Scientific Research Publishing

Open Journal of Business and Management, 2026, 14(2), 1148-1164
https://www.scirp.org/journal/ojbm
ISSN Online: 2329-3292
ISSN Print: 2329-3284

Agribusiness Clusters, Contract Farming, and Tomato Producers' Income in Benin

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How to cite this paper: Dohou, M. D., Adjibi, C., Amadou, Z., & Yabi, J. A. (2026). Agribusiness Clusters, Contract Farming, and Tomato Producers' Income in Benin. *Open Journal of Business and Management, 14,* 1148-1164.
https://doi.org/10.4236/ojbm.2026.142066

Received: February 1, 2026
Accepted: March 16, 2026
Published: March 19, 2026

Abstract

While many studies have separately examined the role of agribusiness clusters and contract farming in shaping farmers' performance, empirical evidence on their joint association with farmers' income remains limited, particularly in the context of vegetable value chains in West Africa. This study analyzes the combined association between agribusiness cluster membership and participation in formal contract farming and the net income of tomato producers in Benin, measured in XOF per hectare. The analysis draws on primary data collected from 237 tomato producers selected through cluster random sampling and relies on Ordinary Least Squares (OLS) regression. Results from Model 1 (without covariates) indicate a positive and statistically significant association between the interaction of cluster membership and contract farming and net income ($p < 0.01$). When controlling for observable characteristics in Model 2, the interaction term remains positive but is only marginally significant ($p = 0.055$). The findings suggest that collective organization through agribusiness clusters and engagement in formal contracting arrangements are jointly associated with higher income levels. The study highlights the potential role of coordinated institutional arrangements in supporting smallholder livelihoods and discusses policy implications for strengthening advisory services, producer organizations, and inclusive contracting schemes within tomato value chains in sub-Saharan Africa.

Keywords

Market, Value Chain, Vegetable, OLS, Africa

1. Introduction

In West Africa, the rate of moderate or severe food insecurity has risen sharply, from 54.2% in 2019 to 68.3% in 2020 (FAO, 2021). Moreover, nearly one third of the region's 62 million children under five years of age are stunted, an indicator of overall nutritional status and 47% of children aged 6 to 59 months suffer from vitamin A deficiency (AGVSA, 2018). In Benin, only 25% of young people have a diversified diet, and 91% of the population lacks access to balanced nutrition. Although overweight and obesity remain rare, the country faces a double burden of malnutrition at all levels. The situation of children under five is particularly alarming, with one third stunted and 58% of women affected by anemia (AGVSA, 2018). For decades, governments have overlooked the importance of vegetable production, prioritizing cereals, cash crops, and legumes in their strategies to combat food and nutrition insecurity (Pingali & Sunder, 2017).

Yet, vegetables are a key component of a healthy diet and play a vital role in addressing micronutrient deficiencies as well as overweight and obesity (Tsiboe et al. 2019). Vegetables provide essential vitamins, minerals (potassium, calcium, sodium, magnesium, and phosphorus), trace elements (iron, copper, zinc, and selenium), and other antioxidants. Specifically, folates (folic acid) reduce the risk of birth defects, vitamin A supports eye and skin health, and vitamin C helps maintain oral health and enhances iron absorption (Schreinemachers et al., 2018). Minerals generally lower the risk of cardiovascular diseases, maintain hair and skin, and regulate blood circulation, while trace elements strengthen the immune system. From an economic perspective, vegetable production represents a significant source of income for producers and other value chain actors, including processors and traders (Galmarini, 2018). From an environmental standpoint, vegetable production contributes to sustainability through the adoption of agroecological practices and reduced food transport distances. It is also crucial for dietary diversification and the rehabilitation of urban wetlands (Drottberger et al., 2021; Moinard et al., 2021).

However, several constraints hinder to limit vegetable production and consumption, including limited access to improved seeds, credit, storage facilities, market information, and the impacts of climate change (Raaijmakers et al., 2019). Postharvest losses remain a major issue, largely due to handling challenges and the perishable nature of produce, leading to losses estimated between 15% and 50% in SubSaharan Africa (FAO-CIRAD, 2021). These constraints often result in market failures, characterized by non-competitive prices where marginal benefits do not align with marginal costs.

To address such market failures, the promotion of Agribusiness Clusters (ABC) has emerged as a key approach in many countries. An ABC refers to a group of farmers, wholesalers, and institutions engaged in the same agricultural or agro-industrial subsector, who interact and build value networks to tackle shared challenges and pursue common opportunities (Galvez-Nogales, 2010). Agribusiness clusters foster collaboration, market access, information sharing, and strengthen the bargaining power of smallholder farmers. They also create employment and

income opportunities within and around their regions (Wardhana et al., 2017).

Issahou & Sodjinou (2024) found that agribusiness clusters promote contract farming adoption by enhancing farmers' understanding of contracts, improving trust among stakeholders, and increasing smallholders' use of recommended soybean production practices making them more attractive to buyers. Similarly, Dureti et al. (2023), using largescale survey data from 3,969 Ethiopian farming households, demonstrated that clustered agriculture significantly improves smallholder commercialization and serves as an effective policy instrument. Regarding the impact of contract farming on income, most studies confirm that farmers engaged in contract schemes experience higher earnings (Nguyen et al., 2015; Chen & Chen, 2021; Ruml et al., 2022). Nevertheless, the literature provides only limited empirical evidence on how the interaction between agribusiness cluster membership and contract farming arrangements shapes farmers' income outcomes. To fill this gap, the present study analyzes the joint effect of contract farming and cluster participation on farmers' income using Ordinary Least Squares (OLS) regression.

This study is aligned with the strategic orientations of the Government of Benin as defined in the Programme d'Actions du Gouvernement (PAG), particularly Strategic Axis 4, which focuses on accelerating economic growth, and Pillar 2, which aims to pursue the structural transformation of the economy, with one of its core objectives being the sustainable improvement of farmers' incomes. At the regional level, this research is also consistent with ECOWAS priorities, notably Pillar 4 on inclusive and sustainable transformation and development, as well as Strategic Objective 4, which seeks to promote the integration of smallholder farmers into structured markets and agricultural value chains. The remainder of the document is structured as follows: theoretical background, data and methods, results and discussion, and conclusion.

2. Theoretical Background

The agency theory, formulated by Jensen & Meckling (1979), examines contractual relationships between two parties, typically referred to as the principal and the agent. It is based on the idea that cooperation may be compromised when the interests of the actors diverge. Three main sources of conflict are identified: information asymmetry, which gives an advantage to the better-informed party; divergent interests, which encourage opportunistic behavior; and coordination problems arising during the implementation of contracts.

In the agricultural sector, this theory has been widely used to analyze contract farming. It highlights potential tensions between the principal (buyer or organization) and the agent (producer), as well as the mechanisms that can help secure and stabilize these relationships. Contract farming offers several advantages. For producers, it provides access to inputs and production services, credit, technologies, and ensures fixed prices and reliable markets (Eaton & Shepherd, 2001). For buyers, it guarantees secured supply chains, standardized quality, risk-sharing, and facilitates the dissemination of improved agricultural inputs. As a result, these contracts

generate positive effects on farmers' productivity and income (Tefera & Bijman, 2021). Moreover, agricultural contracts go beyond technical aspects. They can be used as instruments for structuring value chains and agrifood systems. Contracts help reduce intermediaries, achieve economies of scale, and improve both the quantity and quality of products (Goodhue, 2011; Poussy, 2019). However, their effectiveness depends on how well they are adapted to the type of crop, the objectives, and the actual capacities of producers (Gramzow et al., 2018).

Beyond contractual relationships, agricultural clusters play a key role in shaping collective action, coordination, and learning processes among producers. Cluster membership facilitates information sharing, trust building, and joint decision-making, which can reduce transaction costs and enhance producers' ability to comply with contractual requirements. In this sense, clusters and contract farming can be viewed as complementary institutional arrangements: while contracts address vertical coordination between producers and buyers, clusters strengthen horizontal coordination among producers.

Agency theory suggests that agricultural clusters and contract farming are complementary institutions, as clusters lower coordination and enforcement costs while contracts reduce market and price uncertainty, jointly strengthening income outcome.

Several studies have also highlighted the role of agricultural clusters in promoting contract farming (Issahou & Sodjinou, 2024; Dureti et al., 2023; Endalew et al., 2024). By combining collective organization with formal market arrangements, clusters may enhance the effectiveness of contract farming by mitigating information asymmetries, improving bargaining power, and reducing enforcement problems.

The conceptual model presented below (**Figure 1**) illustrates the relationships between contract farming, agricultural cluster membership, and tomato producers' income, while incorporating socioeconomic characteristics (age, education level, gender, access to credit, experience, etc.) as control variables likely to influence these relationships. Building on the notion of institutional complementarity, the framework explicitly considers the interaction between cluster membership and contract farming. Based on this framework, the study formulates the following hypothesis: Contract farming and agricultural cluster membership have a positive and significant effect on tomato producers' income.

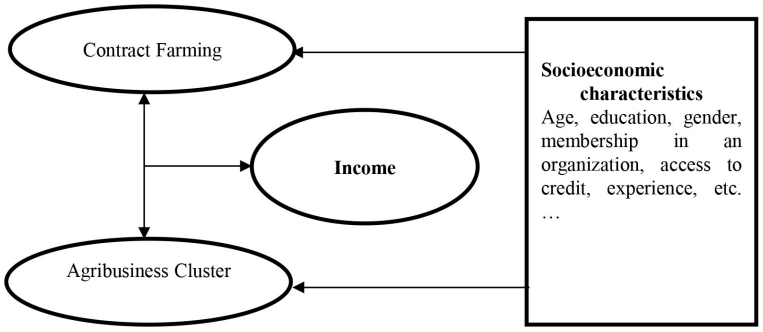

Figure 1. Analytical framework of the research.

3. Data and Methods

3.1. Study Area

The study was conducted in the main vegetable-producing regions of the Central and Southern parts of Benin Republic, where vegetable cluster activities are the most dynamic. The municipalities covered by the study belong to five departments that are heavily involved in vegetable production. In the Atlantique department, the study includes the municipalities of Allada, Calavi, Ouidah, and Tori-Bossito, areas characterized by their proximity to the Cotonou market and their key role in supplying fresh vegetables to urban consumers. The department of Couffo is represented by Aplahoué and Klouékanmè, two municipalities where vegetable farming constitutes a major source of income for rural households. In the Collines department, the study focuses on Dassa, Bantè, Glazoué, and Savalou, which are major centers for tomato and off-season vegetable production. The Zou department includes Abomey, Bohicon, Ouinhi, Zagnanado, and Zogbodomey, areas where vegetable clusters are already well structured around local cooperatives. Finally, the Littoral department is represented by the Cotonou municipality, which combines peri-urban production with a large consumer market. In total, the study covers 15 municipalities across five departments, representing a diversity of agricultural and socioeconomic contexts. These areas are distinguished by their dynamic vegetable sector, the strong organization of producers, and the presence of strategic market actors, particularly in the tomato value chain. Figure 2 shows the map of the study area.

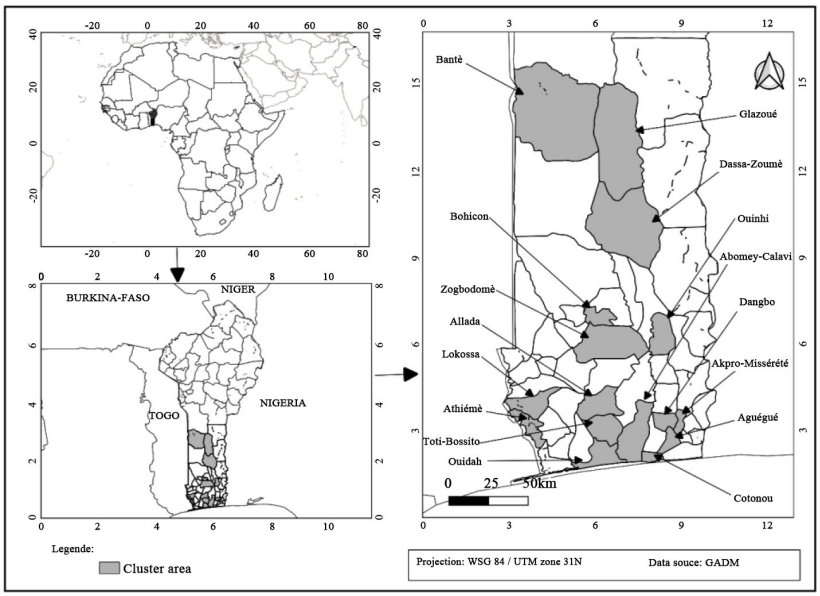

Figure 2. Study area.

3.2. Sample Size and Data

The sampling unit selected for the study is the tomato producer who is a member of a cooperative. The adopted sampling technique is cluster sampling, where clus-

ters are defined based on whether or not producers belong to an agricultural cluster. Accordingly, two main groups were formed: producers who are members of a cluster and those who are not. In each municipality, seven (07) producers integrated into a cluster were selected. The number of non-cluster producers varies slightly from one municipality to another (between 8 and 10), bringing the total number of producers per municipality to 15 to 17. The overall sample consists of 237 producers, including 105 cluster members and 132 non-cluster members. The selection of individuals within each cluster was carried out randomly from the sampling frame. For beneficiaries (cluster members), the selection was made from the list of producers (around a dozen per municipality). As for non-beneficiaries (non-cluster members), they were randomly selected from other members of the same cooperatives who had not received project support. Thus, both beneficiary and non-beneficiary producers belong to the same cooperatives, which ensures better comparability between the two groups. Primary data were collected in line with the study objectives and formulated hypotheses and include both quantitative and qualitative information. The data gathered cover the socio-economic characteristics of respondents (age, gender, education level, farming experience, farm size, household size, access to credit, access to extension services, etc.), household assets (motorcycle, phone, car, house, etc.), as well as information related to contract farming, the cost of seeds, fertilizers, pesticides, labor, and loan interest. Data were collected using a structured questionnaire, which was designed, digitized, and administered through the KoboCollect mobile application to vegetable farmers who are active members of the selected cooperatives.

3.3. Analytical Method

To assess the joint effect of cluster membership and contractual arrangements on net income from tomato production, a multiple linear regression model was estimated by ordinary least squares (OLS). The use of this method is justified by the continuous quantitative nature of the dependent variable, namely the net income of tomato producers, expressed in XOF. Net farm income from tomato production was computed at the plot level and standardized in XOF per hectare (ha) as the difference between gross revenue and production costs, divided by the area cultivated with tomatoes. Gross revenue was calculated as the product of harvested quantities and selling prices observed at the time of sale. Production costs include variable expenses (inputs, fuel, water fees, land rental, and hired labor) and fixed costs (permanent labor, loan interest, and straight-line depreciation of agricultural equipment). Family labor, including mutual aid, was valued using standardized labor units and converted into monetary values using the prevailing local daily wage.

The main explanatory variables of interest are membership in an agricultural cluster and participation in contractual farming, both specified as binary variables. In this study, contractual farming refers exclusively to formal written contracts established between producers and buyers, specifying agreed-upon condi-

tions related to product delivery and commercialization. Assuming that producer-specific characteristics combined with cluster membership and contractualization (Xi) influence income levels (Ri) of tomato producer *i*; the linear income function can be written as follows:

$$R_i = \alpha_0 + \alpha X_i + \varepsilon_i \quad (1)$$

The empirical specification of the model is given by the following equation:

$$\begin{aligned} R_i = {} & \alpha_0 + \alpha_1 AGE + \alpha_2 EXP + \alpha_3 SHARI + \alpha_4 SUP + \alpha_5 ACCEST \\ & + \alpha_6 ACV + \alpha_7 CREDIT + \alpha_8 CONTRACT * CLUSTER \\ & + \alpha_9 CONTRACT + \alpha_{10} CLUSTER + \varepsilon \end{aligned} \quad (2)$$

where:

R_i : denotes the net income from tomato production;

α_0 : is the intercept;

α_8 : is the coefficient associated with the interaction effect between contractualization and cluster membership;

$\alpha_1 \cdots \alpha_{10}$: are the coefficients associated with each covariate;

ε : is the error term.

To ensure the robustness of the analysis, two models were estimated: one without covariates (Model 1), capturing the unconditional associations between income, cluster membership, and contractualization, and another with covariates (Model 2), controlling for producers' socio economic and production characteristics. The inclusion of these controls helps mitigate potential omitted variable bias, improves the precision of the estimated coefficients, and enhances the internal validity of empirical strategy. It also contributes to reducing unexplained variance among the main variables (Wang et al., 2022; Suela et al., 2025). All regressions were estimated using heteroskedasticity-robust standard errors to account for potential heteroskedasticity in the error terms. The multicollinearity was assessed using Variance Inflation Factor (VIF) tests. The mean VIF is 2.25, and all individual VIF values remain well below the conventional threshold of 10, indicating no serious multicollinearity concerns. All explanatory variables included in the model are described in **Table 1**.

Table 1. Variables potentially used as covariates.

Variable	Code	Nature	Expected sign	Justification
Age of respondent	**AGE**	**Continuous**	**+/−**	(Adegbola & Adekambi, 2010) (Kinyangi, 2014)
Experience in vegetable production	**EXP**	**Continuous**	**+/−**	(Wu, 2022) (Paul et al., 2017)
Share of income (out of 10) from vegetable farming	**SHARI**	**Continuous**	**+**	(Carrer et al., 2017) (Ai et al., 2023)

Continued

Cultivated area (hectare)	SUP	Continuous	+/−	(Dovonou et al., 2021)
Inheritance as land access mode	**ACCEST**	**1 = Yes 0 = No**	**+**	(Yabi et al., 2016) (Sandjiry, 2025)
Access to agricultural extension services	**ACV**	**1 = Yes 0 = No**	**+**	(Danso-Abbeam, 2022) (Kifle et al., 2022)
Access to formal credit	**CREDIT**	**1 = Yes 0 = No**	**+**	(Makate et al., 2019) (Ansah & Skevas, 2024)

4. Result

4.1. Socio-Economic Characteristics

Cluster members and contract farmers tend to be younger (35.6 and 35.2 years on average, respectively) and better educated (around eight years of schooling) than non-members and non-contract farmers (about 40 years old and five years of schooling). Access to credit is also much higher among them: 29.52% of cluster members and 14.47% of contract farmers have access to formal credit, while more than 95% and 90%, respectively, benefit from agricultural advisory services, compared with less than half among their counterparts. In addition, 75.24% of cluster members and 78.95% of contract farmers belong to a cooperative or association, compared to only 21.97% and 29.81% among non-members and non-contract farmers. Conversely, non-members and non-contract farmers are slightly more experienced in vegetable production (around 10 years) and cultivate somewhat larger plots (about 0.55 - 0.57 ha) than their counterparts. Land access patterns remain similar across groups, with roughly 60% of farmers cultivating inherited land. Table 2 presents the socio-economic characteristics of vegetable producers according to their membership in an agricultural cluster and their participation in contract farming.

Table 2. Socio-economic characteristics of respondents.

Variables	Agricultural Cluster		Contract Farming	
	Non-membership (N = 132)	**Membership (N = 105)**	**No (N = 161)**	**Yes (N = 76)**
Access to formal credit (%)	**3.79**	**29.52**	**15.53**	**14.47**
Inheritance as Land access mode (%)	**59.09**	**60.95**	**59.01**	**61.84**
Access to agricultural advisory services (%)	**46.21**	**95.24**	**57.14**	**90.79**
Purchase inputs collectively within the cooperative (%)	**21.97**	**75.24**	**29.81**	**78.95**
Age (years)	**40.40 (10.10)**	**35.58 (10.65)**	**39.73 (10.79)**	**35.17 (9.53)**
Experience in vegetable production (years)	**10.42 (6.20)**	**7.85 (9.34)**	**10.27 (8.43)**	**7.18 (5.92)**

Continued

Share of income (out of 10) from vegetable farming	6.01 (1.88)	5.8 (1.93)	5.81 (5.81)	6.14 (1.69)
Cultivated area (hectare)	**0.57** **(0.60)**	**0.46** **(0.447)**	**0.55** **(0.39)**	**0.47** **(0.76)**
Education (Years of schooling completed)	**4.34** **(4.77)**	**7.6** **(6.27)**	**4.74** **(5.04)**	**7.98** **(6.4)**

4.2. Income from Tomato Production

The results indicate significant differences in tomato production income between producers according to their participation in agricultural clusters and contract farming arrangements. Farmers who are members of an agricultural cluster earn on average 4,911,796 XOF/ha, compared to 3,037,201 XOF/ha for non-members, with the difference statistically significant at the 1% level ($p = 0.0007$). Similarly, producers engaged in contract farming generate a much higher average income 5,927,928 XOF/ha than non-contract farmers, whose income averages 3,214,480 XOF/ha ($p = 0.0000$). These findings clearly suggest that both cluster participation and contractual arrangements are associated with a substantial improvement in farmers' revenues, likely due to better access to inputs, technical assistance, and market opportunities offered through collective organization and formalized marketing channels. Table 3 shows the average income from tomato production by cluster membership and contract farming status.

Table 3. Income from tomato production in XOF/ha.

Variables	Agricultural Cluster		Contract Farming	
	Non-membership (N = 132)	Membership (N = 105)	No (N = 161)	Yes (N = 76)
Income in XOF/ha	3,037,201 (305,722)	4,911,796 (518,250)	3,214,480 (287,443)	5,927,928 (742,452)
p-value	0.0007		0.0000	

Standard errors are reported in brackets.

4.3. Joint Effect of Contractualization and Cluster Membership on Income

Table 4 reports the estimated associations between contract farming, cluster membership, and net tomato income per hectare from two OLS specifications: (1) a model without covariates and (2) an extended model including control variables such as age, experience, farm size, income share, land access, agricultural advice, and access to credit. The R-squared values indicate that the model explains a modest but non- negligible share of income variation among tomato producers. Specifically, Model 1 explains 11.6% of the variation in net income, while the inclusion of socioeconomic and farm-level controls in Model 2 increases the explanatory power to 15.9%. The relatively low R squared values are expected in cross-

sectional micro-level income regressions, where substantial heterogeneity across households and unobserved factors explain a large share of income variation. These values are consistent with previous studies on agricultural income studies (Maertens & Swinnen, 2009; Bellemare, 2012) and suggest that institutional arrangements play a meaningful role in explaining income differentials.

An analysis of the results from the two models provides several insights into the influence of agricultural cluster membership and contract farming on tomato producers' income. In the first model, which excludes covariates, the coefficient of the interaction between cluster membership and contract farming is positive and statistically significant. Producers who are both members of an agricultural cluster and engaged in contract farming earn, on average, approximately 3,417,357 XOF per hectare more than non-participating producers ($p < 0.01$). This result indicates a strong positive association between joint participation in clusters and contracts and higher income levels, potentially reflecting improved access to market information, collective input procurement, and more efficient coordination of sales.

In the extended model including covariates, the coefficient of the interaction between cluster membership and contract farming is positive and statistically significant, with an average increase of 3,396,245 XOF/ha. This slight reduction in magnitude suggests that part of the income premium is explained by observable characteristics, but the persistence of the effect point to a robust association that is not fully explained by these controls.

Among the control variables included in Model 2, only the share of household income derived from vegetable farming shows a positive and statistically significant association with net income ($p < 0.05$). This finding suggests that a higher degree of economic specialization in vegetable production is associated with higher net returns from tomato farming. Other variables such as age, experience in vegetable production, cultivated area, land inheritance, access to extension services, collective input purchasing, and access to formal credit do not show statistically significant effects. This indicates that, conditional on cluster membership and contractualization, these characteristics contribute relatively little to explaining income variation within the sample.

Overall, the results provide strong evidence that the joint participation in agricultural clusters and contract farming arrangements substantially increases net income from tomato production. This finding highlights the importance of integrated market-oriented institutional arrangements, which appear to generate income gains beyond individual farmer characteristics.

Table 4. Determinants of income from tomato production.

	Model 1: Without covariates			Model 2: With covariates		
	Coefficient	Standard Error	P > z	Coefficient	Standard Error	P > z
Agricultural Cluster (Yes)*Contract Farming (Yes)	3,417,357	880,010	0.000	3,396,245	1,757,000	0.055

Continued

Contract Farming (Yes)	-	-	-	−577272.4	1,504,649	0.702
Agricultural Cluster (Yes)	-	-	-	345630.5	852942.2	0.686
Age of respondent (years)	-	-	-	−24613.62	30356.46	0.419
Experience in vegetable production (years)	-	-	-	−19465.37	39134.15	0.620
Share of annual income (out of 10) from vegetable farming	-	-	-	298455.9	161716.1	0.067
Cultivated area (hectare)	-	-	-	49255.24	517186.9	0.924
Inheritance as land access mode (Yes)	-	-	-	−901547.4	597650.1	0.133
Access to agricultural extension services (Yes)	-	-	-	645539.1	738101.3	0.383
Purchase inputs collectively within the cooperative (Yes)	-	-	-	−19812.17	730126.7	0.978
Access to formal credit (Yes)	-	-	-	−150301.8	818249.1	0.854
Constante	3,184,244	275,875	0.000	2,634,799	1,688,641	0.120
	Number of observations = 234 F(1,188) = 15.08 Prob > F = 0.0001 R-squared = 0.1156			Number of observations = 237 F(9,230) = 3.06 Prob > F = 0.0097 R-squared = 0.1590		

5. Discussion

The results indicate that the combined effect of cluster membership and contractual arrangements is positively associated with tomato producers' income. This outcome reflects a strong complementarity between collective production dynamics and market-based contractual coordination. Cluster membership facilitates producer networking, access to information, resource sharing, and the diffusion of technical and managerial innovations, while contractual arrangements help secure market outlets and reduce price uncertainty. Together, these mechanisms enhance producers' capacity to plan production activities, lower transaction costs, and improve compliance with quality requirements. This complementarity highlights the structuring role of collective organizations in the governance of agricultural value chains. In contexts characterized by market fragmentation and weak vertical coordination, the joint use of collective action through clusters and contractual coordination emerges as an important institutional lever for improving farm income sustainability. This result is consistent with Bellemare (2012) and Mishra et al. (2024), who emphasize that collective arrangements, when supported by inclusive contractual mechanisms, help reduce information asymmetries, strengthen trust among actors, and enhance the economic resilience of farming households.

Cluster membership on its own is also positively and significantly associated with farmers' income. This finding suggests that clusters enhance access to market

information and business opportunities, allowing producers to commercialize their output more efficiently after harvest. Endalew et al. (2024) similarly found a positive and statistically significant effect of agricultural clustering on teff commercialization. Likewise, Zeleke and Wordofa (2024) showed that cluster-based commercialization is associated with higher profits, as farmers selling through organized networks benefit from better market conditions. Consistent evidence is also reported by Gidelew et al. (2025), who found that cluster participation is associated with higher household income, and by Jr Tabe-Ojong & Dureti (2023), who documented positive correlations between cluster membership, total household income, and per capita income.

Contract farming further exhibits a positive and significant association with the income of tomato producers participating in clusters. By securing sales after harvest and stabilizing farmgate prices, contractual arrangements reduce market risks and income volatility. Arouna et al. (2021) show that well-designed contract farming schemes strengthen vertical coordination, improve productivity, and increase farmers' income, thereby contributing to broader rural transformation. Similarly, Girma & Gardebroek (2015) found that contractual honey supply arrangements significantly increased beekeepers' incomes by linking them to international markets and premium prices. Earlier evidence from Miyata et al. (2009) and more recent findings by Hoang (2021) further confirm that contract farming can enhance smallholders' income, market access, and long-term economic well-being.

Access to agricultural extension services is also positively associated with income among tomato producers integrated into clusters. Extension services provide farmers with technical knowledge and market-oriented information that can improve both production efficiency and commercialization outcomes. In line with this, Danso-Abbeam et al. (2018) documented positive income effects from participation in agricultural extension programs implemented by the Association of Church Development Projects (ACDEP). Similarly, Cawley et al. (2015) reported that sustained engagement with extension services has a statistically significant positive impact on farm income.

Despite these findings, some limitations should be acknowledged. Better-connected farmers may be more likely to self-select into clusters or contractual arrangements, which could lead to upward-biased OLS estimates. However, the cluster-randomized design, baseline balance tests, and the inclusion of a comprehensive set of control variables help mitigate this concern. The results should therefore be interpreted as conditional associations rather than strictly causal structural effects. Another limitation is that the sample is restricted to cooperative-affiliated tomato producers, which may limit the external validity of the findings for non-organized farmers operating outside collective structures.

6. Conclusion

Our results indicate that both cluster membership and contractualization are positively and significantly associated with producers' income. These effects remain ro-

bust after controlling for socio-economic characteristics, while the share of household income derived from vegetable production emerges as a key driver of income performance. Beyond their individual effects, the findings suggest that the combination of collective organization through clusters and market coordination via contracts constitutes a particularly effective income-enhancing mechanism. In the Beninese context, characterized by fragmented markets, high price volatility, and limited bargaining power of smallholder clusters facilitate access to information, inputs, and collective services, while contractual arrangements secure market outlets and reduce commercial uncertainty. Together, these mechanisms strengthen producers' capacity to capture value along the tomato value chain. From a policy perspective, the results point to the need for integrated support strategies that jointly promote farmer organization and contractual market linkages. Public and donor-supported programs in Benin should move beyond isolated interventions by (i) strengthening existing producer clusters through targeted capacity building in collective marketing and negotiation, and (ii) facilitating formal contractual arrangements between clusters and downstream actors such as wholesalers, processors, and institutional buyers. In addition, public agencies could play a brokerage role by supporting standardized contract templates, dispute-resolution mechanisms, and price-setting frameworks adapted to local market conditions. Such policies would directly leverage the complementarities identified in this study and enhance the income-stabilizing effects of both clusters and contracts.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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