Fertilizer Adoption**	
Explanatory variables	Simple logit coefficients	Logit spline coefficients
sex_cm	1,535***	0.4892***
	(0.156)	(0.107)
age_cm	0.991***	-0.01287**
	(0.002)	(0.005)
age_cm2		-0.006**
		(0.003)
education_cm	1,313***	0.245***
	(0.087)	(0.068)
income generating activities	1,323***	0.280***
	(0.069)	(0.054)
Credit access	2,339***	0.789***
	(0.225)	(0.097)
Total area	1,058***	-0.018
	(0.011)	(0.026)
Total area2		0.069***
		(0.014)
Powdery phytosanitary treatment	0.999 (0.00001)	0.004*** (0.0008)
Powdery phytosanitary treatment2		-0.00002* (0.00001)
Liquid phytosanitary treatment	1,000*** (0.00002)	0.002*** (0.0001)
Liquid phytosanitary treatment2		-0.00002 (0.00002)
Household size	0.997	0.011
	(0.004)	(0.014)
Household size2		-0.004
		(0.006)
Pet ownership	1,483	0.548
	(0.501)	(0.352)
Improved seeds	2,286***	
	(0.102)	
Improved seeds2		
Land access	0.778***	-0.192**
	(0.043)	(0.057)
Constant	0.595*	-0.987*
		(0.457)
	Number of obs = 9922 LR chi2(12) = 1710.64 Prob > chi2 = 0.0000 Pseudo R2 = 16.13%	Number of obs = 9922 LR chi2(17) = 2011.14 Prob > chi2 = 0.0000 Nickname R2 = 18.96%

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

Values in parentheses represent standard deviations.

Source :*Constructed by author using 2018-2019 EPA data*

Table 4: Determining factors for the adoption of powdery phytosanitary treatments

Variable explained	**Adoption of powdery phytosanitary treatments**	
Explanatory variables	Simple logit coefficients	Logit spline coefficients
sex_cm	1,082	0.176*
	(0.095)	(0.092)
age_cm	0.991***	-0.027***
	(0.002)	(0.003)
age_cm2		0.005*
		(0.002)
education_cm	0.924	-0.111*
	(0.048)	(0.053)
Peasant organization	1,668***	0.451***
membership	(0.088)	(0.054)
Credit access	1.167*	0.077
	(0.072)	(0.063)
Total area	1,106***	0.174***
	(0.008)	(0.021)
Total area2		0.078***
		(0.009)
Household size	0.998	-0.030**
	(0.004)	(0.011)
Household size2		0.006
		(0.005)
Pet ownership	1,421	0.437
	(0.478)	(0.337)
Land access	0.576***	-0.559***
	(0.026)	(0.045)
fertilizer	1,000	0.003***
	(0.00004)	(0.0004)
Fertilizer2		-0.0004
		(0.00004)
Constant	0.991*	0.431
		(0.413)
	Number of obs = 9922	Number of obs = 9922
	LR chi2(10) = 1056.52	LR chi2(14) = 1179.47
	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000
	Pseudo R2 = 7.93%	Pseudo R2 = 8.86%

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

Values in parentheses represent standard deviations.

Source :*Constructed by author using 2018-2019 EPA data*

Table 5: Determining factors for the adoption of liquid phytosanitary treatments

Variable explained	**Adoption of liquid phytosanitary treatments**	
Explanatory variables	Simple logit coefficients	Logit spline coefficients
sex_cm	1,699***	0.595***
	(0.171)	(0.106)
age_cm	0.990***	-0.012*
	(0.002)	(0.004)
age_cm2		-0.008*
		(0.003)
education_cm	1.136*	0.095
	(0.079)	(0.072)
Income generating activities	0.890*	-0.151**
	(0.048)	(0.056)
Credit access	1,889***	0.589***
	(0.193)	(0.104)
Total area	1,144***	0.228***
	(0.013)	(0.026)
Total area2		0.112***
		(0.016)
Household size	0.958***	-0.109***
	(0.005)	(0.014)
Household size2		-0.019**
		(0.006)
Pet ownership	2.155*	0.951**
	(0.720)	(0.347)
Land access	0.720***	-0.288***
	(0.041)	(0.059)
Fertilizer	1.005***	0.013***
	(0.0002)	(0.0006)
Fertilizer2		0.002***
		(0.0002)
Constant	0.604*	-0.525
		(0.459)
	Number of obs = 9922	Number of obs = 9922
	LR chi2(10) = 2247.96	LR chi2(14) = 2488.70
	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000
	Nickname R2 = 21.56%	Nickname R2 = 23.86%

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

Values in parentheses represent standard deviations.

Source :*Constructed by author using 2018-2019 EPA data*

Table 6: Determinants of adoption of improved seeds

Variable explained	Adoption of improved seeds	
Explanatory variables	Simple logit coefficients	Logit spline coefficients
sex_cm	0.431***	-0.663***
	(0.052)	(0.125)
age_cm	0.992***	0.004
	(0.002)	(0.004)
age_cm2		-0.016***
		(0.003)
education_cm	1,077	-0.018
	(0.062)	(0.059)
Income generating activities	1.012	-0.048
	(0.050)	(0.0516)
Credit access	4,301***	1,295***
	(0.283)	(0.067)
Total area	0.949***	-0.106***
	(0.008)	(0.026)
Total area2		-0.041***
		(0.011)
Powdery phytosanitary treatment	1,000***	0.004***
	(0.00001)	(0.0007)
Powdery phytosanitary treatment2		0.00002*
		(0.00001)
Liquid phytosanitary treatment	1,000***	0.001***
	(0.00002)	(0.0001)
Liquid phytosanitary treatment2		0.0002***
		(0.00002)
Household size	0.993*	0.023*
	(0.004)	(0.013)
Household size2		-0.013*
		(0.005)
Pet ownership	3.109*	1.214*
	(1,736)	(0.574)
Land access	1,375***	0.360***
	(0.0713)	(0.054)
Fertilizer	1,001***	0.009***
	(0.00009)	(0.0005)
Fertilizer2		0.0006***
		(0.00009)
Constant	0.319**	-2.822***
		(0.637)
	Number of obs = 9922 LR chi2(12) = 3652.44 Prob > chi2 = 0.0000 Pseudo R2 = 26.71%	Number of obs = 9,922 LR chi2(18) = 4122.83 Prob > chi2 = 0.0000 Nickname R2 = 30.15%

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

Source :*Constructed by author using 2018-2019 EPA data*

Conclusion and Policy Implications

This essay analyzed the determinants of the adoption of four forms of agricultural intensification in Burkina Faso, including intensification through the use of fertilizer, powdered phytosanitary treatments, liquid phytosanitary treatments and improved seeds. The study used secondary data from the Burkina Faso Ministry of Agriculture's 2018-2019 permanent agricultural survey. In total, nearly 9,285 households were surveyed in all 13 regions covering the country. The methodological approach is the logit model with spline function. The results of the econometric estimations allowed us to confirm the hypothesis according to which the determining factors of the adoption of agricultural intensification techniques are economic factors, socio-demographic and institutional. These factors include cultivated area, access to agricultural credit, membership of a farmers' organization, the responsibility of the head of household in a farmers' organization, the level of education of the head of household, access to land, the level of soil degradation, the size of the household, the sex of the head of household, the income-generating activity, the age of the head of household and the possession of animals. The results obtained could guide political decision-makers in terms of promoting the adoption of agricultural intensification techniques by Burkinabè producers (subsidy policies or free distribution of improved seeds and/or chemical fertilizers). Indeed, a policy that aims to promote the adoption of improved seeds, fertilizers or phytosanitary treatments must be accompanied by a policy which not only makes agricultural credit accessible to producers, but also which supports these producers so that they can properly carry out their income-generating activities (IGA) and their breeding activities. Because agricultural loans, income from IGAs and livestock activities are sources of financing for producers in the purchase of agricultural inputs.

The analysis of the determining factors makes it possible to identify the levers on which the political decision-makers must put access in terms of policy of promotion of the diffusion of the techniques of agricultural intensification. Particularly in terms of achieving the Sustainable Development Goals (SDGs) which the country has set itself through its strategic plan (2019-2023) aimed at ensuring that "smallholder farmers, particularly those affected by recurring climate shocks, have more resilient livelihoods and sustainable food systems".

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APPENDIX: Description of the database and tables of estimates (output).

Database Description

The data we used are secondary data from the Permanent Agricultural Surveys (EPA), from the 2018/2019 agricultural campaign. These data are obtained from the General Directorate of Studies and Sector Statistics of the Ministry of Agriculture and Hydro-agricultural Developments of Burkina Faso.

The Permanent Agricultural Survey (EPA) is the database for collecting economic data on agriculture and food. The main objective of this survey is to provide decision-makers and users with figures on the production, area and yield of the main crops, as well as socio-demographic data on agricultural households. It provides information on the herd, the peasant cereal stock, the sources of income and access to food for agricultural households at the end of the campaign and also the characteristics of the plots. The observation unit is the rural household in which one or more members farm plots or raise animals on behalf of the household. This survey is conducted every year and covers the 45 provinces of Burkina Faso. Also, the sample size is 9285 households distributed in more than 887 villages due to 6 households per village. Data collection for this survey takes place over seven (7) months, from June to December each year.

The various non-exhaustive variables entered during this survey are, among others:

i) Surname and first name of household members, gender (if household member is male or female), relationship (if head of household, husband or wife, son or daughter, etc.), age, marital status, level of education, type of dwelling (type of roof, type of wall), membership of functional farmers' organizations (POs), responsibilities in the functional farmers' organization, manager of rainfed plots, manager of seasonal crop plots dry land, responsible for tree plots, animal owner, occupation status (whether the member is an active agricultural or non-agricultural worker, etc.), activities practiced by household members (rainfed farming, market gardening, livestock farming, fishing, etc.), IGA (Income Generating Activities),Supervision/advice support (Last year of supervision/advice support, supervision structure, etc.), agricultural credit and micro-finance during the last twelve (12) months,

ii) Manager of the plot, characteristics of the plot (type of management of the plot, location of the plot, etc.), crop practiced on the plot, type of plowing, method of sowing,

iii) Use of inputs, type of seed (local, first generation, etc.), organic manure (compost, household waste, etc.), amount of NPK (in kilograms), amount of Urea (kilograms), amount of Burkina phosphate (in kilograms), herbicide, fungicide, multi-use pesticides,

iv) Acquisition of inputs during the present campaign, selected seeds of rainfed crops, selected seeds of vegetable crops, fodder seeds, etc...

v) Method of acquisition, acquisition of inputs on credit, acquisition of inputs in cash,

vi) Use of inputs (the activities for which the inputs are used),

vii) Estimation of the farmer's stock, stock at the granary level and/or batches of stocks outside the granary,

viii) Harvest forecast

ix) Food availability, access to food, use (household food preferences), food consumed in the last seven days, main mode of food acquisition (purchase, loan, barter, donation, etc.)

x) Coping strategy and source of income, source of income, number of days the household borrowed food or received assistance, number of days the household reduced the amount of daily meals, number of days the household had to reduce the consumption of adults in favor of grandchildren, number of household sources of income in the last three (3) months, the amount that the household spent on food products in the last seven (7) days, the amount that the household spent on common non-food products in the last seven (7) last days.

The output of the logit model estimates

Logit model on the determinants of adoption of fertilizer use

Fertilizer Odds Ratio

Logistic regression Number of obs = 9.922

LR chi2(12) = 1710.64

Prob > chi2 = 0.0000

Log likelihood = -4447.7494 Pseudo R2 = 0.1613

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fertilizer | Odds Ratio Std. Err. zP>|z| [95% Conf. Range]

-------------+--

gender_cm | 1.53471 .1561359 4.21 0.000 1.257269 1.873374

age_cm | .9907779 .0019126 -4.80 0.000 .9870365 .9945336

educ_cm | 1.312585 .0874194 4.08 0.000 1.151958 1.495609

agr | 1.322682 .0699991 5.28 0.000 1.192362 1.467246

accrediti12 | 2.339412 .2254873 8.82 0.000 1.936701 2.825862

support | 1.058502 .0114945 5.24 0.000 1.036211 1.081272

traitphytp | .9999848 .000013 -1.17 0.241 .9999594 1.00001

traitphytl | 1.000221 .0000285 7.75 0.000 1.000165 1.000277

seed | 2.286574 .1024283 18.46 0.000 2.094379 2.496407

acct | .7778913 .0430966 -4.53 0.000 .6978479 .8671157

possi | 1.483326 .5017509 1.17 0.244 .764379 2.87849

SIZE_MEN | .9970663 .0045676 -0.64 0.521 .988154 1.006059

_cons | .5955189 .2395434 -1.29 0.198 .2707108 1.310043

. lstat fertilizer (Model prediction level)

Logistic model for fertilizer

-------- True --------

Classified | D~D | Total

-----------+------------+-----------

+ | 7532 2064 | 9596

- | 147 179 | 326

-----------+------------+-----------

Total | 7679 2243 | 9922

Classified + if predicted Pr(D) >= .5

True D defined as fertilizer != 0

Sensitivity Pr(+| D) 98.09%

Specificity Pr(-|~D) 7.98%

Positive predictive value Pr(D| +) 78.49%

Negative predictive value Pr(~D| -) 54.91%

False + rate for true ~D Pr(+|~D) 92.02%

False - rate for true D Pr(-| D) 1.91%

False + rate for classified + Pr(~D| +) 21.51%

False - rate for classified - Pr(D| -) 45.09%

Correctly classified 77.72%

Logit model on the determinants of the adoption of the use of powdery phytosanitary treatments

Odds ratio traitphytp

Logistic regression Number of obs = 9.922

LR chi2(10) = 1056.52

Prob > chi2 = 0.0000

Log likelihood = -6129.9253 Pseudo R2 = 0.0793

----

traitphytp | Odds Ratio Std. Err. zP>|z| [95% Conf. Range]

-------------+--

fertilizer | 1.000037 .0000493 0.75 0.452 .9999405 1.000134

gender_cm | 1.082386 .0958009 0.89 0.371 .9100034 1.287422

age_cm | .9908357 .0016325 -5.59 0.000 .9876411 .9940405

educ_cm | .9242587 .0483691 -1.51 0.132 .8341568 1.024093

aparop | 1.668912 .0885622 9.65 0.000 1.504055 1.851838

accrediti12 | 1.167349 .0725753 2.49 0.013 1.033429 1.318624

support | 1.1061 .0085484 13.05 0.000 1.089472 1.122982

acct | .576173 .0261675 -12.14 0.000 .527102 .6298123

possi | 1.42059 .4785001 1.04 0.297 .7341024 2.749037

SIZE_MEN | .9988269 .0037855 -0.31 0.757 .991435 1.006274

_cons | .9919323 .379961 -0.02 0.983 .4681964 2.101532

. lstat traitphytp

Logistic model for traitphytp

-------- True --------

Classified | D~D | Total

-----------+------------+-----------

+ | 4938 2398 | 7336

- | 1062 1524 | 2586

-----------+------------+-----------

Total | 6000 3922 | 9922

Classified + if predicted Pr(D) >= .5

True D defined as traitphytp != 0

Sensitivity Pr(+| D) 82.30%

Specificity Pr(-|~D) 38.86%

Positive predictive value Pr(D| +) 67.31%

Negative predictive value Pr(~D| -) 58.93%

False + rate for true ~D Pr(+|~D) 61.14%

False - rate for true D Pr(-| D) 17.70%

False + rate for classified + Pr(~D| +) 32.69%

False - rate for classified - Pr(D| -) 41.07%

Correctly classified 65.13%

Logit model on the determinants of the adoption of the use of liquid phytosanitary treatments

. Odds ratio traitphytl

Logistic regression Number of obs = 9.922

LR chi2(10) = 2247.96

Prob > chi2 = 0.0000

Log likelihood = -4090.2489 Pseudo R2 = 0.2156

----

traitphytl | Odds Ratio Std. Err. zP>|z| [95% Conf. Range]

-------------+--

fertilizer | 1.005349 .0002519 21.29 0.000 1.004855 1.005843

gender_cm | 1.699011 .1717989 5.24 0.000 1.393559 2.071415

age_cm | .990824 .0019983 -4.57 0.000 .9869152 .9947483

educ_cm | 1.136493 .0794441 1.83 0.067 .9909812 1.303372

agr | .8909278 .0488434 -2.11 0.035 .8001603 .9919918

accrediti12 | 1.889444 .1937612 6.20 0.000 1.54541 2.310064

support | 1.144879 .0131561 11.77 0.000 1.119382 1.170957

acct | .720777 .0413581 -5.71 0.000 .6441086 .8065713

possi | 2.155932 .7201005 2.30 0.021 1.120278 4.149005

SIZE_MEN | .9589922 .0047538 -8.45 0.000 .94972 .968355

_cons | .6042841 .2433583 -1.25 0.211 .2744378 1.330572

Rating: 0 failures and 238 successes completely determined.

Logistic model for traitphytl

-------- True --------

Classified | D~D | Total

-----------+------------+-----------

+ | 7463 1770 | 9233

- | 287,402 | 689

-----------+------------+-----------

Total | 7750 2172 | 9922

Classified + if predicted Pr(D) >= .5

True D defined as traitphytl != 0

Sensitivity Pr(+| D) 96.30%

Specificity Pr(-|~D) 18.51%

Positive predictive value Pr(D| +) 80.83%

Negative predictive value Pr(~D| -) 58.35%

False + rate for true ~D Pr(+|~D) 81.49%

False - rate for true D Pr(-| D) 3.70%

False + rate for classified + Pr(~D| +) 19.17%

False - rate for classified - Pr(D| -) 41.65%

Correctly classified 79.27%

Logit model on the determinants of the adoption of the use of improved seeds

Logistic regression Number of obs = 9.922

LR chi2(12) = 3652.44

Prob > chi2 = 0.0000

Log likelihood = -5011.7563 Pseudo R2 = 0.2671

----

seed | Odds Ratio Std. Err. zP>|z| [95% Conf. Range]

-------------+---

fertilizer | 1.001407 .0000942 14.95 0.000 1.001222 1.001591

gender_cm | .4314818 .051631 -7.02 0.000 .3412776 .545528

age_cm | .9916828 .0018693 -4.43 0.000 .9880257 .9953534

educ_cm | 1.077139 .0629248 1.27 0.203 .9606071 1.207807

agr | 1.012073 .050375 0.24 0.809 .9180026 1.115782

accrediti12 | 4.300633 .2834886 22.13 0.000 3.779401 4.89375

support | .9488883 .0089157 -5.58 0.000 .9315738 .9665246

traitphytp | 1.000045 .0000112 4.00 0.000 1.000023 1.000067

traitphytl | 1.000367 .0000243 15.08 0.000 1.000319 1.000414

acct | 1.374925 .0713616 6.13 0.000 1.241937 1.522153 possi | 3.109395 1.736674 2.03 0.042 1.04054 9.291652

SIZE_MEN | .992675 .0044163 -1.65 0.098 .9840569 1.001369

_cons | .3195035 .1901402 -1.92 0.055 .0995212 1.025736

Rating: 0 failures and 40 successes completely determined.

Logistic model for semen

-------- True --------

Classified | D~D | Total

-----------+------------+-----------

+ | 2908 677 | 3585

- | 1611 4726 | 6337

-----------+------------+-----------

Total | 4519 5403 | 9922

Classified + if predicted Pr(D) >= .5

True D defined as seed != 0

Sensitivity Pr(+| D) 64.35%

Specificity Pr(-|~D) 87.47%

Positive predictive value Pr(D| +) 81.12%

Negative predictive value Pr(~D| -) 74.58%

False + rate for true ~D Pr(+|~D) 12.53%

False - rate for true D Pr(-| D) 35.65%

False + rate for classified + Pr(~D| +) 18.88%

False - rate for classified - Pr(D| -) 25.42%

Correctly classified 76.94%