Determinants of farmers' participation in sales channels in Nicaragua: plantain case study

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Abstract: Plantains are an important cultivar in Nicaragua, and while the production has increased in recent years, there is a lack of socio-economic research in this sector. This paper aims to study the factors that determine the farmer's decision on whether to sell or not sell their production. The starting point for this analysis came from a discrete choice framework, with the available information coming from the last national agricultural census. Using a binary logit model, variables related to household and production characteristics were evaluated. The main findings suggest that the farm's geographical location plays a vital role when farmers adopt a market-oriented production. Variables such as gender, access to financial resources, and assistance received show a positive and statistically significant effect. The marginal effects of the age and years of schooling of the head of the household suggest little effect of these factors on farmer's decisions.

Keywords: plantain; logit model; farmer's choice; market oriented production.

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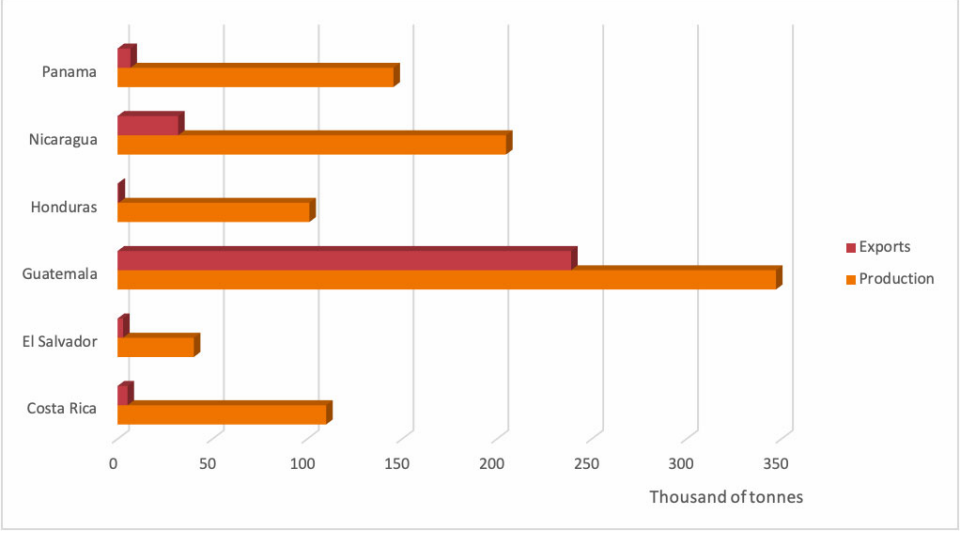
1 Introduction

Plantains are a tropical product of great economic importance and for food security in the Central American (CA) region, it is usually grown in less developed regions and it is marketed fresh and, on a smaller scale, as a processed product (INIDE, 2007). Plantains are produced all year round, make them a reliable staple food, its fruits are generally used in cooking and as fruit (Davidson, 2014; Smyth et al., 2014; Siddiq et al., 2012). According to the Economic Commission for Latin American and the Caribbean[1] the agricultural sector in Nicaragua contributed with about 17.2% to the GDP in 2017, and agricultural products have been the main export commodities (CEPAL, 2019). Plantain

production in Nicaragua has steadily increased since 1998. In 2006, Nicaragua became part of a Regional Trade Agreement with The USA, CA countries, and the Dominican Republic (usually referred to as DR-CAFTA), agricultural products as Plantain were included in the negotiations and tariff were not established which encouraged farmers towards oriented market production.

Figure 1 Production and export levels of plantain by CA countries in 2016 (see online version for colours)



Source: FAO (2019)

Figure 1 shows the levels of plantain production and exports for CA countries in 2016, the 204,824 tons of plantains produced by Nicaragua's farmers represented 21.41% of the total CA production, the second largest in this region, only trailing Guatemala's production which accounted for 36.29% of the total for C.A region. While Guatemala exported around 64.2% of its total production, Nicaragua struggled to reach a 14.8%. This suggests that Nicaragua plantain producers mainly supply the national markets. However, there is a lack of research in the plantain sector and only a few reports from national agencies have given information about plantain producers.

This article is an effort to provide further information on the subject of plantain sector in Nicaragua. Therefore, it aims to analyse the determinants of plantain farmers' decision to participate in the market (whether to sell or not their production), such objective fills the research gap. To the best of the author's knowledge there is no similar research for Nicaragua's case.

The expected results from this study could provide some insights to policy makers in regards to what factors farmers are considering in their decision-making process, and use such information to promote the participation of farmers in local supply chains as well as encourage further research on plantain sector in Nicaragua

The remainder of the paper is laid out as follows. Section 2 presents a review of empirical studies on farmer's choices. Section 3 describes the data, the estimation approach, and variables selection. Estimation results are discussed in Section 4 and Section 5 contains conclusions and policy implications.

2 Literature review

Farmer's decisions have been widely studied in the literature under a discrete choice analysis, and yes or no response to any decision farmer might face, for instance, technology adoption decisions or the selection of marketing channels. The choice of the models depends on the issues of interest and the characteristic of the decision; logit, mixed logit, or multinomial logistic models are among the econometric model most used.

For instance, Adesina and Chianu (2002) assessed the factors influencing farmers' adoption of alley farming technology in Nigeria and their decision to modify it. Their results from a logit model showed that socioeconomic characteristics such as gender, landholding ownership status, farmer's experience on agroforestry and connection with extension officials determined adoption decisions. In another study on farmers' selection of market channels by vegetables producers in Beijing revealed that farmers' market, cooperatives, and wholesalers are the preferred marketing channels for the vegetable producers when safety awareness was at consideration. Similarly, variables such as cooperative membership, land under vegetables production, price satisfaction, and slow sales were significant to explain the farmers' decision whether to sell their production to a cooperative or through the farmer's market (Zhang et al., 2017).

Schipmann and Qaim (2011) used a discrete choice framework and through a mixed logit model application analysed how institutional arrangements between sweet pepper smallholder producers and traders in different market channels are associated with farmers' participation in the modern supply chains in Thailand.

Teferra et al. (2019) used information of 253 households to investigate the land allocation decision for lupin production as a break crop by farmers in Ethiopia. The results from the logit regression analysis indicated that the differences in the farmers' decision to practice crop rotation with lupin were associated with family size, total land assets, and contacts with extension agents.

In another research, Tefera (2014) analysed the decision of chickpea producer to participate in different marketing channels. Using a multinomial logit (MNL) model found that variables such as family size, land assets, access to market information, crops sales revenue and extension services explains the differences in farmers' choices among wholesale, retails, or at farm gate market option.

In a research based on a choice experiment, Panda (2012) studied the selection of marketing channel for vegetables by farmers in India, from the result of a MNL regression researchers observed that variables such as access to market information, training and education, value addition, roads and market infrastructure, and guaranteed markets influenced the farmers' decision whether non-market or formal market participation.

Arora et al. (2019) examinated the willingness to pay for drought-tolerant rice cultivars and the potential market of these varieties. They found that regardless of the farmers' awareness of the risk of drought only those settled in drought-prone or submergence prone regions, would generally be willing to pay a significant premium price.

Nxumalo et al. (2019) characterised maize and sunflower farmers in South Africa and the determinants of marketing channel selection. The findings suggest that socioeconomic factors such as age, marital status, gender and education as well as credit access, and farming experience are significant to explain the differences in the market channel choice among farmers

Safi et al. (2018) aim to determine the most efficient marketing channels and its choice by grape farmers in Afghanistan. Results indicated that wholesale is the most efficient marketing channel. Significant differences were observed in socio-economics variables such as educational level and family size, the distance to market, and market information that drive market channel selection.

This study on plantain farmers' behaviours choosing a market-oriented production and its key factors incorporate the practical considerations and approaches that authors follow in the literature previously cited.

3 Material and methods

3.1 Data

The Data used in this article comes from The Fourth National Agricultural Census (IV CENAGRO by its acronym in Spanish) conducted by The Nicaraguan National Institute of Information for Development (INIDE) and The Ministry of Agriculture and Forestry (MAGFOR) (INIDE, 2011). In the past three others Agricultural census have been conducted in Nicaragua (1963, 1971, 2001); thus, the IV CENAGRO offers updated information on the main structural variables of the agricultural sector, characteristics of agricultural holdings, characteristics of agricultural producers, as well as the conditions of access and services of rural communities. The information of the IV CENAGRO was collected from May 15 to June 16, 2011 and during the survey, 262,974 interviews were conducted, with 97.77% complete interview in 156 municipalities.

3.2 Econometric approach

Farmers' welfare or utility maximisation framework has been used in many studies to model farmers' adoption decision, the rationalities of such models are that profit is a function of the farmer's choices of crops, technology and any other decision made during growing, post-harvest activities, etc. Therefore, a farmer's welfare depends on his discrete selection of which crop, which technology, if sell or not decisions, etc. In this study, the farmer is assumed to maximise his utility by choosing between sell their product or not to sell it. The observed choice reveals which decision provides a greater utility (Bernard et al., 2010).

As previously mentioned, the selection of the model depends on the characteristic of the decision to be modelled as well as the researcher's interest. Following previous studies, in this research the observed yes/no (whether to sell or not) decision is viewed as the outcome of a binary choice model, in such case logit regression analysis is a well-established approach that has been used in empirical research to study the adoption of new agricultural technologies and/or modern farming practices as seen in Ayele (2008), Ward et al. (2018) and Pivoto et al. (2019). In the logit regression analysis, the farmer's choice is expressed by the dummy variable derived as follows:

$$y = \begin{cases} 1, & \text{if farmer sell the production} \\ 0, & \text{if farmer does not sell the production} \end{cases}$$

In this binary variable setting, the dependent variable y takes one of two values. Lets

$$y = \begin{cases} 1, & | \text{ with probability } p \\ 0, & | \text{ with probability } 1-p \end{cases}$$

Therefore, what is being modelled is the probability (p) of the outcome occurring. As this research aim to ascertain what are the factors driving farmers' decision and how much those factors influence whether a farmer chooses to have a market-oriented production or not, a logit model is selected for accomplishing this objective. Farmer respondents in the IV CENAGRO were asked if they sold their production or has used to self-subsistence.

Estimation procedure is developed following Cameron and Trivedi (2005). In the logit model, the probability p is parameterised to depend on a regressor vector x and a $K \times 1$ parameter vector β. The conditional probability is given by

$$p \equiv \Pr[yi = 1 \mid x] = F\left(x_i'\beta\right)$$

where $F(\bullet)$ is a cumulative distribution function, to specify that probabilities are between $0 \leq p \leq 1$ range. The logit model or logistic regression model specifies:

$$p = \wedge\left(x^i\beta\right) = \frac{e^{x^i\beta}}{1-e^{x^i\beta}},$$

where $\wedge(\bullet)$ is the logistic cdf.

Given the fact that logit coefficient has no direct interpretation the practical solution goes through the estimation of its marginal effects, these can be obtained from the coefficients estimated in the logit model by partial differentiation

$$(\partial p / \partial xj) = \wedge\left(x^i\beta\right)\left[\wedge\left(x^i\beta\right)\right]\beta_j$$

The binary outcome models are estimated by maximum likelihood estimation since the distribution of the data is determined by the Bernoulli model (Cameron & Trivedi, 2005). The latent version of the model can be derived from the latent outcome variable, lets y* be a latent variable, and suppose that

$$y^* = \beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k + e, \quad y = 1\left[y^* > 0\right]$$

3.3 Variables' specification

Possible factors affecting the plantain farmers decision were selected in concordance with the information available in the IV CENAGRO and the literature review. These factors were organised into the following groups that may influence a farmer to decide whether to have a market-oriented production or not.

To explain the outcome variable *decision* the seven variables selected were divided in two categories:

a Farmers' characteristics, previous studies have shown the importance of farmers' socio-economic characteristics in their decision-making process (Adesina and Chianu, 2002; Fahad et al., 2018; Nxumalo et al., 2019; Pivoto et al., 2019; Teferra et al., 2019), the set of variables selected include gender to account for differences among farmers due to gender's gap; the age of farmers, it is expected that younger farmers are more prompt to market their production due to a higher risk aversion;

finally years of formal education when it is expected that farmers with higher education are able to concrete more market transaction.

b the second category includes variables related to production practices, empirical evidence highlights the importance of economic factors such as information and inputs constraint that can affect farmers' choices. Here, the following variables are included: whether a farmer is part of a cooperative and if he/she has received training or not as proxies of information constraint, also if he/she had access to financial resources (capital access), and finally is the farmer residence to control for market differences that might exist among regions, dummies for two well-known plantain production cities are included, Masaya and Rivas.

Masaya and Rivas have been recognised of its plantain production. Those cities are close to the capital (within 40 and 80 miles, respectively), good vial infrastructure makes easy for brokers to visit those cities and buy the product at the farm gate, and it is easy for farmers with transportation resources to trade their products in the capital city markets and receive a higher price.

Table 1 Variables and their definitions

Name	*Variable definition*	*Mean*	*Std. dev.*
Dependent variable			
Decision	1 if farmer sold the production, 0 otherwise	0.287	0.452
Independent variables			
Farmer characteristics			
Gender	1 if the farmer is a male, 0 otherwise	0.756	0.429
Age	Age of the farmer	49.091	15.069
Education	Number of years of schooling of the farmer	4.014	4.149
Production characteristic			
Farmer's type	1 if farmer belong to a cooperative, 0 otherwise	0.102	0.302
Location1	1 if farmer lives in Rivas, 0 otherwise	0.080	0.271
Location2	1 if farmer lives in Masaya, 0 otherwise	0.178	0.383
Assistance	1 if farmer received capacitation, 0 otherwise	0.210	0.408
Loan	1 if farmer received a loan, 0 otherwise	0.174	0.379

Notes: Table 1 presents dependent and independent variables from the IV CENAGRO, and to be used for the econometric model estimation. n = 35,434.

Table 1 shows the variables selected and its definitions, mean and standard deviation is displayed as well, as it was previously explained in this selection two dummies variables were included for specific effects of the two plantain production locations, Masaya and Rivas.

4 Results and discussion

4.1 Descriptive results

Table 2 represents the decision of plantain farmers to sell or not their production, according to the information in the IV CENAGRO, a total of 35,434 farmers grown plantain as a semi-permanent crop. The descriptive show that 28.7% of the farmers sold their products, and 71.3% grown plantain as a staple crop for self-subsistence. Also, there is a high concentration of plantain production in the pacific region of Nicaragua, particularly, Masaya and Rivas's departments concentrate 17.8% and 8% of farmers respectively, moreover in these departments were located 43.55% of farmers who sold their production.

Table 2 Distribution of plantain selling farmers in Nicaragua

Location	*Plantain selling farmers (%)*		*Total*
	Yes	*No*	
Masaya	6.6	11.2	17.8
Rivas	5.9	2.1	8
Others	16.2	58	74.2
	28.7	71.3	100

Notes: 35,434 farmers reported grown plantain in the IV CENAGRO.

Table 3 presents the difference in gender distribution and the farmers' type by whether the farmer sold or did not sell the product. Overall female producers represent 24.4% of the total farmer and male producers 75.6%, the gender distribution of who report sold the production is quite similar where female participation goes up to 23% of the total farmer. But the scenario is different for the farmer who belongs to a cooperative, a small 10.2% of those who grown plantain take part of a group of farmers and this ratio is slightly greater for farmers who sold their production with 3.5% of 28.6% of total 'yes' answers (this ratio is equal to 12.23%). These descriptive results suggest a low level of association among Nicaraguan farmers.

Table 3 Distribution of plantain farmers by gender and cooperative status

Sell decision	*Gender (values %)*		*Cooperative (values %)*		*Total*
	Female	*Male*	*No*	*Yes*	
No	17.7	53.6	64.7	6.7	71.4
Yes	6.6	22.0	25.1	3.5	28.6
Total	24.4	75.6	89.8	10.2	100.0

Notes: Table shows percentage of farmers by gender and whether they are part of a group of farmer or not. n = 35,344.

Table 4 shows the distribution of farmers for two important variables as Extension services and financial resource. In general, farmers in Nicaragua suffer from lack of training, and little support from financial institutions, 79% of farmers in the plantain sector, did not receive assistance for the period under study and 82.6% did not receive any kind of loan for production activities. The percentages of farmers who report sold the

production and received assistance and financial resources were 6.5 percent and 6.3 percent, which represent around 22 percent of 10,163 farmers.

Table 4 Distribution of plantain farmers by whether they received assistance and credit

Sell decision	*Assistance (values %)*		*Loan (values %)*		*Total*
	No	*Yes*	*No*	*Yes*	
No	56.8	14.6	60.2	11.1	71.4
Yes	22.2	6.5	22.4	6.3	28.6
Total	79.0	21.0	82.6	17.4	100.0

Notes: Table shows percentage of farmers according if they received assistance and loans, n = 35,344.

4.2 Econometrics results

The logit model, as well as the statistical measures for model goodness of fit, were estimated using the software Stata/MP 13.1 and following Cameron and Trivedi (2005) specifications. The functional form proposed has the following structure:

$$p(y=1 \mid x) = \beta_0 + \beta_1 gender + \beta_2 education + \beta_3 age + \beta_4 farmers\ type + \beta_5 Masaya + \beta_6 Rivas + \beta_7 assistance + \beta_8 loan + e$$

4.2.1 Goodness of fit

Table 5 presents the results of the estimation; the first two columns include the coefficients and standard error for the logit model; the third and fourth columns present the marginal effect and standard error calculated from the previous step. The level of significance is displayed for each parameter estimated. Results for the Hosmer-Lemeshow test of goodness of fit have a value of chi-squared 0.7374 which acknowledged that the model fits well (Archer and Lemeshow, 2006). Moreover, the power of prediction of the model indicate that 74.20% of the observations were accurately predicted by the explanatory variables included in the estimation.

4.2.2 Results of logit model

All variables show statistical significance, within all the variables included, Assistance is the only one with statistical significance at the 10% level. Those result clearly indicate that the farmer's choice on whether market its production or not is significantly determinate by own farmers characteristic and some related variables which affect their production practices.

In particular, findings suggest that there is a significant difference between farmers regarding their gender, a male farmer has a 3.6% greater likelihood of selling their products than their female farmers' counterparts. Age of household head and year of schooling results statistically significant at 1% level but marginal effect results suggest a weak contribution to explain the farmers' decision. Surprisingly, the coefficient for the age of household head and its marginal effect implied that older farmers as opposed to youngers ones tend to commercialise their production. On another hand, an additional

year of formal education increase the farmers' probability of market the production in 0.8%.

As it is expected farmers who belong to a cooperative or group of farmers have higher opportunities to trade their production, the results show that being a part of a cooperative increase the farmers' likelihood of selling their product by 3.7%.

The coefficient and marginal effect of Assistance suggest a positive effect of the extension services to influence the farmer's decision. Hence, a farmer who has received assistance has a 1.5% higher probability to market the plantain production in comparison with those who have not received it, but even though it is recognised that agricultural extension service can enhance the farmers' productivity by giving information and building human capital, it is difficult to provide a strong conclusion due to the nature of this question in the survey in which it is not possible to identify if the training that farmers received was exclusively related to production or marketing practices for plantain.

The variables that summarise information whether a farmer has received financial support or not along with the geographical location of farmers show a positive impact and a high explanatory power, which reveals the farmers' rational behaviour when considering the cost associated to the production and commercialisation, the marginal effect of Loan variable indicates that the likelihood to sell their production increase by 7.4% as the farmer has access to the financial market to support their production practices; Similar effect is showed by location variable.

Table 5 Logit model estimation output and marginal effects

Variable	*Regression*		*Marginal effect*	
	Coefficient	*Std. error*	*Coefficient*	*Std. error*
Gender				
Male	0.208***	0.033	0.036***	0.006
Age	0.015***	0.001	0.003***	0.00
Education	0.043***	0.003	0.008***	0.001
Farmer's Type	0.204***	0.048	0.037***	0.009
Location				
Masaya	0.737***	0.035	0.143***	0.007
Rivas	2.299***	0.05	0.504***	0.01
Assistance	0.085*	0.036	0.015*	0.006
Loan	0.403***	0.037	0.074***	0.007
_cons	–2.533***	0.062		
Log likelihood	–15,921.14			
McFadden's R^2	0.10			
Hosmer-Lemeshow $\chi^2(8)$	5.19			
Prob > χ^2	0.7374			

Notes: n = 35,344.***Significance at 1% level. *Significance at 10% level.

Consequently, farmers living in Masaya department have a 14.3% higher probability to sell their products in contrasts with farmers in other localities (without including Rivas), the likelihood of selling the product for farmers living in Rivas increase up to 50.4% in

contrast with farmers in other localities (without including Masaya). This result is explained by the empirical evidence that in the plantain value chain brokers are the key factor. Usually in Nicaragua, brokers and small middleman travel to Rivas or Masaya departments farms (which are well known for the quality of the plantain produced there) to buy the plantain production, which suggest that in this scenario farmers in these localities have better or easier opportunity to sell their production (INIDE, 2007).

5 Conclusions and policy implications

Using farmer level data collected in the IV CENAGRO agricultural census in Nicaragua, this study has aimed to analyse the determinants of farmer's choice to sell its plantain production. The determinants were evaluated using a binary logit model and the estimation outcomes show that farmer's characteristics, as well as characteristics associated with the production stage, are positively related with the farmers' decision of selling the products.

The major findings suggest that the geographical location and the access to financial resources have greater importance that explain the difference among farmers. When considering the lack of association among farmers, it may be suggested to implement programs to promote the cooperation between farmers in these regions. It is essential that government's efforts focus on strengthening the capacities of the farmers to organise themselves, since greater integration of farmers in cooperatives can reduce the risk aversion for those farmers that have not participate in the market, or those with few experience growing plantain and new younger farmers, through acquiring knowledge and advises from their counterparts that already has experience in the national and even international markets.

As literature also suggest, financial resources are important for farmers with the decision of self-subsistence or market-oriented production. The farmers' association has their own importance when a financial institution decides to give loans to farmers who belong to these organisation. For this reason, the government has to implement mechanisms of financial support for the plantain sector, particularly when the integration of farmers to the supply and value chains may take long periods, for instance, farmers need to learn the requirements for different markets and adjust their practices, such learning process takes time and may not occur in the short run.

Furthermore, extension services ought not to be only limited only to government agencies, but improving farmers conditions requires creating synergies between rural development organisations, NGOs, and farmers organisations as well. Finally, the result showed a difference in participation related to the gender gap, it is necessary the design better policies for improving female participation and their empowerment in the agricultural sector, as well as enhance awareness of female farmers participation in the markets for plantain.

In summation, the findings of this research are an effort to understand which factors are influencing the farmer's decision in the plantain sector, however, variable selection was limited due to the specific information of the plantain farmers available. For further research, it would be interesting to understand the impact of the relationship of farmers with the middleman or market price information as well as the revenues of farmers for participating in a specific supply chain when having a market-oriented production. Another interesting idea to explore could be to conduct an in-site research project, Rivas

and Masaya can be good candidates according to the results of this research. These interesting issues should be delved into in future studies. Generally, many of the suggestions of this study could be applied to the improvement of farmers' participation in the Nicaragua plantain market.

References

Adesina, A.A. and Chianu, J. (2002) 'Determinants of farmers' adoption and adaptation of alley farming technology in Nigeria', *Agroforestry Systems*, Vol. 55, No. 2, pp.99–112.

Archer, K.J. and Lemeshow, S.A. (2006) 'Goodness-of-fit test for a logistic regression model fitted using survey sample data', *Stata Journal*, Vol. 6, No. 1, pp.97–105.

Arora, A., Bansal, S. and Ward, P.S. (2019) 'Do farmers value rice varieties tolerant to droughts and floods? Evidence from a discrete choice experiment in Odisha, India', *Water Resources and Economics*, Vol. 25, No. 1, pp.27–41.

Ayele, Z.E. (2008) *Smallholder Farmers' Decision Making in Farm Tree Growing in the Highlands of Ethiopia*, Doctoral dissertation, Oregon State University.

Bernard, M., Hellin, J., Nyikal, R.A. and Mburu, J.G. (2010) 'Determinants for use of certified maize seed and the relative importance of transaction costs', *In 2010 AAAE Third Conference/AEASA 48th Conference*, 19–23 September, Cape Town, South Africa (No. 96423), African Association of Agricultural Economists (AAAE).

Cameron, A.C. and Trivedi, P.K. (2005) *Microeconometrics: Methods and Applications*, pp.463–474, Cambridge University Press, New York, USA.

Comisión Económica para América Latina y el Caribe (CEPAL) (2019) *Nicaragua: PERFIL NACIONAL ECONÓMICO* [online] https://estadisticas.cepal.org/cepalstat/Perfil_Nacional_Economico.html?pais=NIC&idioma=Spanish (accessed 19 April 2019).

Davidson, A. (2014) *The Oxford Companion to Food*, OUP Oxford, New York, USA.

Fahad, S., Wang, J., Hu, G., Wang, H., Yang, X., Shah, A.A. and Bilal, A. (2018) 'Empirical analysis of factors influencing farmers crop insurance decisions in Pakistan: evidence from Khyber Pakhtunkhwa province', *Land Use Policy*, Vol. 75, No. 6, pp.459–467.

Food and Agricultural Organization of United Nations (FAO) (2019) *Crops and Livestock Products* [online] http://www.fao.org/faostat/en/#data/TP (accessed 19 April 2019).

Mariano, M.J., Villano, R. and Fleming, E. (2012) 'Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines', *Agricultural Systems*, Vol. 110, No. 7, pp.41–53.

Nicaragua National Institute of Information for Development (INIDE) (2007) *Ficha Platano*, Managua, Nicaragua [online] http://cenida.una.edu.ni/relectronicos/RENF01N583.pdf (accessed 28 March 2019).

Nicaraguan National Institute of Information for Development (INIDE) (2011) *IV National Agricultural Census* [online] http://www.inide.gob.ni/ (accessed 28 March 2019).

Nxumalo, K.K.S., Oduniyi, O.S., Antwi, M.A. and Tekana, S.S. (2019) 'Determinants of market channel choice utilised by maize and sunflower farmers in the North West province, South Africa', *Cogent Social Sciences*, Vol. 5, No. 1, p.1678451.

Panda, R.K. (2012) 'Marketing channel choice and marketing efficiency assessment in agribusiness', *Journal of International Food & Agribusiness Marketing*, Vol. 24, No. 3, pp.213–230.

Pivoto, D., Barham, B., Dabdab, P., Zhang, D. and Talamin, E. (2019) 'Factors influencing the adoption of smart farming by Brazilian grain farmers', *International Food and Agribusiness Management Review*, Vol. 22, No. 4, pp.571–588.

Safi, M.A., Amekawa, Y., Isoda, H., Hassanzoy, N. and Ito, S. (2018) 'Cost-benefit efficiency and factors influencing farmers' choice of marketing channel in grape value chain: evidence from Kabul, Afghanistan', *Journal of the Faculty of Agriculture, Kyushu University*, Vol. 63, No. 1, pp.159–168.

Schipmann, C. and Qaim, M. (2011) 'Supply chain differentiation, contract agriculture, and farmers' marketing preferences: the case of sweet pepper in Thailand', *Food Policy*, Vol. 36, No. 5, pp.667–677.

Siddiq, M., Ahmed, J., Lobo, M.G. and Ozadali, F. (Eds.) (2012) *Tropical and Subtropical Fruits: Postharvest Physiology, Processing and Packaging*, John Wiley & Sons, Oxford, UK.

Smyth, S.J., Phillips, P.W. and Castle, D. (Eds.) (2014) *Handbook on Agriculture, Biotechnology and Development*, Edward Elgar Publishing, Cheltenham, UK.

Tefera, T. (2014) 'Analysis of chickpea value chain and determinants of market options choice in selected districts of southern Ethiopia', *Journal of Agricultural Science*, Vol. 6, No. 10, p.26.

Teferra, B., Yeheyis, L., Nelson, M., Taylor, J., McNaughton, D., Sergeant, A. and Sanders, H. (2019) 'Farmers decisions and determinants of crop rotations with Lupin: the case of West Amhara Region, Ethiopia', *Review of Agricultural and Applied Economics (RAAE)*, Vol. 22, No. 1, pp.24–31.

Ward, P.S., Bell, A.R., Droppelmann, K. and Benton, T.G. (2018) 'Early adoption of conservation agriculture practices: Understanding partial compliance in programs with multiple adoption decisions', *Land Use Policy*, Vol. 70, No. 1, pp.27–37.

Zhang, B., Fu, Z., Wang, J., Tang, X., Zhao, Y. and Zhang, L. (2017) 'Effect of householder characteristics, production, sales and safety awareness on farmers' choice of vegetable marketing channels in Beijing, China', *British Food Journal*, Vol. 119, No. 6, pp.1216–1231.

Notes

1 CEPAL by its acronym in Spanish.