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Drivers of Farmers' Contract Compliance Behavior: Evidence From a Case Study of Dangote Tomato Processing Plant in Northern Nigeria

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ABSTRACT

Contract farming is a viable strategy agribusinesses rely on to strengthen coordination across actors in the value chain. However, low contract compliance remains a significant setback to agribusinesses' contract performance in low- and middle-income country context. This study aims to identify what drives smallholder farmers' contract compliance behavior in northern Nigeria. Qualitative information was collected through focus group discussions to enrich the design of the survey questionnaire administered to a sample of 300 randomly selected farmers contracted by the Dangote Tomato Processing Plant in four regions of northern Nigeria. Novel transaction-level data of tomato sales covering one season were collected in addition to socio-economic information of the sampled farmers. Probit model results show that open fresh market tomato prices and payment delays negatively affect farmers' compliance behavior while education level, bonuses, land ownership, and resource-provision correlated positively with compliance. The study suggests that contract compliance could improve if contracting firms devise a reliable and timely payment plan (e.g., digital payment), continuing input and service provisions (e.g., improved seeds, extension services), and incentives (e.g., loyalty rewards, bonuses) in the contract.

JEL Classification: L24, O13, O55, Q12

1 | Introduction

Contract farming (CF) is postulated to enhance the performance of agricultural markets and remove market imperfections in developing economies (Olomola 2010). The use of CF become increasingly necessary for firms and farms to position themselves well in the global value chains (Ifeoma and Agwu 2014; Kumar et al. 2018; Luh 2020). CF allows agribusinesses to secure raw material inputs of suitable quality and minimize yield and/or price risks associated with food production (Bellemare and Lim 2018). It enables farmers also to benefit from enhanced welfare and productivity (Mishra, Shaik, et al. 2018), stable income (Barrett et al. 2012; Bellemare 2010; Tefera et al. 2020), and access to services and productive resources (Cai and Ma 2015; Fehr et al. 2009; Luo et al. 2013). CF minimizes transaction costs that farmers may face due to risks and uncertainties (Mishra, Shaik, et al. 2018), as farmers can obtain necessary inputs and sell their outputs to the contracted firm directly and promptly, thereby avoiding the need to search for suitable markets. However, most contracting firms continue to suffer from low compliance from smallholders. Thus, this paper analyses the drivers of smallholder contract compliance behavior.

CF is particularly essential for perishable agricultural commodities such as milk, fruits, and vegetables that require fast and efficient transactions in selling products in suitable markets (Jia and Bijman 2013). This is more relevant in LMICs with weak market and/or marketing infrastructure. For example, Nigerian farmers producing perishable products, such as

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tomatoes, are being constantly pinned down by excess harvest losses due to a lack of guaranteed market and storage facilities (Ugonna et al. 2015); volatility in prices (Kitinoja et al. 2019) and market failure (Ochieng et al. 2017; Tijani et al. 2010; Ochilo et al. 2018). Over 50% of tomatoes produced by farmers cannot make it to the market due to excessive harvest losses (Issahaku 2012; Plaisier et al. 2019). However, most contracted farmers find it easy to break the contract and sell to traders who offer them a price that is slightly higher than the contract price (Adepetu 2012; Arah et al. 2015).

In 2016, the Dangote Tomato Processing Plants (DTPP) was established as the largest and only functional processing plant in Northern Nigeria. It provides over 10,000 contractual opportunities to farmers annually. The contract has a guaranteed fixed price, which transfers most of the risks to DTPP and provides farmers with access to hybrid seedlings; technical and extension services (Kutawa 2016). However, most farmers ended up selling a substantial quantity of the contracted tomatoes outside the contract, which affected DTPP's performance in the domestic market (Jeremiah 2020).

Although Adamu (2021) and Branthome (2021) note that the firm faces some challenges ranging from erratic supply of tomatoes locally, destruction of vast areas of tomatoes from pests during 2017, disputes with farmers over payments, ban on importing tomatoes for processing and high overhead cost. However, breach of contract has been the most notable challenge the firm faces over the years, despite the threat of contract termination for such behavior. As a result, DTPP struggles to operate at 20% capacity of its potential of 1200 metric tons per day, thereby creating losses and undermining the government's focus on boosting local production and reducing dependence on imports.

Given this backdrop, the overarching question that this study aims to answer is "What drives farmers' contract compliance behavior?" This is because breaching contracts by farmers is a major issue in CF in developing economies, and drivers for such behavior vary widely (for details, please see next section). Literature also suggests that contract compliance is quite low for small farmers. The present study is based on a random sample of 300 tomato farmers contracted by DTPP spread over four areas of northern Nigeria.

The study contributes to the existing literature investigating contract compliance behavior in the following ways. First, to the best of the researcher's knowledge, the study is the first to use transaction-level data of tomato sales covering one season to measure contract compliance and investigate its determinants. This entails actual recording of multiple transactions made by individual contracted farmers with DTPP covering one tomato growing season, which clearly provides an accurate record of sales. This is a major improvement as opposed to studies in the literature, which either relied on aggregated data or self-reported surveys that may be misleading and/or unable to accurately determine the actual amount of sales made to the contracted firm. Second, based on the review of literature, a wide range of drivers expected to influence contract compliance behavior, either positively or negatively were used (e.g., Robinson et al. 2012; Fathelrahman et al. 2017; Saenger et al. 2013; Meemken and Bellemare 2019; Ton et al. 2018; Vassalos & Li 2016). And third, the study uses a mixed method approach, by conducting Focus Group Discussions (FGDs) with tomato farmers first to inform the design of the questionnaire of the farmers' survey as well as lending support to explain the results from the econometric model.

The paper is organized as follows. Section 1 presents the background, rationale, and objectives of the study. Section 2 provides a review of pertinent literature to identify drivers of farmers' compliance behavior for use in the econometric model. Section 3 presents the methodology. Section 4 presents the results. Section 5 concludes and draws policy implications.

2 | Farmer's Compliance Behavior and Drivers: A Review of Literature

2.1 | CF and Smallholder Farmers

CF has become increasingly important for all actors along the agrifood chains, and it has been largely acknowledged by the Agricultural Economics literature as the dominant strategy adopted by processing companies to source high-quality raw materials (Hoang and Nguyen 2023). There is a general consensus in the literature that smallholders who are critical stakeholders in the agrifood sector, remain major beneficiaries of CF, as they benefit from stable income, reduced uncertainties, enhanced production efficiency, and access to resources and services (Bellemare 2018; Bellemare and Lim 2018; Bidzakin et al. 2020; Dubbert 2019; Kumar et al. 2023; Luh 2020; Mishra, Joshi, et al. 2018; Xie et al. 2023). CF also lowers the use of chemical fertilizers among farmers and addresses environmental degradation issues (Mishra, Joshi, et al. 2018), enhances the adoption of food safety at the farm level (Kumar et al. 2018). Thus, it Is postulated that CF enhances the performance of agricultural markets and removes market imperfections (Olomola 2010).

However, several issues and challenges are associated with CF. For instance, the positive effect of CF on smallholder's income is echoed in Bellemare (2015) and Kumar et al. (2023, 2020, 2018). This was contested by Escobal and Cavero (2012) who argued that CF marginalizes smallholder farmers. This is because farmers who have more land are better educated and well organized and, therefore, able to deal with the complexities of contractual arrangements better. As a result, smallholder farmers, although receiving increased income to some extent, suffer from unequal distribution of earnings, thereby generating a more polarized small-farmer economy.

Moreover, parties involved in CF arrangements may also be at risk of being exploited by one another (Lu et al. 2017). For example, Kariuku and Loy (2016) and Mishra et al. (2022) observed that farmers may not have full autonomy and flexibility to market changes; large firms may prey on them by shifting production risks to them and take advantage of their cheap labor, and they may face problems with contract terms like price, quantity, delivery time, and payment among other things due to uneven farmer – firm relationship. Similarly, contracting firms may face hold-up problems from farmers,

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high transaction costs in managing a huge number of farmers and in seeking alternative (Cai and Ma 2015).

2.2 | Drivers of Farmers' Contract Compliance Behavior

Although firms rely heavily on CF to secure high-quality products, they continue to struggle with farmer's contractual breach, which greatly affect firm's performance (Cai and Ma 2015). Literature indicates that contractual breach among farmers is inevitable. Farmers are naturally opportunistic and do not take contracts seriously, finding breaching contracts to be easy (Zhang and Aramyan 2009). For instance, Luo et al. (2013) and Kumar et al. (2013) observed that open market price created unanticipated rent to the contracting firms, as most farmers are willing to break contract for a better price. Similarly, in Ghana, Robinson et al. (2012) observed that if a market for fresh tomatoes exists, contracted farmers will always have the option to break the contract for a better price of their produce, even if it is profitable to comply with the contract. This attitude may disrupt farmer – firm relationship, lowers firm's motivation for specialty investment, and affect processed food supply, which threatens the fragile food security situation (Luo et al. 2013). Fathelrahman et al. (2017) found that transport costs, payment delays, and lack of delivery schedule negatively affect farmers' compliance to agreement. However, contractual provisions like resource provisions, extension, and technical services enhance farmers' compliance (Luh 2020).

Some studies observed that incentive instruments such as bonus, penalties, and premia are critical determinants of smallholder compliance. For example, Saenger et al. (2013) examined the effect of incentive instruments (price penalty and bonus) on dairy farmers' commitment to contract compliance and found that a low price penalty for the supply of low-quality input pushes farmers to perform better while a bonus payment enhances a consistent supply of high-quality input. Luo et al. (2013) Investigated the effect of incentive instruments (penalty and rebate) on low contract compliance rates among Chinese grain farmers and concluded that, compared to not offering incentives, rebate and penalty reasonably increases smallholders' contract compliance. Cai and Ma (2015) found evidence that resource–provision correlated positively with the farmers' choice of the proportion of output to be supplied to the contracting firm. Similarly, Ruml and Qaim (2020a) and Bidzakin et al. (2020) found a positive association between resource provisions and contract compliance among farmers. Moreover, cooperative membership and socioeconomic endowments, such as education, wealth, and land size are observed to influence compliance (Lu 2007; Meemken and Bellemare 2019; Ton et al. 2018; Vassalos & Li 2016). Kumar et al. (2013), in their investigation of factors influencing contractual fulfillment among organic basmati paddy farmers in India, found that a bonus clause introduced into a contract is likely to promote contract fulfillment among the contracted farmers.

Rosch and Ortega (2019) investigated differences in willingness and opportunity to accept contracts between farmers in and out of Kenya's French bean supply market and found evidence that farmers use price premiums as an indicator of buyer reliability. They concluded that where formal enforcement is impossible, price premiums could imperfectly enforce contracts.

Repar et al. (2018) explored challenges associated with the sustainability of contract arrangements along the paprika supply chain in Malawi. They use focus groups and interviews to collect information from supply-chain stakeholders, and found that most contracts suffer from side-selling and often fail because of the price premium offered by the parallel markets, which offers farmers a more profitable option to sell outside the contract.

Moreover, transaction costs and their characteristics were also observed to affect smallholder contract compliance. These costs vary with contract type, and they include monitoring, bargaining, and information costs (Vishnu and Dsouza 2020). For example, Escobal and Cavero (2012) examined the distributional effect of lowering the transaction costs to allow access to improved market opportunities for small farmers in the Peruvian Highlands and found that choosing where to transact is influenced by the proportion of transaction costs (notably transportation cost). Similarly, Cai and Ma (2015) investigated the impact of trust and transaction costs on farmers' contract compliance choices. They found a negative association between distance to delivery place and contract compliance choice. However, they found that proximity to the main road tends to have positive and statistically significant impacts on contract compliance choice. Osebeyo and Aye (2014) examined the impact of transaction costs and other institutional and socioeconomic factors on smallholder tomato farmers' marketing decisions. They found that transport cost and market distance correlate with farmers' choice of marketing channel during harvest. Key et al. (2000) found that transportation costs and time spent delivering the products to the market affect contract compliance.

Furthermore, resource provision potentially affects smallholder contract compliance. Ruml et al. (2021) used cross-sectional survey data to examine the association between CF and income in the Ghana palm oil sector. They found that although farmers with both marketing and resource-providing contracts have a significantly higher income, farmers with only resource-providing contract arrangements have a notably higher income difference. The implication is that farmers under resource-providing contracts are likely to perform better.

Farmers' socioeconomic endowments also play a key role in contractual commitments. Guo et al. (2007) evaluated contract performance based on farmers' acceptance, informed by farmers' perceived incentive to engage in contracts in China. They found that contract acceptability is uncorrelated with the educational level of the farmer.

Tefera et al. (2020) examined the determinants of quality performance under marketing arrangements among smallholder barley farmers in Ethiopia and found that farmers' level of performance or commitment to quality improvement is positively associated with their educational attainment.

Although the above studies identified several factors that drive contract compliance or breach, the main limitation of these

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studies is the use of either aggregated data or self-reported survey responses that may be misleading and/or unable to identify farmers' reasons for breaching contracts accurately. To circumvent such weakness, the present study uses novel transaction-level data recording each sale to accurately measure contract compliance.

2.3 | Conceptual Model of Smallholder Contract Compliance Behavior

Based on the review of the above literature, a conceptual model was developed that underpins this study. Contract compliance in the context of this study refers to a situation whereby a farmer supplies the contracting agribusiness firm (i.e., DTTP) with the actual contracted quantity of the commodity, as documented in Cai and Ma (2015). Thus, any sale outside the contract is regarded as a breach. Figure 1 below summarizes the socioeconomic drivers that influence smallholder compliance behavior either positively or negatively.

Transaction costs may lower smallholders' contract compliance behavior. Most farmers are sensitive to extra costs after harvest as they often opt for the closest market (Alene et al. 2008; Cai and Ma 2015; Osebeyo and Aye 2014; Rujis et al. 2004). Moreover, because most small-scale farmers produce on credit, they prefer markets with cash and carry payments and tend to opt for markets where payment is instantaneous to settle outstanding debts.

Resource provision may influence farmers' positive attitudes toward contracts. A resource-providing contract alleviates the problem of market access that smallholders face due to high-quality input requirements (Ruml and Qaim 2020b). it provides farmers with high-quality inputs at a discounted rate and the training needed to meet international food safety and quality standards (Kumar et al. 2023). Therefore, resource provisions will motivate them to perform better. They may feel more obliged to the contract terms as they will want to continue to enjoy the input and service provisions associated with the contract.

Incentive Instruments may have a positive effect on smallholder contract compliance behavior. For example, bonus/rebate encourages positive behavior among farmers, and penalty discourages bad outcome among farmers (Cadilhon et al. 2006; Kumar et al. 2013; Saenger et al. 2013). Moreover, evidence from Rosch and Ortega (2019) suggests that price premium positively influences farmer's compliance behavior.

Farmer characteristics could be a critical driver for compliance. For instance, well-educated farmers may understand contract terms and their implications better (Cai and Ma 2015). Moreover, farmers who are more economically endowed may better deal with the ex-post transaction costs that compliance entails (Escobal and Cavero 2012). Furthermore, a number of evidence revealed that larger farm size correlate positively with farmers' performance in a contract (Ton et al. 2018; Meemken and Bellemare 2019; Kutawa 2016).

Open market price could potentially affect smallholder compliance behavior. It created unanticipated rent that increases the benefit of contract breach among farmers (Kumar et al. 2013). Robinson et al. (2012) found evidence that tomato farmers break contract if fresh market price is better even if they remain profitable in complying with the contract. Therefore, it is expected that rational farmers will easily break contracts and go for alternatives that maximize profits.

3 | Methodology

The study adopts a mixed research methods. Qualitative data was collected from contracted farmers first using FGDs which informed the design of the survey questionnaire administered to investigate farmers' contract compliance behavior econometrically at the second stage.

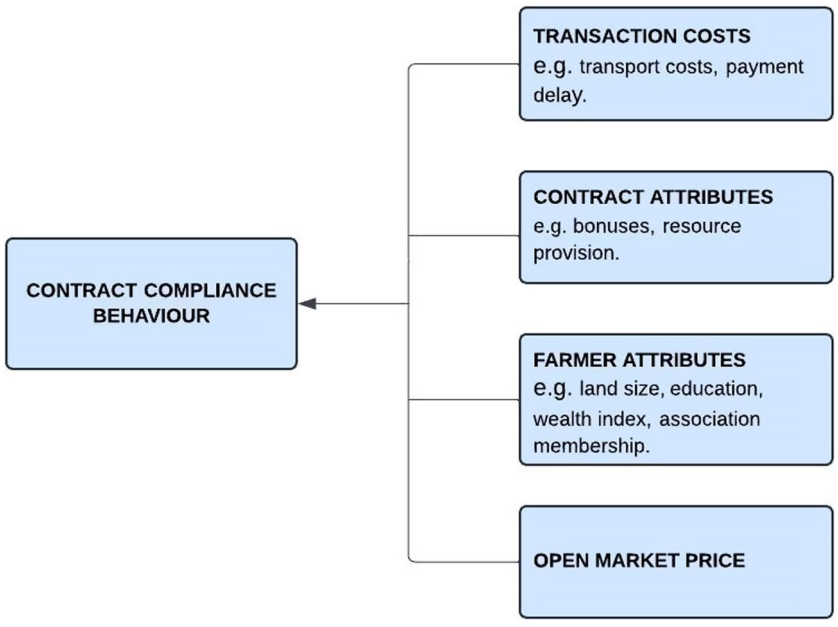

FIGURE 1 | Drivers of contract compliance behavior.

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3.1 | Study Area

Kano state has four seasons: hot–dry season, wet–warm season, dry and warm, and a cool–dry season based on the annual rainfall pattern and varying temperatures, (Muhammad et al. 2012; Mustapha et al. 2014). The cool and dry season lasts from November to February and is the most conducive season for tomato production. temperature ranges between 21°C and 23°C with a diurnal range of 12°C–14°C, which allows vegetables to thrive and grow better. Over 60% of vegetable crop farmers undertake their production in this season (Lynch et al. 2001; Olofin et al. 2008; Plaisier et al. 2019).

Most farmers have no access to improve seeds, fertilizers, and pesticides (Mohammed et al. 2015). They source seeds from their own stock or purchase from the open market (Adegbola et al. 2012), and rely on household refuse, animal droppings and/or ash for manure. However, farmers get massive opportunity to partake in irrigation farming because they live along Kano River Irrigation Project (KRIP) that covers about 62,000 hectares of land, and the Hadejia Valley project that cuts across many villages and towns (Mustapha et al. 2014). Over a million people depend on these irrigation facilities for farming activities (Ahmad and Haie 2018). In addition, Shadoof irrigation, called "*Fadama*" in the native language, has long been practised by farmers along the flood plains of rivers, such as the Watari, Challawa, and Jakara, mainly for vegetables and fruit production.

3.2 | Case Study Choice and Justification

The DTPP was chosen purposively as the case study. The company is the largest and the only functional processing plant in northern Nigeria. The company was created with a view to help country to reduce 300,000+ metric tonnes of imported tomato paste, resulting from 700+ metric tonnes of tomato loss recorded annually. DTPP provided various contracts to over 10,000 farmers to meet its economies of scale if operate with full capacity to process 1200 metric tonnes of tomatoes per day (Shuaibu 2020). The company is located at Dorawar Sallau, Garun Mallam local government area (LGA) of Kano State, which is the country's heart of tomato production with proximity to areas covered by KRIP, which provides farmers and the state a comparative advantage in tomato production. Evidence revealed that despite farmers located around KRIP and other parts of the states producing tomatoes in abundance, DTPP could not operate profitably due to a poor supply of tomatoes to the firm. It could only process less than 300 metric tonnes of tomatoes daily, equivalent to one-fourth of its processing capacity, which is attributed to excess breach of contract that is common among the contracted farmers (Jeremiah 2020). As mentioned earlier, due to a ban in tomato imports, DTPP is unable to source much-needed supply of tomatoes and incur losses in operation (Adamu 2021; Branthome 2021).

Although DTPP has farms, it relies heavily on the contracted supply of raw materials to meet its economy of scale. Its contract has interesting features: the price is fixed, and farmers have access to inputs and services that would otherwise be unavailable. Farmers contracted by the DTPP can use their contract offer as collateral to receive a production input loan through a commercial bank that has an agreement with the company. When the contracted quantity is supplied to the company, the farmer receives a payment greater than the loan previously taken from the bank. However, many contracted farmers sell the contracted tomatoes outside the contract (Kutawa 2016). Most farmers do not care about the consequences of breaking the contract, and they pay much attention to their short-term gratification over and above a long-term relationship with DTPP. This behavior may be because of the operation of the company is intermittent, and most farmers that produce tomatoes all year round do not see DTPP as a reliable market. Thus, even if they are profitable by complying, they may break the contract and sell to buyers that offer better prices (Robinson et al. 2012)

Recently, after attempting many unsuccessful strategies to deal with farmers' poor participation and opportunistic behavior, DTPP enjoyed Federal Government intervention through the Anchor Borrower Program (ABP) (Shuaibu 2023). ABP is a program introduced by the government to strengthen the growth of local processing industries and connect farmers to the market (Ugonna et al. 2015). The ABP adopts DTPP as an *anchor*. An anchor is a large-scale processing company supported by the Federal Government on the agreement that it will contract smallholder farmers accredited by the government through various farmer associations. Under the ABP arrangement, the government provides funding to DTPP to produce a hybrid seedling that meets the processing requirements, which was issued to farmers under the program. The government determines the contract price, which is always above the price in the nearby rural market. However, the story remains the same as most farmers assume that the inputs and services given to them by the contracting firm (DTPP) are a free resource from the government, so they find it easier to break the contract (Kutawa 2016).

3.3 | Data Collection

Before data collection, multistage random sampling procedure was applied in the selection of respondents. First, the list of farmers that participated in the contract was generated from the production clusters identified in the four LGAs with the help of the Kano State Agricultural and Rural Development Authority (KNARDA) and leaders of the Farmers' Association. The list was generated based on participation in the DTPP market, which served as the sample frame used to draw sample respondents/farmers. Second, four LGA, namely, Kura, Garun Mallam, Bunkure, and Dambatta, were randomly selected from the major catchment areas of the processing company – areas covered by the KRIP. Third, five production clusters are randomly selected from each of the selected LGAs. Finally, 15 farmers from each cluster were randomly selected to produce a sample size of 300 farmers.

The data were collected using the survey questionnaire. informed by the literature and FGDs with farmers. The FGD helped explore and identify potential instrumental variables (IVs). The questionnaire has two parts: The first part is the household-level data, covering farmers' socioeconomic

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characteristics, transaction costs and related characteristics, and contract design attributes. The second part is the transaction level data, which covers the date of sales, to whom the sale is made, quantity sold, price paid, transport cost incurred, variety grown, and type of payment. The data are collected in two distinct phases. During the first contact (between December 21, 2021, and January 15, 2022), household-level data was collected, and then a series of follow-up surveys were conducted for the 2021–2022 dry season – irrigated tomato production to collect transaction-level data each time a farmer made sale throughout the season.

3.4 | Determinants of Farmer's Contract Compliance: Probit Model Using Transaction Level Data

A binary probability model (probit model) was used to identify the determinants of farmers' contract compliance behavior using the variables indicated in the conceptual framework and following the work of Guo et al. (2007) and Dubbert (2019). Transaction-level data on tomato sales was used along with socioeconomic, infrastructure, and other variables in the model. The dependent variable is a dummy of compliance. The probit model to be estimated can be expressed as:

$$ComP_i = \boldsymbol{\beta_1 X_i} + \boldsymbol{\beta_2 T_i} + \boldsymbol{\beta_3 C_i} + \beta_4 S_i + e_i, \quad (1)$$

where, $ComP_i$ is the decision made by farmer i to comply or not with the contract. The variable takes the value 1 if the farmer have complied ($ComP_i = 1$) and 0 otherwise, that is, farmer have not complied ($ComP_i = 0$). $\boldsymbol{X_i}$ is a vector representing farmer socioeconomic and other characteristics (education, land size, wealth index, association membership), $\boldsymbol{T_i}$ is the vector representing transaction costs (transport cost, payment delay), $\boldsymbol{C_i}$ is a vector of contract characteristics (bonuses, resource provision), S_i is the dummy of harvest sub-periods (early, peak, late), and e_i is the error term. $\boldsymbol{\beta_1}$–$\boldsymbol{\beta_4}$ are the coefficients of parameters to be estimated. Note that the analysis is at the transaction – level, thus, the standard errors were clustered at the household-level to avoid duplication.

3.4.1 | Addressing Endogeneity in the Model

The variable "quantity harvested" is suspected to be endogenous to compliance, as its effect on compliance is moderated by other variables that have no direct correlation with farmers' compliance. Therefore, we have applied the IV approach to correct for endogeneity. It is conceivable that land size directly affects the quantity of tomatoes traded, however, it may not directly affect farmers' compliance choice but only through quantity traded. Thus, It is sensible to empirically think that the quantity of tomatoes traded is endogenous to contract compliance. As a larger quantity traded may imply compliance, land size determines the quantity of surplus traded. This instrument was also observed in studies like Fafchamps (2004) and Zanello et al. (2014). Thus, the variable "land size" is assumed to be a potential instrument. Therefore, to correct the endogeneity problem, a two stage regression was estimated as in Kumar et al. (2018, 2023). The reduced form Equation (2) is presented below:

$$ComP_i = \gamma_0 + \gamma_1 W + \boldsymbol{\gamma_2 Z_i} + v_i, \quad (2)$$

where W is the instrument and $\boldsymbol{Z_i}$ is a vector of exogenous variables. To diagnose the instrument, we estimate the first stage regression in Equation (3) below.

$$InQuantityTraded = \delta_0 + \delta_1 Landsize + \delta_2 Landsize_squa + \sigma_i, \quad (3)$$

where, $\delta_0 - \delta_2$ are the parameters to be estimated and "ln" is the natural logarithm of quantity traded.

We checked for Sargan Statistics, Anderson canon test, and Stock–Yogo Weak ID critical values to evaluate the validity, relevance, and strength of the instrument (land size). The results confirmed that the instrument is relevant and valid considering the p-values of Sargan and Anderson canon test, but weak in its strength, considering the restrictive Stock–Yogo threshold. See the result of the first stage regression attached to this paper as Appendix I.

However, we retain the instrument in the model as it is valid and relevant (strong correlation with the endogenous variable "quantity traded" in the first–stage regression) due to its theoretical and economic importance. A robustness test was applied to the results to adjust for possible errors, as highlighted in Murray (2006). For instance, land is a fundamental factor of production, its quality and productivity directly affect output, and larger land size allows for economies of scale (Mishra et al. 2023). Similarly, land is a primary input in agricultural production function. It forms the foundational role that sets the stage for other inputs to operate (Sheng et al. 2016). Thus, we assumed that the instrument's weak strength may be due to factors like land quality, crop type, technology, and management that affect the impact of land on quantity harvested, making its strength partial, explaining only a small portion of the variation in the endogenous variable, which can dilute its effect in the analysis (Gerssen-Gondelach et al. 2015).

4 | Results and Discussion

4.1 | Summary Statistics of Tomato Farmers' Contracted by DTPP

4.1.1 | Household Head's Characteristics

The results presented in Table 1 below revealed that an average contract farmer in the study area is about 41 years old, with an average household size of 11 people, contract experience of 1.6 years, and can at least read and write (an average of junior level education). On average, a tomato farmer cultivates about 3 hectares of land, which are mostly acquired by inheritance. Most farmers (61%) have a membership of the Tomato Farmers Association. Furthermore, the results show that about 70% of the farmers were under resource–providing contracts and had

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TABLE 1 | Summary statistics of household head characteristics compared across compliance category.

Variable	Full sample ($n = 1223$) Mean ($\bar{x}$)	Compliance group ($n = 603$) Mean ($\bar{x}_c$)	Renege group ($n = 620$) Mean ($\bar{x}_r$)	Group difference
Age of the household head (in years)	41.07	41.71	40.48	1.23**
Household size (persons)	11.09	11.30	10.97	0.33^{NS}
Farm size (in Ha)	2.79	3.05	2.60	0.45**
Years of relationship with DTPP	1.61	1.48	1.71	−0.23***
Farm distance from DTPP (km)	20.65	23.65	18.26	5.39***
No. of traders visited farmer's farm	3.60	3.61	3.60	0.01
Gender of the household head (1 = male; 0 = female)	1.00	1.00	1.00	0.00^{NS}
Education status (0 = none; 1 = primary/junior; 2 = secondary; 3 = tertiary)	2.66	2.80	2.53	0.27***
Wealth Index (0 = 25th percentile; 1 = 50th percentile; 2 = 75th percentile; 3 = > 75th percentile)	1.50	2.11	1.91	0.20
Contract type (1 = resource providing; 0 = otherwise)	0.69	0.67	0.33	0.34*
Association membership (1 = member; 0 = otherwise)	0.61	0.58	0.62	−0.04
Anchor borrower program (1 = participant; 0 = otherwise)	0.57	0.54	0.46	0.08**
Type of land ownership (1 = owned; 0 = leased)	0.81	0.64	0.36	0.28

*Significant at 10% level ($p < 0.10$).
**Significant at 5% level ($p < 0.5$).
***Significant at 1% level ($p < 0.01$).

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their farms located, on average 21 km away from DTPP. Farmers had an average of about 2 years of trading experience with the company.

4.1.2 | Transaction-Level Characteristics

Results in Table 2 show that an average farmer harvested 3890 kg of tomatoes during the 2021/2022 dry season. Farmers selling to open markets received an average price of Naira 36.8 per kg. Those in the renege group received an average price of Naira 42.18 per kg, which is Naira 2.18 more than the resource–providing contract price (i.e., Naira 40 per kg), and Naira 12.18 higher than the non-resource–providing contract price (i.e., Naira 30 per kg). The implication is that some farmers are motivated by open market prices as well as other factors to break the contract. Over 47% of payments were instant payments on a cash-and-carry basis. A farmer incurred average transport costs of Naira 2.38 per 55.7 kg basket to transport tomatoes. About 51% of transactions were made during the peak harvest subperiod.

4.2 | Empirical Results of Drivers of Contract Compliance

To observe the behavior of the models with increasing level of complexity, three models were estimated by varying explanatory variables: the transaction level attributes, the household characteristics, and the contract characteristics, as presented in Table 3. The Wald chi-square statistics, which test the joint significance of variables in the three models, are significant at a 1% level implying that the inclusion of these variables in the models are justified. The pseudo R^2 values of model A, model B, and model C are 80.2%, 80.5%, and 80.7%, respectively.

To preserve the length of the manuscript, interpretation and discussion are limited to the key variables in model C, which is the full model of contract compliance behavior. "Delayed payment," "open market price," "harvest subperiod," and "wealth index" are significantly negatively correlated with contract compliance. On the other hand, "variety," "land ownership," "association membership," "bonuses," "education," and "resource provision" are all significantly positively associated with contract compliance behavior.

Kumar et al. (2013) found that farmers who purchase production inputs on credit may be economically constrained by payment delay, and they will break the contract in the presence of an alternative that offers a timely payment, which is consistent with our result that shows most farmers break the contract in the presence of other market option. The contracting firm (DTPP) adopted a non-instantaneous payment mode, and it was agreed that farmers would receive their payment within 2 days after delivery. The results indicate that the probability of complying with the contract is 70.7% less likely for farmers whose payments are delayed. The FGD results also confirmed that pressing financial needs compelled most farmers to sell outside the contract. This finding is closely similar to the

TABLE 2 | Summary statistics of household head transaction-level characteristics.

Variable	Full sample ($n = 1223$) Mean ($\bar{x}$)	Compliance group ($n = 603$) Mean ($\bar{x}_c$)	Renege group ($n = 620$) Mean ($\bar{x}_r$)	Group difference
Quantity harvested (1000 kg)	3.89	5.46	2.65	2.81***
Open market price (in Naira/kg)	36.83	0.00	42.18	−42.18***
Transport cost (in N1000)	2.38	4.43	0.59	3.84***
Tomato variety transacted (1 = Dangote hybrid, 0 = otherwise)	0.57	0.69	0.46	0.23***
Delayed payment (1 = yes, 0 = otherwise)	0.52	0.32	0.63	−0.31***
Harvest subperiods (0 = early; 1 = Peak; 2 = late)	0.51	0.81	0.23	0.58

Note: 1USD ($) = 1607.2.
***Significant at 1% level ($p < 0.01$).

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TABLE 3 | Endogeneity corrected probit regression results of factors affecting farmers' contract compliance behavior ($n = 1223$).

	Compliance model (A)			Compliance model (B)			Compliance model (C)		
Variable	**Coef. (β)**	**SE**	**ME**	**Coef. (β)**	**SE**	**ME**	**Coef. (β)**	**SE**	**ME**
Transaction-level attributes									
Log quantity sold (1000 kg)	0.329	0.600	0.018	0.593*	0.718	0.019	0.592	0.704	0.020
Delayed payment (1 = yes)	−3.101***	0.319	−0.745	−2.851***	0.679	−0.707	−2.887***	0.651	−0.707
Variety (1 = Dangote hybrid)	0.647***	0.183	0.051	0.671***	0.270	0.061	0.702***	0.259	0.063
Transport costs (in 1000 Naira/kg)	0.343	0.245	0.027	0.240	0.346	0.028	0.236	0.332	−0.027
Open market price (Naira/kg)	−0.033***	0.008	−0.002	−0.032***	0.010	−0.024	−0.033***	0.010	−0.030
Harvest subperiods									
(1) Peak subperiod	0.008	0.249	0.004	−0.045	0.245	0.005	−0.039	0.242	0.020
(2) Late subperiod	−0.413**	0.165	−0.029	−0.418**	0.176	−0.036	−0.422**	0.171	−0.036
Farmer characteristics									
Education level									
(1) Junior secondary				0.192	0.256	0.016	0.241	0.252	0.019
(2) Senior secondary				0.325	0.234	0.037	0.309	0.232	0.035
(3) Tertiary				0.245	0.191	0.026	0.270**	0.189	0.027
Assoc. membership (1 = yes)				0.388**	0.156	0.029	0.353***	0.155	0.026
Type of land ownership (1 = owned)				0.378**	0.161	0.027	0.363**	0.163	0.025
Wealth Index category									
(1) Index at the 50th percentile				0.017	0.210	0.005	−0.021	0.198	−0.010
(2) Index at ≥ 75th percentile				−0.030	0.198	−0.131	−0.040*	0.196	−0.030
Years of relationship with DTPP				0.002	0.017	0.005	0.101	0.168	0.004
Contract characteristics									
Bonus (1 = yes)							0.396***	0.143	0.025
Resource provision (1 = yes)							0.210*	0.111	0.301
Constant	1.848***	0.487		1.177	0.811		1.093*	0.794	
Pseudo R^2	0.802			0.805			0.807		
Correct Prediction Ratio (CPR)[a]	1.14			1.15			1.15		

Abbreviations: ME, marginal effect; SE, standard error.
[a]CPR tests the model's goodness of fit. It is estimated as the sum of the fractions of zeros correctly predicted and the ones correctly predicted (McIntosh and Dorfman 1992 as cited in Zanello et al. 2014).
*Significant at 10% level ($p < 0.10$).
**Significant at 5% level ($p < 0.5$).
***Significant at 1% level ($p < 0.01$).

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findings of Cai and Ma (2015), who found a positive correlation between delayed payment and low contract enforcement choice among farmers. Our result also agrees with Blandon et al. (2010), who found that most farmers prefer selling to the market where payment is immediate.

As pointed out by Kumar et al. (2013), open market price generates unanticipated rent to the contracting firms, which may increase the benefits of contract breach among the contracted farmers. This study found evidence that a one percent increase in open market price decreases farmer's probability of compliance by 3% – implying that farmers break contracts for a better price option. Thus, when the price in the open market is high, a rational farmer will break the contract to maximize profit by selling tomatoes to the higher-paid market. This result is consistent with Robinson et al. (2012), who found that contracted farmers always have the option of breaking contracts even if they are profitable in complying because of other reason, for example, payment delay. The finding is also in line with Rosch and Ortega (2019), Repar et al. (2018), and Ton et al. (2018), who found that price premiums arising from the open market negatively influence compliance among farmers.

The results also established that compared to the early subperiod, the probability of farmer's compliance increases by 2% and decreases by 3.6% during the peak and late harvest subperiods. This suggests that the probability of breaching the contract is higher among farmers who harvest their tomatoes at the late harvest subperiod compared to farmers in other categories. This finding is closely similar to Robinson et al. (2012) who observed that during the lean harvest period, tomato prices are very high in the open market due to the high demand for fresh tomatoes and farmers find it easy to breach the processor's contract to exploit the rent created by the open market price.

Escobal and Cavero (2012) found that more economically endowed farmers are more likely to perform better in a contract because of their ability to deal with the complexities that the contractual transaction entails. This finding agrees with the result of this study that established that compared to those farmers who leased farm lands, the probability of contract compliance among farmers who owned farm lands is 2.5% higher. This claim is supported by the focus group data, which revealed that most tomato farmers who maintained a relationship with DTPP owned their farms. However, farmers' wealth index is significantly and negatively correlated with contract compliance behavior, particularly those whose wealth index category falls at the 75th percentile and above. The probability of compliance for farmers in this category is 3% less likely compared to those in the other categories. This result is closely related to the findings of Lu et al. (2017), who found that an increase in income from other off-farm diversification discourages farmers' engagement and commitment to contracts.

The role of farmer associations and cooperative societies on contract performance is documented in the literature. For example, Au and Culas (2021) found that agribusiness firms are likely to engage farmers who are members of cooperative associations to minimize contractual breaches. Similarly, Cai and Ma (2015) found a positive relationship between contractual compliance and membership of cooperative associations. These findings are consistent with this study. "Association membership" is significantly positively associated with the farmers' contract compliance behavior, implying that the probability of compliance for members of farmer associations is 2.6% higher than for those who are non-members. This claim is supported by the focus group findings, which revealed that most farmers who participate in the contract use their association as a guarantor.

The literature further shows that resource provision in the contract design plays a vital role in influencing farmers' performance in a contract (Kumar et al. 2013). For example, Cai and Ma (2015) found evidence that resource–provision correlated positively with the farmers' choice of the proportion of output to be supplied to the contracting firm. Similarly, Ruml and Qaim (2020a) and Bidzakin et al. (2020) in their studies found a positive association between resource provisions and contract performance among farmers. These findings are consistent with our results, which established that resource provision increases farmers' contract compliance probability by 30.1% compared to non-resource provision, as farmers may not want to lose the opportunity to access inputs through the contract. Moreover, the marginal effect of 0.025 for bonus implies that the probability of contract compliance is 2.5% higher for farmers who received bonus compared to those who have not received, suggesting that bonus provision will make contracted farmers more likely to comply with the contract. This finding is similar to Luo et al. (2013) that find a positive correlation between farmers contract compliance behavior and contract compliance. It also agrees with Kumar et al. (2013) that found bonus to significantly impacted on performance of the contract farmers.

5 | Conclusions and Policy Implications

Contract compliance is indispensable for the efficient performance of every contracting agribusiness (Cai and Ma 2015). The excess contractual breach that is becoming increasingly noticeable among smallholders tends to discourage private investors, disconnect farmers from the advanced markets, and disrupt the agrifood supply chain (Zhang and Aramyan 2009). Thus, understanding "what drives contract compliance among smallholders in Nigeria" is crucial to policymakers, researchers, and agribusinesses. The research is based on a case study of a random sample of 300 farmers contracted by DTPP in four regions of northern Nigeria. A novel transaction-level data was used in conjunction with household-level and other socioeconomic variables. Results prove that tomato farmers' contract compliance behavior is significantly positively associated with "land ownership," "association membership," "educational level," "bonuses," and "resource provision." In contrast, the "open fresh market prices," "payment delay," "late harvest subperiod," and "wealth index" negatively correlate with farmers' contract compliance behavior.

The findings of this study have important implications for agribusinesses and policymakers. Firstly, the sensitivity of farmers to payment delay calls for an effective measure to settle the timing of payment to farmers to avoid the risk of breaching the contract. This can be done by encouraging agribusinesses to

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adopt digital payment methods which will minimize payment delays that compel farmers with pressing financial needs to sell their produce outside the contract where payment is immediate in the open fresh tomato markets. Moreover, farmers have shown strong motivation for incentives, suggesting that agribusinesses may do better if they introduce incentives into the contract design, such as rewarding loyalty and a high level of compliance through bonus payments and other tangible forms of recognition. The finding contributes to the discussion on contract enforcement, which emphasizes the importance of penalty and reward for successful contractual transaction (Cai and Ma 2015; Cungu et al. 2008). Secondly, farmers have shown strong tendency to receive technical support and agricultural inputs from the contracting agribusiness firms. Thus, to enhance farmers' contract compliance, public agencies should continue to support agribusiness firms that engage in contracts. The government shall pay more attention to introducing more programs like the ABP, which in addition to connecting farmers to the market, helps agribusinesses with infrastructural development, access to credit, and other investment incentives.

One limitation of the study is that since the price in the open market varies, whether there is a particular level of price differential that triggers farmers to break the contract could provide a better understanding of the contract compliance behavior of farmers in the agri-food sector.

Author Contributions

Umar Shehu Umar: writing—original draft, investigation, funding acquisition, conceptualization, software, formal analysis, project administration, data curation, methodology, resources. **Sanzidur Rahman:** conceptualization, methodology, validation, writing—review and editing, supervision, visualization. **Giacomo Zanello:** conceptualization, writing—review and editing, methodology, validation, supervision.

Ethics Statement

Ethical clearance was obtained from the School of Agriculture, Policy and Development Ethics Committee, University of Reading, UK before conducting interviews and surveys for this research project.

Data Availability Statement

The data supporting the findings of these study are available from the corresponding author upon reasonable request.

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Appendix 1

Instrumenting Quantity Harvested

See Table A1.

TABLE A1 | Instrumenting regression results of log of quantity harvested ($n = 1223$).

Variable	Model A		Model B		Model C	
	Coef.	SE	Coef.	SE	Coef.	SE
Land size (in Ha)	0.077***	0.028	0.054	0.034	0.056*	0.034
Land size square (in Ha)	−0.008***	0.003	−0.007**	0.003	−0.007**	0.003
Delayed payment (1 = yes)	−0.251***	0.057	−0.280***	0.059	−0.283***	0.059
Variety (1 = Dangote hybrid)	0.119*	0.047	0.081	0.049	0.078**	0.049
Log transport cost (in N1000)	0.375***	0.022	0.369***	0.022	0.367***	0.022
Open market price (Naira/kg)	0.009	0.001	0.002	0.001	0.008	0.002
Harvest subperiods						
(1) Peak subperiod	0.179***	0.055	0.184***	0.056	0.186	0.055
(2) Late subperiod	0.032	0.060	−0.011	0.061	−0.007	0.061
Education level						
(1) Junior secondary			−0.166	0.084	−0.169	0.084
(2) Senior secondary			0.019	0.063	0.028	0.063
(3) Tertiary			−0.020	0.062	−0.019	0.062
Assoc. membership (1 = yes)			−0.166	0.049	−0.158	0.049
Type of land ownership (1 = owned)			−0.067	0.063	−0.156	0.064
Wealth Index Category						
Wealth Index at 50th percentile			0.044	0.059	0.042	0.059
Wealth Index at 75th percentile or above			0.092	0.061	0.091	0.061
Years of relationship with trader			−0.018	0.021	−0.071	0.020
Bonus (1 = yes)					0.038	0.049
Resource provision (1 = yes)					−0.066	0.051
Constant	0.479***	0.087	0.658***	0.104	0.766***	0.116
Anderson Canon Test of Instrument Relevance	14.81***		12.52***		13.04***	
Sargan test of instrument validity	0.36^{NS}		1.55^{NS}		0.015^{NS}	
Stock and Yogo Weak ID *F*-Test	7.44***		4.98**		5.22**	

Abbreviation: SE, standard error.
*Significant at 10% level ($p < 0.10$).
**Significant at 5% level ($p < 0.5$).
***Significant at 1% level ($p < 0.01$).

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