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PERFORMANCE AND RESILIENCE OF MAJOR VERSUS MINOR CROPS IN NIGERIA'S CERTIFIED SEED INDUSTRY: IMPLICATIONS FOR CROP DIVERSIFICATION AND FOOD SECURITY (2007-2025)

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ABSTRACT

Nigeria's certified seed industry is structurally concentrated. Over the 2007-2025 period, maize and rice alone accounted for an average of 87.7 percent of total annual certified seed production, leaving eight other crop species to compete for the remaining share. Analysis of official time-series data from the National Agricultural Seeds Council (NASC) reveals a system that expanded dramatically between 2007 and 2014 from 10,122 metric tons to 178,057 metric tons before contracting sharply during the 2015-2017 economic recession. While major crops recovered modestly in volume, minor crops such as cowpea, groundnut, millet, and soybean posted superior compound annual growth rates in the recovery period (17 - 40 percent), and the minor crop share of total certified seed production rose from 4.4 percent in 2017 to 26.3 percent by 2025. Concentration indices confirm a long-run dominance bias: the Herfindahl-Hirschman Index averaged above 3,700 across the study period, though it has declined toward 2,916 in 2025, signalling an incipient diversification trend. The Shannon Diversity Index similarly trended upward after 2017. Wheat recorded exceptional post-recession volume growth driven by domestic policy incentives, while cotton experienced a structural collapse from which it has not recovered. The findings underscore the risks of over-reliance on a two-crop seed system, highlight the untapped potential of leguminous and nutrient-dense minor crops for nutrition security and climate adaptation, and provide an empirical basis for recalibrated investment priorities in the 2025-2030 national agricultural planning cycle.
Keywords: crop diversification; seed system resilience; major versus minor crops; food security; Nigeria; certified seed production; Herfindahl-Hirschman Index; Shannon Diversity Index.

1. INTRODUCTION

Nigeria occupies a paradoxical position in sub-Saharan African agriculture. As the continent's most populous nation, it carries the burden of feeding over 220 million people across agro-ecological zones ranging from the semi-arid Sahel to humid coastal lowlands [18]. At the same time, its agricultural transformation agenda has leaned heavily on a narrow set of staple crops, maize and rice, for seed system investment, public subsidy allocation, and extension support. This concentration reflects both political economy pressures and historical production advantages, but it increasingly runs counter to the nutritional, environmental, and adaptive diversification imperatives embedded in contemporary global food security frameworks [1,2].

The seed system is the foundational node of any agricultural value chain. Access to certified, quality-declared seed of the right variety at the right time determines yield potential more than any single downstream input. In Nigeria, the National Agricultural Seeds Council (NASC) is the statutory authority responsible for overseeing certified seed production, quality assurance, and market regulation. Since 2007, NASC has compiled annual data on certified seed production volumes disaggregated by crop type, a dataset that offers an unusually long and consistent window into the structural dynamics of the country's seed industry. This study exploits that dataset to conduct the first systematic statistical analysis of major versus minor crop performance across a 19-year period spanning three distinct macroeconomic phases: the expansion years (2007-2014), the recession-driven contraction (2015-2017), and the recovery and restructuring phase (2018-2025).

The calls for agricultural diversification in Nigeria are not new, but they have intensified. The National Food Security Policy (2023 revision), the Agricultural Promotion Policy (known as the Green Alternative), and successive Economic Recovery and Growth Plans have all identified legumes, roots and tubers, and horticulture as priority subsectors for diversification and nutritional improvement. These policy commitments stand in notable tension with on-the-ground resource allocation, where certified seed production for minor crops such as cowpea, groundnut, millet, sorghum, and soybean has historically remained below 15 percent of total certified volumes. Reconciling this policy-practice gap requires a clear empirical picture of how different crop seed systems have performed, how resilient they are to production shocks, and what structural barriers constrain their expansion [3,4].

The concept of seed system resilience draws on both ecological and economic thinking. In resilience theory, a system is resilient to the extent that it can absorb disturbance and reorganize while undergoing change, to retain essentially the same function, structure, and identity [5]. For seed systems, resilience manifests as the capacity to maintain or restore certified seed supply in the aftermath of macroeconomic shocks, extreme weather events, or policy discontinuities. High production concentration in two crops means that any systemic shock, such as the 2015-2016 recession triggered by collapsing oil revenues, will simultaneously depress output across most of the seed portfolio, as the data presented here confirm. A more diversified seed system, by contrast, distributes risk across a broader crop portfolio and may leverage the counter-cyclical properties of individual commodities.

The nutrition security dimension is equally compelling. Maize and rice are calorie-dense staples, but they contribute little to dietary protein, micronutrient, or essential fat intake. Legumes, particularly cowpea, groundnut, and soybean, are protein-rich, iron- and zinc-dense, and critically important for the diets of low-income rural households who cannot afford animal protein daily [6,5]. The underinvestment in certified seed systems for these crops limits the supply of improved varieties to farmers, constrains yield gains, and reinforces nutritional vulnerability at household level. Climate change adds a further dimension: many minor crops, including sorghum, millet, and cowpea, are significantly more drought-tolerant and heat-resilient than maize and rice, properties that may prove decisive as temperature and rainfall variability intensify across Nigeria's major farming belts [2,7].

This study addresses three research objectives. First, it compares the growth performance, volatility, and relative contribution of major crops (maize and rice) versus minor crops (sorghum, millet, cowpea, soybean, groundnut, sesame, cotton, and wheat) in certified seed production from 2007 to 2025, using compound annual growth rates computed across the full period and three sub-periods. Second, it evaluates the resilience of different crop seed systems to production shocks and assesses the level of crop concentration and diversification using the Herfindahl-Hirschman Index (HHI) and the Shannon Diversity Index (SDI). Third, it analyses the implications of observed structural patterns for agricultural diversification, climate resilience, and national food and nutrition security in Nigeria, drawing on these empirical findings to generate concrete policy recommendations for the 2025-2030 planning cycle.

The article is structured as follows. Section 2 reviews the literature on crop concentration risks, seed system resilience, and diversification benefits in Nigeria and the broader sub-Saharan African context. Section 3 describes the dataset and the analytical methods applied. Section 4 presents and discusses the results, organized around growth performance, concentration dynamics, resilience metrics, and cluster patterns. Section 5 synthesizes the findings into policy conclusions and identifies limitations and directions for future research.

2. LITERATURE REVIEW

2.1 Crop Concentration Risks in Seed Systems

The risks associated with narrow crop diversity in agricultural systems are well-documented in the agrifood literature. At the global level, Khoury et al. [8] demonstrated a long-run homogenization of food supply portfolios, with maize, wheat, and rice accounting for an ever-larger share of human caloric intake, crowding out traditional and nutrient-diverse crops. This dietary convergence, mirrored at the seed system level, creates systemic brittleness, a reduction in functional redundancy. When a dominant crop fails or seed supply collapses, there is no portfolio buffer [5].

In Sub-Saharan Africa, the concentration of formal seed systems around a small number of hybrid cereals, primarily maize and rice, reflects the historical privileging of Green Revolution germplasm. Spielman et al. [9] trace how seed industry structure in developing countries tends to follow investment returns, concentrating commercial and public resources in crops with established markets, processing infrastructure, and policy mandates. This creates a self-reinforcing loop: maize and rice attract more investment, yielding more improved varieties, which attract more farmers, which further deepens the commercial incentive structure. Minor crops remain in the informal seed sector, with limited access to breeders, poor quality assurance, and highly variable availability [10].

The economic theory of industrial concentration, measured through indices such as the HHI and SDI, provides analytical tools for quantifying this structural bias. The HHI, calculated as the sum of squared market shares scaled to 10,000, is widely used in competition analysis: values above 2,500 signal high concentration and limited competitive diversity [11]. The SDI draws from information theory, measuring entropy across a portfolio, with higher values indicating greater diversity. Applied to seed production portfolios rather than markets, these indices reveal not just which crops dominate each year but whether the system is converging toward or diverging away from a concentrated equilibrium over time.

Nigeria's seed industry structure exemplifies this concentration problem. In 2023, ASTA [4] conducted an institutional analysis of Nigerian seed sector governance and found that NASC's regulatory framework, while formally covering all crops, operationally prioritizes maize and rice through seed certification standards, testing protocols, and varietal release procedures calibrated to high-volume cereals. Minor crop seed producers face higher per-unit compliance costs, less extension support, and weaker market linkages, structural disadvantages that suppress certified seed production volumes independently of any agronomic constraint.

2.2 Seed System Resilience: Concepts and Evidence

Resilience in seed systems has been conceptualized along multiple dimensions. FAO [5] distinguish between engineering resilience (ability to return to pre-shock equilibrium) and ecological resilience (ability to reorganize and persist in an altered state). For Nigerian certified seed production, both dimensions are relevant. The post-2017 recovery of maize and rice volumes exhibits engineering resilience, a return toward the pre-recession trajectory, while the simultaneous emergence of cowpea, soybean, and groundnut as rising contributors represents a more structural reorganization consistent with ecological resilience theory.

Production volatility, measured by the coefficient of variation (CV) of annual output, is a standard proxy for seed system resilience risk. High CV values indicate that supply is erratic, undermining farmer planning, agro-dealer stocking decisions, and credit allocation by financial institutions [12]. In Nigeria's certified seed sector, volatility is systematically higher among minor crops than among maize and rice, partly reflecting their smaller base volumes and partly reflecting policy inconsistency in subsidy support and procurement guarantees. Diagne et al. [13] documented similar volatility patterns for rice seed supply in West Africa, linking them to rice import tariff fluctuations that periodically undercut domestic certified seed demand.

The 2015-2017 contraction in Nigeria's certified seed industry is a pivotal case study in seed system shock absorption. The naira devaluation following the collapse of oil revenues sharply increased the cost of imported agrochemicals, breeder seed, and packaging materials, while simultaneously contracting purchasing power among seed buyers. Oyinbo et al. [14] analysed the impact of this shock on smallholder access to improved seed varieties in Nigeria, finding that certified seed utilization rates fell by up to 40 percent in affected farming systems between 2015 and 2017. The NASC production data analysed here are consistent with this finding: aggregate certified seed production fell from a peak of 178,057 MT in 2014 to just 73,083 MT in 2017, a decline of nearly 59 percent.

An important but underexplored dimension of resilience is cropping portfolio diversity as a buffer. Garrett et al. [15] showed, using global farm system data, that crop-livestock and multi-crop systems are more resilient to income shocks than specialized monoculture systems, because diversified portfolios reduce covariance of returns. The same logic applies to seed production systems: if a seed enterprise or a national seed sector produces a broad portfolio of crops, the co-movement of volumes across crops during a shock determines aggregate resilience. If minor crops exhibit different cyclical patterns, as cowpea and wheat appear to during 2014-2017, they can provide a countercyclical contribution to aggregate supply.

2.3 Diversification Benefits: Legumes and Orphan Crops

The case for expanding certified seed production of legumes and orphan crops in Nigeria rests on converging agronomic, nutritional, and economic grounds. Cowpea is the primary protein source for an estimated 200 million people across West Africa, and improved varieties developed by the International Institute of Tropical Agriculture (IITA) have demonstrated yield gains of 40-60 percent over traditional varieties under farmer conditions [6]. However, farmer access to certified improved cowpea seed remains severely constrained by the underdevelopment of formal seed supply chains, particularly in the Guinea Savannah and Sudan Savannah zones where the crop is most widely grown.

Soybean has emerged as one of the fastest-growing commercial crops in Nigeria's middle belt, driven by demand from the rapidly expanding poultry feed industry. IITA [16] documented the soybean value chain in sub-Saharan Africa, noting that formal seed systems have struggled to keep pace with commercial demand growth, creating persistent seed gaps filled by recycled farm-saved seed of declining genetic purity. The certified soybean seed production data from NASC tell a similar story: production rose from 415 MT in 2007 to a high of 6,153 MT in 2024 but still represents only 4.6 percent of total certified seed output.

Millet and sorghum, despite their critical roles in the food security of northern Nigerian households and their documented drought tolerance, have received comparatively little investment in formal seed system development. Yadav et al. [17] argue that the neglect of sorghum and millet in sub-Saharan African seed systems reflects a systemic urban and market bias, since these crops are primarily consumed within smallholder households and carry less commercial value than rice or maize. Addressing this bias requires deliberate policy instruments targeting informal and community seed systems alongside formal certification.

Climate adaptation imperatives strengthen the diversification case. Yadav et al. [17] synthesized evidence on crop adaptation to climate change, demonstrating that the genetic diversity represented in minor crop portfolios offers a reservoir of traits, heat tolerance, water-use efficiency, nitrogen fixation, that are increasingly relevant as temperature and rainfall variability intensify. For Nigeria, the projected expansion of arid and semi-arid zones into currently productive farming belts [18] makes investment in certified seed production of climate-resilient minor crops a strategic necessity rather than an optional complement to the dominant maize-rice system.

3. DATA AND METHODOLOGY

3.1 Dataset Description

The primary data source is the certified seed production time-series compiled by the National Agricultural Seeds Council (NASC) of Nigeria, covering ten crop species from 2007 to 2025 [19]. The dataset records annual certified seed production in metric tons (MT) for maize, rice, sorghum, millet, cowpea, soybean, groundnut, sesame, cotton, and wheat. These data reflect production by licensed seed companies that have undergone NASC field inspection and quality testing under the Seeds and Seedlings Act and associated regulations. The dataset thus represents the formal certified seed sector and does not capture informal or farm-saved seed production, which by conservative estimates constitutes 60-80 percent of seed used by smallholders in Nigeria [20].

The dataset spans 19 years (2007-2025), providing sufficient temporal depth for trend analysis, shock identification, and resilience assessment. The period encompasses three distinct macroeconomic phases: a growth phase (2007-2014) marked by large-scale government seed subsidy programs under the Growth Enhancement Support Scheme (GESS) and its successors; a contraction phase (2015-2017) corresponding to the oil price collapse and naira devaluation; and a recovery phase (2018-2025) marked by policy restructuring, the introduction of the Anchor Borrowers Program, and renewed donor investment in seed system development.

3.2 ANALYTICAL FRAMEWORK AND METHODS

3.2.1 Growth Performance: Compound Annual Growth Rates

Growth performance was evaluated using the Compound Annual Growth Rate (CAGR), which measures the average annual rate of growth over a specified period while accounting for compounding effects. The CAGR was computed as:

$$\text{CAGR} = \left[\left(\frac{V_f}{V_i}\right)^{\frac{1}{n}} - 1\right]$$

Where V_f is the terminal-period production, V_i is the base-period production, and n is the number of intervening years. CAGRs are computed for three periods: the full study period (2007-2025, n = 18), the growth phase (2007-2014, n = 7), and the contraction-recovery sub-periods (2014-2017, n = 3; 2017-2025, n = 8). The use of sub-period CAGRs allows disaggregation of the overall trajectory into phase-specific growth dynamics, illuminating whether crops that grew rapidly in absolute terms during the expansion phase were primarily reflecting that tailwind, or whether they exhibited structural growth momentum in the recovery period as well [21].

3.2.2 Volatility: Coefficient of Variation

Production volatility was assessed using the coefficient of variation (CV), which standardizes variability relative to the mean and facilitates comparison across crops with substantially different production levels. The coefficient of variation was calculated as:

$$CV(\%) = \frac{\sigma}{\mu} \times 100$$

Where:

- σ = standard deviation of annual certified seed production.
- μ = mean annual certified seed production.

Higher CV values indicate greater production instability and lower resilience, whereas lower values indicate relatively stable production over time [5,21].

3.2.3 Concentration and Diversity Indices

Crop concentration was evaluated using the Herfindahl-Hirschman Index (HHI), computed as

$$\mathrm{HHI}_t = \sum_{i=1}^{N} \left(s_{i,t}\right)^2 \times 10{,}000 \text{ (scaled version)}$$

Where $s_{i,t}$ is the production share of crop i in year t. HHI values range from 0 to 10,000, with larger values indicating greater production concentration. Following international competition guidelines, HHI values exceeding 2,500 indicate highly concentrated production systems (Oyetunde-Usman, 2022).

The Shannon Diversity Index (SDI)
This index is computed as:

$$H_i = -\sum p_{i,t} \ln\left(p_{i,t}\right)$$

where $p_{i,t}$ is crop i's proportion of total production in year t. Higher SDI values indicate greater production diversity. Both indices are computed for each year from 2007 to 2025 to trace concentration dynamics over time.

Unlike HHI, higher SDI values indicate greater diversification and a more balanced production portfolio. Both indices were computed annually from 2007 to 2025 to evaluate structural changes in the Nigerian certified seed industry [11,21].

3.2.4 Resilience Metrics and Cluster Analysis

Crop-level resilience is assessed through two metrics: (a) the coefficient of variation (CV) as a measure of production stability; and (b) the post-trough recovery rate, defined as the percentage change from the 2017 production trough to the subsequent peak within the 2017-2025 window. Crops are grouped into four clusters based on their average production share, CAGR, and CV profiles: Cluster I (Dominant Staples: maize and rice), Cluster II (Rising Minors: cowpea, groundnut, millet, soybean), Cluster III (Volatile Niche Crops: sesame, cotton, wheat), and Cluster IV (Stagnant Minor: sorghum). The clustering approach is consistent with typological methods applied in comparative seed system analysis [5].

4. RESULTS AND DISCUSSION

4.1 Total Certified Seed Production: System-Level Dynamics

Total certified seed production in Nigeria grew from 10,122 MT in 2007 to a peak of 178,057 MT in 2014, an increase of over 1,659 percent in seven years. This extraordinary expansion was driven primarily by government-supported seed subsidy programs, particularly the GESS, which created a demand shock for certified seed that the private sector responded to at scale. The subsequent collapse was equally dramatic: by 2017, total certified production had fallen to 73,083 MT, representing a 59 percent contraction from the 2014 peak. Recovery was gradual and uneven, reaching 133,399 MT in 2024 before easing slightly to 122,544 MT in 2025.

Figure 1 presents the full trend comparison of major versus minor crop groups across the study period, both in absolute volumes (Figure 1A) and as proportional shares of total certified production (Figure 1B). The divergence between major and minor crop trajectories is visually unambiguous: major crops dominate the aggregate trend in both panels, yet the widening minor crop share from 2017 onward marks a structural inflection point that underpins the diversification narrative.

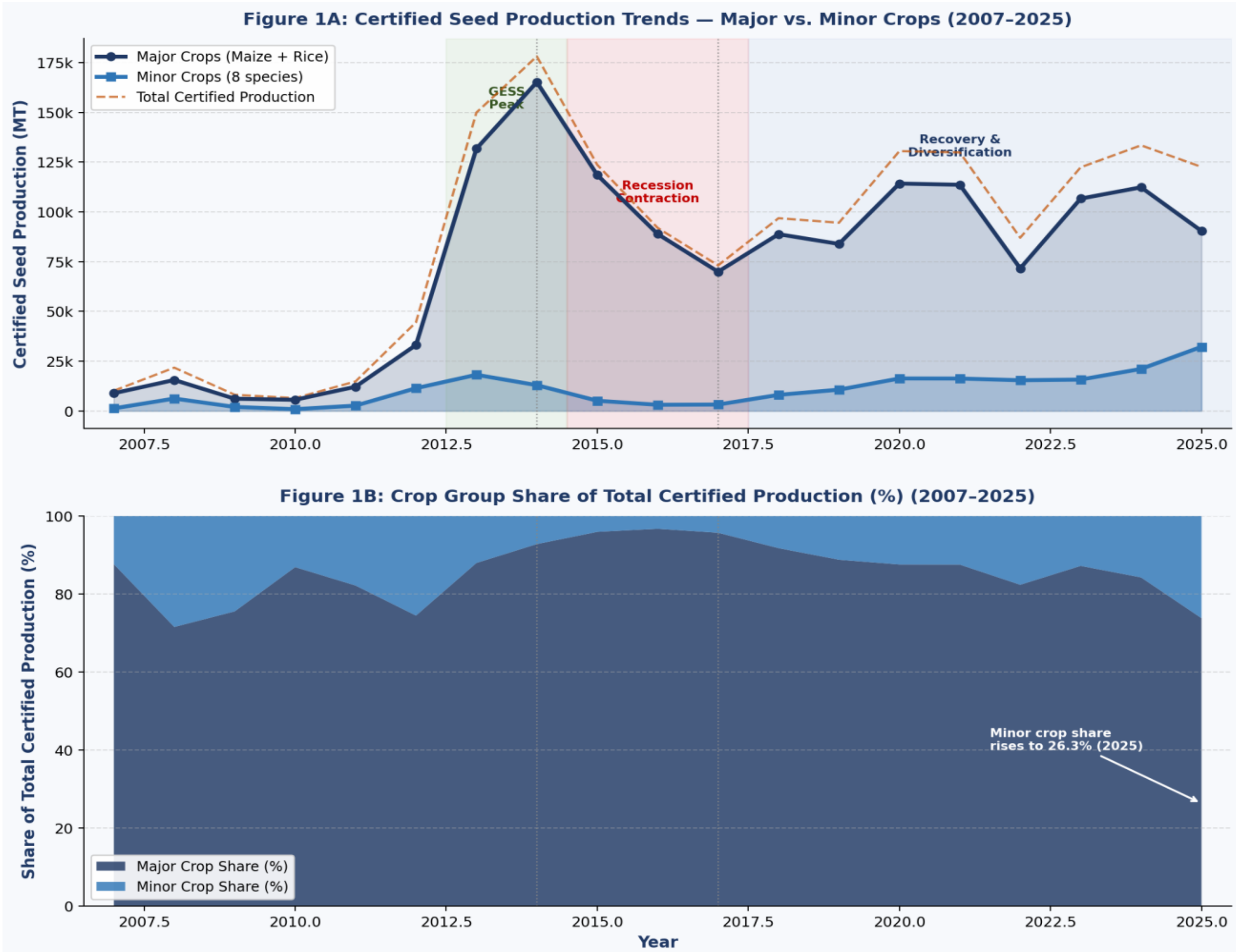

Figure 1: Comparative Trend Lines - Major versus Minor Certified Seed Production, Nigeria (2007-2025)

Shaded regions denote the three macroeconomic phases: Growth (2007-2014), Contraction (2015-2017), and Recovery (2018-2025). Dashed vertical lines in 2014- and 2017-mark phase boundaries. Source: Computed from NASC (2025) certified seed production data.

To complement the overall production trends presented in Figure 1, Table 1 summarizes certified seed production for each crop at four strategic reference years representing the beginning of the study period (2007), the pre-recession peak (2014), the recession trough (2017), and the most recent production year (2025). These benchmark years provide a clearer understanding of the structural changes that occurred within individual crop seed systems and highlight the differing recovery trajectories of major and minor crops. Table 1 presents the full production history by crop at key reference years.

Table 1. Certified Seed Production by Crop: Key Reference Years (MT)

Crop	Group	2007 (MT)	2014 (MT)	2017 (MT)	2025 (MT)	2025 Share (%)
Maize	Major	3,323	74,081	32,207	47,802	39.0
Rice	Major	5,543	91,056	37,695	42,563	34.7
Sorghum	Minor	199	2,845	1,204	3,005	2.5
Millet	Minor	161	365	295	2,827	2.3
Cowpea	Minor	154	97	332	3,154	2.6

Crop	Group	2007 (MT)	2014 (MT)	2017 (MT)	2025 (MT)	2025 Share (%)
Soybean	Minor	415	1,304	976	5,271	4.3
Groundnut	Minor	144	463	200	3,018	2.5
Sesame	Minor	19	150	7	134	0.1
Cotton	Minor	94	7,526	66	8	0.01
Wheat	Minor	70	170	101	14,762	12.0
TOTAL		10,122	178,057	73,083	122,544	100.0

Source: NASC (2025). Note: Values rounded to nearest metric ton.

4.2 Growth Performance: Major Crops versus Minor Crops

Table 2 summarizes CAGR, volatility, and contribution shares by crop. Both maize and rice achieved full-period CAGRs of 12-16 percent, reflecting strong long-run growth anchored in the 2007-2014 expansion. However, their growth rates in the recovery period (2017-2025) were substantially lower: 5.1 percent for maize and 1.5 percent for rice. This deceleration reflects market saturation effects, the shift from government-driven to market-driven demand, and a plateauing of the subsidy-supported farmer base.

Table 2. CAGR, Volatility, Contribution Shares and Resilience by Crop (2007-2025)

Crop	Group	CAGR 2007-25 (%)	CAGR 2007-14 (%)	CAGR 2014-17 (%)	CAGR 2017-25 (%)	CV (%) Volatility	Avg. Share (%)	Recovery 2017 Trough (%)
Maize	Major	15.97	55.8	-24.2	5.1	63.7	42.70	93.3
Rice	Major	11.99	49.2	-25.5	1.5	67.4	44.96	56.6
Sorghum	Minor	16.28	46.2	-24.9	12.1	77.6	2.70	363.2
Millet	Minor	17.26	12.4	-6.9	32.6	108.8	1.37	1,443.8
Cowpea	Minor	18.26	-6.4	50.7	32.5	103.1	1.20	849.9
Soybean	Minor	15.17	17.8	-9.2	23.5	80.7	2.66	530.5
Groundnut	Minor	18.42	18.2	-24.4	40.4	114.1	0.98	1,409.2
Sesame	Minor	11.44	34.3	-64.0	44.6	113.3	0.18	10,925.7
Cotton	Minor	-12.51	87.0	-79.4	-22.6	212.8	2.07	462.1
Wheat	Minor	34.62	13.5	-15.9	86.5	332.2	1.17	14,516.0

Source: Computed from NASC (2025) certified seed production data. CAGR = Compound Annual Growth Rate; CV = Coefficient of Variation; Recovery rate measures percentage increase from 2017 trough to subsequent peak within 2017-2025.

Minor crops tell a strikingly different story in the recovery phase. Millet achieved a recovery-period CAGR of 32.6 percent, cowpea 32.5 percent, groundnut 40.4 percent, and sesame 44.6 percent. These rates exceed the major crop recovery rates by factors of six to twenty-nine. Wheat warrants separate treatment: its 86.5 percent recovery-period CAGR and exceptional 2025 volume of 14,762 MT reflect a specific policy push around domestic wheat production in the context of the global wheat price shock following the Russia-Ukraine conflict in 2022 [18]. Cowpea stands out as structurally notable: while every other crop recorded negative CAGR during the 2014-2017 contraction, cowpea achieved a 50.7 percent CAGR, the only crop to grow through the recession [6,22].

4.3 Concentration and Diversification Indices

Table 3 presents the HHI and SDI time series. The seed production portfolio remained highly concentrated throughout the study period, with HHI values above 2,500 in all years. The most extreme concentration occurred in 2015-2016, when maize and rice accounted for nearly 96 percent of total certified output and the HHI peaked above 4,770, indicating a near-duopoly at the crop level. The post-2017 trajectory shows an unambiguous, if incomplete, diversification trend: the HHI fell from 4,607 in 2017 to 2,916 in 2025, its lowest recorded value, while the SDI rose from 0.907 to 1.496. The minor crop share of total certified production increased from 4.4 percent in 2017 to 26.3 percent in 2025.

Table 3. Concentration and Diversification Indices (Selected Years)

Year	2007	2009	2011	2013	2015	2017	2019	2022	2025
HHI	4,106	4,105	3,575	3,999	4,771	4,607	3,994	3,445	2,916
SDI (H)	1.183	1.280	1.228	1.072	0.892	0.907	1.120	1.354	1.496
Major Share (%)	87.6	75.5	82.1	87.9	95.9	95.6	88.7	82.3	73.7
Minor Share (%)	12.4	24.5	17.9	12.1	4.1	4.4	11.3	17.7	26.3

Source: Computed from NASC (2025) data. HHI = Herfindahl-Hirschman Index (10,000 = maximum concentration); SDI = Shannon Diversity Index (higher values indicate greater diversity).

4.4 Cluster Patterns and Heatmap Analysis

Figure 2 presents the crop performance heatmap, normalizing each crop's annual production to its own peak value (= 100) to enable visual comparison across the dramatically different production scales of major and minor crops. Cluster boundaries and phase periods are indicated. The heatmap reveals several structural patterns not immediately visible in aggregate trend lines.

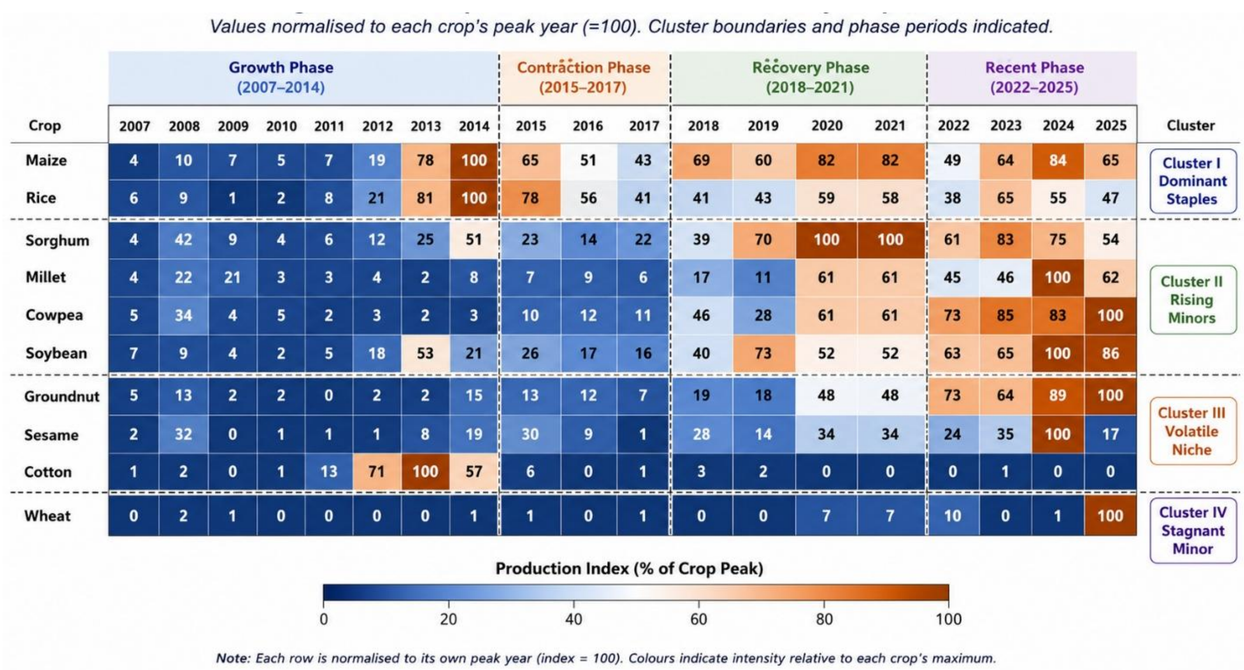

Figure 2: Heatmap of Certified Seed Production by Crop and Cluster (2007-2025)

Source: Computed from NASC (2025) data. Cell values represent each crop's production as a percentage of its own peak-year output (peak = 100). Blue shading indicates low production relative to peak; orange-red shading indicates high production. Horizontal dashed lines separate cluster groupings; vertical dashed lines mark phase boundaries (2014 and 2017).

Cluster I (Maize and Rice) shows a consistent warm-to-hot pattern through 2013-2014, a sharp cooling during 2015-2017, and partial re-warming in the recovery phase, visually confirming the boom-bust-recovery cycle. The crops move almost in lockstep, confirming high co-movement risk. Cluster II (Rising Minors: Sorghum, Millet, Cowpea, Soybean) shows distinctly different heatmap signatures. Cowpea's 2015-2017 cells are notably warmer than those of other Cluster II crops, consistent with its counter-cyclical production behaviour. Millet and groundnut display dark cells through 2013-2016 before transitioning to progressively warmer tones, reflecting their late-emerging recovery trajectory. Cluster III (Sesame, Cotton, Wheat) is visually the most heterogeneous. Cotton's bright warm cells in 2012-2013 and near-black cells from 2016 onward capture its structural collapse. Wheat's dramatically warm 2025 cell stands out as an isolated policy-driven surge. Sesame fluctuates between extremes without a clear directional trend.

Table 4. Cluster Typology of Certified Seed Crops by Performance and Resilience Profile

Cluster	Crops	Characterization	Avg. CAGR (%)	Avg. CV (%)	2025 Share (%)
I - Dominant	Maize, Rice	High-volume, moderate growth, moderate volatility	13.98	65.6	73.7
II - Rising Minor	Cowpea, Groundnut, Millet, Soybean	Low base, high CAGR, high post-trough recovery	17.28	101.7	11.6
III - Volatile Niche	Sesame, Cotton, Wheat	Extreme volatility, sporadic policy shocks	11.18	219.4	12.2
IV - Stagnant Minor	Sorghum	Moderate volume, moderate growth, stable trajectory	16.28	77.6	2.5

Source: Author's analysis based on NASC (2025) data. Cluster characteristics derived from full-period CAGR, coefficient of variation, and 2025 production share computations.

Table 4 classifies Nigeria's certified seed crops into four performance-resilience clusters based on their long-term growth rate, production volatility, and relative contribution to certified seed production. The results show that maize and rice remain the dominant crops, accounting for nearly three-quarters of total certified seed production in 2025 despite only moderate long-term growth. In contrast, Cluster II crops (cowpea, groundnut, millet, and soybean) demonstrate the strongest growth momentum and recovery potential, indicating considerable opportunities for diversification. Cluster III consists of highly volatile crops whose performance is largely influenced by intermittent policy interventions, while sorghum forms a distinct cluster characterized by relatively stable but modest growth. This classification provides a practical framework for prioritizing future investment and policy interventions according to the resilience profile of each crop group.

The implications for food and nutrition security are direct. Nigeria ranks 109th of 125 nations on the 2022 Global Hunger Index and faces a double burden of acute caloric insufficiency and micronutrient deficiency [23]. The certified seed system bias toward maize and rice prioritizes calorie supply but neglects protein and micronutrient supply. A system that allocated more certified seed production to Cluster II legumes would simultaneously improve dietary protein availability, reduce dietary diversity deficits, and strengthen the seed supply base for crops with superior climate resilience profiles [24,8].

The cluster classification highlights important differences in the structural behaviour of Nigeria's certified seed system. Cluster I comprises maize and rice, which dominate certified seed production because of sustained government investment, relatively mature seed markets, and strong farmer demand. However, their moderate growth rates suggest that these crops are approaching market maturity. Cluster II demonstrates the greatest strategic potential for future expansion. The strong recovery performance of cowpea, soybean, millet, and groundnut reflects increasing market demand for climate-resilient and nutrient-dense crops, consistent with recent evidence that diversified seed systems improve food system resilience and reduce production risk [5,21,24].

Cluster III exhibits high production volatility resulting from irregular policy support, fluctuating market demand, and dependence on external economic conditions. Wheat illustrates how targeted policy interventions can rapidly stimulate certified seed production, whereas cotton demonstrates the consequences of declining market competitiveness. Sorghum forms an independent cluster because its relatively stable growth pattern and moderate production levels distinguish it from both dominant cereals and rapidly expanding minor crops. These findings support the argument that diversified seed portfolios improve agricultural resilience by reducing dependence on a small number of dominant crops and enhancing the capacity of seed systems to respond to climatic and economic shocks [2,21,5].

4.5 Resilience to Production Shocks

The 2014-2017 contraction constitutes the primary shock event for resilience analysis. Recovery rates from the 2017 trough vary enormously across crops. Minor crops generally exhibited far greater percentage recovery rates than major crops: millet recovered by 1,444 percent from its 2017 trough, groundnut by 1,409 percent, and cowpea by 850 percent. These extreme percentage figures reflect the very low trough values in 2017 rather than absolute volume comparisons, but they confirm that minor crop seed systems, once demand stimulus improved, were highly responsive. Soybean's 530 percent recovery reflects the explosive growth of domestic soybean meal demand from the poultry feed sector [16]. Major crops showed comparatively muted recoveries: maize at 93 percent and rice at 57 percent above their 2017 troughs. Cotton's recovery failure is structurally informative: 2025 production of 8.5 MT represents a system that has effectively exited the formal certified seed market [18].

5. CONCLUSION AND POLICY IMPLICATIONS

This study provides the first comprehensive statistical analysis of Nigeria's certified seed production system across a 19-year period, using NASC data covering ten crop species from 2007 to 2025. The certified seed industry is structurally concentrated in maize and rice, which account for an average of 87.7 percent of total annual production over the study period. This concentration creates systemic fragility: the 2015-2017 recession demonstrated that simultaneous shocks to the dominant crops can produce a 59 percent industry-wide production collapse. The HHI, peaking above 4,770 in 2015-2016, quantifies this concentration in terms comparable to a highly uncompetitive market structure.

The post-2017 recovery period reveals an incipient structural diversification, with the HHI declining to 2,916 by 2025 and the SDI rising to 1.496. Minor crop share increased from 4.4 to 26.3 percent. The driving crops, cowpea, groundnut, millet, and soybean, achieved recovery-period CAGRs of 32-40 percent, suggesting that commercial and policy incentives are beginning to shift toward a more diverse crop portfolio, but from a very low base. The resilience analysis confirms that minor crops, despite higher inter-annual volatility, possess dynamic adaptive capacity. Cowpea's counter-cyclical growth during the 2014-2017 shock and the exceptional post-trough recovery rates of legumes suggest these crops can function as portfolio stabilizers in a diversified seed system.

5.1 Policy Recommendations

First, a dedicated minor crop seed development facility should be established under NASC to provide subsidized breeder seed, varietal testing support, and fast-track certification pathways for Cluster II legumes. The current certification apparatus is calibrated for high-volume cereal seed and imposes disproportionate compliance costs on minor crop seed producers [4,25].

Second, a certified seed diversification incentive should be introduced, rewarding seed enterprises achieving above-threshold shares of minor crop production in their annual certified output. This creates a positive market signal without distorting major crop supply [26,11].

Third, sorghum hybrid seed commercialization should be integrated into the northern agricultural extension program, with IITA-developed drought-tolerant hybrid sorghum varieties as the primary technology vehicle, given sorghum's exceptional climate resilience and food security role in Nigeria's most climate-vulnerable farming populations [2,7].

Fourth, a rolling annual seed system resilience index, computed from NASC production data using the HHI and SDI metrics developed in this study, should be institutionalized as a standard monitoring tool within the NASC Annual Statistical Bulletin [5,12].

Fifth, a demand-side intervention program should link cowpea and soybean certified seed uptake to the National School Feeding Program and institutional procurement of legume-based food products. Demand-side pull can be as important as supply-side seed development in sustaining the Cluster II diversification momentum observed since 2017 [22,23].

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APPENDIX:

Appendix: Full Annual Certified Seed Production Data (2007-2025)

Table A1 presents the complete annual certified seed production series for all ten crops, sourced from NASC (2025). Values are in metric tons.

Year	Maize	Rice	Sorghum	Millet	Cowpea	Soybean	Groundnut	Sesame	Cotton	Wheat
2007	3,323	5,543	199	161	154	415	144	19	94	70
2008	7,208	8,315	2,366	1,002	1,078	546	404	245	301	250
2009	4,931	1,184	509	938	115	240	73	3	15	93
2010	3,410	2,156	245	157	153	151	62	6	70	0
2011	5,313	6,830	327	148	67	329	15	8	1,751	0
2012	14,251	18,850	644	171	88	1,081	60	10	9,333	0
2013	58,128	73,585	1,388	98	50	3,278	69	60	13,189	0
2014	74,081	91,056	2,845	365	97	1,304	463	150	7,526	170
2015	47,812	70,689	1,286	321	302	1,624	384	233	781	165
2016	37,640	51,208	784	388	368	1,062	365	69	0	30
2017	32,207	37,695	1,204	295	332	976	200	7	66	101
2018	50,977	37,783	2,178	776	1,448	2,463	586	213	371	0
2019	44,612	39,245	3,889	512	869	4,467	532	111	269	0
2020	60,856	53,341	5,577	2,791	1,927	3,224	1,463	259	21	1,026
2021	60,841	52,735	5,560	2,783	1,924	3,219	1,460	259	21	1,026
2022	36,582	35,013	3,375	2,038	2,292	3,859	2,193	184	27	1,424
2023	47,594	59,032	4,637	2,102	2,670	4,003	1,937	268	101	0
2024	62,260	50,049	4,182	4,554	2,617	6,153	2,688	772	41	83
2025	47,802	42,563	3,005	2,827	3,154	5,271	3,018	134	8	14,762

Source: NASC (2025). Note: Zeros indicate negligible or no certified production recorded in that year.