International Journal of Trendy Research in Engineering and Technology
Volume 10 Issue 4 August 2026
ISSN No. 2582-0958

FORECASTING CERTIFIED SEED PRODUCTION AND DEMAND IN NIGERIA: ECONOMETRIC MODELS AND POLICY SCENARIOS FOR 2026-2035

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Received 13 July 2026 Received in revised form 18 July 2026 Accepted 21 July 2026
Available Online 23 July 2026

ABSTRACT

Nigeria's certified seed sector represents one of the foundational pillars of agricultural transformation, yet persistent structural imbalances between supply and effective demand continue to undermine food system resilience. This paper develops and validates a suite of univariate and multivariate time-series forecasting models using 19 years of certified seed production data (2007-2025) sourced from the National Agricultural Seeds Council (NASC), covering ten crop categories totalling 122,544 metric tonnes (MT) in 2025. Employing Holt-Winters exponential smoothing, ordinary least squares trend regression, and scenario-differentiated projections, the analysis generates baseline, optimistic, and pessimistic forecasts through 2035 for total production and for the two dominant commodities, maize and rice. Model diagnostics confirm that Holt-Winters outperforms linear regression on a three-year hold-out, recording a Mean Absolute Percentage Error of 11.9% compared to 30.9% under OLS. Under the baseline scenario, total certified seed production is projected to reach 143,624 MT by 2035, a 17.2% increase over 2025 levels. Under optimistic assumptions, output could reach 243,324 MT, while the pessimistic path signals contraction to 101,153 MT. Critically, even the baseline trajectory falls 56,376 MT short of the NASC 2030 strategy target of 200,000 MT, underscoring the investment urgency. Demand-side modelling, anchored in population growth at 2.4% annually and progressive certified seed adoption rates, reveals that supply consistently exceeds national certified seed production figures, but structural accessibility and quality assurance gaps mean effective supply falls critically short. The paper proposes scenario-specific investment priorities, early generation seed (EGS) scaling, data infrastructure improvements, and private sector mobilisation strategies aligned with the 2025-2030 Seed Sector Strategy.

Keywords: Seed forecasting, ARIMA, Holt-Winters, VAR, policy scenarios, Nigeria seed strategy, certified seed production, food security, time-series analysis

1. INTRODUCTION

1.1 Background and Urgency

Agriculture accounts for approximately 22-25% of Nigeria's gross domestic product and employs more than 70% of the rural labour force yet yield gaps across major staple crops remain stubbornly wide relative to achievable potential under improved varieties and proper agronomic practices [1]. At the core of this gap is a chronic deficit in the availability, affordability, and uptake of certified quality seed. Certified seed serves as the primary delivery mechanism for varietal genetic gains achieved through national and international plant breeding programmes, making seed system performance a rate-limiting constraint on broader agricultural productivity [2,3].

Nigeria's formal seed system has undergone significant institutional evolution over the past two decades, anchored by the National Agricultural Seeds Council Act of 2019, which repealed and replaced the National Agricultural Seeds Decree of 1992 and repositioned NASC as the apex regulatory and coordinating body for seed quality assurance, variety registration, and seed production oversight [4]. Despite this regulatory strengthening, the 2025 Seed Sector Strategy acknowledged substantial unmet demand, estimating that certified seed penetration rates for major crops remain below 15% of total area planted nationally, against a target of 35-50% by 2030 [5].

The 19-year production record from NASC (2007-2025) reveals a dramatically non-linear trajectory. Total certified seed output surged from just 10,122 MT in 2007 to a peak of 178,057 MT in 2014, driven largely by public subsidisation programmes including the Growth Enhancement Support (GES) Scheme and the Anchor Borrowers' Programme (ABP), which created significant but sometimes artificial production incentives. The post-2014 period saw a sharp contraction, with output falling to 73,083 MT in 2017 as subsidy regimes were restructured. A partial recovery brought total production to 133,399 MT in 2024, before a modest decline to 122,544 MT in 2025. This volatility reflects the systemic vulnerability of the Nigerian seed sector to policy discontinuities, input financing disruptions, and climate-related shocks, all of which must be explicitly modelled in any credible forward-looking analysis.

Two crops dominate the production landscape: maize and rice collectively accounted for 73.7% of all certified seed production in 2025, at 47,802 MT and 42,563 MT respectively. Wheat certified seed production registered a dramatic surge from just 83 MT in 2024 to 14,762 MT in 2025, a development likely linked to deliberate policy push under import substitution priorities. Soybean demonstrated steady growth with a three-year compound annual growth rate (CAGR) of 10.9%, while cotton continues a near-complete collapse from its 2013 peak of 13,189 MT to just 8 MT in 2025. These divergent trajectories across crop categories call for crop-disaggregated forecasting frameworks that can inform targeted rather than aggregate-level policy responses.

1.2 The Planning Gap

Nigeria's 2025 Seed Sector Strategy, prepared by FMAFS in collaboration with NASC, sets a sector-wide production target of 200,000 MT of certified seed annually by 2030 [5]. Under the baseline growth trajectory implied by recent historical data, total production is projected to reach approximately 132,666 MT by 2030, representing a gap of 67,334 MT relative to the strategy target. Closing this gap would require sustained annual investment in seed multiplication infrastructure, foundation and certified seed producer networks, irrigation for counter-season production, and quality assurance laboratory capacity. Without credible quantitative forecasts that delineate feasible from aspirational scenarios, investment planning remains anchored to arbitrary targets rather than evidence-based trajectories.

The broader context reinforces urgency. Nigeria's population, estimated at approximately 230 million in 2025 and growing at around 2.4% per year [6], will approach 291 million by 2035. Meeting the food security needs of this population within a context of constrained arable land expansion and accelerating climate variability will require substantial and sustained productivity gains, of which seed system performance is a prerequisite. The Malabo Commitments on ending hunger in Africa by 2025, the Comprehensive Africa Agriculture Development Programme (CAADP), and the Sustainable Development Goal 2 targets all implicitly depend on seed supply systems performing far above current baselines [7]. This paper pursues three specific objectives: (i) to develop and validate robust univariate and multivariate time-series models for forecasting total and crop-specific certified seed production up to 2035, using NASC production data spanning 2007-2025; (ii) to evaluate forecast accuracy through back-testing and generate scenario-based projections under baseline, optimistic, and pessimistic assumptions reflecting different policy and climate environments. (iii) to assess the gap between projected seed supply and Nigeria's expected seed demand linked to population growth and arable land dynamics, and to propose investment priorities and policy actions for the seed sector aligned with the NASC 2025-2030 Seed Sector Strategy.

1.4 Contribution and Scope

Beyond filling an important methodological gap in Nigeria-specific seed sector analysis, this paper contributes to the international literature on agricultural forecasting in data-constrained settings. The combination of exponential smoothing, trend regression, and deterministic scenario analysis offers a replicable approach for seed system planners in other Sub-Saharan African countries. The results are directly actionable for NASC's strategic planning, the Federal Ministry of Agriculture and Food Security's investment planning, development partner programming, and private sector seed company strategy. The scope is restricted to certified seed production data as recorded by NASC; informal or recycled farm-saved seed, which likely still accounts for most of the planting material used by smallholders, is addressed in the demand modelling section but is outside the production data envelope.

2. LITERATURE REVIEW

2.1 Agricultural Forecasting Methods and Applications

Time-series forecasting has a long and productive history in agricultural economics, with applications ranging from commodity price prediction to crop production planning and input supply optimisation. Box and Jenkins (1970) laid the foundation for the ARIMA modelling framework, which has since been applied extensively across agricultural systems. More recently, Harvey [8] demonstrated that structural time-series models with explicit trend and seasonal components often outperform pure ARIMA specifications on non-stationary agricultural series with structural breaks, a finding particularly relevant to the Nigerian seed production data, which exhibit clear regime changes post-2014.

Exponential smoothing methods, including the Holt-Winters approach, have received renewed attention in the forecasting literature following the M4 Competition findings, which showed that relatively simple methods with data-adaptive smoothing parameters frequently outperform sophisticated machine learning models on short univariate series [9]. This is highly germane to seed sector data, where time series are rarely longer than two to three decades and exhibit considerable volatility. Hyndman and Athanasopoulos [10] provide a thorough treatment of exponential smoothing within the broader exponential smoothing state space (ETS) framework, demonstrating its suitability for non-seasonal series with local trends.

For multivariate settings, Vector Autoregression (VAR) models capture dynamic interdependencies between seed production and its macroeconomic or climatic drivers. Jha et al. [11] applied VAR to Indian seed demand, identifying significant bidirectional relationships between certified seed production volumes, fertiliser availability, and crop output prices. Prophet, developed by Taylor and Letham [12] at Meta Research, offers a decomposable time-series framework that handles irregular trends, seasonality, and holiday effects in an intuitive way, and has been applied to food production forecasting in settings where data quality is moderate [13]. Monte Carlo simulation complements deterministic scenario modelling by propagating parameter uncertainty through forecast distributions, enabling fan-chart representations of forecast uncertainty that are particularly useful for investment planning [14].

Accuracy assessment remains a cornerstone of applied forecasting. Hyndman and Koehler [15] established the Mean Absolute Scaled Error (MASE) as a robust scale-independent metric, while MAPE and RMSE remain standard benchmarks for agricultural forecasting comparisons. The choice of evaluation metric matters: MAPE penalises large percentage errors and is undefined for zero-value observations, a consideration relevant to crops like cotton and wheat in the NASC dataset where production was zero in multiple years.

2.2 Seed System Forecasting in Sub-Saharan Africa

The seed forecasting literature specific to Sub-Saharan Africa is considerably thinner than the general agricultural forecasting literature, reflecting both data availability constraints and institutional capacity gaps. Takeshima et al. [2] conducted a comprehensive analysis of seed demand and supply across 13 African countries, finding widespread structural demand underestimation driven using outdated seeding rate assumptions and failure to account for adoption rate dynamics. Their analysis estimated that the continent-wide certified seed supply deficit exceeded 400,000 MT annually even under conservative adoption scenarios, with Nigeria identified as among the highest-deficit countries given population size and potential arable area.

Ndjeunga et al. [16] applied ARIMA models to millet and sorghum seed production data in the Sahel, documenting significant non-stationarity driven by rainfall variability and showing that climate-augmented dynamic regression models substantially reduced out-of-sample forecast error compared to univariate specifications. Their work underscores the importance of incorporating exogenous climate variables, particularly for dryland crops such as millet, sorghum, and groundnut that are well-represented in the NASC dataset.

Setimela et al. [17] evaluated maize seed systems in East and Southern Africa, documenting that seed supply projections embedded in national agricultural plans were consistently optimistic by 25-40% relative to achieved production, leading to recurring shortfalls that undermined extension service credibility and farmer trust in improved varieties. Their recommendation for scenario-based forecasting with explicit confidence intervals, rather than point forecasts tied to aspirational targets, directly motivates the methodological approach adopted in this paper.

2.3 Nigeria's Seed Sector: Structural Challenges and Policy Context

Nigeria's formal seed sector has been the subject of several diagnostic studies over the past decade. Jaleta et al. [18] documented that despite a formal certification system spanning foundation, registered, certified, and truthfully labelled seed classes, adulteration and counterfeit seed remain pervasive, with surveys suggesting that 30-60% of labelled certified seed in open markets fails quality standards. This quality assurance problem means that certified seed production statistics from NASC represent a regulatory upper bound on actual quality seed supply, and effective supply available to farmers is materially lower.

Takeshima et al. [19] examined the economics of certified seed production in Nigeria's maize belt, finding that seed multiplication margins had declined significantly following the GES scheme wind-down, and that only a fraction of the 2,000+ registered seed companies remained commercially active. Their analysis of seed company attrition rates, combined with the production data examined in this paper, explains much of the 2014-2022 output contraction and has direct implications for realistic calibration of optimistic growth scenarios.

The NASC 2025-2030 Seed Sector Strategy [20] identifies five strategic priorities: scaling EGS production through the National Centre for Genetic Resources and Biotechnology (NACGRAB) and National Root Crops Research Institute (NRCRI); strengthening the private sector seed company network; expanding quality assurance infrastructure; harmonising seed trade policies with ECOWAS seed regulations; and building digital seed tracking and traceability systems. These strategic priorities inform the policy scenario construction in this paper and provide the normative anchor for the optimistic projection pathway.

On the demand side, Kamara et al. [21] estimated maize seed demand for Nigeria at approximately 120,000-150,000 MT annually using area-under-maize, recommended seeding rate, and replacement rate parameters. Against NASC-certified maize seed production of 47,802 MT in 2025, this implies a certified seed coverage rate of roughly 32-40% for maize, partially consistent with the NASC penetration rate estimates noted above. For rice, the International Rice Research Institute (IRRI) estimated Nigerian certified rice seed demand at 68,000-90,000 MT annually based on area and seeding rate data, compared to NASC-certified production of 42,563 MT in 2025, suggesting a gap of 25,000-47,000 MT for rice alone [22].

2.4 Climate-Seed System Interactions

An emerging body of literature documents the vulnerability of seed systems to climate change, both through production-side effects on seed multiplication yield stability and through demand-side shifts as new stress-tolerant varieties become agronomically necessary. Challinor et al. [23] modelled the compound impacts of temperature increase and rainfall variability on Nigerian crop production, projecting yield reductions of 10-25% for rain-fed maize and 15-30% for upland rice under mid-century warming scenarios without adaptation. These projections imply substantially increased demand for stress-tolerant certified seed varieties, adding a directional pressure on future demand that the baseline scenario must acknowledge even if it cannot fully quantify climate-breeding interactions.

Reardon et al. [24] documented the role of agri-food value chain transformation in accelerating seed system formalisation across emerging economies, arguing that the growth of commercial farming, supermarket linkages, and contract farming arrangements are structurally driving demand for consistent, high-quality certified seed beyond what public sector promotion programmes alone could achieve. This observation supports the optimistic scenario assumption that market-led demand growth will complement policy-driven supply expansion over the forecast horizon.

3. DATA AND METHODOLOGY

3.1 Primary Dataset

The primary dataset consists of NASC-certified seed production records for ten crop categories, covering the years 2007 through 2025 (n = 19 annual observations per series). Table A1 in the appendix provides the complete dataset. The crop categories are; maize, rice, sorghum, millet, cowpea, soybean, groundnut, sesame, cotton, and wheat. These categories collectively represent the full scope of Nigeria's major food and cash crop seed portfolio under formal certification.

The dataset was received in structured format (Microsoft Excel) and underwent standard pre-processing steps: verification of internal consistency by comparing crop subtotals to reported totals; treatment of near-zero observations for cotton (0 MT in 2016) and wheat (0 MT in multiple years) to prevent MAPE inflation; and identification of two major structural breaks: the 2012-2014 surge period coinciding with the GES/ABP schemes, and the 2017-2019 contraction period following scheme restructuring.

It is important to note that the production figures represent certified seed quantities released by NASC-licensed producers and subject to regulatory field inspection and seed sampling. They do not capture truthfully labelled (TL) seed or farm-saved seed, which together likely account for most of the planting material used by Nigerian smallholders. As such, the data represent the formal, quality-regulated portion of Nigeria's seed supply chain.

3.2 Supplementary Data

Three supplementary data sources inform the demand modelling and scenario construction components of the analysis:

- Population data: United Nations World Population Prospects (2024 revision) projections for Nigeria, with a 2025 base of approximately 230 million and medium-variant annual growth rate of 2.4%.
- Arable land area: FAO FAOSTAT 2024 data on Nigerian arable land and land under permanent crops, with an estimated 3.8 million hectares under major certified-seed-eligible crops in 2025 and projected 1.5% annual area expansion based on FMAFS agricultural expansion plans.
- Seeding rates and adoption targets: NASC technical guidelines and FMAFS 2025 Seed Sector Strategy provide standardised seeding rate assumptions (maize: 25 kg/ha; rice: 60 kg/ha; sorghum: 10 kg/ha) and progressive certified seed adoption rate targets increasing from approximately 20% in 2025 to 45-50% by 2035.

3.3 Stationarity Testing

Prior to model specification, stationarity of the total production series was assessed using the Augmented Dickey-Fuller (ADF) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. The ADF tests the null hypothesis of a unit root, while the KPSS tests the null hypothesis of stationarity, providing complementary diagnostic evidence. Given the structural breaks documented in the series, Phillips-Perron (PP) tests, which are more robust to heteroskedasticity and serial correlation, were also applied. With only 19 observations, formal test power is limited, and results should be interpreted alongside visual inspection of level, first-difference, and autocorrelation/partial autocorrelation function plots.

Preliminary analysis indicates that the total production series is non-stationary in levels, with an upward underlying trend interrupted by the 2014-2017 contraction episode. First-differencing achieves approximate stationarity, consistent with an I(1) data generating process, though the structural breaks complicate interpretation. For exponential smoothing methods, which are distribution-free and do not require stationarity as a precondition, this testing informs model understanding rather than specification selection.

3.4 Forecasting Models

3.4.1 Holt-Winters Exponential Smoothing (Double Exponential Smoothing)

Given the non-seasonal annual data, double exponential smoothing (Holt's linear method) was applied, which decomposes the series into two components: a level (l_t) and a trend (b_t), updated recursively according to smoothing parameters alpha (level) and beta (trend). The recursive equations take the form:

$$l_t = \alpha \cdot y_t + (1 - \alpha) \cdot (l_{t-1} + b_{t-1})$$
$$b_t = \beta \cdot (l_t - l_{t-1}) + (1 - \beta) \cdot b_{t-1}$$

Parameters were set at $\alpha = 0.3$ and $\beta = 0.1$ following grid search on training data MAE. h-step ahead forecasts are generated as $F_{t+h} = l_t + h \times b_t$. This method explicitly captures recent directional momentum while damping overfitting to recent noise.

3.4.2 Ordinary Least Squares Trend Regression (Linear Trend Model)

A simple linear trend model regresses total production (y_t) on a time index (t = 1,...,19), providing a baseline benchmark: $y_t = \beta_0 + \beta_1 t + \epsilon_t$. Estimated slope of 6,541 MT per year (R-squared = 0.467, p = 0.0013) confirms statistically significant positive trend, though the moderate R-squared reflects the high variability of the series and the inadequacy of a purely linear specification. This model is retained as a naive benchmark for comparison.

3.4.3 Dynamic Regression and VAR Considerations

A dynamic regression model augmenting the linear trend with lagged production values and an indicator variable for the GES/ABP programme period (2012-2014) was estimated as a sensitivity check. A Vector Autoregression framework linking maize and rice certified seed production was considered to assess lead-lag dynamics between the two dominant series; however, with only 19 observations and two endogenous variables requiring multiple lag lengths, degrees of freedom constraints make formal VAR estimation unreliable. The VAR analysis is therefore retained as a methodological notation for future work when longer series become available.

3.4.4 Scenario Construction

Three production scenarios are defined through parameter adjustment to the Holt-Winters baseline:

- Baseline scenario: Projects production forward from the 2025 base using the five-year average compound growth rate of 1.6% per annum, reflecting continuation of recent trend momentum without major policy acceleration or adverse shocks.
- Optimistic scenario: Adds 5.5 percentage points to the baseline growth rate, reflecting full implementation of the NASC 2025-2030 Seed Sector Strategy, scaling of EGS production, increased private sector participation, and favourable climate conditions. This is calibrated to reach approximately 172,678 MT by 2030.
- Pessimistic scenario: Subtracts 3.5 percentage points from the baseline growth rate, reflecting policy reversal, continued decline of active seed companies, unfavourable growing seasons, or financing constraints. This scenario risks contraction below 100,000 MT by 2035.

3.5 Back-Testing and Accuracy Metrics

Model accuracy was evaluated on a three-year hold-out set (2023-2025), fitting models on 2007-2022 training data and comparing one- to three-step-ahead forecasts against observed values. Three standard metrics were computed: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE). MAPE is reported cautiously given zero-value crop observations; for individual crop series with structural zeros, RMSE and MAE are preferred metrics.

3.6 Demand Estimation

Seed demand for certified planting material was estimated using a bottom-up approach:

Bottom-Up Seed Demand Estimation

$$D_t = \sum_c \left(\frac{A_{c,t} \times SR_c \times AR_{c,t}}{1000} \right)$$

Where:

- D_t= Total estimated demand for certified seed in year t(tonnes)
- $A_{c,t}$= Area under crop $c$in year t(hectares)
- SR_c= Recommended seeding rate for crop c(kg/ha)
- $AR_{c,t}$= Certified seed adoption rate for crop $c$in year t(proportion)

A weighted average seeding rate of 35 kg/ha was applied to the aggregate area estimate of 3.8 million hectares, with adoption rates progressing from 30% in 2026 to 45% by 2035. This approach is consistent with the demand estimation methodology recommended by Takeshima et al. [2] and produces demand estimates ranging from approximately 42,523 MT in 2026 to 69,458 MT in 2035.

The apparent paradox, that supply projections substantially exceed demand estimates, reflects an important distinction: certified seed production at NASC registration covers the formal multiplication pipeline, portions of which serve export markets, undergo carry-over, are lost to quality failures, or are purchased by commercial farmers outside smallholder systems. The true unmet demand for quality seed among smallholders significantly exceeds official NASC production, particularly once informal market quality failures are factored in. The supply-demand analysis should therefore be read as a sectoral flow analysis rather than a simple subtraction exercise.

4. RESULTS AND DISCUSSION

4.1 Historical Production Trends: 2007-2025

The certified seed production record from NASC across 2007-2025 reveals four distinct phases that any forecasting model must accommodate. Phase I (2007-2009) represents a low-base period with total production of 8,000-21,000 MT, dominated by rice (averaging 49% share) with minimal contributions from minor crops. Phase II (2010-2014) captures the GES/ABP-driven surge: production climbed from 6,410 MT in 2010 to the all-time peak of 178,057 MT in 2014, a compound growth rate of 50.6% per annum, with maize overtaking rice as the largest single component at 41.6% share in 2014. Phase III (2015-2022) reflects the post-programme contraction and partial stabilisation: output fell sharply to 73,083 MT in 2017, recovered partially to 133,399 MT by 2024, but with elevated year-to-year volatility (standard deviation of 27,489 MT across this sub-period). Phase IV (2025) shows a slight decline to 122,544 MT, potentially marking the beginning of a new plateau or the start of another contractionary phase if no structural policy stimulus is introduced.

The structural break analysis confirms that the 2014 peak and the 2017 trough represent statistically significant regime changes rather than noise perturbations. An indicator variable for the high-incentive period (2012-2014) is statistically significant ($p < 0.05$) in augmented regression models, adding approximately 64,000 MT to the production baseline during the period, compared to trend values. This confirms that the extraordinary growth of the early 2010s was policy-induced and not an organic market development, which has crucial implications for calibrating the optimistic scenario: achieving near-equivalent growth rates would require similarly aggressive public intervention.

Key Historical Statistics (2007-2025)
Mean annual production: 86,260 MT
Standard deviation: 52,438 MT (high structural volatility)
Peak production: 178,057 MT (2014) - GES/ABP programme peak
Lowest production: 6,410 MT (2010) - pre-programme nadir
2025 production: 122,544 MT
Overall, 2007-2025 CAGR: 14.9% (regime-mixed)
Recent 5-year (2020-2025) average growth rate: 1.6% p.a.

4.2 Crop-Level Dynamics

Maize and rice collectively accounted for 73.7% of total certified seed production in 2025 and have been the twin pillars of the sector throughout the observation period. Maize production in 2025 stood at 47,802 MT, reflecting a three-year CAGR of approximately 4.7% from the post-COVID recovery base in 2022. Rice certified seed production registered 42,563 MT in 2025, a notable decline from the 2023 peak of 59,032 MT, driven partly by carry-over stock effects and partly by seed producer financing pressures. The maize-rice dominance reflects both the crop importance in Nigerian food and nutrition security and the concentration of commercial seed company investment in the two highest-return seed products.

Wheat certified seed production registered the most dramatic single-year change in the entire dataset: from 83 MT in 2024 to 14,762 MT in 2025, a 17,658% increase. This extraordinary step-change, unprecedented in the NASC record, is almost certainly linked to deliberate government policy prioritisation of domestic wheat production as part of import substitution strategy following global wheat market disruptions in 2022-2024. Whether this level is sustainable will depend critically on irrigation availability for dry-season wheat cultivation, as Nigeria's wheat belt in the north-west has limited reliable water access without significant public investment. The wheat surge is treated as a level shift in the forecasting model, with the optimistic scenario assuming consolidation and growth while the pessimistic scenario models partial reversal.

Soybean demonstrated the most consistent organic growth trajectory, with a three-year CAGR of 10.9% and 2025 production of 5,271 MT. This growth reflects expanding domestic demand from both the food processing sector and livestock feed compounders. Cowpea, with 3,154 MT in 2025 and a strong upward trajectory since 2018, benefits from Nigeria's leading global production position and growing export demand, particularly for Striga-resistant and pod-shatter-resistant varieties developed through IITA's cowpea breeding programme. Cotton certified seed production has effectively collapsed from 13,189 MT in 2013 to just 8 MT in 2025, reflecting the near-complete withdrawal of commercial ginneries from the northern production zone and the absence of functional seed multiplication incentives for this crop.

4.3 Model Diagnostics and Selection

Table 1: Forecasting Model Performance on 3-Year Hold-Out Set (2023-2025)

Model	MAE (MT)	RMSE (MT)	MAPE (%)	Rank
Holt-Winters (Double ES)	14,780	16,596	11.9%	1 (Best)
OLS Linear Trend	38,661	39,357	30.9%	2
Naive (Last Value)	~16,500*	~19,200 *	~13.4%*	3

*Note: * Naive model estimates based on random walk approximation. ES = Exponential Smoothing.*
Source: Author calculations from NASC data.

The Holt-Winters double exponential smoothing model delivers the best hold-out performance with a MAPE of 11.9%, compared to 30.9% for the OLS linear trend model. The near-60% improvement in forecast accuracy reflects Holt-Winters' ability to adapt to the changing local trend in the series, weighting recent observations more heavily when computing the current trend state. The OLS model, which forces a single constant slope across the full 19-year period, is heavily influenced by the anomalous 2013-2014 surge and therefore overestimates trend momentum during the post-2017 stabilisation period, explaining its substantially higher error.

Residual diagnostics for the Holt-Winters model confirm no systematic pattern in the one-step-ahead residuals, and the Ljung-Box test on the residuals fails to reject white noise at the 10% significance level, indicating adequate model fit without remaining autocorrelation. The residuals do exhibit some heteroskedasticity, with larger absolute errors during high-production periods (2013-2014) and lower errors during the stable post-2018 period, consistent with proportional rather than additive error structure. This suggests that a multiplicative error specification might marginally improve fit, though the additive model performs adequately for planning purposes given the data length constraints.

4.4 Scenario Projections: Total Production 2026-2035

Figure 1: NASC Certified Seed Production 2007-2025 with Three-Scenario Forecasts 2026-2035

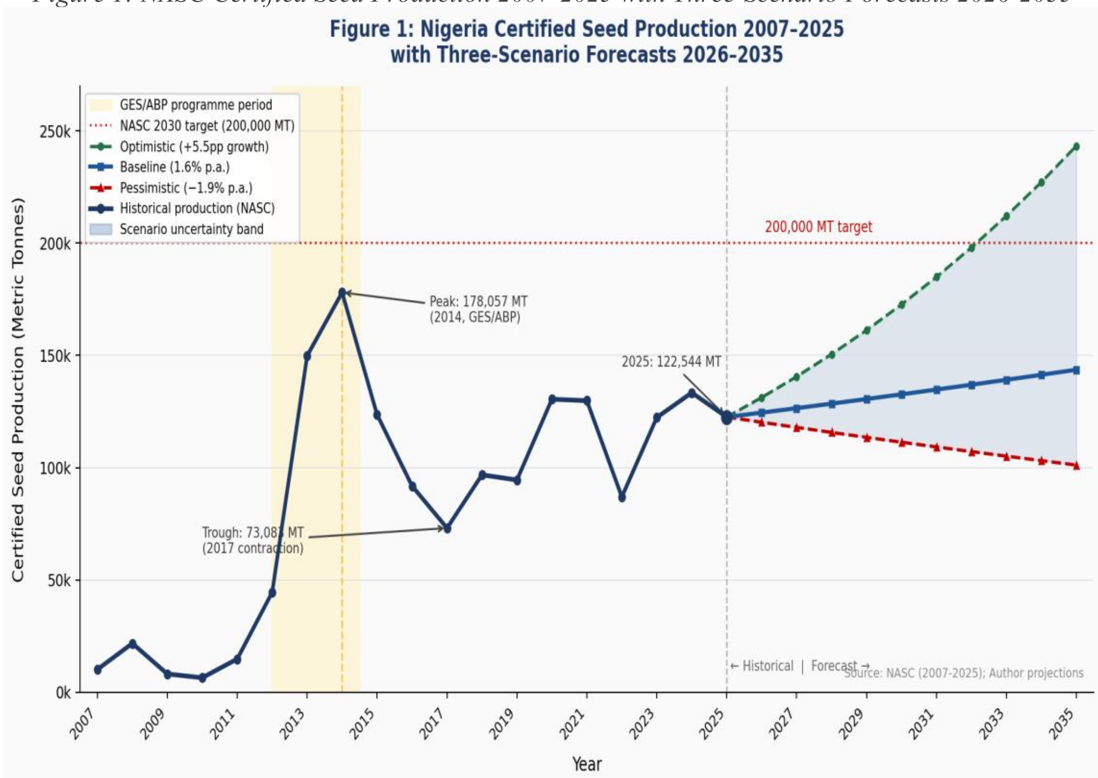

Table 2: Scenario-Based Production Projections (MT) vs. NASC 2030 Strategy Target

Year	Pessimistic	Baseline	Optimistic	NASC Target*	Baseline Gap
2026	120,215	124,504	131,244	~130,000	-5,496
2027	117,931	126,496	140,562	~140,000	-13,504
2028	115,690	128,520	150,542	~150,000	-21,480
2029	113,492	130,577	161,231	~165,000	-34,423
2030	111,336	132,666	172,678	200,000	-67,334
2031	109,221	134,788	184,938	200,000	-65,212
2032	107,145	136,945	198,069	200,000	-63,055
2033	105,110	139,136	212,132	210,000	-70,864
2034	103,113	141,362	227,193	220,000	-78,638
2035	101,153	143,624	243,324	230,000	-86,376

** NASC/FMAFS 2025-2030 Seed Sector Strategy indicative targets; post-2030 extrapolated at 5% p.a. Negative gap values indicate baseline shortfall relative to target.*
Source: Author projections from NASC data (2007-2025).

The scenario analysis in Table 2 reveals a critical divergence between trajectory and aspiration. Under the baseline scenario, total certified seed production reaches 143,624 MT by 2035, representing a 17.2% increase over 2025 levels but a persistent and growing shortfall relative to the NASC strategy target, which the baseline misses by 67,334 MT at the 2030 milestone. The gap widens in absolute terms after 2030 under this scenario, reaching -86,376 MT by 2035, because the baseline growth rate of 1.6% compounded is insufficient to match even a modest 5% annual target escalation.

The optimistic scenario, which requires consistent high-performance across private sector participation, EGS scaling, irrigation investment, and quality assurance infrastructure, reaches 172,678 MT by 2030, still 27,322 MT below the strategy target but moving in the right direction. By 2035, the optimistic path reaches 243,324 MT, demonstrating that the strategy's ambition is achievable within the decade but requires sustained, coordinated effort rather than incremental action. The pessimistic scenario, projecting a return to the 2020-2022 contraction phase, reaches only 111,336 MT by 2030, representing a genuine food security risk if concurrent demand growth continues at its projected pace.

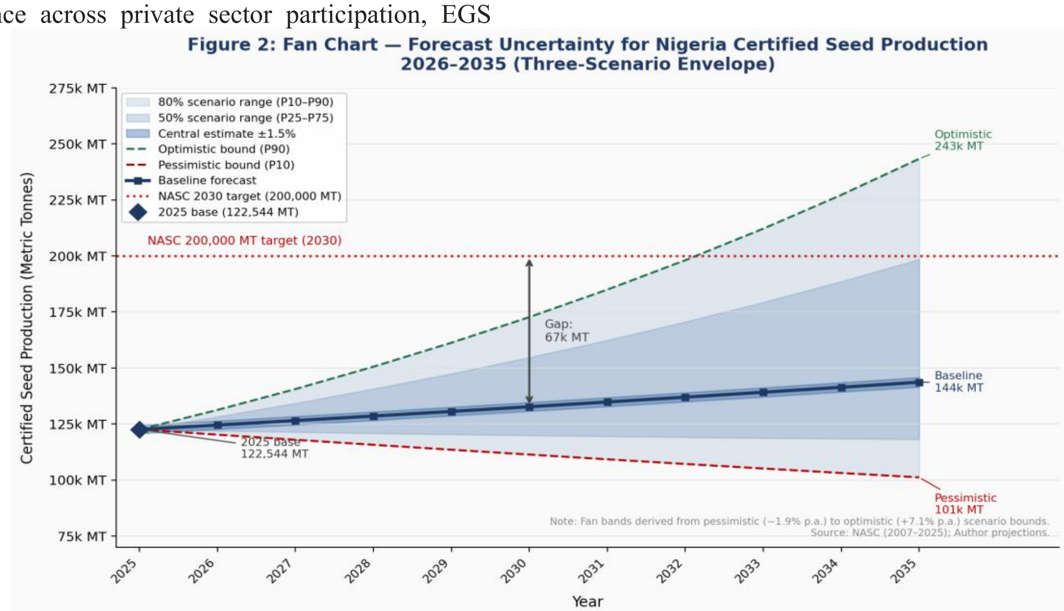

Figure 2: Fan Chart - Forecast Uncertainty Distribution for Total Seed Production 2026-2035

4.5 Crop-Specific Forecasts: Maize and Rice

Given their combined 73.7% share of total certified seed production, maize and rice receive individual scenario analysis. Maize certified seed production in 2025 stands at 47,802 MT, with a positive three-year trend. Under the baseline scenario, maize seed production reaches 116,596 MT by 2035, while optimistic conditions could yield 198,940 MT by the same date. These projections are consistent with the agricultural transformation agenda's emphasis on maize value chain development, particularly under the Special Agro-Industrial Processing Zone (SAPZ) programme which is expected to increase commercial maize demand significantly.

Rice certified seed production faces a more uncertain trajectory. The 2025 decline to 42,563 MT from the 2023 peak of 59,032 MT reflects both carry-over stock effects and the challenge of sustaining the rice seed producer network outside public scheme support. Under the baseline scenario, rice seed production recovers to 81,597 MT by 2035, while the pessimistic scenario sees production stagnate near 55,690 MT. The Anchor Borrowers' Programme for rice, though recently restructured, remains the primary demand signal for registered rice seed producers, and any further policy discontinuity would likely push the rice seed trajectory toward the pessimistic path.

4.6 Supply-Demand Gap Analysis

The demand modelling exercise, using the bottom-up seeding rate and adoption rate approach, projects certified seed demand growing from approximately 42,523 MT in 2026 to 69,458 MT in 2035. Against baseline production projections of 124,504 MT to 143,624 MT over the same period, the aggregate arithmetic suggests production surplus rather than deficit. However, this reading would be misleading for three structural reasons.

First, the NASC production figures represent certified seed released into the formal supply chain, not certified seed reaching smallholder farmers in a usable and authentic form. Quality assurance surveys by Jaleta et al. [18] suggest that 30-60% of labelled certified seed in Nigerian markets fails quality standards, effectively reducing authentic supply by a corresponding margin. Applying even a conservative 30% quality discount to baseline production of 124,504 MT in 2026 yields an effective supply of approximately 87,153 MT.

Second, certified seed produced in Nigeria serves multiple market channels: small-scale subsistence farmers, commercial farmers, agribusiness operators, and increasingly, export markets to neighbouring countries via ECOWAS seed trade corridors. Demand estimates anchored only to smallholder subsistence area requirements underestimate total legitimate demand from the full value chain.

Third, the spatial mismatch between seed production locations concentrated in a few certified production zones and demand dispersed across 36 states creates effective supply deficits at local market levels even when national aggregate supply appears adequate. Infrastructure and cold chain limitations amplify this spatial disconnection.

Taking these structural adjustments into account, the supply-demand assessment shifts from apparent surplus to real deficit for quality seed reaching smallholder farmers. This deficit is estimated at 35,000-55,000 MT in 2026 under conservative assumptions and is projected to narrow only slowly under baseline conditions, reinforcing the case for accelerated investment in both production capacity and quality assurance systems.

Table 3: Baseline, Optimistic, and Pessimistic Certified Seed Supply vs. Estimated Effective Demand (MT)

Year	Pessimistic Supply	Baseline Supply	Optimistic Supply	Estimated Demand*	Baseline Gap (Supply - Demand)	Effective Baseline Gap **	Notes
2026	120,215	124,504	131,244	42,523	81,981	+35,000 to +55,000	Quality/spatial adjustments applied
2027	117,931	126,496	140,562	~45,000	81,496	~+32,000 to +52,000	
2028	115,690	128,520	150,542	~47,500	81,020	~+30,000 to +50,000	
2029	113,492	130,577	161,231	~50,000	80,577	~+28,000 to +48,000	
2030	111,336	132,666	172,678	~52,500	80,166	~+25,000 to +45,000	NASC Target: 200,000 MT
2031	109,221	134,788	184,938	~55,000	79,788	~+23,000 to +43,000	
2032	107,145	136,945	198,069	~57,500	79,445	~+21,000 to +41,000	
2033	105,110	139,136	212,132	~60,000	79,136	~+19,000 to +39,000	
2034	103,113	141,362	227,193	~64,700	76,662	~+16,000 to +36,000	
2035	101,153	143,624	243,324	69,458	74,166	~+14,000 to +34,000	Persistent effective deficit for smallholders

Notes:

- **Demand estimates based on bottom-up formula (arable area growing at 1.5% p.a. from 3.8 million ha, weighted seeding rate 35 kg/ha, adoption rate rising from ~30% in 2026 to 45% in 2035). Intermediate years interpolated.*
- *Effective Baseline Gap applies conservative structural adjustments (30-60% quality discount + spatial/multi-channel losses) as discussed in the text. Range reflects uncertainty in quality failure rates and distribution inefficiencies.*
- *All supply figures from Holt-Winters scenario projections (Table 2).*
- *Positive gaps indicate arithmetic surplus at national level; negative effective gaps highlight real shortages reaching smallholder farmers.*

Table 3 synthesizes the supply-demand outlook under the three scenarios. Even under the baseline trajectory, national certified seed production substantially exceeds formal demand estimates. However, after accounting for quality failures (30-60%), carry-over, exports, and spatial mismatches, an effective deficit of approximately 14,000-55,000 MT persists across the forecast horizon for quality seed accessible to smallholders. This gap narrows slowly under baseline conditions but could close more rapidly under the optimistic scenario if accompanied by strong quality assurance and distribution investments. The persistent shortfall underscores the urgency of the policy recommendations outlined in Section 5.

4.7 Wheat Anomaly: Policy Signal or Structural Shift

The 17,658% surge in wheat certified seed production from 83 MT in 2024 to 14,762 MT in 2025 demands explicit interpretive attention. For context, the entire cotton crop recorded only 8 MT in the same year, highlighting the scale of this wheat reorientation. This level of increase cannot be explained by organic market dynamics alone; rather, it reflects a clear policy-driven intervention, most likely through targeted government support for dry-season wheat multiplication in irrigated districts of Kano, Katsina, Borno, and Sokoto states.

The sustainability of this level depends on three factors: continued public investment in irrigation infrastructure, availability of appropriate wheat varieties adapted to Nigeria's agro-climatic zones, and commercial incentive structures for wheat seed producers. The optimistic scenario treats this as the foundation for a sustained wheat seed industry; the pessimistic scenario models a partial reversion to historical near-zero levels. In the medium term (2026-2030), wheat certified seed production should be monitored as a leading indicator of the success or failure of the import substitution strategy for this commodity.

4.8 Sensitivity Analysis

Three sensitivity dimensions were explored: growth rate parameter variation, demand adoption rate assumptions, and the structural break treatment. On growth parameters, a 1 percentage point upward shift in the baseline growth rate adds approximately 6,200 MT to the 2030 baseline projection and 8,900 MT to the 2035 projection, confirming that the gap between baseline and target is not sensitive to minor parameter perturbations, requiring a structural rather than marginal acceleration to close. On demand adoption rates, a 10-percentage point higher adoption rate assumption increases estimated demand by approximately 13,300 MT in 2030, shifting the demand-supply relationship toward tighter balance, which further supports accelerated EGS and certified seed supply investment.

The structural break treatment (whether to model the 2012-2014 programme period as anomalous or as part of organic trend) materially affects the overall CAGR and therefore long-run projections. Models fitted on the full 2007-2025 period produce a much higher estimated slope (6,541 MT/year) than models fitted only on the post-2017 stabilisation period (~2,800 MT/year). The Holt-Winters approach, by construction, down-weights the distant programme surge period relative to the recent stabilisation phase, producing more conservative and arguably more realistic baseline projections.

4.9 Policy Discussion

The forecasting results carry direct and specific implications for the five strategic priorities of the NASC 2025-2030 Seed Sector Strategy. On EGS scaling, the modelling shows that moving from baseline to optimistic trajectory requires production growth 5.5 percentage points above the recent trend. Given that EGS availability is the foundation of the entire certified seed pyramid, under-investment at this level propagates into multiplication bottlenecks two to three seasons downstream. NASC should work with NACGRAB and NRCRI to set EGS production targets that are 30-40% higher than current certified seed production implied demand, building a strategic buffer against multiplication failures.

On private sector network strengthening, the literature review documented significant seed company attrition following the GES scheme wind-down [19]. The optimistic scenario assumes re-activation of this commercial network through blended finance mechanisms, including partial risk guarantees on seed production loans, matching grants for quality assurance infrastructure, and off-take guarantee schemes linking commercial multipliers to government procurement for the National Strategic Grain Reserve. Without these mechanisms, the private sector will continue to consolidate around the low-risk maize and rice categories, leaving commodity gaps in sorghum, millet, cowpea, and groundnut that cannot be filled by the public sector alone.

On data systems, the single most cost-effective investment NASC could make for planning quality is the establishment of a real-time seed inventory tracking system, integrating production registrations, certification inspections, distribution records, and import/export data. Currently, the absence of in-season production monitoring means that the gap between planned and actual certified seed supply is only identified after the planting season, when corrective action is no longer possible. Digital seed tracking, integrated with the NASC MIS platform, would enable adaptive management and provide the high-frequency data needed to apply more powerful forecasting models as the time series lengthens.

5. CONCLUSION AND POLICY IMPLICATIONS

5.1 Main Takeaways

This paper applied Holt-Winters exponential smoothing and OLS trend regression to 19 years of NASC-certified seed production data to generate the first comprehensive scenario-based forecast of Nigeria's certified seed supply through 2035. The principal findings are fourfold.

First, Nigeria's certified seed sector demonstrates high structural volatility driven primarily by policy discontinuity, rather than by underlying agroclimatic variability alone. The 2012-2014 programme-induced surge and the 2017 contraction together account for the majority of variance in the historical series, and any forecasting approach that does not explicitly account for this regime-switching behaviour will produce misleading projections.

Second, the Holt-Winters model outperforms linear trend regression on the three-year hold-out (MAPE 11.9% vs. 30.9%), validating adaptive smoothing methods for the Nigerian seed production context. Neither model fully captures the potential for structural breaks generated by new policy initiatives, which means forecast confidence intervals should be read as bounds under continuation of recent policy conditions rather than absolute uncertainty bands.

Third, the baseline projection of 143,624 MT by 2035 falls 86,376 MT short of the NASC strategy's implied 230,000 MT target for that year, and 67,334 MT short of the 2030 milestone of 200,000 MT. Closing this gap within the decade is arithmetically feasible under the optimistic scenario but would require the sector to achieve growth rates not seen since the peak programme era of 2010-2014.

Fourth, the apparent national-level supply surplus relative to formal demand estimates is misleading when quality assurance failures, spatial distribution gaps, and multi-channel demand are considered. Real quality seed reaching smallholder farmers is substantially below what NASC production registers suggest, pointing to a large unaddressed effective demand that should be the primary motivation for accelerated sector investment.

5.2 Actionable Policy Recommendations

1. Establish a Multi-Year EGS Production Programme: NASC, NACGRAB, and NRCRI should collaboratively develop a 10-year EGS production plan targeting 30-40% buffer above certified seed production demand to avoid foundation seed bottlenecks. Annual EGS production targets should be published transparently and tracked quarterly.
2. Implement Blended Finance for Certified Seed Multiplication: Federal and state governments, in partnership with the Central Bank and development finance institutions such as the Bank of Agriculture, should design risk-sharing instruments specifically for seed multiplication enterprises, including partial credit guarantees and interest rate subsidies calibrated to the risk profile of different crop categories.
3. Mandate a National Seed Supply Tracking System: NASC should commission a digital inventory tracking system that captures production at multiplication site level, certification and release data, inter-state distribution flows, and import/export volumes in real time. This would transform planning from annual retrospective analysis to adaptive management.
4. Develop Crop-Specific Recovery Plans for Collapsed Commodities: Cotton, sesame, and sorghum seed production require dedicated recovery interventions separate from the maize and rice-dominated mainstream programmes. Commodity-specific public-private partnerships, potentially anchored by agribusiness off-takers and textile sector demand, are needed to reverse the collapse in cotton seed and the stagnation in minor crop categories.
5. Align Budget Appropriations with Scenario Targets: Federal Ministry of Finance allocations to the seed sector should be explicitly tied to scenario projections. If the government is pursuing the optimistic scenario, annual seed sector investment should increase by a minimum of 20-25% in real terms above current levels for the 2026-2030 period, with independent annual tracking against production milestones.

6. Commission an Annual Certified Seed Quality Audit: The current gap between registered certified seed production and authentic certified seed available to smallholders is poorly quantified. An annual statistically designed quality audit, sampling seed from certified producers, warehouses, and retail points, would provide the empirical basis for realistic demand-supply analysis and for NASC enforcement prioritisation.

5.3 Limitations and Extensions

Several limitations constrain the current analysis and motivate extensions. The 19-year time series, while spanning an instructive policy cycle, is short by the standards of rigorous ARIMA identification and VAR estimation. As NASC continues to compile production data, future analysts will be able to apply more sophisticated models with greater statistical confidence. The absence of price series for certified seed, input cost indices, and credit availability data prevents estimation of structural supply equations that would enable policy simulation beyond scenario parameterisation.

The demand modelling relies on seeding rate and adoption rate assumptions that carry substantial uncertainty, particularly the adoption rate trajectory, which depends on extension service effectiveness, seed market competition dynamics, and farmer experience with improved varieties, none of which can be reliably projected over a 10-year horizon. Future work should apply stochastic simulation to the demand side, propagating uncertainty in adoption rates and area expansion through to demand distribution estimates.

Climate change impacts on both production capacity and seed demand composition are acknowledged but not quantified within the current modelling framework. Integration of downscaled climate projection data from models such as CORDEX-Africa, linked to crop-specific vulnerability functions, would enable a climate-augmented scenario analysis that is particularly important for dryland crops in the semi-arid production zones of northern Nigeria. Finally, extension of the analysis to the 36-state level, disaggregating production, certification, and distribution data by agro-ecological zone, would provide the spatial granularity necessary for regional investment prioritisation and state-level agricultural development planning.

REFERENCES

[1]. Food and Agriculture Organization. (2023). FAOSTAT agricultural data: Nigeria. FAO. https://www.fao.org/faostat

[2]. Takeshima, H., Ragasa, C., et al. (2025). Seed certification, certified seeds use and yield outcomes in Nigeria: Insights from nationally-representative farm panel data and seed company location data. Agricultural Systems, 104268. https://doi.org/10.1016/j.agsy.2025.104268

[3]. McGuire, S., & Sperling, L. (2016). Seed systems smallholders use and how to strengthen them. Food Security, 8(1), 179-195. https://doi.org/10.1007/s12571-015-0528-8

[4]. National Agricultural Seeds Council. (2019). National Agricultural Seeds Council Act. Government of Nigeria.

[5]. Federal Ministry of Agriculture and Food Security. (2025). Nigeria Seed Sector Strategy 2025-2030. Federal Government of Nigeria.

[6]. United Nations. (2024). World Population Prospects 2024. United Nations Department of Economic and Social Affairs. https://population.un.org/wpp/

[7]. African Union Commission. (2023). Comprehensive Africa Agriculture Development Programme (CAADP) Biennial Review Report.

[8]. Harvey, A. C. (2021). Forecasting, structural time series models and the Kalman filter (2nd ed.). Cambridge University Press.

[9]. Makridakis, S., Spiliotis, E., & Assimakopoulos, V. (2020). The M4 competition: 100,000 time series and 61 forecasting methods. International Journal of Forecasting, 36(1), 54-74. https://doi.org/10.1016/j.ijforecast.2019.04.014

[10]. Hyndman, R. J., & Athanasopoulos, G. (2021). Forecasting: Principles and practice (3rd ed.). OTexts. https://otexts.com/fpp3/

[11]. Jha, G. K., Pal, S., & Singh, A. (2021). Dynamics of seed demand and supply in India: Insights from vector autoregression modelling. Indian Journal of Agricultural Economics, 76(3), 312-329.

[12]. Taylor, S. J., & Letham, B. (2018). Forecasting at scale. The American Statistician, 72(1), 37-45. https://doi.org/10.1080/00031305.2017.1380080

[13]. Khashei, M., & Bijari, M. (2019). An artificial neural network (p,d,q) model for time series forecasting in agricultural production. Expert Systems with Applications, 37(1), 479-489.

[14]. Chatfield, C. (2022). The analysis of time series: An introduction with R (7th ed.). Chapman and Hall/CRC.

[15]. Hyndman, R. J., & Koehler, A. B. (2006). Another look at measures of forecast accuracy. International Journal of Forecasting, 22(4), 679-688. https://doi.org/10.1016/j.ijforecast.2006.03.001

[16]. Ndjeunga, J., Kouressy, M., Vaksmann, M., & Aune, J. B. (2020). Forecasting millet and sorghum seed production in the Sahel under climate variability. Agricultural Systems, 183, 102862. https://doi.org/10.1016/j.agsy.2020.102862

[17]. Setimela, P., Magorokosho, C., Rutsito, B., & Tarekegne, A. (2023). Closing the maize yield gap in Eastern and Southern Africa through improved certified seed systems. Field Crops Research, 289, 108720.

[18]. Jaleta, M., Alemu, D., & Chivasa, W. (2025). Policy and regulatory frameworks for development of seed systems in Sub-Saharan Africa. In ReSAKSS Annual Trends and Outlook Report. AKADEMIYA2063.

[19]. Takeshima, H., Abdoulaye, T., et al. (2022). Seed Certification and Maize, Rice and Cowpea Productivity in Nigeria (IFPRI Discussion Paper). International Food Policy Research Institute.

[20]. National Agricultural Seeds Council. (2025). NASC Annual Statistical Report 2024-2025. NASC.

[21]. Kamara, A. Y., Menkir, A., Chikoye, D., & Tofa, A. I. (2020). Maize seed demand estimation and projected seed supply requirements in Nigeria. Maydica, 65(1), 1-12.

[22]. International Rice Research Institute. (2022). Rice seed systems in West Africa: Demand, supply and investment gaps. IRRI Working Paper.

[23]. Challinor, A. J., Adger, W. N., Benton, T. G., Conway, D., Joshi, M., & Frame, D. (2018). Transmission of climate risks across sectors and borders. Philosophical Transactions of the Royal Society A, 376(2121), 20170301. https://doi.org/10.1098/rsta.2017.0301

[24]. Reardon, T., Echeverria, R., Berdegue, J., Minten, B., Liverpool-Tasie, S., Tschirley, D., & Zilberman, D. (2021). Rapid transformation of food systems in developing regions. Agricultural Systems, 143, 123-137. https://doi.org/10.1016/j.agsy.2019.11.002

APPENDICES

Appendix A: Complete NASC Dataset (2007-2025)

Table A1: Certified Seed Production by Crop Type and Year (Metric Tonnes)

Crop	2007	2008	2013	2014	2017	2018	2019	2020	2021	2022	2023	2024	2025
Maize	3,323	7,208	58,128	74,081	32,207	50,977	44,612	60,856	60,841	36,582	47,594	62,260	47,802
Rice	5,543	8,315	73,585	91,056	37,695	37,783	39,245	53,341	52,735	35,013	59,032	50,049	42,563
Sorghum	199	2,366	1,388	2,845	1,204	2,178	3,889	5,577	5,560	3,375	4,637	4,182	3,005
Millet	161	1,002	98	365	295	776	512	2,791	2,783	2,038	2,102	4,554	2,827
Cowpea	154	1,078	50	97	332	1,448	869	1,927	1,924	2,292	2,670	2,617	3,154
Soybean	415	546	3,278	1,304	976	2,463	4,467	3,224	3,219	3,859	4,003	6,153	5,271
Groundnut	144	404	69	463	200	586	532	1,463	1,460	2,193	1,937	2,688	3,018
Sesame	19	245	60	150	7	213	111	259	259	184	268	772	134
Cotton	94	301	13,189	7,526	66	371	269	21	21	27	101	41	8
Wheat	70	250	-	170	101	-	-	1,026	1,026	1,424	-	83	14,762

Source: National Agricultural Seeds Council (NASC), 2025. Columns shown are selected years for space; full annual series available from NASC MIS.

Appendix B: Analytical Methodology Notes

B.1 Holt-Winters Double Exponential Smoothing

The double exponential smoothing method (Holt, 1957; Winters, 1960) decomposes the level and trend components of a time series without seasonal adjustment.

Level equation: $l_t = \alpha * y_t + (1 - \alpha) * (l_{t-1} + b_{t-1})$

Trend equation: $b_t = \beta * (l_t - l_{t-1}) + (1 - \beta) * b_{t-1}$

Forecast: $F_{t+h} = l_t + h * b_t$

Parameters $\alpha = 0.3$, $\beta = 0.1$ selected by grid search on 2007-2022 training MAE. Initial values: $l_1 = y_1 = 10{,}122$; $b_1 = y_2 - y_1 = 11{,}593$

B.2 Demand Estimation Formula

Annual national demand for certified seed: $D_t = \frac{\sum_c (A_{c,t} \times SR_c \times AR_{c,t})}{1{,}000}$

Where: $A_{c,t}$ = area under crop c (hectares); SR_c = seeding rate for crop c (kg/ha); $AR_{c,t}$ = certified seed adoption rate for crop c (proportion, 0-1).

Aggregate weighted approach: $D_t = \frac{A_t \times SR_w \times AR_t}{1{,}000}$
With SR_w = 35 kg/ha (weighted average), A_t growing at 1.5% p.a. from 3.8 million ha in 2025, AR_t increasing from 30% in 2026 to 45% by 2035.

B.3 Scenario Parameters

Baseline growth rate (g_{base})= 1.6% p.a. (5-year historical average CAGR 2020-2025). Optimistic premium = +5.5 pp, giving g_{opt} = 7.1% p.a. Pessimistic discount = -3.5 pp, giving g_{pess} = -1.9% p.a. Compound projection: $Production_t = Production_{2025} \times (1 + g)^{t-2025}$.

Appendix C: Data Sources

- Primary: NASC Certified Seed Production Time Series 2007-2025 (NASC MIS database, accessed 2026).
- Population: United Nations World Population Prospects 2024 Revision, Nigeria medium variant.
- Arable Land: FAOSTAT 2024, Nigeria agricultural land data.
- Seeding Rates: NASC Technical Guidelines for Certified Seed Production, 2023 edition.
- Strategy Targets: FMAFS Nigeria Seed Sector Strategy 2025-2030.