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Article

Technical Challenges of Tractor Adoption Among Cereal Famers in Taraba State, Nigeria

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Abstract

This study examines the challenges of tractor adoption among Cereal Farmers in Taraba State, Nigeria. Using multi-stage, purposive, and simple random sampling techniques, 240 respondents were selected, and data were obtained through questionnaires. Descriptive analytics on the processed raw data was performed. Results revealed that high tractor costs with a Mean Score (MS) of 4.53, limited access to credit with MS of 4.45, and inadequate technical knowledge with a MS of 4.30 were the most critical constraints to adoption. Other challenges, with MSs ranging from 3.3 to 4.2, included shortage of trained operators, poor extension services, inconsistent government policies, and lack of capital. The study recommends that government and non-governmental organizations provide credit facilities, subsidies, improved extension services, and affordable machinery to enhance mechanization among Cereal farmers in Taraba State.

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1. Introduction

Tractorization in agriculture means replacing human/animal power with mechanical power – mainly tractor-powered implements for farm operations. Tractorization is the use of tractors to replace hoes, cutlasses and oxen for tilling, planting, harvesting among other operations. The key aspect of tractorization include; mechanization of land preparation, tractor drawn implements, scale and efficiency, and reduced drudgery in farming. Taraba State is rich in diverse natural resources, offer significant opportunities for Cereal Farmers to engage in agricultural development, specifically mechanized farming. Though tractor use among farmers in the study area remain minimal, conversely, most of these farmers rely on the use of manual tools and animal traction, affecting their productivity and income.

Tractors, a key mechanization tool, can significantly reduce the time and physical burden of land preparation, planting, harvesting transporting, among other tasks. Farm tractors also offer definite benefits to farmers in terms of greater efficiency, economy, and higher productivity particularly by speeding up farm operations during crucial periods. [5] reported that agricultural machinery plays a critical role in improving farm productivity, increases efficiency, optimize land use, and reduce labour shortage, ultimately leading to higher crop yields and farm income among farmers in Taraba State.

Despite Taraba State favourable agricultural environment, Cereal Farmers faced several challenges in adopting tractors in farming. Challenges such as; high maintenance cost, inadequate infrastructures, financial constraints and inadequate extension contact can impede farmers from embracing tractors use in farming, limiting their capacity to enhance productivity and income as reported by other studies ([2], [5]). However, specific challenges hindering tractor adoption in the context of Cereal Farmers remains poorly understood in Taraba state, limiting effective support for tractor-based agricultural practices in the state. This research gap is addressed by identifying the unique challenges associated with tractors adoption by Taraba State Cereal Farmers (TSCF).

2. Materials and Methods

2.1. Study Area

Taraba ranks as Nigeria's third-largest state by land area, trailing only Borno. Situated in the southern tier of the country's North-East region, it lies along the eastern international border separating Nigeria from Cameroon. Geographically, Taraba stretches between latitudes 6°25′N and 9°30′N, and longitudes 9°30′E and 11°45′E. It shares its western borders with Nasarawa and Plateau states, while Bauchi and Gombe lie to its north, and Adamawa sits to the northeast. Benue State edges its southwestern rim, while the Republic of Cameroon forms its official south-southeastern international boundary.

Taraba State encompasses a total land area of approximately 54,473 km², with a baseline population recorded at 2,300,736 individuals during the National Population Census [8], which is projected to reach 3,608,800 [9]. The region experiences a distinct bimodal climate characterized by rainy and dry seasons. The wet season typically spans from April/May through September/October, whereas the dry season persists from November until March/April. This dry period is further marked by harmattan winds blowing between November and February. Due to its advantageous hydrological conditions, fertile soils, and favorable climate, the state is highly conducive to agriculture. The predominantly agrarian economy thrives on these rich soils, facilitating efficient food and cash crop production. Cultivated staples prominently feature cereals such as maize, millet, and sorghum, alongside root crops like yam and cassava, citrus fruits, and various tree crops. Concurrently, livestock production—encompassing cattle, sheep, goats, and fisheries remains vital, particularly across the Donga, Karim Lamido, Wukari, Ibi, Bali, Yorro, and Zing Local Government Areas (LGAs).

2.2. Source and Data Collection Method

Primary data for this research were gathered via the administration of structured questionnaires. The survey instruments incorporated a mix of closed-ended and open-ended items; the former served to secure precise, quantifiable responses, while the latter allowed respondents to provide nuanced, detailed insights into the subject matter. Structurally, the questionnaire was divided into two distinct components. The first section documented the socioeconomic profiles of the surveyed cereal farmers. The second section evaluated the specific constraints and challenges hindering tractor adoption among cereal farmers within the study area.

2.3. Sampling Method and Sample Size Determination

A multi-stage sampling framework integrating both purposive and simple random selection methods was deployed to select the study respondents. Taraba State is categorized into three primary agricultural zones: the Northern Guinea Savanna, Southern Guinea Savanna, and Sudan Savanna. In the initial stage, the Northern and Southern Guinea Savanna zones were randomly selected. The second stage involved the purposive selection of three Local Government Areas (LGAs) from each of the two chosen zones, targeting areas with a high density of cereal cultivation. This yielded six LGAs in total: Ibi, Wukari, and Bali representing the Northern Guinea Savanna, alongside Ussa, Kurmi, and Donga representing the Southern Guinea Savanna. During the third stage, two wards were randomly selected from each of these LGAs. The fourth stage involved a random selection of two farming communities per ward. In the final stage, ten cereal farmers were randomly sampled from each community, culminating in an aggregate sample size of 240 respondents.

3. Results and Discussion

In this section, results obtained from respondents' frequency, mean responses, and other descriptive analytics are presented and discussed in detail.

3.1. Characterization of TSCF Socio-Economic Status

3.1.1. Age and Educational Profile

As outlined in Table 1, the mean age of the sampled farmers was 44 years. This demographic profile indicates a relatively young workforce capable of enduring the physical demands of modern agricultural practices and adopting innovative technologies. This finding aligns with the work of [14], who reported a similar mean age of 43 years among cereal producers in Kaduna State, Nigeria.

Education serves as a critical determinant for processing agricultural information and adopting improved farming techniques. The empirical results demonstrate that 87.5% of the respondents possessed formal education, while 12.5% had non-formal training. Crucially, a majority (56.66%) completed secondary school education. This educational baseline suggests that farmers within the study area have the literacy required to comprehend the economic and operational benefits of mechanized tractor technologies. This observation is consistent with [6], where 65.7% of the surveyed population attained secondary education.

3.1.2. Farming Experience and Technical Support

Farming experience, measured by the number of years dedicated to agricultural production, critically influences mechanization choices. The data indicates that approximately half of the respondents (49.6%) possessed between 1 and 20 years of experience, yielding a cohort mean of 23.0 years. Accumulating years in farming typically enhances a cultivator's awareness of operational bottlenecks and the efficacy of technological interventions. Experienced producers are generally more inclined to adopt tools that maximize efficiency. This trend parallels the findings of [11], who observed that 78% of sorghum farmers in Niger State had between 6 and 20 years of experience.

Agricultural extension services play a pivotal role in facilitating technology transfer among smallholders. Regular contact with extension agents, paired with technical training, acts as a primary catalyst for mechanization. Conversely, information deficits hinder technological adoption. The results indicate an evident deficit in institutional support: 95.8% of respondents recorded fewer than two extension visits, with a sample mean of just 0.67 visits. This weak institutional engagement likely acts as a barrier to tractor adoption. These shortfalls corroborate the findings of [11], who reported that only 68.3% of respondents had access to extension contacts.

This training deficiency is further underscored by the fact that 97.5% of the farmers participated in a mere 0 to 2 technical training sessions (mean = 0.2). This statistical trend highlights a severe lack of capacity-building programs regarding the strategic benefits and handling of tractor operations.

3.1.3. Farm Size, Household Dynamics, and Gender Distribution

Farm size remains a foundational determinant of agricultural mechanization. Smallholders with relatively larger holdings generally scale up technology adoption faster than those operating on highly fragmented plots. The results reveal that 92.1% of the respondents managed fewer than 10 hectares of land, with an overall mean of 4.56 hectares. This scale of operation is comparable to the mean farm size of 5.41 hectares reported by [14] among Fadama II grain farmers in Taraba State.

Household size serves as an indicator of both available family labor and household dependency burdens. While larger households boast a broader internal labor pool, they also face intense competing financial commitments, which can deplete the capital needed to adopt costly technologies. The data reveals that a majority (55.0%) of the households comprised 1 to 5 members, with an overall mean of 5.2 persons. This mirrors the findings of [15], who reported that approximately 45% of farming households had fewer than 5 members, despite a slightly higher overall mean of 7 persons.

Regarding gender, the demographic distribution shows a distinct male predominance in cereal cultivation within Taraba State, with men constituting 58.8% of the sample compared to 41.2% for women. This distribution is supported by [10], who similarly observed a male majority (55.5%) among maize farmers.

3.1.4. Labour, Income, and Credit Access

Labour allocation remains a critical factor in managing agricultural operations. The study reveals a high reliance on subsistence networks, with 44.2% of the respondents depending entirely on family labor. Conversely, only 25% utilized a mixed labor strategy combining family and hired hands. This heavy reliance on family units corresponds with the dynamics described by [6], where 75.8% of producers secured labor exclusively from within the household.

Financial capacity heavily dictates the transition to mechanization. The findings show that 49.6% of the respondents generated an annual farm income below ₦200,000. In comparison, [1] reported that the majority of maize farmers in Taraba State earned upwards of ₦123,108.87. As established by [3], higher income levels correlate positively with the financial liquidity required to invest in capital-intensive innovations like tractor services.

This financial constraint is worsened by restricted credit access. Only 33.3% of the surveyed farmers secured agricultural credit, leaving the remaining 66.7% financially constrained. This finding stands in contrast to the trends identified by [15], who found that a majority (55.63%) of the respondents, maintained access to credit facilities. Enhancing credit accessibility presents a clear pathway toward boosting tractor adoption rates, as institutional credit positively impacts both capital acquisition and mechanization literacy. Encouragingly, despite these financial and institutional bottlenecks, baseline awareness of agricultural machinery remains high, with 96.2% of the surveyed cereal farmers demonstrating a clear knowledge of tractor technology and its potential utility.

Table 1. Socioeconomic Characteristics of TSCF (n = 240)

Variable	Frequency	Percentage	Mean
Age			
20 – 39	113	47.0	
40 – 59	81	34	
60 – 79	43	18	
80>	3	1	44.4
Education Qualification			
Non-formal education	30	12.50	

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Primary Education	49	20.42	
Secondary Education	136	56.66	
Tertiary Education	25	10.42	
Farming Experience			
1 – 20	119	49.6	
21 – 40	94	39.2	
41 – 60	26	10.8	
61 – 80	1	0.4	23.0
Number of Extension Visit			
0 – 2	230	95.8	
3 – 5	9	3.8	
6 – 8	1	0.4	0.667
Types of Training			
0 – 2	234	97.5	
3 – 5	4	1.7	
6 – 8	2	0.8	0.1750
Farm Size			
< 10 ha	221	92.1	
11 – 20	13	5.4	
21 – 30	2	0.8	
> 31	4	1.7	4.56
Household Size			
1 – 5	132	55.0	
6 – 10	81	37.9	
11 – 15	16	6.7	
16 – 20	1	0.4	5.2
Sex			
Female	99	41.2	
Male	141	58	
Labour Source			
Family Labour	106	44.2	
Hire	56	23.3	
Mechanization Access	18	7.5	
All of the above	60	25.00	
Annual Income Status			
Less Than N 200,000	119	49.6	
200,000 – 400,000	60	25.0	
Greater than 400,000	61	25.4	
Access to credit			
No	160	66.7	
Yes	80	33.3	
Tractor Knowledge			
No	8	3.7	
Yes	231	96.3	

Source: Field Survey, 2025

3.2. Constraints to Agricultural Mechanization and Tractor Adoption Among TSCF

3.2.1. Institutional, Financial, and Technical Bottlenecks

As illustrated by the empirical data in Table 2, the constraints hindering tractor adoption among cereal farmers in Taraba State span an array of technological, socio-economic, institutional, and infrastructural dimensions. Financial and credit-related limitations emerged as primary impediments. Specifically, the high acquisition cost of tractors (mean = 4.53) and a pervasive lack of access to agricultural credit (mean = 4.45) were identified by respondents as critical barriers to mechanization, heavily compounded by a general lack of investment capital (mean = 3.37). These financial restrictions severely restrict smallholder liquidity, a dynamic that mirrors findings by [2], who observed that 40% of smallholders in the Gambella region were constrained by credit deficits, while 27% were locked out by high initial capital requirements. Similarly, research by [4] and in Delta State, alongside a national assessment by, underscores poverty and credit inaccessibility as systemic constraints to upgrading conventional farm power.

Technical and institutional deficiencies further aggravate these adoption barriers. Respondents strongly highlighted a lack of up-to-date knowledge regarding tractor technologies (mean = 4.30), an acute shortage of well-trained machinery operators (mean = 4.30), and an absence of structured maintenance and repair protocols (mean = 4.20). These technical bottlenecks are exacerbated by a scarcity of mechanical spare parts (mean = 4.24) and weak agricultural extension engagement (mean = 4.12).

This constellation of technical constraints aligns with the work of [16], who identified deficient mechanization literacy and costly inputs as primary limitations. It also corroborates the findings of [17], where deficient technical support, poorly trained operators (mean = 4.27), and weak extension systems (mean = 3.68) significantly impeded mechanization. Furthermore, these patterns reflect the rural challenges documented by and, where spare part shortages and a lack of qualified operators consistently disrupted mechanical workflows.

3.2.2. Socio-Cultural, Structural, and Policy Barriers

Beyond financial and technical bottlenecks, deep-seated structural and educational challenges continue to hinder the adoption process. Farmer illiteracy (mean = 4.28) was validated as a significant friction point, limiting the capacity of producers to comprehend or manage complex mechanical systems. This structural barrier is heavily reinforced by land-related bottlenecks, notably the prevailing land tenure system (mean = 3.61) and small, fragmented landholdings (mean = 3.52).

These land dynamics create operational inefficiencies that make tractor usage economically unviable for small plots. This observation is strongly supported by [4], who identified land availability (mean = 4.58) and land accessibility (mean = 4.52) as the most severe obstacles to machine utilization. It is also consistent with [9], where land fragmentation scored highly as a primary operational barrier (mean = 4.91).

Finally, macroeconomic and political instabilities create an unpredictable environment for long-term agricultural investments. Respondents identified inconsistent government policies (mean = 3.48) as a notable institutional constraint, a finding that matches the policy frictions (mean = 3.56) noted by [4]. Cumulatively, these multifaceted challenges explain why Nigerian smallholders continue to have access to less than 1% of conventional agricultural power [13], as the intersection of poverty, poor infrastructure, restrictive land tenure rules, and technical knowledge gaps creates a highly restrictive environment for sustainable tractor adoption.

Table 2. The Challenges of Tractor Adoption among Cereal Farmers in Taraba State: (n = 240)

Constraints	SA	A	U	D	SD	MS	Rank	SD
High cost of tractor	135 (56.2%)	98 (40.8%)	7 (2.9%)	0 (0.0%)	0 (0.0%)	4.53	1st	0.55
Access to credit	122 (50.8%)	108 (45.0%)	9 (3.8%)	0 (0.0%)	1 (0.4%)	4.45	2nd	0.61
Lack of capital	94 (39.2%)	141 (58.8%)	5 (2.1%)	0 (0.0%)	0 (0.0%)	4.37	3rd	0.53
Lack of latest knowledge of farm mechanization	84 (35.0%)	145 (60.4%)	11 (4.6%)	0 (0.0%)	0 (0.0%)	4.30	4th	0.55
Lack of well-trained machinery operators	86 (35.8%)	140 (58.3%)	13 (5.4%)	1 (0.4%)	0 (0.0%)	4.29	5th	0.59
Illiteracy of farmers	88 (36.7%)	127 (52.9%)	24 (10.0%)	0 (0.0%)	1 (0.4%)	4.26	6th	0.65
Shortage of spare parts	80 (33.3%)	139 (57.9%)	21 (8.8%)	0 (0.0%)	0 (0.0%)	4.25	7th	0.60
Lack of proper maintenance and repair of farm machines	62 (25.8%)	166 (69.2%)	12 (5.0%)	0 (0.0%)	0 (0.0%)	4.21	8th	0.51
Poor extension activities	66 (27.5%)	146 (60.8%)	22 (9.2%)	4 (1.7%)	2 (0.8%)	4.12	9th	0.74
Inconsistent government policies	44 (18.3%)	123 (51.2%)	65 (27.1%)	7 (2.9%)	1 (0.4%)	3.84	10th	0.82
Land tenure system	36 (15.0%)	121 (50.4%)	49 (20.4%)	22 (9.2%)	12 (5.0%)	3.61	11th	1.06
Small land holding by farmers	43 (17.9%)	107 (44.6%)	48 (20.0%)	16 (6.7%)	26 (10.8%)	3.52	12th	1.20

Sources: *Field survey, 2025.* ***SA*** *~ Strongly Agreed;* ***A*** *~ Agreed;* ***U*** *~ Undecided;* ***D*** *~ Disagreed;* ***SD*** *~ Strongly Disagreed;* ***MS*** *~ Mean Score;* ***SD*** *~ Standard Deviation*

4. Conclusions

In conclusion, this study underscores that the transition from subsistence tool utilization to sustainable agricultural mechanization among TSCF is severely bottlenecked by an intersecting matrix of capital deficits, prohibitive machinery acquisition costs, institutional credit constraints, low technical literacy, and structural land fragmentation driven by rigid land tenure systems. To dismantle these barriers and accelerate tractor adoption, a coordinated, multi-stakeholder approach is imperative. State agricultural authorities must forge strategic alliances with financial institutions and non-governmental entities to establish targeted machinery subsidies, flexible credit facilities, and scale-appropriate tractor-leasing frameworks tailored for smallholders. Concurrently, public investment should be directed toward revitalizing agricultural extension systems to deliver continuous capacity-building workshops and technical operations training, thereby bridging the prevalent mechanization knowledge gaps and cultivating a skilled pool of local operators. Furthermore, manufacturing and distribution policies must prioritize the importation and local fabrication of low-cost, durable, and scale-appropriate equipment alongside reliable spare-part supply chains. Finally, regional governments must initiate legislative reviews of existing land tenure frameworks to mitigate the inefficiencies of plot fragmentation,

thereby creating contiguous, highly accessible farming blocks that render mechanical traction both logistically feasible and economically viable for rural grain producers.

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