Risk Exposure and Risk Attitudes Among Seed Out-Growers in North-Central and North-West Nigeria

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ABSTRACT

Agricultural production is characterised by uncertainty arising from production conditions, market arrangements and institutional factors, which can influence farmers' decisions and willingness to participate in commercial agricultural activities. This study examined risk exposure and risk attitudes among seed out-growers in North-Central and North-West Nigeria. Primary data were collected from 394 seed out-growers, comprising 155 respondents from North-Central Nigeria and 239 from North-West Nigeria, using a structured questionnaire administered between February and November 2023. Descriptive statistics were used to examine the prevalence of production, marketing, financial, institutional, personal and other risks. Beta-distribution probability estimates were employed to assess the likelihood that the underlying prevalence of each risk exceeded 80% and 85%, while the safety-first approach was used to classify respondents according to their risk attitudes. The results showed that crop failure and low-quality output were the most prevalent production risks, each reported by 92.9% of respondents, followed by low crop yields (90.9%). Major marketing risks included market restrictions and off-takers' refusal to buy back produce (89.8% each), as well as glut or lack of off-take (89.1%). Government instability (94.4%) and lack of insurance (93.4%) were the most prevalent institutional risks. The beta-distribution estimates further indicated high probabilities of exceeding the 80% prevalence threshold for major production, marketing and institutional risks. Regarding risk attitudes, 55.3% of respondents were classified as highly risk averse, 33.0% as moderately risk averse and 11.7% as having low risk aversion. The findings demonstrate that seed out-growers face substantial production, marketing and institutional uncertainties, alongside a predominance of risk-averse behaviour. Strengthening risk-management arrangements, improving contractual enforcement, expanding agricultural insurance and providing reliable market information are therefore important for supporting sustainable participation in seed out-grower schemes.

Keywords: Agricultural risk; beta distribution; risk aversion; safety-first approach; seed out-growers; Nigeria.

INTRODUCTION

Agricultural production is inherently exposed to uncertainty arising from weather conditions, biological processes, input and output markets, institutional arrangements, and human behaviour. These uncertainties can affect production outcomes, farm income, investment decisions, and the willingness of producers to commit resources to agricultural activities. The consequences are particularly important for smallholder farmers because limited financial reserves and restricted access to formal risk-management instruments can reduce their capacity to absorb adverse shocks. Evidence from Nigeria shows that farmers' responses to uncertainty are not uniform, with risk attitudes influencing production choices, technology decisions, resource allocation, and livelihood strategies (Begho *et al.,* 2022). Studies also shows that farmers' perceptions of specific risks can alter the use of productive inputs and the scale of farm operations. For example, Nnaji *et al*. (2023) found that greater perceptions of farmer–herder conflict risk reduced fertilizer use and cropland rental among rural households in Nigeria. These findings indicate that agricultural risk is not only an outcome of production shocks but also an important determinant of farmers' economic behaviour.

Seed production presents a particularly important setting in which to examine agricultural risk because the activity combines biological production uncertainty with stringent quality requirements and market relationships. Seed is a critical input into crop production, and the availability of adequate quantities of quality seed is essential for improving agricultural productivity and strengthening the resilience of farming systems. However, the Nigerian seed system continues to face challenges related to access, quality assurance, distribution, infrastructure, and the availability of preferred varieties (Izuogu *et al*. 2023). These challenges create uncertainty for farmers involved in seed production because production outcomes depend not only on agronomic conditions but also on whether harvested seed satisfies quality requirements and can be marketed under prevailing contractual and institutional arrangements.

Out-grower arrangements have emerged as an important mechanism for linking smallholder farmers with seed companies and other agricultural enterprises. Under such arrangements, farmers may receive production inputs, technical guidance, quality-control services, and an assured or intended market, while contracting firms obtain access to a distributed production base. Studies from Nigeria suggests that contract farming can improve farmers' access to inputs, technical assistance, and market opportunities, although concerns relating to pricing and institutional arrangements remain (Enwelu and Iyere-Freedom, 2023). The economic performance of an out-grower scheme therefore depends on more than the expected profitability of production. Farmers must also assess the possibility that yields will be below expectations, produce will fail to meet quality standards, prices or input costs will change, contracted produce will not be purchased as anticipated, or institutional conditions will disrupt production and marketing. These considerations make risk exposure a central component of the economics of seed out-grower production.

The relevance of risk is further heightened in Northern Nigeria, where agricultural producers face overlapping production, market, financial, institutional, and security-related uncertainties. Recent evidence from Nigeria demonstrates that conflict-related risk perceptions can influence farm input decisions and land-use behaviour, while broader reviews of the Nigerian literature show that risk aversion is widespread among farmers and is associated with differences in production and management decisions (Nnaji *et al*. 2023; Begho *et al.,* 2022). Evidence from other Nigerian farming systems similarly indicates substantial prevalence of risk-averse behaviour. Adegbite and Ayinde (2024) found that risk aversion predominated among smallholder farmers in South-West Nigeria. These findings are relevant to seed out-growers because farmers who are highly averse to risk may respond differently to uncertain production and market conditions from those who are more willing to accept risk. Therefore, the economic implications of a particular risk cannot be fully understood without considering farmers' attitudes towards risk.

The distinction between risk exposure and risk attitude is important. Risk exposure concerns the types and intensity of uncertain events to which farmers are subject, whereas risk attitude reflects the degree to which farmers are willing to accept or avoid uncertain outcomes. Farmers operating under similar conditions may therefore respond differently because of differences in risk preferences, resources, experience, or expectations. Begho et al. (2022) found that 26 of 39 reviewed studies reported that most Nigerian farmers were risk averse, although the degree of risk aversion varied across studies. The review also identified age, household size, education, income, poverty status, farm size, and access to credit as recurring correlates of risk attitudes. Cardell et al. (2023) further demonstrated that farmers' risk tolerance can affect the economic attractiveness of storing maize under uncertain market returns. Understanding risk attitudes is therefore necessary for interpreting farmers' responses to uncertainty in agricultural production and marketing.

Despite the growing literature on agricultural risk in Nigeria, relatively limited attention has been given to seed out-growers as a distinct group of agricultural producers. Existing studies have examined risk attitudes among general smallholder farmers and participants in particular crop value chains, while research on Nigerian out-grower arrangements has focused largely on participation, productivity, financial viability, or contract-related outcomes (Enwelu and Iyere-Freedom 2023). The recent literature on Nigerian seed systems has likewise emphasised access to quality seed, distribution, certification, and market-related challenges rather than the joint assessment of the risks experienced by seed producers and their attitudes towards those risks (Izuogu *et al.* 2023). This leaves an empirical gap concerning how different categories of risk are distributed among seed out-growers and whether farmers operating within the same broad production system exhibit similar or different degrees of

risk aversion. Addressing this gap is particularly relevant in North-Central and North-West Nigeria, where seed out-grower production is increasingly integrated into commercial agricultural value chains.

This article examines risk exposure and risk attitudes among seed out-growers in North-Central and North-West Nigeria. It contributes to the literature by jointly identifying the major production, marketing, financial, institutional, personal, and other risks reported by seed out-growers; estimating, through Monte Carlo simulation, the probability that selected risks exceed specified occurrence thresholds; and determining farmers' risk attitudes using the safety-first approach. This integrated analysis links the risks farmers face with their willingness to accept uncertain outcomes.

MATERIALS AND METHODS

Study setting

The study was conducted in four States selected from the North-Central and North-West geopolitical zones of Nigeria: Federal Capital Territory (FCT) and Niger State in the North-Central zone, and Kaduna and Kano States in the North-West zone. The two zones constitute important agricultural production areas with substantial participation in commercial crop production and seed multiplication. The FCT lies approximately between 8°25′N and 9°20′N and 6°45′E and 7°39′E, covering about 7,315 km². The territory is characterised by a tropical climate with distinct rainy and dry seasons and annual rainfall of approximately 1,100–1,600 mm.

Niger State lies approximately between 8°20′N and 11°30′N and 3°30′E and 7°20′E, covering approximately 76,363 km². The state has a tropical climate, with rainfall concentrated between May and October and a dry season extending from November to March. Annual rainfall generally ranges from 1,100 to 1,600 mm. Its extensive agricultural land, fertile soils, and river systems, including the River Niger, support both rain-fed and irrigated production. Major crops include rice, maize, millet, sorghum, yam, and groundnut, and the state has substantial involvement in commercial seed production.

Kaduna State is located approximately between 9°02′N and 11°32′N and 6°15′E and 8°38′E, covering about 46,053 km². Rainfall generally ranges from approximately 1,000 mm in the north to 1,500 mm in the south, with a rainy season extending from about May to October. The vegetation is predominantly Northern Guinea Savannah, with some transition towards Sudan Savannah in the northern part of the State. Kaduna has a diversified agricultural economy involving maize, sorghum, millet, rice, and livestock production and has an established presence of public and private seed enterprises.

Kano State is situated between approximately 10°33′N and 12°37′N and 7°34′E and 9°29′E, covering about 20,131 km². It lies predominantly within the Sudan Savannah ecological zone and receives less than 1,000 mm of annual rainfall, concentrated mainly between June and September. The State has a prolonged dry season and relies substantially on irrigation for dry-season agricultural production. Major crops include rice, millet, maize, and groundnut. Kano also has an extensive agricultural market system and a substantial presence of commercial farming and seed-related activities.

A multistage sampling procedure was used to select seed out-growers. The sampling frame was constructed from information on registered seed companies obtained from the National Agricultural Seeds Council (NASC). The North-Central and North-West zones were selected because of their substantial concentration of registered seed companies and seed production activities. The NASC database available for the study period contained 314 registered seed companies nationally, of which 199 were located within the two study zones.

In the first stage, two states were purposively selected from each zone based on the concentration of registered seed companies and seed production activities. Niger State and the FCT were selected from the North-Central zone, while Kaduna and Kano States were selected from the North-West zone.

In the second stage, approximately 10% of the registered seed companies in each selected state were selected to establish the operational sampling frame. The selected companies had an estimated total of 28,000 seed out-

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growers across the four states. The farmer sample size was subsequently determined using the Yamane finite-population formula:

$$n = \frac{N}{1 + N(e)^2}, \qquad (1)$$

where $n$is the required sample size, $N$is the total population of seed out-growers in the sampling frame, and $e$is the desired level of precision. With $N = 28{,}000$ and $e = 0.05$, the calculated sample size was approximately 394 seed out-growers.

The resulting sample was allocated proportionately among the four states according to the number of out-growers in each state's sampling frame. The proportional allocation was calculated as:

$$n_h = \frac{N_h}{N_T} n, \qquad (2)$$

where $n_h$is the sample allocated to state h, $N_h$is the number of seed out-growers in state h, $N_T$is the total number of out-growers in the sampling frame, and $n$is the overall sample size. The resulting sample consisted of 113 respondents from the FCT, 42 from Niger State, 126 from Kaduna State, and 113 from Kano State, giving a total of 394 respondents.

Within the selected seed companies, eligible out-growers were identified from company production records and selected for interview. The final sample therefore comprised farmers actively engaged in seed out-grower production during the survey period.

The study relied primarily on cross-sectional primary data collected through a structured questionnaire administered to seed out-growers between February and November 2023. The extended fieldwork period was intended to capture information covering the relevant stages of the seed production cycle and to reduce the possibility that responses would reflect conditions from only a single point in the production season.

The questionnaire was reviewed by the research supervisory team to establish content validity and ensure that the questions adequately addressed the study objectives. Trained enumerators familiar with the study area and local languages administered the questionnaire. Before the main survey, enumerators were trained on the objectives of the study, questionnaire administration, respondent selection, ethical conduct, and procedures for recording responses consistently. The questionnaire was programmed and administered electronically using KoboCollect.

Measurement and analysis of risk exposure

Risk exposure was assessed across six broad categories: production, marketing, financial, institutional, personal, and other risks. The selection of risk variables was guided by the agricultural-risk literature and conditions identified during the preliminary field assessment. Production risks comprised low crop yields, crop failure, soil deterioration, pests and diseases, labour shortages, and low-quality output. Marketing risks comprised glut or lack of off-take, market restrictions, limited market information, side selling, and refusal by off-takers to purchase contracted output. Financial risks comprised price fixing by off-takers, fluctuations in input prices, and reductions in output prices by off-takers. Institutional risks comprised lack of formal contracts, lack of insurance, and government instability. Personal risks comprised low skills or education and poor storage practices, while other risks comprised farmer–herder conflict, ion or iron toxicity where applicable, natural disasters, and theft.

Respondents indicated whether they had experienced each identified risk during their seed production activities. For each risk, the number and proportion of respondents reporting its occurrence were calculated. The prevalence of each risk was expressed as:

$$P_j = \frac{n_j}{N} \times 100, \qquad (3)$$

where $P_j$is the percentage of respondents reporting risk j, $n_j$is the number of respondents reporting risk j, and $N$is the total number of respondents.

This procedure provided an empirical measure of farmers' exposure to different forms of uncertainty before the simulation and risk-attitude analyses were undertaken.

Safety-first measure of risk attitude

The safety-first approach was used to estimate an individual risk-aversion parameter for each seed out-grower. The approach follows Abdulrazaq *et al.* (2022), who applied the safety-first model to classify farmers according to their willingness to accept production risk. The model identifies the amount of risk a farmer is willing to bear while maintaining a minimum acceptable level of expected return.

For farmer i, the risk-aversion parameter was expressed as:

$$K_{si} = f\left(\theta, P_i, W_i, P, B_i, U_y\right), \qquad (4)$$

where K_{si}denotes the risk index of farmer i; $\theta$is the variance parameter; $P_i$is the unit price of the most influential input used by farmer i; $W_i$is the quantity of that input used by farmer i; $P$is the unit price of output; $B_i$is the elasticity of output with respect to the selected input; and $U_y$is mean output. The specific functional form follows the safety-first formulation used in the study's empirical application.

The input considered in the safety-first model was identified from the estimated production relationship by examining marginal products together with the coefficient of variation, input prices, and quantities of the relevant inputs and outputs. The production-function estimates provided the elasticity and marginal-product information required for identifying the most influential production factor.

The estimated $K_s$values were used to classify respondents into three risk-attitude groups. Farmers with $0 < K_s < 0.4$were classified as having low risk aversion or risk preference; those with $0.4 < K_s < 1.2$were classified as having moderate or intermediate risk aversion; and those with $1.2 < K_s < 2.0$were classified as highly risk averse.

Estimation of Risk Exposure Using the Beta Distribution

The prevalence of the identified risks among seed out-growers was estimated from the proportion of respondents who reported exposure to each risk. For each risk, responses were classified as either exposed or not exposed, and the observed prevalence was calculated as the number of respondents reporting exposure divided by the total number of respondents surveyed, expressed as a percentage. Given the binary nature of the responses, a beta distribution was employed to account for uncertainty surrounding the underlying prevalence of each identified risk.

The beta distribution was selected because it is bounded between zero and one and is appropriate for modelling uncertainty associated with proportions. For each risk, the distribution was parameterised using the observed number of respondents reporting exposure and those who did not report exposure. The parameters were specified as:

Alpha (α) = $x_j + 0.5$

Beta (β) = $(n - x_j) + 0.5$

where (α) and (β) are the shape parameters of the beta distribution for risk (j); (x_j) represents the number of respondents who reported exposure to risk (j); (n) is the total number of respondents (394); and 0.5 represents the Jeffreys prior adjustment applied to both parameters. Consequently, the underlying prevalence of each risk was represented by:

$p_j \sim Beta(\alpha_j, \beta_j)$

where (p_j) denotes the uncertain underlying prevalence of risk (j).

To assess the likelihood that each identified risk constituted a widespread exposure among seed out-growers, two threshold levels, 80% and 85%, were adopted. The probability that the underlying prevalence of each risk exceeded these thresholds was estimated from the cumulative beta distribution as follows:

$$P(p_j > 0.80) = 1 - F_Beta(0.80;\ \alpha_j, \beta_j)$$

$$P(p_j > 0.85) = 1 - F_Beta(0.85;\ \alpha_j, \beta_j)$$

where (F_Beta) represents the cumulative distribution function of the beta distribution. The resulting probabilities indicate the degree of statistical support for the underlying prevalence of each risk exceeding the specified thresholds. Higher probabilities indicate stronger evidence that the proportion of seed out-growers exposed to a particular risk exceeds the corresponding threshold.

For interpretation, risks with a probability of at least 80% of exceeding the 80% prevalence threshold were classified as most likely. Risks with probabilities of at least 50% but below 80% were classified as likely, while those with probabilities below 50% were classified as not likely. This classification provided a basis for distinguishing risks with relatively high prevalence from those with weaker evidence of widespread exposure among seed out-growers.

RESULT AND DISCUSSION

Risks Analysis in Seed Out-growers Schemes

Types of risk

The result in Table 1 reveals the various risks associated with out-grower seed production in the study area. These includes; production risks, marketing risks, financial risks, institutional risks, personal risks and others.

Table 1: Various risks involved in seed out-growers' schemes

Sources of risks	North-central (n=155)	North-west (n=239)	Pooled (n=394)
Production risks	**Freq (%)**	**Freq (%)**	**Freq (%)**
Low crop yields	147 (94.8)	211 (88.3)	358(90.9)
Crop failure	151 (97.4)	215 (90.0)	366(92.9)
Soil deterioration	127 (81.9)	195 (81.6)	322(81.7)
Pest and diseases	117 (75.5)	180 (75.3)	297(75.4)
Lack of labour	114 (73.5)	173 (72.4)	287(72.8)
Low quality output	141 (91.0)	225 (94.1)	366(92.9)
Marketing risks			
Glut and lack of off-take	139 (89.7)	212 (88.7)	351(89.1)
Market restriction	135 (87.1)	219 (91.6)	354(89.8)
Low market information	132 (85.2)	200 (83.7)	332(84.3)
Side selling	108 (69.7)	179 (74.9)	287(72.8)
Off taker refuses to buyback	140 (90.3)	214 (89.5)	354(89.8)
Financial risks			
Price fixing by off taker	73 (47.1)	101 (42.3)	174(44.2)
Fluctuating input prices	98 (63.2)	135 (56.5)	233(59.1)
Off-takers reduces price	76 (49.0)	117 (49.0)	193(49.0)

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Institutional risks			
Lack of Formal contract	61 (39.4)	81 (33.9)	142(36.0)
Lack of insurance	151 (97.4)	217 (90.8)	368(93.4)
Government instability	144 (92.9)	228 (95.4)	372(94.4)
Personal risks			
Low skills/education	120 (77.4)	187 (78.2)	307(77.9)
Poor storage technique	126 (81.3)	188 (78.7)	314(79.7)
Others sources of risks			
Herders/Farmers clashes	120 (77.4)	203 (84.9)	323(82.0)
Ion toxicity	134 (86.5)	87 (36.4)	221(56.1)
Natural disaster	93 (60.0)	180 (75.3)	273(69.3)
Theft	67 (43.2)	131 (54.8)	198(50.3)

Source: Field survey, 2026

Table 1 shows that majority (97.4%) of the farmers in North-central region identified crop failure as a major risk associated with out-grower seed production. This could be as a result of the effect of adverse weather condition such as high temperature or drought that causes crop failure among the farmers in North-central Nigeria. Farmers also considered low crop yields (94.8%) and low-quality output (91.0%) as severe production risk. Similarly, low quality output (94.1%) and crop failure (90.0%) were major production risks affecting out-grower seed production. These results agree with the findings of Ragasa *et al.* (2021) who shows that 87.5% of loss occurrence was due to the outbreak of natural elements (such as drought, pest and diseases), 61.3% due to social elements (theft) and 53.8% as a result of economic factors such as price fluctuation.

Marketing risk, particularly off-takers' refusal to buy back produce (90.3% and 89.5%), emerged as a major issue in seed production in North-central and North-west region respectively. The pooled results confirmed this as a severe challenge. This risk may arise from seed companies questioning seed quality standards, even when seed enterprise was seen to be efficiency across both regions. Over production or reduced market demand further exacerbates the situation, as companies may limit purchases due to market saturation or excess supply. This implies that farmers lack absolute control over their produce, leaving them vulnerable to buyers' decisions. In many cases, they are compelled to accept prices dictated by the buyers, regardless of production costs. Strengthening contractual agreements and creating alternative marketing channels could reduce these risks and improve farmers' market power.

Market restriction, identified as a risk (87.1% and 91.6%), poses challenges for out-growers in seed production. The pooled results confirm this as a widespread issue. These restrictions may stem from seed companies enforcing exclusive contracts that limit farmers to specific buyers, preventing them from accessing alternative market. This is in consonance with the findings of Sperling *et al.* (2020) who reported that off-takers refusal to buyback farmers' produce and fluctuations in the buyback prices of cereal crops seriously affected its productivity in Northern Nigeria.

The result in Table 1 reveals that the most severe financial risk among seed out-growers was fluctuation of inputs prices (63.2% and 56.5%) in North-central and North-west. The pooled results also reveal that about 59.1% of the farmers reported fluctuation of inputs prices as a major financial risk associated with out-growers seed production. The situation is further compounded by incessant reduction of off-takers' prices as reported by 49% of the farmers across the study areas. This implies that variations in the prices of inputs and outputs are serious setback to seed out-growers productivity in Northern Nigeria. This corroborates the findings of Jankelova *et al.* (2021) who reported that 34.3% of the farmers in North Nigeria suffered financial risks related to price fluctuation in production inputs and outputs.

The result in Table 1 further shows that lack of insurance (97.4% and 90.8%) was the major institutional risk faced by farmers. This implies that majority of the out-grower seed farmers lack insurance against unforeseen circumstances for their seed production enterprise. The pooled result (93.4%) confirmed lack of insurance for production activities among farmers as the most common institutional risks in Northern Nigeria. More so,

government instability (94.4%) as reveals in the pooled result and poor implementation of agricultural policies which renders farming enterprise less lucrative could be a contributing factor to low insurance by the farmers in Northern Nigeria. Rice importation is allowed at 100% tariff, thereby making foreign rice relatively expensive. This could lead to increased demand for domestic rice varieties, including those produced by out-growers. However, it may also increase input costs, such as fertilizers and agrochemicals, due to heightened competition for resources. Additionally, local producers may face pressure to meet quality standards to remain competitive in the market. This result is in line with Cardell *et al.* (2023) and Prowse (2022) who reported that loss occurrence due to the outbreak of natural elements (such as fire, pest, and disease), social element (such as theft) and economic factors (such as price fluctuation) could have been drastically mitigated through stable policies and insurance.

The result in Table 1 further indicates that poor storage techniques (81.3% and 78.7%) was the major source of personal risk among the farmers. This implies that farmers in the study area had limited knowledge on storage techniques which may lead to loss of farm produce among the farmers in the study area. The pooled result also shows that about 79.7% of the farmers had poor storage techniques.

In addition, majority of the out-growers farmers' (78.2% and 77.4%) in North-west and North-central respectively reported low skills/education in risk management of the out-grower seed production as a source of personal risk. This could affect their output from adverse climatic effect and environmental degradation in cereal crop production. Furthermore, herders-farmers conflict and theft were reported to have posed serious risk to out-grower seed farmers as it may affect the production scale of cereal crop in the study area. This result aligns with the findings of Abdulrazaq *et al.* (2022) who reported that farmers in Northern Nigeria were challenged by human activities such as bush burning, theft and poor storage techniques.

Risk prediction among seed out-growers

Table 2 presents the beta-distribution estimates of the probability that the prevalence of identified risks among seed out-growers exceeded 80% and 85%. The estimates provide an indication of the likelihood that exposure to each risk was widespread among the respondents, taking account of uncertainty around the observed prevalence. The results reveal considerable variation across the production, marketing, financial, institutional and personal risk categories, with production, marketing and institutional risks generally recording higher probabilities of exceeding the specified prevalence thresholds.

Among production risks, low crop yields and crop failure recorded high observed prevalence of 90.9% and 92.9%, respectively. Their estimated probabilities of exceeding the 80% threshold were both 100%, while the probabilities of exceeding 85% were 99.97% and 100%, respectively. These results indicate strong statistical evidence that exposure to low crop yields and crop failure was widespread among the seed out-growers. Low-quality output also recorded an observed prevalence of 92.9%, with a 100% probability of exceeding both thresholds. These findings suggest that production-related challenges were not limited to the quantity of output but also affected the quality of produce obtained by participating farmers. Soil deterioration recorded an observed prevalence of 81.7% and an 80.32% probability of exceeding the 80% threshold. However, its probability of exceeding 85% declined to 3.70%, indicating that although the risk was widespread, the evidence that its prevalence exceeded the higher threshold was relatively weak. In contrast, pests and diseases (75.4%) and lack of labour (72.8%) had probabilities of 1.24% and 0.03%, respectively, of exceeding the 80% threshold. This suggests that, despite being reported by considerable proportions of respondents, these risks were less likely to affect more than four-fifths of the sampled seed out-growers.

Marketing risks also featured prominently. Glut and lack of off-take recorded an observed prevalence of 89.1%, with probabilities of 100% and 99.06% of exceeding the 80% and 85% thresholds, respectively. Similarly, market restriction and refusal by off-takers to buy back produce each recorded an observed prevalence of 89.8%, with corresponding probabilities of 100% of exceeding the 80% threshold and 99.76% of exceeding the 85% threshold. These estimates indicate that difficulties associated with produce evacuation, market access and the fulfilment of off-take arrangements were widespread among the respondents. Low market information was reported by 84.3% of the seed out-growers and had a 98.48% probability of exceeding the 80% threshold. However, its probability of exceeding 85% was 33.62%, suggesting that the evidence strongly supports a

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prevalence above 80%, but not above 85%. Side selling, despite an observed prevalence of 72.8%, had only a 0.03% probability of exceeding the 80% threshold. This indicates that side selling was reported by a substantial proportion of farmers but was unlikely to affect more than 80% of the respondents.

In the financial risk category, the estimated probabilities were considerably lower. Price fixing by off-takers, fluctuating input prices and price reductions by off-takers recorded observed prevalences of 44.2%, 59.1% and 49.0%, respectively. All three risks had estimated probabilities of 0% of exceeding either the 80% or 85% threshold at the reported precision. Similarly, lack of formal contracts, an institutional risk reported by 36.0% of respondents, had no appreciable probability of exceeding either threshold. These results suggest that financial and contractual risks, although present among the seed out-growers, were less widespread than the major production, marketing and institutional challenges identified in the study.

The institutional risk category showed a different pattern. Lack of insurance and government instability recorded observed prevalences of 93.4% and 94.4%, respectively. Both risks had estimated probabilities of 100% of exceeding the 80% and 85% thresholds. This indicates strong evidence that inadequate insurance coverage and concerns associated with government instability were widespread among the sampled seed out-growers. The high prevalence of these risks highlights the institutional environment within which seed out-growers operate, particularly the limited availability of formal mechanisms for managing production and market uncertainties.

With respect to personal and other risks, low skills and education recorded an observed prevalence of 77.9%, but its probability of exceeding the 80% threshold was only 15.10%. Poor storage techniques were reported by 79.7% of respondents and had a 43.51% probability of exceeding the 80% threshold. The probability of this risk exceeding 85% was only 0.23%. These findings indicate that both challenges were reported by substantial proportions of respondents, although the evidence did not strongly support prevalence above the specified thresholds. Herders–farmers clashes, however, recorded an observed prevalence of 82.0%, with an 83.70% probability of exceeding the 80% threshold. Its probability of exceeding 85% was 4.93%, suggesting that the risk was likely to affect more than 80% of the respondents but unlikely to exceed the higher threshold. Natural disasters and theft recorded observed prevalences of 69.3% and 50.3%, respectively, but their probabilities of exceeding either threshold were negligible at the reported precision.

Table 2: Beta-distribution estimates of the probability of widespread risk exposure among seed out-growers.

Risk variable	Observed prevalence (%)	Beta parameter α	Beta parameter β	Prob. > 80%	Prob. > 85%	Remark
Production risks						
Low crop yields	90.9	358.5	36.5	100.00	99.97	Most likely
Crop failure	92.9	366.5	28.5	100.00	100.00	Most likely
Soil deterioration	81.7	322.5	72.5	80.32	3.70	Most likely
Pest and diseases	75.4	297.5	97.5	1.24	0.00	Not likely
Lack of labour	72.8	287.5	107.5	0.03	0.00	Not likely
Low quality output	92.9	366.5	28.5	100.00	100.00	Most likely
Marketing risk						
Glut and lack of off-take	89.1	351.5	43.5	100.00	99.06	Most likely
Market restriction	89.8	354.5	40.5	100.00	99.76	Most likely
Low market information	84.3	332.5	62.5	98.48	33.62	Most likely
Side selling	72.8	287.5	107.5	0.03	0.00	Not likely
Off-taker refuses to buyback	89.8	354.5	40.5	100.00	99.76	Most likely
Financial risk						
Price fixing by off-taker	44.2	174.5	220.5	0.00	0.00	Not likely
Fluctuating input prices	59.1	233.5	161.5	0.00	0.00	Not likely
Off-taker reduces price	49.0	193.5	201.5	0.00	0.00	Not likely
Institutional risk						

Lack of formal contract	36.0	142.5	252.5	0.00	0.00	Not likely
Lack of insurance	93.4	368.5	26.5	100.00	100.00	Most likely
Government instability	94.4	372.5	22.5	100.00	100.00	Most likely
Personal risk						
Low skills/education	77.9	307.5	87.5	15.10	0.01	Not likely
Poor storage technique	79.7	314.5	80.5	43.51	0.23	Not likely
Herders/farmers clashes	82.0	323.5	71.5	83.70	4.93	Most likely
Ion toxicity	56.1	221.5	173.5	0.00	0.00	Not likely
Natural disaster	69.3	273.5	121.5	0.00	0.00	Not likely
Theft	50.3	198.5	196.5	0.00	0.00	Not likely

Source: Field survey, 2023

Entries in Table 2 indicates substantial marketing risks, with factors like market restrictions, glut and lack of off-take and off-taker refusals to buy back indicating high probabilities. These risks have triangular peaks skewed toward the maximum probability values, showing 100% likelihood at both thresholds. This suggests that these issues are recurring concerns that farmers face due to unpredictable demand or limited market reach. Notably, low market information has a 100% probability above the 80% threshold but drops sharply to only 2.89% above the 85% level, illustrating a medium-high triangular peak. Farmers often lack timely access to market data, affecting price negotiations and demand forecasting, but this risk does not consistently escalate to extreme levels. Side selling, meanwhile, holds a 0% probability, as contracts and agreements between farmers and buyers appear stable. Effective cooperative structures and government interventions likely contribute to this stability, reducing the incidence of unapproved sales and supporting adherence to contract agreements. Given these probabilities, addressing marketing risks could involve strengthening cooperative support, improving access to market information, and creating more favourable buy-back agreements.

Table 2 further reveals that the financial risks like price fixing by off-takers, fluctuating input prices, and reduction in purchase price demonstrate low probabilities, with their triangular peaks shifted toward minimal impact. This indicates that while these risks exist, their likelihood of significantly affecting farmers' profits remains low. Price-fixing, for example, may be minimized

Risk attitude of the out-grower farmers

Farmers' preference or attitude towards risk explains many observed economic decisions. Therefore, knowledge of farmers' attitude towards risk has important implications for the adoption of new farm technologies and the success of rural development programme (Abdulai and Al-hassan, 2020). The out-grower seed farmers were categorized into risk attitude groups. Low risk aversion/risk preference, intermediate/moderate risk aversion/risk neutral and high-risk aversion. The result in Table 3 shows the risk attitude of the out-growers in North-central and North-west regions. The results indicate that large proportion (61.3% and 51.5% of the farmers in North-central and North-west region, respectively) were risk averse with a negative attitude towards risk.

Table 3: Risk attitudes of the out-growers farmers

Risks aversion	Classification criterion	North-central (n=155)	North-west (n=239)	Pooled (n=394)
Variables		Freq (%)	Freq (%)	Freq (%)
Low risk aversion	$0 < K_s < 0.4$	21 (13.5)	25 (10.4)	46 (11.7)
Moderate risk aversion	$0.4 < K_s < 1.2$	39 (25.2)	91 (38.1)	130 (33.0)
High risk aversion	$1.2 < K_s < 2.0$	95 (61.3)*	123 (51.5)*	218 (55.3)*

Source: Field survey, 2023

This could be as results of uncertainty in contract enforcement, where some out-growers may have experienced contract breaches by off-takers, making them reluctant to take risks in expanding production. Price volatility

also plays a role, as fluctuating seed prices and unpredictable market demand discourage farmers from taking risks due to fear of financial losses. The pooled result also shows that about 55.3% of the farmers were risk averse towards out-grower seed production in the study area. However, about 38.1% and 25.2% of the farmers in North-west and North-central regions, respectively were risk neutral while about 13.5% and 10.4% were found to be risk lovers. Thus, very few farmers had the mindset of taking a higher entrepreneurial risk to produce for the market. These are the profit-oriented farmers who produce at commercial quantity for both domestic and international market. Similar observation was noted in the pooled result, in which 11.7% of the farmers were risk lovers. This result corroborates with the findings of Komarek *et al.* (2020) who reveals that farmers in Northern States were low to moderate risk lovers and barely produce to meet market demand. Furthermore, Jankelova *et al.* (2021) reported that many farmers in Northern Nigeria were not as risk-averse as assumed in literature. While McGuire and Sperling (2020) and Kliem and Sievers-Glotzbach (2021) reveals that Northern farmers had negative attitude towards risk.

CONCLUSION

The study established that seed out-growers in North-Central and North-West Nigeria face substantial production, marketing and institutional risks. Crop failure, low-quality output, low crop yields, market restrictions, refusal by off-takers to buy back produce, government instability and inadequate agricultural insurance were particularly prominent. The beta-distribution estimates further indicated a high probability that several of these risks affect a large proportion of out-growers. The findings also revealed that 55.3% of respondents exhibited high risk aversion, while 33.0% and 11.7% showed moderate and low risk aversion, respectively. The study recommended that seed companies and relevant agricultural institutions should therefore expand access to crop insurance, establish clearer and enforceable contractual terms, strengthen quality assurance and alternative marketing channels, and introduce mechanisms that reduce uncertainty in input prices and produce buy-back arrangements.

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