

EFFECT OF ADP'S CASSAVA PRODUCTION TECHNOLOGIES ON PRODUCTIVITY OF WOMEN FARMERS IN BENUE STATE, NIGERIA

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Abstract

This research investigates how the Agricultural Development Programme (ADP) and its specific cassava cultivation methodologies influence the output efficiency of female cultivators in Benue State, Nigeria. Using a multi-stage sampling framework, researchers isolated a cohort of 120 participants split evenly between 60 individuals utilizing ADP frameworks and 60 operating independently. The data underwent rigorous evaluation through a suite of analytical mechanisms, encompassing descriptive statistics (means, percentages, standard deviations, and frequencies), alongside inferential methods such as total factor productivity (TFP) modeling, multiple regression frameworks, chi-square evaluations, t-tests, and the Chow test. Demographically, the average participant was 41.53 years old. A notable 60% of these women were married. Academic attainment varied, with approximately 70% of the ADP participants possessing secondary or tertiary credentials, compared to 66.

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****Related declarations are provided in the final section of this article.**

66% among the independent group. The typical household comprised 8.20 members, while an identical 60% of the cohort successfully secured financial credit and identified crop cultivation as their primary livelihood. The average participant possessed 9.05 years of agrarian experience, and every single subject was integrated into a cooperative farming alliance. Both indigenous and genetically enhanced crop strains were utilized by 59% of the surveyed cultivators. Among the accessible crop variants, the TMS4(2)142 and TMS 3419 strains dominated usage rates at 57% and 60%, respectively. Output efficiency averages stood at 11.86 for the ADP cohort and 10.95 for the independent group. Regression analysis highlighted that age, plot dimensions, and cultivation history were the primary catalysts driving ADP participant output. Conversely, age and family size emerged as the core determinants of success for the independent demographic. Crucially, the Chow's F statistic calculation demonstrated a 1% significance level, solidly confirming that ADP-driven cassava methodologies wield a tangible and meaningful impact on the overall productivity of the participating female farmers.

Introduction

Occupying a sprawling expanse of roughly 98.3 million hectares, the Federal Republic of Nigeria houses a heavily rural demographic numbering near 150 million people, distributed across an intricate tapestry of 350 ethnic classifications. Geographically, the nation spans an estimated 1,200 kilometers from its eastern to western borders and stretches 1,500 kilometers north to south. The territory is immensely rich in natural capital, boasting massive petroleum reservoirs and diverse solid mineral deposits. Its hydrological assets are similarly formidable, encompassing 268 billion cubic meters of accessible surface water and 58 billion cubic meters of subterranean reserves. Coupled with a sweeping coastline and substantial annual precipitation volumes ranging from 300 to 400 million meters, the geographical landscape theoretically provides the ideal physical and human infrastructure necessary to catalyze explosive growth within its agrarian economy.

In stark contrast to this profound resource abundance, the nation's workforce registers among the least efficient globally. Even with national revenues and wealth generation exceeding the 300 billion US Dollar mark since the 1970s, widespread economic hardship persists; notably, average per capita earnings hovered at a mere ₦1,078 as recently as 2009. Because non-petroleum export contributions remain marginal, the nation's financial inflows are perilously tethered to the volatility of global oil and gas markets. Consequently, federal fiscal frameworks, inextricably linked to these commodity prices, suffer from corresponding economic turbulence.

Historically, the Nigerian agricultural landscape has been dominated by fragmented, small-scale subsistence farming. This structural bottleneck severely restricts profit margins, effectively locking cultivators out of accessing advanced, high-yield technologies and perpetually

depressing crop outputs. Depleted incomes inherently choke off farm-level reinvestment, trapping communities in what is widely recognized as the vicious cycle of poverty.

To dismantle this cycle and breathe vitality back into the agricultural sector, successive Nigerian administrations have launched an array of strategic interventions and revitalization programs over the decades. Standing at the forefront of these initiatives is the Agricultural Development Programme (ADP), initially propelled through a collaborative funding matrix involving the World Bank, the Federal Government, and respective State administrations.

The ADP represents arguably the most aggressive strategy mobilized by the Nigerian government to modernize the agrarian economy, functioning as the core engine for direct public financial injection into smallholder farming. The program's architectural blueprint aimed to overhaul archaic cultivation practices and amplify output by equipping farmers with vetted, high-performance methodologies, streamlining the acquisition of farming inputs, and erecting necessary rural infrastructure (Mdoda et al., 2026).

To hit these ambitious targets within the crop cultivation sphere, the ADP typically deployed frameworks such as On-farm Adaptive Research (OFAR) alongside the Small Plot Adoption Technique (SPAT). These strategies were systematically integrated into the broader Training and Visits (T & V) extension paradigm. Within this system, designated male and female "contact farmers" acted as the vital conduits for all extension activities. A contact farmer is defined as a forward-thinking, adaptable cultivator who receives specialized instruction from a Village Extension Agent (V.E.A) regarding novel agricultural practices. These individuals are subsequently tasked with disseminating this newly acquired knowledge to their agrarian peers across rural localities.

Despite the crucial, and often disproportionate, contributions made by female contact farmers to the agricultural ecosystem, these women frequently operate under severe systemic disadvantages. Their ability to secure adequate healthcare, educational advancement, financial credit, extension support, and advanced training remains critically constrained. Documentation from the World Bank attributes this discrepancy to deeply entrenched cultural, regulatory, and structural blockades that systematically relegate the socio-economic standing of female cultivators below that of their male counterparts.

The cumulative effect of these barriers has engineered a scenario wherein female farmers exhibit a forced reliance on men, cementing a rigid gender-based segregation within the division of

labour. Male figures overwhelmingly maintain absolute control over familial land holdings, capital generation, and the physical labour of the women within the household. This dynamic intentionally curtails women's mobility, stunting their ability to embrace innovative concepts, cultivate professional networks, or secure non-domestic employment. As a direct result, the dividends of localized economic progression are disproportionately harvested by men. The intensity of this rural impoverishment reaches its absolute peak within polygamous familial structures, a reality that inflicts severe hardship upon countless women traversing both the rural and urban geographies of the country (Agbugba et al., 2025).

Zooming in on the specific agrarian profile of Benue State, the ADP deliberately pivoted its resources toward cultivators of *Manihot esculenta*—cassava. This strategic prioritization stemmed from several undeniable advantages inherent to the crop:

First, it holds unquestionable dominance across Benue State's agricultural hierarchy.

Second, the region maintains zero cultural or social prohibitions regarding its cultivation.

Third, surging global demand for ethanol-based biofuels has radically elevated the crop's international market value.

Finally, the Federal Republic of Nigeria possesses a distinct comparative advantage, holding the intrinsic capacity to cultivate the root at a markedly lower opportunity cost relative to global competitors.

The ADP explicitly outlined granular objectives specifically tailored for these cassava cultivators. The goals included expanding the footprint of extension services directly into remote rural enclaves; rigorously training and motivating cultivators to integrate advanced methodologies spanning cultivation, processing, and commercial utilization; and underwriting localized research to engineer sustainable technological solutions for tasks exclusively handled by these farmers. Additional mandates involved upskilling farmers in lucrative income-generating ventures by promoting the establishment of cooperative societies—entities designed to consolidate power and facilitate the acquisition of robust operational skills. Finally, the framework demanded aggressive liaison and partnership with domestic and global agencies operating parallel agricultural support networks.

Derivatives of the cassava crop play an indispensable role in securing rural incomes and sustaining daily livelihoods, while simultaneously forming the bedrock of urban food security.

Nevertheless, female cultivators face highly discouraging hurdles when attempting to scale their operations. Often, farmers fortunate enough to yield surplus crops find themselves forced to liquidate their harvests within chaotic, unregulated markets. Because they cannot dictate equitable pricing structures for their commodities, this dynamic fundamentally accelerates their trajectory toward poverty. Driven by these realities, this scholarly investigation aims to robustly evaluate how ADP-sponsored cassava methodologies influence both the efficiency metrics and the economic well-being of female cultivators within the targeted region. The research further intends to juxtapose the productivity and poverty profiles of ADP-affiliated women against those operating entirely outside the program's umbrella.

To systematically tackle gender disparities, the ADP launched the Women in Agriculture (WIA) subdivision in 1990. The overarching mission of the ADP remained focused on elevating both the output capacity and the domestic living standards of farming households. The WIA module, however, was precision-engineered to confront the distinct obstacles facing female farmers. It directed 70% of its focus toward primary cultivation mechanics and allocated the remaining 30% to post-harvest processing methodologies. The stated aims of the WIA mirrored the broader ADP mandates: broadening rural extension access, compelling women to embrace modern processing and farming techniques, financing targeted research for female-dominated agricultural tasks, and heavily incentivizing the formation of female-centric cooperatives. Cross-collaboration with international entities dedicated to women's empowerment also remained a core priority. The ultimate metric for success was a tangible elevation in agrarian income streams, sparking a direct improvement in household welfare.

Since its inception, the Benue State WIA extension has aggressively deployed a spectrum of innovations directly to local women. These include localized yam minisett technologies; comprehensive agroforestry systems encompassing apiary management, honey extraction, heliculture (snail farming), and fungal cultivation; optimized seed variants across maize, soy, rice, peanut, and cassava crops; sophisticated FADAMA protocols detailing water pump operations and tube well management; integrated intercropping systems blending yams, cassava, maize, and melon; and crucial post-harvest blueprints covering advanced packaging, secure storage, and streamlined commercial marketing tactics.

The central objectives underpinning this research are articulated as follows:

- i. To systematically outline the socio-economic profiles of female cassava cultivators operating within the specified geography.
- ii. To catalog and thoroughly evaluate the spectrum of cassava cultivation technologies presently accessible in the targeted area.
- iii. To mathematically gauge and compare the exact productivity thresholds distinguishing ADP-supported female cassava farmers from their independent counterparts situated within Benue State's Northern agricultural quadrant.

METHODOLOGY

The geographical anchor for this investigation was the Northern Agricultural Zone of Benue State, a territory situated strictly between latitudes 6°50' North and longitudes 7°50' to 10° East. This quadrant encompasses a sweeping landmass totalling roughly 10,318.2 km², sustaining an estimated demographic of 959,512 individuals. Administratively, the territory is segmented into seven Local Government Areas (LGAs): Gboko, Buruku, Guma, Makurdi, Gwer East, and Gwer West. The climatic profile is decidedly tropical, divided rigidly into a wet and a dry season. The rains arrive in April and persist through October, while arid conditions dominate from November through March. Precipitation patterns reveal a dual-peak structure, delivering a cumulative annual rainfall averaging 1500 mm. The initial, milder peak materializes between May and June, followed by a significantly heavier deluge stretching across August and September. Post-precipitation, the region endures three to four months of aridity, characterized intensely by the presence of harsh harmattan winds spanning December to March. Temperature averages sit at roughly 28°C during the monsoon months, spiking to an average of 35°C during the arid season. Agrarian pursuits overwhelmingly dictate the occupational framework of the populace.

To curate an optimal sample base, the research deployed a highly structured, multi-stage random sampling protocol. The foundational stage involved an intentional, purposive extraction of three cassava-heavy LGAs from the northern quadrant—specifically Gwer-West, Makurdi, and Gwer East. The secondary phase executed a randomized selection of two distinct communities located within each of these three LGAs, generating an operational matrix of six communities. In the final stage, a proportionate sampling strategy isolated five female farmers integrated into the ADP's WIA framework alongside five independent female farmers from two villages within each selected community. This meticulous alignment produced an equal split of 60 ADP affiliates and 60 non-affiliated individuals, resulting in a robust, cumulative sample pool of 120 respondents.

Information gathering relied upon a hybrid of secondary literature and primary empirical data, with the latter captured through rigorously pretested, highly structured questionnaires.

The subsequent data refinement processes utilized descriptive statistical parameters—such as percentage distributions, frequencies, averages, and visual charting—merged seamlessly with complex econometric mechanisms including Z-tests, Total Factor Productivity (TFP) indexing, chi-square evaluations, and Chow test applications.

The initial objective, focused on detailing respondent socio-economics, was resolved via straightforward descriptive tools including charts, averages, and percentage matrices. The second objective, aimed at auditing the availability of regional cassava technologies, similarly leveraged averages, visual data, and frequency tables. The critical third objective, juxtaposing the output efficiency of the two cultivator groups, was executed using the TFP mathematical framework alongside Z-test diagnostics.

$$\text{Total factor productivity} = \left(\frac{\text{total outputs}}{\text{total inputs}} \right) \text{measured in naira} \quad - \quad - \quad - \quad (3.1)$$

Z-Test

The model is given as:

$$Z = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad \text{-----} \quad (3.2)$$

$$\mu_1 = 0$$

$$\mu_2 = 0$$

$$Z = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad \text{.....} \quad (3.3)$$

z = z-test

x = mean

s = standard deviation.

n = sample size.

The ordinary least square regression method was used in examining the factor affecting the productivity of the respondents. The Total factor productivity as used by Anyaegbunam, (2021), is specified as:

$$Y = (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9,)$$

Y = Total factor production = $(\frac{\text{total outputs}}{\text{total inputs}})$ measured in naira.

X_1 = Age of the farmer (years).

X_2 = Farmer's education (years)

X_3 = Household size of the farmer.

X_4 = Farm size (hectare).

X_5 = Farmer's experience (number of years of farming).

X_6 = Labour cost (measured in naira ₦)

X_7 = Capital inputs (depreciation on fixed inputs, taxes, rent, interest and insurance measured in naira ₦)

X_8 = Fertilizer (kg)

X_9 = Access to credit (measured in naira ₦)

This same model will be used for Non-ADP Farmers

Determinants of productivity among ADP beneficiaries and non-ADP beneficiaries (pooled with dummy)

$$Y = (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10})$$

Y = Total factor production = $(\frac{\text{total output}}{\text{total input}})$ measured in naira, ₦.

X_1 = Age of the farmer (years).

X_2 = Farmer's education (years)

X_3 = Household size of the farmer.

X_4 = Farm size (hectare).

X_5 = Farmer's experience (number of years of farming).

X_6 = Labour cost (measured in naira ₦)

X_7 = Capital inputs (depreciation on fixed inputs, taxes, rent, interest and insurance measured in naira ₦)

X_8 = Fertilizer (kg)

X_9 = Access to credit (measured in naira ₦)

X_{10} = Dummy variable (ADP 1, NON-ADP 0)

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents

The demographic and socio-economic frameworks of the surveyed women were comprehensively audited, with the ensuing data visualized in the appended matrices.

Table 1: Socio-economic characteristics of respondents

Variable	ADP Farmers		Non-ADP Farmers		Pooled	
	Freq.	%	Freq.	%	Freq.	%
Age (Years)						
15 – 18	-	-	2	3.33	2	1.67
19 – 22	-	-	5	8.33	5	4.17
23 – 26	2	3.33	3	5.00	5	4.17
27 – 30	5	8.33	5	8.33	10	8.33
31 -34	10	16.67	4	6.67	14	11.67
35 -38	10	16.67	6	10.00	16	13.33
39 -42	9	15.00	13	21.67	22	18.33
43 -46	4	6.67	6	10.00	10	8.33
47 -50	7	11.67	6	10.00	13	10.83
51 -54	5	8.33	2	3.33	7	5.83
55 -58	5	8.33	4	6.67	9	7.50
59 – 62	3	5.00	2	3.33	5	4.17
63 -66	-	-	-	-	-	-
67 – 70			2	3.33	2	1.67
Total	60	100	60	100	120	100
Mean	41.53			39.70		40.62
Marital status						
Single	10	16.67	4	6.67	14	11.67
Married	36	60.00	42	70.00	78	65.00
Divorced	3	5.00	4	6.67	7	5.83
Widowed	11	18.33	10	16.67	21	17.50
Total	60	100	60	100	120	100

Educational level						
No formal education	10	16.67	10	16.67	20	16.67
Primary	8	13.33	10	16.67	18	15.00
Secondary	12	20.00	17	28.33	29	24.17
Tertiary	30	50.00	23	38.33	53	44.17
Total	60	100	60	100	120	100
Farming experience (Years)						
1 – 5	30	50.00	32	53.33	62	51.67
6 – 10	9	15.00	11	18.33	20	17.50
11 – 15	11	18.33	3	5.00	14	12.50
16 – 20	4	6.67	8	13.33	12	9.17
21 – 25	1	1.67	-	-	1	1.67
26– 30	1	1.67	4	6.67	5	5.83
31 – 35	1	1.67	1	1.67	2	0.83
36 – 40	-	-	1	1.67	1	0.83
Total	60	100	60	100	120	100
Mean	9.05		9.90		9.48	

Source: Field Survey, 2025

Analysis of the age demographics within Table 1 reveals that ADP participants operating within the age brackets of 35-38 and 39-42 (effectively the 31-42 range) absolutely dominated the cultivation sphere, accounting for 48.34% of that cohort. Within the independent faction, individuals aged between 39 and 50 years formed the majority block, representing 41.67% of those respondents. When viewed collectively, the 31-42 age bracket constituted 43.33% of the entire study base. ADP subjects recorded a mean age of 41.53 years, slightly older than the 39.70-year average observed in the independent group. The combined average rested precisely at 40.62 years. These metrics unequivocally indicate that these women are actively operating within their most productive biological window, retaining the physical vitality necessary to execute the strenuous physical demands inherent to root crop farming. Given that chronologic maturity deeply correlates with active capacity, farming efficiency theoretically scales upward with age, as the cultivator accumulates irreplaceable hands-on experience. Naturally, as advanced old age approaches, physiological limitations trigger a gradual decay in output. The data effectively validates that a massive 48.34% of the ADP cultivators are situated safely within

this optimal, high-yield biological phase. This age matrix is critically important because deep rural agriculture remains heavily dependent upon manual human labor, heavily favoring younger, physically resilient bodies.

Turning to relationship statuses, the metrics overwhelmingly confirmed that legally married women monopolized the local cassava industry, representing 60% of the ADP group and an even steeper 70% of the independent group. Across the aggregate sample, married individuals comprised 65% of the total demographic. The dominance of married women in this economic sector is largely driven by pressing familial obligations, requiring them to actively subsidize household economies while offering critical manual labor directly on their husbands' plots. The direct correlation between marital status and elevated productivity is primarily rooted in labor dynamics; spousal and child contributions drastically amplify the raw volume of domestic labor injected into the farm.

Regarding educational backgrounds, an impressive 70% of the ADP-supported women successfully completed secondary and tertiary schooling, a figure slightly surpassing the 66% recorded among their independent peers. Across the entirety of the sample pool, 68.34% demonstrated advanced academic backgrounds. This elevated literacy rate is a powerful metric, strongly suggesting that these women possess the intellectual agility to actively identify, comprehend, and seamlessly adapt to modern technological interventions. Education functions as a foundational pillar for technological integration. Academic instruction acts as a direct capital investment into human potential, sharpening technical aptitudes and analytical capacities. Consequently, an educated farming demographic enjoys maximized operational efficiency, driving up monetary yields while simultaneously suppressing localized poverty markers. Because the ADP demographic exhibits a marginally higher literacy threshold than their independent counterparts, they are theoretically better equipped to weaponize modern techniques to catalyze economic growth. Elevated literacy guarantees fluid access to complex informational networks, empowering cultivators to dissect farm-level crises with objective precision.

Examining the agrarian experience timelines, the metrics demonstrated that an overwhelming majority of the participants—83.33% within the ADP faction and 76.66% within the independent bracket—possessed between 1 and 15 years of active farming history. On an aggregate level, this experience bracket accounted for 81.67% of all surveyed women. The precise numerical average for field experience sat at 9.05 years for the ADP members and 9.90 years for the independent cultivators, culminating in a synthesized mean of 9.48 years. Because experiential learning

provides invaluable practical schematics for managing volatile field conditions, the data suggests both groups are highly capable. Veteran cultivators consistently outperform novices in risk management protocols. If leveraged appropriately, this repository of experiential knowledge serves as a potent vehicle for eradicating poverty and elevating output standards for both immediate households and broader communities. Nevertheless, extended experience occasionally manifests as a restrictive liability, creating stubborn psychological barriers that prevent older cultivators from discarding obsolete methods in favor of high-efficiency innovations. Thus, while deep experience is highly beneficial, it must be paired with an ongoing willingness to absorb contemporary methodologies. Prolonged immersion in the agrarian sector primarily equips the cultivator with the reactive instincts necessary to neutralize localized production hurdles.

Cassava Technologies Available

Integrating heavy and light technology into row crop farming has fundamentally catalyzed output volumes globally. Driven by this reality, Benue State's central ADP apparatus deployed a vast portfolio of tools and genetic materials designed to scale the commercial viability of female operators. The precise allocation and availability of these specific interventions are detailed extensively below.

Table 2: Distribution of Respondents according to Cassava Technologies Available

S/N	Cassava technologies	ADP farmers		NON-ADP farmers		pooled	
		AVAILABLE	NOT AVAILABLE	AVAILABLE	NOT AVAILABLE	AVAILABLE (PERCENTAGE)	NOT AVAILABLE (PERCENTGE)
1	TMS4(2)142	60	-	40	20	100	20.00
2	TMS 30555	56	4	41	19	97.00	23.00
3	TMS 3419	57	3	39	21	96.00	24.00
4	NR 7221	49	11	21	39	70.00	50.00
5	NR 7706	13	47	21	39	34.00	86.00
6	FRYER	56	4	38	22	94.00	26.00
7	PRESSER	59	1	40	20	99.00	21.00
8	GRATER	60	-	38	22	98.00	22.00
9	DRYER	43	17	33	27	76.00	44.00

Source: Field Survey Data, 2025

The distribution metrics strictly indicate massive integration rates among the ADP cohort, showcasing that 60%, 60%, 59%, and 57% possessed direct, unimpeded access to the TMS4(2)142 strain, industrial graters, mechanical pressers, and the TMS 3419 variant respectively. The immense popularity of the TMS4(2)142 and TMS 3419 genetic strains is

heavily predicated upon their engineered biological resistance to shifting climate variables, endemic pests, and fungal diseases, tightly coupled with their massive yield payloads and radically compressed gestation timelines. The ubiquity of graters and pressers is primarily a byproduct of their localized affordability and their absolute necessity during the starch extraction phase. By contrast, independent farmers demonstrated lower integration, with only 41%, 40%, 40%, and 39% successfully securing access to TMS 30555, TMS4(2)142, mechanical pressers, and TMS 3419, respectively.

The technological ecosystem within the Benue geography is heavily saturated with elite cultivars developed directly by the International Institute for Tropical Agriculture, predominantly featuring the highly successful Tropical Manioc Selection (TMS) lineage. The most heavily trafficked genetic variants currently embedded within the state include TMS 4(2)142, TMS 30555, TMS 30572, and TMS 3419, functioning alongside alternative strains like NR7221 and NR7706. Specifically, female operators heavily preferred the TMS 30572 variant to produce premium-grade garri and akpu, ensuring its dominant geographical footprint across the surveyed zones. Hardware mechanization throughout the processing hierarchy remains critical, with local infrastructures leaning heavily upon automated fryers, hydraulic pressers, motorized graters, and thermal dryers.

TOTAL FACTOR PRODUCTIVITY

Researchers executed a mathematically precise evaluation of output efficiency across the entire geographic sample. This index was strictly calculated by contrasting the ultimate financial value of all yielded crops against the cumulative capital and labour inputs injected during the growing cycle.

Table 3: Distribution of Respondents according to their Productivity Levels

Productivity level	ADP farmers		Non-ADP farmers		Pooled	
	Freq.	percentage	Freq.	percentage	Freq.	percentage
0.1 – 10.0	29	48.33	34	56.67	63	52.50
10.1 – 20.0	28	46.67	19	31.66	47	39.17
20.1 – 30.0	2	3.33	2	3.33	4	3.33
30.1 – 40.0	-		3	5.0	3	2.50
40.1 – 50.0	-		1	1.67	1	0.83

50.1 – 60.0	-		1	1.67	1	0.83
60.1 – 70.0	-		-			
70.1 – 80.0	-		-			
80.1 – 90.0	1	1.67	-		1	0.83
TOTAL	60	100	60	100	120	100
MEAN	11.86		10.95		11.40	
STDEV	10.43		10.69		10.52	

Source: Computed from Field Survey Data, 2025

The arithmetic averages derived from the productivity calculations settled at 11.86 for the ADP participants, marginally outperforming the 10.95 recorded for the independent segment, generating an overarching average of 11.40. An overwhelming 94.90% of the ADP operatives operated strictly within the 0.1 to 20.0 output spectrum. Parallel to this, 88.33% of the non-affiliated farmers, alongside 91.67% of the total demographic pool, remained clustered within this identical 0.1 to 20.0 bracket. This heavy concentration strongly suggests highly optimized resource-to-tuber conversion protocols, heavily bolstered by the sheer geographic scale and intrinsic soil fertility characteristic of the Benue basin. Amplifying national agricultural output remains the foundational catalyst required to ignite genuine macro-economic evolution and stabilization across the nation. Furthermore, optimized farm-level output serves as the most potent mechanism for permanently eroding the poverty metrics crippling rural demographics.

Table 4: Comparing Productivity Levels of ADP and non-ADP using Z-test statistics

PAIRED SAMPLE STATISTICS					
	MEAN	N	STD DEVIATION		
NADP	12.9677	60	18.82642		
ADP	12.96808	60	11.56615		
PAIRED SAMPLE CORRELATION					
		N	CORRELATION	SIGNIFICANCE	
PAIRED 1	NADP & ADP	60	-0.140	0.286	
PAIRED SAMPLE TEST					
	MEAN	STD.DEV	T	DF	SIGNIFICANCE 2-TAILED

PAIRED	NADP-ADP	0.28692	23.43332	0.095	59	0.925
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Source: Computed from Field Survey Data, 2025

The mathematical deployment of the Z-test, engineered specifically to map the precise output deviations between the affiliated and independent factions, yielded a calculated \$Z\$ score of 0.926. Because this derived figure sits decisively below the formal tabulated baseline of 1.98, the statistics strictly assert that no statistically meaningful divide exists separating the raw productivity metrics of the two groups. Based on this irrefutable numeric reality, the secondary research hypothesis was unequivocally validated and accepted.

Determinant of Productivity

The analytical engine advanced into an Ordinary Least Squares (OLS) multiple regression matrix to isolate exactly which independent factors truly dictated the output trajectories of the targeted cultivators. The premier regression equation was carefully isolated after evaluating a stringent set of diagnostics, including the multiple determination coefficient (R^2), specific algebraic parameter signs, coefficient metrics, and an overriding statistical significance ceiling set at 1%, guaranteeing that every selected variable integrated flawlessly into the predictive model.

Table 5: Multiple Regression Result on Determinants of Productivity of ADP, NON-ADP and Pooled using double-log

	ADP FARMERS		NON-ADP FARMERS		POOLED WITH DUMMY VARIABLE	
Variables	Double log		Double log		Double log	
	Coefficient	t. value	coefficient	t. value	Coefficient	t. value
Constant	7.886	1.491	-2.719	1.0052	0.075	0.050
(S.E)	(5.291)		(2.585)		(1.5001)	
Age (X_1)	-0.955	2.776***	1.191	2.111**	0.044	0.147
	(5.291)		(0.564)		(0.301)	
Education (X_2)	-0.036	0.437	0.087	0.543	0.154	1.847
	(0.82)		(0.160)		(0.083)	
Household size (X_3)	0.167	0.649	-0.920	2.388**	0.409	1.703
	(0.288)		(0.385)		(0.240)	
Farm size (X_4)	-0.392	2.163**	0.052	0.180	-0.409	1.703
	(0.181)		(0.292)		(0.240)	
Experience (X_5)	0.172	2.020**	0.010	0.050	0.234	1.957
	(0.085)		(0.193)		(0.119)	
Labour (X_6)	0.014	0.629	-0.043	1.338	-0.035	1.740

	(0.022)		(0.032)		(0.020)	
Capital inputs (X_7)=	0.061 (0.148)	0.415	0.191 (0.258)	0.739	0.156 (0.144)	1.078
Fertilizer (X_8)	0.075 (0.127)	0.589	0.017 (0.039)	0.0424	-0.025 (0.029)	0.876
Credit (X_9)	-0.319 (0.468)	0.681	0.030 (0.052)	0.576	0.068 (0.036)	1.888
Dummy variable (X_{10})	-	-	-	-	-1.496 (0.533)	2.804***

Diagnostic statistics

R^2	0.263	0.279	0.218
Adjust	0.130	0.149	0.146
Df	9	9	10
Observation	60	60	120
F-statistic	1.981**	2.151**	3.035***

Source: Computed from Field Survey Data, 2025 + lead equation, *** significant at 1%, ** significant at 5%
The isolated R^2 matrices registered distinct readings of 0.263, 0.279, and 0.213. This mathematical translation indicates that shifting dynamics embedded within the predictive model directly govern 26.30% of the output variance among ADP members, 27.90% among independent operators, and 21.30% across the consolidated aggregate. Age proved to be a highly potent variable, demonstrating absolute statistical impact at the 1% boundary for the ADP cohort and the 5% boundary for the independent group. This directly aligns with overarching academic consensus postulating that advancing age forces an upward swing in farm-level capability, as the prolonged passage of time guarantees that the operator thoroughly masters the nuanced mechanics of local agriculture. Historical observations validate this robust correlation, confirming that veteran cultivators wildly outpace younger operators purely due to extensive, unbroken years embedded within the field. Contradictory academic thought, however, proposes an inverse correlation, arguing that physical degeneration inevitably strips the elderly operator of the sheer kinetic energy required to sustain heavy yields.

The total count of individuals residing within the family structure manifested a 5% significance threshold exclusively within the independent, non-ADP demographic. This metric highlights that expanding domestic populations inherently escalate total crop yields. This logic is anchored in the reality that rural cultivators consistently tap their own family members for manual field labor rather than exhausting limited financial reserves on external, salaried farmhands. Expansive

households effectively trigger a massive influx of free domestic labor, thereby scaling field capabilities and aggressively stripping away localized poverty markers.

Total land mass cultivation parameters similarly showcased a 5% statistical significance, though entirely restricted to the ADP-supported fraction. This clearly illustrates that expanding the sheer physical footprint of the active farm directly accelerates productivity parameters. This particular observation fiercely contests parallel scholarly literature that posits a strict negative correlation between massive land banks and overall operational efficiency, a dynamic typically triggered by the severe lack of access to institutional credit and crippling market bottlenecks encountered when attempting to move immense crop volumes.

Cumulative agricultural experience likewise registered heavily, hitting the 5% significance barrier solely for the ADP group. This outcome explicitly confirms that an extended chronological footprint within the root crop sector smoothly translates into escalated operational output. Deep experience inherently forces operators to internalize and execute highly modernized techniques, fundamentally restructuring and optimizing their entire operational philosophy. The binary dummy variable exhibited massive force, clearing the 1% significance hurdle within the consolidated data pool, definitively proving that both ADP participation and independent status violently warp total cohort productivity metrics.

The specific Chow test calculation was executed mathematically as follows:

Where,

$$F = \frac{[(\sum e_3^2 - (\sum e_1^2 + \sum e_2^2))]K_3 - K_1 - K_2}{(\sum e_1^2 + \sum e_2^2)/K_1 + K_2}$$

$$\sum e_3^2 \text{ And } K_3 \text{ (POOLED)} = 22.368 \text{ and } 10$$

$$\sum e_2^2 \text{ And } K_2 \text{ (NON-ADP)} = 22.027 \text{ and } 9$$

$$\sum e_1^2 \text{ And } K_1 \text{ (ADP)} = 5.158 \text{ and } 9$$

$$F = \frac{[(22.368 - (5.158 + 22.027))10 - 9 - 9]}{\frac{(5.158 + 22.027)}{9 + 9}}$$

$$F = \frac{-12.817}{1.510} = -8.488$$

$$F = -8.488***$$

This Chow test mechanism was deployed intentionally to capture the exact magnitude to which program-sponsored technologies influenced output metrics spanning both divided demographics within the Benue geography. The core utility of the Chow model rests entirely in its capacity to verify parameter equilibrium across split matrices. The foundational null hypothesis operated on the premise that all overarching parameters maintained perfect equilibrium, suggesting that every independent variable generated perfectly identical ripple effects across both distinct cultivator populations.

The operative hypothesis scrutinizing program engagement initially anticipated absolutely zero divergence in operational output among the targeted women. However, the calculated Chow F-statistic unequivocally shattered this assumption, registering heavily at the 1% significance marker while indicating a decidedly negative correlation trajectory against raw productivity. This severe mathematical deviation emphatically proves a massive structural gulf separating the actual performance ceilings of the ADP operatives from their non-affiliated counterparts. In light of this glaring statistical discrepancy, the core null hypothesis claiming operational uniformity was entirely rejected and discarded.

CONCLUSION AND RECOMMENDATIONS

Synthesizing the exhaustive analytical data generated through this investigation, it is definitively established that the structural interventions supplied through the Agricultural Development Programme (ADP) exert a profound and highly measurable force upon the ultimate yields generated by female cultivators operating across Benue State. Conclusively, operators functioning beneath the ADP umbrella operate at a much higher tier of efficiency relative to independent actors, though paradoxically, the crippling poverty metrics suffocating both populations stubbornly refuse to recede.

Guided strictly by the analytical footprint of the research, the following strategic remedies are advanced.

- i.** Aggressive, highly subsidized financial credit pipelines must be engineered specifically for female agricultural operators. Due to their distinct vulnerability to economic shocks, fluid capital access remains the only mechanism allowing them to secure premium inputs and seamlessly absorb inevitable operational crises.
- ii.** Operators must face intense institutional encouragement to forge new cooperative conglomerates or aggressively merge into pre-existing communal structures. This consolidation

allows for the mass pooling of scattered capital, positioning them perfectly to intercept and monopolize external developmental grants. Accompanying this must be draconian administrative oversight, permanently neutralizing any attempts to bleed agricultural funding streams toward non-commercial expenditures.

iii. The highly volatile independent variables driving efficiency spikes—specifically operator age, sheer household density, and geographic farm expanse—must be permanently woven into the architectural fabric of future macro-economic policy frameworks affecting both affiliated and independent populations.

iv. Heavily synchronized state actions must be deployed strictly to skyrocket gross root crop output. This absolute volume scale-up is universally required to quench the escalating domestic demand curves and guarantee robust food security parameters across the immediate local geography and the broader Federal Republic.

v. While output metrics among these operators are undeniably impressive, the demographics remain violently impoverished, severely lacking foundational civic infrastructure. State architecture alongside allied extension networks must rapidly install baseline public utilities to drastically suppress localized overhead costs. Concurrently, federal security apparatuses must immediately deploy heavily armed perimeter defenses to permanently neutralize the catastrophic physical and financial damages continually inflicted by nomadic pastoralists breaching established agricultural boundaries.

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