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| RESEARCH ARTICLE

Determinants of small farmers' integration and agricultural yield in inclusive business models: Insights from the cocoa sector in Côte d'Ivoire

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| ABSTRACT
This paper examines the factors influencing the integration of smallholder farmers and their agricultural yields within inclusive business models (IBs). The Heckman two-stage selection method was used for the analysis. The first-stage results showed that the farmer's age, household size, possession of a Tax Declaration of Existence, and association membership were determinants of smallholders' probability of being integrated into IBs. Concerning the second stage, the number of working days, gender (male), and the farmer's experience had a positive and significant influence on agricultural yield.

| KEYWORDS
Inclusive business models, smallholder farmers, agricultural performance, cocoa sector.

| ARTICLE INFORMATION
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1. Introduction

IB models are implemented by multinational companies in the "Base of the Pyramid" (BoP) markets of developing countries (Ranjatoelina, 2019). This concept aims to generate positive development impacts through a financially sustainable business model. According to the UNDP (2008), IB models include the poor on the demand side as customers and on the supply side as employees, producers, and business owners in the value chain. IBs seek to create employment opportunities and generate income for groups such as local communities with low education levels, youth, people with disabilities, and other vulnerable populations. These business models typically target the low-income segment of the market, with the main goal of enhancing the living standards of the poor (Dos Santos de Sousa Teodósio and Comini, 2012).

Based on the global poverty line of USD 1.25, Dia and Ahouré (2023) found that 76% of the population at the BoP in Côte d'Ivoire were poor. The incidence of poverty in the BoP was highest in agriculture (78%), followed by construction (77%) in the country. In value chains, the poorest were non-permanent employees (84%), followed by raw material suppliers (79%). Individuals at the BoP were mainly integrated into IBs through the agricultural sector, especially those involved in raw material procurement.

Almost all cocoa in West Africa is produced by smallholder farmers, many of whom are poor (Fountain & Hütz-Adams, 2018). Côte d'Ivoire is the world's largest cocoa producer. The concept of inclusive entrepreneurship was developed by Syracuse University's Whitman School of Management and the Burton Blatt Institute in 2008, when a startup project for people with disabilities was created. The concept has since evolved to include marginalised groups (Pilková et al., 2016). Inclusive business integrates the most disadvantaged and vulnerable populations, known as the "Base of the Pyramid - BoP," into its value chain as consumers, producers, or distributors. IBs serve as a means to offer shared value propositions in West Africa to support cocoa farmers and address concerns about an insufficient supply of cocoa beans (Odijie, 2018).

The transaction cost approach developed by Coase (1937) and Williamson (1979, 1971) provides a framework for studying vertical integration across sectors. Vertical coordination involves coordinating markets, contracts, and ownership (Frank & Henderson, 1992). Contracting is the main form of vertical coordination mechanism that enables smallholder farmers to

participate in agri-food value chains (Bolwig et al., 2009; Otsuka et al., 2016). It falls between spot market transactions (0% vertical coordination) and full vertical integration (100% vertical coordination). Its main goal is to reduce constraints related to limited access to credit, market imperfections, and high transaction costs (Bellemare, 2012).

This research aims to identify the key factors affecting integration and agricultural yield among small cocoa farmers in IBs in Côte d'Ivoire. It will include a review of relevant literature, the methodology employed, the analysis results, and the interpretation of those findings.

2. Theoretical review

2.1. Inclusive Entrepreneurship/Inclusive Business model

The concept of inclusive entrepreneurship was developed by Syracuse University's Whitman School of Management and the Burton Blatt Institute in 2008, when a startup project for people with disabilities was created. The concept of inclusive entrepreneurship has evolved to include marginalised groups (Pilková et al., 2016). IBs integrates the most disadvantaged and vulnerable populations, known as the "Base of the Pyramid - BoP", into its value chain as consumers, producers, or distributors. IBs are a way to offer shared value propositions and integrate poor or low-income communities into value creation processes.

2.2. Inclusive Business Models in Agro-Industry

The IB concept offers benefits over traditional business methods. Since the approach focuses on profitability, it requires little or no public funding (Wach, 2012). Companies practising IB model have, among other things, intricate partnerships with low-income smallholders and communities by integrating them into agricultural or commercial value chains. These companies provide income-generating opportunities to their partners and are recognised as empowering smallholders and communities. The idea of inclusive agribusiness is mainly realised through contract farming models in the Global South (Chamberlain & Anseeuw, 2017).

Many frameworks have been proposed to assess the impact of IBs, including the Rockefeller Impact Reporting and Investment Standards (IRIS), the Oxfam Poverty Footprint methodology, and the INSEAD Economic Footprint approach. Impact evaluations should be conducted under two circumstances, according to Khandker et al. (2010): (i) the program intervention is innovative and of strategic importance, or (ii) the impact evaluation exercise contributes to the lack of knowledge about what works and what does not. Given the relatively new nature of IBs (Ashley, 2009), their scale, and the numerous new initiatives, measuring their impact is necessary.

3. Empirical review

3.1. Vertical Coordination Mechanisms and Farm Performance

Trifkovic (2016) examined the effect of vertical coordination options (contract farming and vertical integration) on farm performance, measured by yields and income per hectare. The findings indicated that farms with vertical integration achieve significantly higher yields and income per hectare compared to non-integrated farms. Abdul-Rahaman and Abdulai (2020) investigated the factors influencing smallholder participation in vertical coordination mechanisms and their effects on farm performance, using a multinomial BFG model (developed by Bourguignon, Fournier, and Gurgand, 2007) to address selection bias from observed and unobserved characteristics. Their results showed that participation in vertical coordination was affected by access to credit, mobile phone ownership, labour, membership in farmer associations, sales to institutional buyers, market perception, and the significance of legal contracts. Engagement in written and verbal contracts within smallholder production transactions enhanced agricultural outcomes such as net farm income, total farm income, and labour productivity.

According to Chamberlain and Anseeuw (2017), the concept of inclusive agribusiness is mainly implemented through contract farming models in the Global South. Several studies suggest that contract farming could improve farmers' efficiency by offering, among other things, better knowledge and inputs (Ramaswami et al., 2006). Since contract farmers are generally not a random sample of the population, they may differ from the broader population in ways that also impact yields. They might differ in observable characteristics, such as farm size or education level, and/or in unobservable traits, like intelligence. Standard regression analysis can control for the effects of observable characteristics, but to account for bias from unobservable traits, methods such as a Heckman selection model or an instrumental variable model can be employed.

Chiapo (2017) analysed rice contract farming in Côte d'Ivoire. Compared to rice farmers without formal education, those with a lower secondary education level were more likely to participate in rice contract farming, with a marginal effect of 22%. Additionally, Bidzakin et al. (2019) identified education level and rice field size as positive factors influencing participation in contract farming in Ghana. Elepu (2015) employed the two-stage Heckman method to account for selection bias in farmers' participation in contract farming in Uganda. The first-stage probit regression model results showed that contract participation was positively related to group membership. In the second stage, farm size, access to extension services, and farmer age were

other factors affecting farmers' profits. Simmons et al. (2005) studied farmers involved in contract farming of poultry, maize seed, and rice seed in Indonesia. They found that poultry contracts and maize seed contracts resulted in improved returns on capital, whereas no significant impact was observed for rice seed. The contracts contributed to increased income and welfare.

3.2 Determinants of agricultural yield

Agricultural yield is influenced by a range of factors, including environmental, biological, management, socioeconomic, technological, policy, institutional, and economic factors, as well as climate change.

Niang et al. (2017), in their analysis of variability and determinants of yields in rice production systems of West Africa, showed that high rice yields were linked to high solar radiation, high maximum temperatures, moderate air humidity, multiple split nitrogen (N) fertiliser applications, frequent weeding, use of certified seeds, and well-levelled fields in the irrigated lowland system. However, Tanko et al. (2016) demonstrated that yield is positively related to the prices rice producers receive and the availability of labour. This may be due to increased farmers' purchasing power and the ability of labour to maximise output with minimal resource activities.

Kangogo et al. (2024) highlighted that the gender of the household head influences the level of production. Gebre et al. (2021) observed that male-headed households tend to produce more maize than female-headed ones. Female-headed households often face limited access to productive resources such as land. Furthermore, farmers with more experience in the sector tend to be more knowledgeable, enabling them to mitigate risks and capitalise on opportunities for improved outcomes. Kwambai et al. (2023) also noted that experienced farmers possess greater knowledge about production methods, which leads to increased yields.

4. Methodology

4.1. Presentation of Data

The data used are primary survey data collected as part of the International Development and Research Centre project on "Economic inclusion of youth and women through inclusive entrepreneurship: the case of Burkina Faso, Ivory Coast and Kenya". These data were collected through a survey conducted between February and May 2019 in Ivory Coast according to a quasi-experimental protocol. The primary data are cross-sectional and consider the year 2018.

Table 1: Description of variables

Variables of model (1) of integration in IBs	Description
Gender	Discrete (Male = 1, Female = 0)
Household size	Continuous
Junior high school certificate (first cycle of secondary studies)	Discrete (Yes = 1, No = 0)
Secondary school diploma (the baccalaureate)	Discrete (Yes = 1, No = 0)
Age of the farmer	Discrete (18 to 35 years old = 1, 36 years old and over = 0)
Membership of an association	Discrete (Yes = 1, No = 0)
Possession of a Tax Declaration of Existence	Discrete (Yes = 1, No = 0)
Father's professional category	Discrete (Farmer = 1, If not = 0)
Southern Region	Discrete (Yes = 1, No = 0)
South-East Region	Discrete (Yes = 1, No = 0)
Central-West Region	Discrete (Yes = 1, No = 0)
Western Region	Discrete (Yes = 1, No = 0)
Eastern Region	Discrete (Yes = 1, No = 0)
Variables of model (2) of agricultural yield	
Log of production yield (kg/ha)	Continuous
Number of working days (annual)	Continuous
Farmer's experience	Discrete (1 to 5 years = 1; 6 to 10 years = 2; 11 to 15 years = 3; 16 to 20 years = 4; 21 years and over = 5)
Gender	Discrete (Male = 1, Female = 0)
Innovation in logistics methods	Discrete (Yes = 1, No = 0)
Mobile rainfall application	Discrete (Yes = 1, No = 0)
Technical training	Discrete (Yes = 1, No = 0)
Household size	Continuous
Junior high school certificate (first cycle of secondary studies)	Discrete (Yes = 1, No = 0)
Secondary school diploma (the baccalaureate)	Discrete (Yes = 1, No = 0)

Source: Author's calculation, from the CAPEC-IDRC Database (2019)

The sample comprised 323 small cocoa farmers at BoP, including 119 IBs beneficiaries and 204 non-beneficiaries of an IB model. The classification used to categorise smallholders is based on FAO (2018, 2013) and Lécole (2021). FAO (2013) describes smallholders as small farmers managing areas ranging from less than 1 hectare to 10 hectares. However, according to FAO (2018), the thresholds for identifying smallholder food producers in the selected countries, such as Côte d'Ivoire (2008), indicated an area of 11.00 ha. For the analysis, smallholders with farm sizes ranging from 1 ha to 11 ha were considered.

4.2. Specification of The Two-Stage Heckman Model

As the farmers integrated into IB models were not a random sample, the Heckman (1979) selection model was appropriate. Some characteristics of the sampled population could not be observed due to selection problems. According to the Heckman selection model, the participation equation can be specified as follows:

$$P_r(Z_i = 1 \mid w_i, \alpha) = \Phi\,(h(w_i, \alpha)) + \varepsilon_i \quad (1)$$

Where Z_i is an indicator equal to unity for smallholders' beneficiaries of IBs; Φ is the standard normal cumulative distribution function; w_i is a vector of factors affecting IBs integration; α is a vector of coefficients to be estimated; and ε_i is the error term assumed to be normally distributed with zero mean and variance σ^2. The variable Z_i takes the value 1 if the marginal utility that farmer i derives from participating in IBs is greater than zero, and zero otherwise. The equation is therefore:

$$Z_i^* = \alpha w_i + v_i \quad (2)$$

Where Z_i^* is the latent level of utility that the farmer derives from its integration, $v_i \sim$ N(0,1) and,

$$Z_i = \begin{cases} 1\ if\ Z_i = 1\ if\ Z_i^* > 0 \\ 0\ if\ Z_i = 0\ if\ Z_i^* \leq 0 \end{cases} \quad (3)$$

In the second step, the Inverse Mills Ratio (IMR) will be added as a regressor in the farm yield function to correct for potential selection bias. The coefficient vector α is estimated by the probit via maximum likelihood estimation (MLE), usually using an exclusion restriction (only farmers integrated in IBs are included in the second step), and then to estimate the IMR:

$$\hat{\lambda} = \frac{\varphi(h(w_i,\hat{\alpha})}{\Phi(w_i,\hat{\alpha})} \quad (4)$$

Where Φ(.) is the normal probability density function. The equation for the second step is then given by:

$$\mathrm{E}(Y_i \mid Z = 1) f(X_i, \beta) + \gamma\ \frac{\varphi(h(w_i,\hat{\alpha})}{\Phi(w_i,\hat{\alpha})} \quad (5)$$

With *E* the operator of what is expected, *Y* is the extent (continuous) of the yield level, *X* is a vector of independent variables affecting yield and β is the vector of corresponding coefficients to be estimated. Y_i can be expressed as:

$$Y_i = \beta' X_i + \gamma\hat{\lambda} + v_i \quad (6)$$

Where $\mu \sim$ N(0,δ_μ), Y_i^* is only observed for participants in IBs (Z_i=1), in this case Y_i=Y_i^*.

5. Results

The sample comprises 36.84% smallholder farmers who are beneficiaries of IBs and 63.16% who are non-beneficiaries, distributed across five (05) regions of Côte d'Ivoire: South (16.72%), South-East (5.88%), Centre-West (68.73%), West (5.88%), and East (2.79%).

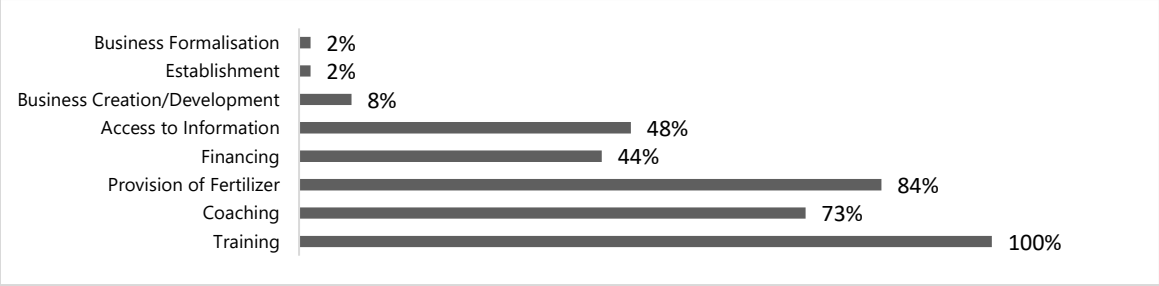
Table 2: Descriptive statistics

		IBs beneficiaries		Non-beneficiaries		Total	
		N	%	N	%	N	%
Gender	Male	104	87.39	180	88.24	284	87.82
	Female	15	12.61	24	11.76	39	12.18
Age of the farmer	18 to 35 years old	53	44.54	72	35.29	125	39.92
	36 years and over	66	55.46	132	64.71	198	60.08
Junior high school certificate	Yes	18	15.13	16	7.84	34	11.48
	No	101	84.87	188	92.16	289	88.52
Secondary school diploma	Yes	1	0.84	7	3.43	8	2.14
	No	118	99.16	197	96.57	315	97.86
Membership of an association	Yes	66	55.46	91	44.61	157	50.04
	No	53	44.54	113	55.39	166	49.96
Possession of a Tax Declaration of Existence	Yes	19	15.97	2	0.98	21	8.47
	No	100	84.03	202	99.02	302	91.53
Farm size	1 to 5 ha	111	93.28	193	94.61	304	93.94
	6 to 10 ha	8	6.72	10	4.90	18	5.81
	11 ha	0	0.00	1	0.49	1	0.49
Total		119	36.84%	204	63.16%	323	100

Source: Author's calculation, from the CAPEC-IDRC Database (2019)

The full sample is mainly composed of male smallholders (88%), with women accounting for only 12%. On average, smallholders were not young; only 45% of IBs beneficiaries were 35 years old or younger, compared to 35% of non-beneficiaries. The average age of the entire sample was 42 years. On average, 15% and 8% of farmers had a first-cycle diploma, respectively, for beneficiaries and non-beneficiaries. The proportion of farmers with a secondary school diploma was even lower, at only 1% for small farmers at BoP Integrated in IBs. Typically, small farmers who are members of an association participated in IBs (55%) more than non-beneficiaries (45%). 16% of beneficiaries held a Tax Declaration of Existence compared to 1% of non-beneficiaries. 94% of the BoP farmers in the sample farmed on land ranging from 1 to 5 hectares. In terms of capital structure, more than three-quarters (86%) of these smallholders owned 100% of the capital of their farm, with the remaining being co-owners holding at least 50%. Regarding support provided to IB beneficiaries, all (100%) received training. The second and third most important types of support were the supply of fertilisers (84%) and coaching (73%).

Figure 1: Types of support provided to IBs beneficiaries



Source: Illustration by the author, from the CAPEC-IDRC database (2019)

Furthermore, the smallholders were generally experienced. The average number of years of experience was 15 for the full sample. Participants in IBs had an average of 17 years of experience.

Table 3 : Years of farmer's experience

Integration in IBs	1 to 5 years	6 to 10 years	11 to 15 years	16 to 20 years	21 years and over
Beneficiaries	8.40%	17.65%	26.05%	26.05%	21.85%
Non-beneficiaries	10.78%	27.45%	24.02%	19.12%	18.63%
Total	9.91%	23.84%	24.77%	21.67%	19.81%

Source: Author's calculation, from the CAPEC-IDRC Database (2019)

Beneficiaries achieved an average yield of 861 kg/ha in 2018, surpassing the full sample (758 kg/ha) and non-beneficiaries (698 kg/ha) in the study. The yield of BoP's farmers integrated into IBs was 22% higher than that of non-beneficiaries.

5.1. Determinants of smallholders' probability of being integrated in IBs

The results of the marginal effects for the Probit model estimation are presented in *Table 4*. They revealed that the age of the farmer, household size, possession of a Tax Declaration of Existence, and membership in an association were determinants of smallholders' integration probability in IBs. For smallholders, being young (18 to 35 years old) increased integration into IBs by 12%. Increasing the household size by one member influenced their probability of being integrated into IBs by 3.4%. This could imply that larger households have more available and affordable family labour for their farming activities (Akumu et al., 2020). Farm formalisation is a key factor, as possessing a Tax Declaration of Existence increased a farmer's integration into IBs by 56%. Lastly, belonging to an association also increased integration by 13%. These findings were consistent with those of Bellemare (2012) and Abdul-Rahaman and Abdulai (2020) regarding membership in an association. Membership in a farmer group allows farmers to access agricultural information and benefit from enhanced opportunities.

Table 4: Determinants of smallholders' probability of being integrated in IBs

	(1)	(2)
	Probit	Marginal effects dy /dx
Age of the farmer	0.316*	0.120*
	(0.165)	(0.063)
Household size	0.090***	0.034***
	(0.026)	(0.010)
Junior high school certificate (first cycle of secondary studies)	0.320	0.124
	(0.255)	(0.108)
Secondary school diploma	-0.962	-0.274
	(0.596)	(0.111)
Membership of an association	0.341**	0.128**
	(0.156)	(0.058)
Possession of a Tax Declaration of Existence	1.640***	0.557***
	(0.406)	(0.088)
Gender	-0.164	-0.063
	(0.241)	(0.095)
Father's professional category	0.095	0.035
	(0.236)	(0.086)
South Region	0.392	0.203
	(0.543)	(0.151)
South-East Region	0.044	0.067
	(0.601)	(0.178)
Centre-West Region	-0.007	0.046
	(0.531)	(0.134)
West Region	-0.131	-0.048
	(0.612)	(0.237)
East Region	-	
Constant	-1.403**	
	(0.583)	
Wald chi2	23.47**	
Observations	323	323

Source: Author's estimates, from the CAPEC-IDRC Database (2019) /
*Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*

The results from the second stage of the Heckman model will be presented subsequently.

5.2. Determinants of agricultural yield among smallholders participating in IBs

The estimated Mills ratio coefficient is statistically significant at the 5% level, as required by the two-step Heckman model. The Ordinary Least Squares (OLS) regression was estimated and found to be unbiased, as it incorporated the inverse Mills ratio, a term correcting for selection bias. The positive and significant coefficient of the inverse Mills ratio confirmed that the agricultural yield of smallholder beneficiaries of IBs was, on average, higher than that of non-beneficiaries.

Findings indicated that the number of working days, gender (male), and experience had a positive and significant influence on the agricultural yield of IBs beneficiaries. When the number of working days increased by one day, the yield increased by 0.4%, all other factors being equal. Regarding the experience of smallholders, a one-year increase in experience - specifically for the categories of 16 to 20 years and 21 years and above - resulted in improved agricultural yields of 65% and 79%, respectively. Regarding the effect of gender (being male), Rico et al. (2023) also noted that gender influences farmers' performance. This could be due to the predominance of men working in agriculture. Studies conducted in Uganda, Malawi, and Senegal observed little or no participation of women farmers in various contract farming schemes. One reason could be that women are excluded from contractual agreements with private investors due to their limited direct access to land and control over productive resources (Schneider & Gugerty, 2010).

Table 5: Determinants of agricultural yield among smallholders participating in IBs

	(1)
	OLS
Gender	0.558*
	(0.312)
Number of working days	0.004**
	(0.002)
Household size	0.042
	(0.035)
Junior high school certificate	0.294
	(0.298)
Secondary school diploma	-1.689
	(1.038)
Farmer's experience (6 to 10 years)	0.588
	(0.405)
Farmer's experience (11 to 15 years)	0.482
	(0.375)
Farmer's experience (16 to 20 years)	0.651*
	(0.376)
Farmer's experience (21 years and over)	0.789**
	(0.395)
Innovation in logistics methods	0.188
	(0.190)
Mobile rainfall application	0.209
	(0.460)
Technical training	0.028
	(0.639)
Lambda (Mills ratio)	0.694**
	(0.300)
Constant	3.127***
	(0.795)
Wald chi2	23.47**
Observations	119

Source : Estimations de l'auteur, à partir de la Base de données CAPEC-CRDI (2019) /
*Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

In this analysis, the level of education had no effect, while the farmer's experience had a positive and significant impact on agricultural yield. This positive effect of experience could stem from farmers' improvement in production skills over the years. These skill enhancements might be linked to the training received through IBs programmes. This finding aligns with other authors (Lawal et al., 2013 and Okoli et al., 2015), including Okam et al. (2016), who reported that more experienced farmers possessed better production skills, leading to higher agricultural productivity.

6. Conclusion

The findings of this analysis revealed that the number of working days, gender (male), and experience had a positive and significant influence on the agricultural yield of smallholder farmers integrated in IBs. These smallholder farmers at the BoP level had higher agricultural yields than non-beneficiaries. As part of this business partnership, the IBs provided various supports to participating smallholder farmers, including training, provision of fertilisers, coaching, and financing. IBs are an important tool that should be promoted and implemented to ensure increased cocoa production while reducing poverty among BoP's smallholder farmers in the country.

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