



**Socio-economic Determinants of Adoption of Good Cashew Production Practices in Benin Republic**

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**Abstract**

*This study analysed factors that drive producers' decision to adopt good production practices in cashew production. Data were collected from 395 randomly selected producers from 23 top favourable municipalities (based on criteria such as climate, soil, and disease management) for cashew production in Benin. A multivariate probit regression model was used to estimate the determinants of the adoption of good practices. Findings showed that 70.38% of the cashew producers use firebreaks, 58.23% carried out thinning and 18.48% employed good pest and disease management practices. Overall, the adoption of good agricultural practices in cashew production was negatively influenced by the farm-to-market distance, the sex of the cashew producer and positively correlated with the cashew land size owned; the income from cashew production, membership of a cooperative group,*



*contact with a research agency, participation in agricultural training and perception of good cashew production practices. The pace of adoption of pest and disease management practices is still low yet pests and diseases are one of the major constraints to cashew production. Policies and programs that support cashew production to focus on strengthening the capacities of producers through adequate extension services delivery, and by considering their access to productive resources.*

**Keywords:** Adoption of cashew, cashew good agricultural practices, cashew in Benin

## Introduction

The cashew tree, long considered a forest plant, is now one of the main crops grown by farmers, particularly in the savannahs, which results in an increasingly significant social and economic change in this environment (Kouassi & Kouakou, 2020). Because of its potential for association with food crops, cashew is increasingly participating in a new structuring of the agricultural landscape and is tending to migrate towards a cash crop that contributes to the improvement of the social, economic and living conditions of the farmers who invest in it (Koffi & Oura, 2019). In Benin, cashew is the second most important export crop after cotton (N'kalo, 2018). During the period 2010 to 2018, raw cashew production increased by an average of 8.82% with a peak of about 140,000 tons in 2018 (Ton et al., 2018). Cashew contributes 1.7% to gross domestic product (GDP) and accounts for 4.73% of export earnings (Direction de la Statistique Agricole du Ministère de l'Agriculture, de l'Élevage et de la Pêche (DSA-MAEP), 2021).

Despite the importance of the cashew industry in the local economy, cashew yields remain low. Indeed, nut yields in plantations are around 250 to 400 kg/ha (DSA-MAEP, 2017) while performance is higher in other producing countries in the world where productivity can reach 1500 kg per hectare (N'Djolosse et al., 2019). The relatively low level of productivity of cashew plantations is explained by the adoption of unimproved plant material for the establishment of plantations and unsuitable agricultural practices (Bello, 2018). Other factors limiting cashew productivity are poor management of plantations and failure to follow recommended silvicultural techniques (Lo et al., 2016). Faced with these constraints, the dissemination of good production practices, maintenance of cashew orchards and management of wildfires would make it possible to increase the production of raw cashew nuts (Koffi & Oura, 2019). Similarly, Ouattara (2017) recommended the implementation of specific programmes to intensify the technical training of farmers on good cashew cultivation practices to induce a good perception of these practices and, therefore, their adoption.



Unfortunately, the efforts made to disseminate good cashew production practices have not yet yielded the expected results. In other words, the total application of good agricultural practices by producers is yet to be a reality and the yield of cashew orchards remains low (Houndahouan et al., 2018). This situation is explained, among other things, by the diversity of practices of producers on farms which do not promote the improvement of the productivity of cashew plantations (Ndiaye et al., 2017).

Although several studies have been carried out on cashew both in Benin and in the West African sub-region (Ouattara, 2017; Ton et al., 2018; Koffi & Oura, 2019; Adjobo & Yabi, 2020; Kouassi and Kouakou, 2020; N'Djolosse et al., 2020), they did not refer primarily to the adoption of good cashew production practices and the underlying determinants. This study, therefore, aimed to fill this knowledge gap by answering the following research questions. Are good agricultural practices rooted in the habits of cashew producers? What factors explain the adoption of good practices in the production of cashew trees in Benin? Ultimately, the results of this research will make it possible to develop more effective approaches for disseminating good cashew production practices and thus encourage wider adoption to boost local production and the national economy.

## Methodology

This study was conducted in the 23 municipalities considered favourable areas (based on criteria such as climate, soil, and disease management) for the cultivation of cashew trees in central and northern Benin which is located at latitude 9° 30'S and longitude 2°15'E. These areas produce almost a large proportion of cashew nuts in the country and have benefited for several years from the interventions of projects/programmes, research and public agricultural advisory services focused on the cashew value chain. Most technologies and good practices for cashew production have been disseminated in these areas. These areas include the region of Atacora, Donga, Borgou, Zou, Plateau and Collines (N'djolesse et al., 2020). Altogether, these regions cover around 79,919 km<sup>2</sup> (70% of the national territory), of which about 60% is arable land. The sample size of cashew farmers to be surveyed was determined using Yamane's (1967) formula:

$$n_0 = \frac{N}{(1 + Nd^2)}$$

Where:  $n_0$  is the minimum sample size,  $N$  is the total number of cashew producers at the national level,  $d$  is the desired level of precision. A margin of error of 5% was chosen for this study. Using the formula, a minimum size of approximately 395



cashew producers was obtained. As for the number of cashew producers to be surveyed in each municipality, a proportional stratified sampling was used based on the formula:

$$n_i = \frac{N_i}{N} \times n_0$$

In each municipality, a simple random technique was employed to select cashew producers within villages formed based on the cashew production level. Practically, in each village, a comprehensive list of cashew producers was established with the support of agricultural extension agents working with the cashew producers' cooperatives. Subsequently, cashew producers were numbered from 1 to  $n$ . Depending on the number of producers to be surveyed in the village, the pitch was determined by dividing the number of registered cashew producers by the number of producers to be interviewed.

Data collected include the socio-economic characteristics of the producers, the use of good agricultural practices, reasons for use, the number of years of experience in the use of the good practices, the areas planted with cashew trees and cashew producers' perceptions of good practices. These different primary data were collected through interviews with a structured questionnaire.

### **Estimation of the Determinants of Adoption of Good Agricultural Practices**

The random utility maximization theory was used to model the decisions to adopt good cashew production practices. The theory suggests that cashew farmers choose among several alternatives, the one that gives them the greatest utility. Thus, considering a producer  $i$  who seeks to maximize his level of utility linked to a production system integrating a given good agricultural practice  $j$ , this producer will adopt a given good agricultural practice if his expected level of utility, denoted by  $U_1^*(j)$  is higher than that which he would derive if he had not adopted it, represented by  $U_0^*(j)$ , that is  $U_1^*(j) > U_0^*(j)$ . The utility to be maximized can be represented by the latent variable as follows:

$$U_i = \alpha X_i + \varepsilon_i \text{ With } i = 1, 2, \dots, N$$

With  $\beta$  the vector of parameters to be estimated and  $\varepsilon_i$  the random perturbation.

The study looked at three good agricultural practices (GAPs) that influence cashew yield, namely "thinning", "firebreaks" and "pest and disease management". According to Musafiri et al. (2022), the producer adopts a set of GAPs that will help him increase his expected utility. This assumes that there is an interdependence of the decisions



to adopt each of these good agricultural practices. To test this hypothesis between GAPs in this study, variables designating GAPs were subjected to correlation analysis. It turned out that GAPs are interrelated. To take into consideration the interdependency in decision-making regarding the adoption of GAPs, the multivariate probit regression model was used (Dassoundo-Assogba et al., 2019). This multivariate probit model is an extension of the bivariate probit model (Greene, 2018) which applies Monte Carlo simulation techniques to simultaneously estimate the multivariate probit regression equation system. The joint adoptions for the three GAPs can be modelled by a system of three dichotomous adoption equations  $Y_i$  as follows:

$$\begin{cases} Y_1 = 1 \text{ si } U_1^* > U_0^*, Y_1 = 0 \text{ if otherwise} \\ Y_2 = 1 \text{ si } U_2^* > U_0^*, Y_2 = 0 \text{ if otherwise} \\ Y_3 = 1 \text{ si } U_3^* > U_0^*, Y_3 = 0 \text{ if otherwise} \end{cases}$$

The probability of adoption of GAPs associated with this system is estimated using the multivariate probit regression model to take into account any correlation between the error terms of the different binary adoption equations. The empirical equation of the estimated model with the variables introduced in the estimates is as follows:

$$GAP_j = \alpha_1 ATT_i + \alpha_2 YEAR\_EXPE_i + \alpha_3 AAGRP_i + \alpha_4 \ln REVENAN_i + \alpha_5 COOPE_i + \alpha_6 SEX_i + \alpha_7 TLAND_i + \alpha_8 ACCTER_i + \alpha_9 CREDI_i + \alpha_{10} CONT\_06_i + \alpha_{11} PARTF_i + \varepsilon_i$$

With  $GAP_j$  the dependent variable takes the value 1 if the producer adopts the  $GAP_j$  and 0 otherwise.  $J$  represents good production practices such as thinning, firebreak and pest and disease management.



## Results and Discussion

### Characteristics of Cashew Producers

The socio-economic characteristics of cashew producers (Table 1) show that very few women have adopted good cashew production practices. Cashew producers have limited access to agricultural credit for farm expansion (36%). However, it is noted that adopters (42%) of “pest and disease management” have more access to credit than non-adopters (32%). More than half of the cashew producers (adopters and non-adopters) are educated. In addition, the social capital (cooperative membership, contact with extension and participation in agricultural training) of adopters of good agricultural practices is more developed. About 69% of adopters belong to farmers’ cooperatives against 52% of non-adopters.

The same pattern applies to research contact and participation in the agricultural training. In terms of experience in agricultural production, results show that the respondents have been in cashew production for an average of 16 years. In addition, the number of agricultural workers who constitute the main labour force (family labour) within the households of cashew producers varies on average from six to seven people regardless of the practice considered. In terms of perceptions, the findings indicate that adopters were more favourable to good cashew production practices.



**Table 1: Characteristics of cashew producers**

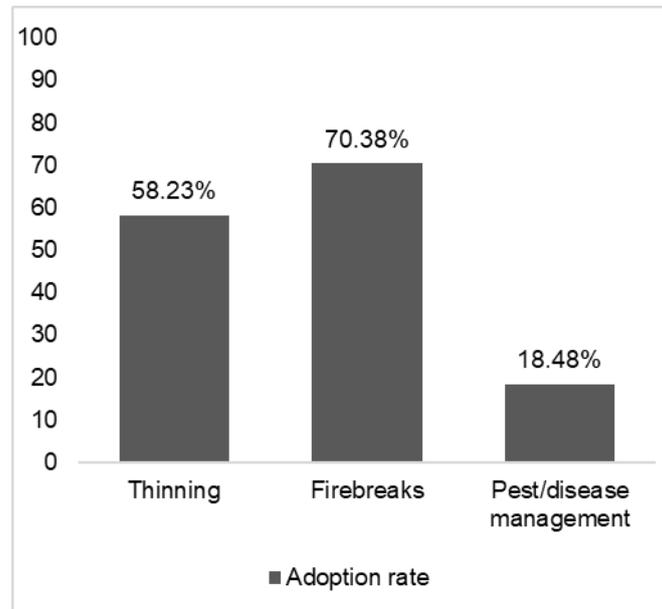
Characteristics	Thinning		t-test	Firebreaks		t-test	Pest/disease management		t-test
	Non-adopter (n=165)	Adopter (n=230)		Non-adopter (n=117)	Adopter (n=278)		Non-adopter (n=322)	Adopter (n=73)	
Sex (% female)	7.27	7.83	0.04	3.42	9.35	4.13***	8.07	5.48	0.57
Formal education	61.21	57.83	0.46	57.26	60.07	0.7	57.45	67.12	2.30
Type of farmer (<2ha)	41.82	46.52	0.86	41.88	45.68	0.48	41.61	57.53	6.11
Access to agricultural credit (% Yes)	30.91	36.09	1.15	33.33	34.17	0.026	31.99	42.47	2.92*
Cooperative membership (% Yes)	49.09	68.70	15.45***	49.57	65.11	8.32***	57.14	75.34	8.25***
Contact with Research	22.42	34.35	6.59***	22.22	32.37	4.09**	24.84	49.32	17.18***
Participation in agricultural training	65.45	80.87	11.99***	64.10	78.78	9.32***	70.50	91.78	14.17***
Farm-to-market distance	13.50	11.7	1.17	14.89	11.43	2.09**	12.08	14.11	-1.04
Cashew production experience	16.67	16.89	-0.24	18.09	16.25	1.85*	16.88	16.41	0.40
Number of agricultural workers	6.22	6.59	-0.833	6.32	6.49	-0.36	6.54	5.96	1.06
Income from cashew	12.64	12.75	-1.10	12.81	12.66	1.47	12.70	12.73	-0.25
Perceptions of GAP	2.78	3.29	-6.34***	2.08	3.22	-11.13***	2.53	3.15	-3.54***

Source: Field data, 2020

### Adoption of Good Agricultural Practices in Cashew Production

Cashew producers who used good agricultural practices during the year preceding the data collection were considered adopters of GAPs. Findings revealed a high adoption rate (70.38%) for firebreaks and a low adoption rate (18.48%) for pest and disease management practices. About 58% of them practice thinning (Figure 1). The high adoption of firebreaks may be due to the multi-beneficial effect of the practice. Firebreaks help cashew farmers in retarding fires that could cause extensive damage (Muthee et al., 2021). Besides, compared to thinning and pest and disease management practices which are implemented in the rainy season, firebreaks are created during the dry season, when other agricultural activities have decreased (Bassett et al., 2018). However, the effectiveness of this practice depends on how the trees are managed (Duguma, et al., 2021). This also integrates pest and disease management practices which recorded low adoption among cashew producers. Yet, pest and disease occurrence in cashew orchards is still one of the major constraints

faced by cashew growers (Thushyanthini & Sanotharan, 2018 and Kandeegan & Mahendran, 2019).



**Figure 1: Adoption of good agricultural practices**

Source: Field data, 2020

### Determinants of the Adoption of Good Agricultural Practices

The farm-to-market distance had a negative influence on the adoption of thinning ( $\alpha = -0.009$ ) and firebreaks ( $\alpha = -0.014$ ). The farther producers' farms are from their town market, the less they practice good cashew production practices. Teno et al. (2018) had shown that the distance between home and farm can make it difficult and/or expensive to transport certain inputs to the farm. In addition, this distance can limit producers' access to labour and, therefore, a high cost to carry out thinning and firebreak operations. The negative effect of farm-to-market distance on technology adoption was also noted by Adekambi et al. (2021) while analysing the factors that drive the adoption of integrated soil fertility management measures in northern Benin.

The sex of the cashew producer negatively influences the adoption of the firebreaks ( $\alpha = -0.58$ ) in cashew plantations. This shows that women are more willing to adopt new technologies than men. Mushagalusa (2019) have shown that women market gardeners were more likely to try innovative techniques for sustainable market gardening. On the other hand, the type of producer (large producer vs small



producer) as determined and defined by the size of the cashew plantations has a positive and significant influence on the adoption of good cashew production practices. The larger the area of the cashew plantation cultivated by the producer, the greater the likelihood of adopting firebreak ( $\alpha = 0.34$ ) and pest/disease management ( $\alpha=0.42$ ) Indeed, producers with large areas of cashew can afford to allocate part of their plantations to experimenting with new technologies which, if successful, can lead to adoption (Issoufou et al., 2017; Udimma et al., 2017) and thus improve the yield of orchards and therefore maximize their profit (Ullah et al., 2018). For Gebre et al. (2019), an increase in the size of the earth increases the probability of adopting new technologies.

Also, belonging to a group of cashew producers positively influences the adoption of thinning. Belem (2017) asserted that membership in a peasant cooperative group offers members the opportunity to observe the practices of other members in a sociocultural context that fosters solidarity and the pooling of production resources. Furthermore, the supportive interactions between producers can have a ripple effect that can lead to the adoption of good cashew production practices (Gebre et al., 2019). Similarly, farmers' organizations are developing initiatives aimed at increasing the exposure and facilitating the use of agricultural technologies (Sarr Diouf et al., 2018). For Hermans et al. (2017), peasant or professional organizations serve as formal and informal networks for the dissemination of information and, in turn, affect the adoption of agricultural technologies.

Moreover, the contact of cashew producers with research agencies fosters the adoption of good production practices such as thinning ( $\alpha=0.27$ ;  $p < 0.1$ ) and the management of pests and diseases ( $\alpha=0.46$ ;  $p < 0.01$ ). When farmers are in contact with research agencies, they have easy access to information on new technologies and benefit from closer supervision (Ullah et al., 2018). Knowledge and innovation play a crucial role in helping farmers address their agricultural challenges. Farmers occupy a central position in the agricultural knowledge and information system (AKIS), enabling them to improve the effectiveness of the use of new technologies and practices through learning and capacity building, through their contact with various actors including research, extension, and universities etc. (Urhibo, 2021). These findings are in line with those obtained by Adekambi et al. (2021) and Adechian et al. (2020). Furthermore, cashew producers' participation in agricultural training positively and significantly determines their adoption of the pest and disease management practice ( $\alpha=0.48$ ). In other words, training in agriculture improves the knowledge of producers in cashew production and raises their awareness of the problems related to the management of pests and diseases of this crop (Balasha and Fyama, 2020; Allahyari et al., 2017).



Finally, the perception of good agricultural practices increases the likelihood of cashew producers to adopt thinning, ( $\alpha=0.80$ ) firebreaks ( $\alpha=0.702$ ); and the management of harmful pests and diseases ( $\alpha=0.18$ ). Indeed, producers are more likely to adopt good agricultural practices if they believe they will improve their cashew production system. A producer's ability to understand the benefits of GAPs can influence his perception (Teno et al., 2018).

**Table 2: Determinants of GAPs adoption**

Variables	Thinning	firebreaks	pest management
Farm-to-market distance	-0.009**	-0.014***	0.003
Sex	-0.171	-0.586*	-0.015
Formal education	-0.138	0.086	0.166
Type of farmer	0.017	0.335**	0.423**
Cashew production experience	-0.006	-0.0141	-0.008
Number of agricultural workers	0.005	0.009	-0.024
Income from cashew	0.029	-0.322	-0.059
Cooperative membership	0.310**	0.257	0.131
Access to agricultural credit	0.079	-0.114	0.160
Land access	-0.074	0.050	-0.089
Contact with Research	0.265*	0.239	0.463***
Participation in agricultural training	0.164	0.244	0.476*
Perceptions of GAP	0.802***	0.721***	0.178***
Constant	-2.654**	2,890***	-1.352
Number of sightings		395	
Wald chi (39)		178.74***	

Source: 2020 Field Data

### Conclusion and Recommendations

Factors that influence the adoption of good agricultural practices in cashew production include the farm-to-market distance, the sex of the producer, the size of



the farm (cashew nut area), membership of a cooperative, contact with agricultural research, participation in agricultural training and producers' perception of good cashew production practices. Strengthening the capacities of cashew producers and the use of effective channels for the transmission of the least asymmetrical information, in particular the proximity of extension and research services, should be favoured in the process of disseminating agricultural technologies and innovations. Ultimately, policy changes may, therefore, be needed to target innovations tailored to small producers and increase their access to factors of production.

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The authors declare that no conflict of interests existed for this study.

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### Authors' contributions

LCH: Conceived, coordinated data collection, and supervised the entire research process

AOAA: Supervised field work, and analysed data

ST: Wrote the original draft of the manuscript

EARO: Contributed in editorial work of the manuscript

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