# IMPACT OF THE NEW AGRO-CERTIFICATION SYSTEM (SEEDCODEX) ON NIGERIAN SEED INDUSTRY AND CROP FARMING

**Folarin Sunday Okelola[1], Sakiru Oladele Akinbode[2]*, Akaninyene Sunday Uteh[3], Charles Onwuka[4], Solomon Oladele Oladeji[5]**

## Abstract

There have been increase in the incidence of fake crop seeds in Nigerian market. This has multiple implications on crop yield and food security. In order to address this problem the National Agricultural Seed Council (NASC) in 2019 introduced a seed quality assurance tagging and tracking system named SEEDCODEX into the Nigerian seed induatry. Meanwhile, there is no knowledge about the impact of the new system on the industry. This study therefore assessed the impact of Seedcodex on the industry with the aim of understanding the level of awareness, use and constriants among key actors in the seed value chain. Also it has to identify socioeconomic variables affecting the use of seedcodex among end users and come up with recommendations which are capable of enhancing the achievement of the objectives of the system. Data were collected from 44 seed companies, 57 agro-dealers and 211 farmers and analyzed with Contingent valuation willingness to pay (WTP), Logit and Tobit regressions. Results revealed that seed companies were aware of Seedcodex and posited that its introduction has increased cost of production, but believed it will sanitize agricultural seed market. All the agro-dealers were aware of Seedcodex. Majority of the farmers plant seeds produced by companies and sold by agro-dealers, while few others source seeds from fellow

1 Folarin Sunday Okelola, Ph.D., National Agricultural Seed Council, km 29, Abuja-Lokoja Express Way Sheda, Abuja, Nigeria, Phone: +234 703 604 61 57 , E-mail: fspkelola@gmail.com, ORCID: 0000-0001-8870-1458

2 Sakiru Oladele Akinbode, Ph.D., Department of Economics, Federal University of Agriculture, P.M.B 2240, Abeokuta, Nigeria, Phone: +234 803 836 04 86, E-mail: akinbodeso@funaab.edu.ng, (*corresponding author), ORCID: 0000-0001-7283-2373

3 Akaninyene Sunday Uteh, Ph.D., National Agricultural Seed Council, km 29, Abuja-Lokoja Express Way Sheda, Abuja, Nigeria, Phone: +234 803 428 86 89, E-mail: akanuteh.au@gmail.com, ORCID: 0009-0001-0020-3911

4 Charles Onwuka, M.Sc., National Agricultural Seed Council, km 29, Abuja-Lokoja Express Way Sheda, Abuja, Nigeria, Phone: +234 704 036 25 69, E-mail: charles.onwuka@hotmail.com, ORCID: 0009-0001-7075-2553

5 Solomon Oladele Oladeji, Ph.D., Department of Agricultural Economics, Federal University of Agriculture, P.M.B 2240, Abeokuta, Nigeria, Phone: +234 805 628 39 51, E-mail: oladejiso@funaab.edu.ng, ORCID: 0000-0002-8010-6109

farmers, or use previous year harvest. Only about 31% of the farmers were aware of Seedcodex, among whom majority usually scratch the code but some do not send such for authentication. The Logit estimation revealed that increase in age reduced the likelihood of using the code while education, farm size and access to credit increased the likelihood of using it for authentication. The contingent valuation of WTP revealed that farmers were willing to pay 26.82% extra to obtain certified quality seeds. The Tobit regression estimation revealed that farmers' age and extension contact reduced WTP amount, while farming experience and farm size increased it. It is recommended that efforts be made to attend to companies' complaints on the cost of seed labels and/or create labels corresponding to weight of seed packages in place of the present flat rate, ensure timely delivery and educate farmers more on SEEDCODEX.

**Key words:** Seed certification, seed quality, crop farming, willingness to pay.

**JEL[6]:** D01, Q12, Q18

## Introduction

The success of any crop farming enterprise begins with the quality of the seeds planted. Even when other supporting factors such as soil, rainfall or water supply, temperature, humidity, pest and disease control are favourable, the lack of quality seed substantially impairs yield and overall output of crop farming with multiple implications on food self-sufficiency objective of the Federal Government of Nigeria. This underscore the importance of quality seed to the agricultural and of course the food sector of the country.

It is a common occurrence to notice that in every planting season, farmers face challenges relating to buying quality seeds for planting. Some farmers eventually buy fake seeds from agro vendors or sometimes plant grains in place of seeds. More often than not, some plant previous year harvest (recycled seed) which may lack hybrid vigour and the required viability.

The incidence of low yield is prevalent in Nigeria. The low average yield reported for most common food crops in the country may be partly explained by the quality of seeds farmers plant. For instance, Nigeria's maize yield in 2019 was 1.69 t/ha (IITA, 2020). This is low compared with the world average yield of about 5.8 t/ha for the same year (FAO, 2021). These were also corroborated by Chand (2021). In the same vein, rice which is consumed across all socioeconomic strata and therefore in high demand across the country has been bedeviled by low yied. For

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instance, average yield in Nigeria remains about 2 t/ha (FAO, 2021) while average yield in the USA is about 8.7 t/ha. This shows a wide gap in productivity which can be partially solved by ensuring sufficient amount of plant certified quality seeds for farmers in Nigeria. Some authors (Awotide et al., 2013) make a study that assessed the impact of seed vouchers on poverty alleviation, using Nigerian rice farmers as case study concluded that availability of good quality seed at prices which are affordable could be capable of raisng agricultural productivity, raise income and alleviate household poverty.

Takeshima et al. (2010) posited that the adoption of improved seeds by farmers for growing common cereal crops is low in Nigeria. But the low level of such uptake was attributed to difficulties, in both the demand and the supply ends of the system. Lakiw and Alemu (2012) posited that offer of just one option in terms of the type of crop variety available to farmers during planting period in Ethiopia by the authority reduces the tendency to manage production and marketing challenges farmers encounter in the country. Meanwhile, the poor supply system of desired agricultural crop seeds is neither perculiar to Nigeria nor developing countries of Sub-Saharan Africa. For instance, the basic convention of organic farming in the EU is that whenever external inputs are needed, it must be organic. However, Orsini et al. (2020) reported that there is a lack of organic seeds for many crops which always results in the use of non-organic untreated seeds granted through derogation requests. Meanwhile, Doring et al. (2012) had reported that the actual demand for certified organic seeds in the EU was only a portion of the total potential seed requirement.

Given that fake seeds in addition to yielding low quality grains also have influence on the values of farm production in local and especially international market, ensuring production, supply and general availability of quality seed is a a major goal of the National Agricultural Seeds Council of Nigeria (NASC). The mandate of the agency includes seed certification and overall regulation of the Nigerian agricultural seed industry (FRNOG, 2019). According to Joshi et al. (2020) seed certification is an important step in seed production and marketing which is usually carried out to maintain high-quality seed standard and making same available to farmers for maintaining good and quality yield. The process involves growing genetically diverse crops with the target of examining the level of purity, viability, physical identity and characteristics of seeds.

FRNOG (2019) Act, Cap N5 repealed the National Seed Act Cap. N5 and enacted the National Agricultural Seeds Council whose functions are "*to promote and stimulate the development of dependable seed industry, regulate and control the registration of released varieties, protect the farmers from the sales of poor quality*

*seeds, facilitate the production and marketing of high quality seeds in Nigeria and provide legal backing for official testing, certification, sales, importation, exportation and use of seed, and for related matters".*

With a view to ensuring that quality seeds are purchased by farmers, National Agricultural Seeds Council (NASC) partnered with Mpedigree in 2019 with sponsorship from the Alliance for a Green Revolution in Africa (AGRA) to introduce a digital seed labeling and verification system that is capable of stopping the prevalence of fake and low-quality seeds in the country. The aim was to provide an electronic agro certification system, called "SEEDCODEX". Seed buyers/farmers are simply expected to scratch open the label and send the embedded code to a designated number in order to determine whether or not the seed producers are certificated by the NASC (Olagunju, 2019).

Therefore, the need to evaluate the impact of the certification policy is imperative to ensure improvement and policy guide which will be useful to seed companies, retailers and most importantly farmers who are the end users in the seed value chain. It is worthy of note that there have been about two planting seasons since the introduction of the new agro certification system. However, little is known about the success/impact of the new authentication policy. In the light of this, there is a need to evolve a study aimed at assessing the impact of the system on the seed industry in Nigeria. In order to bridge this obvious knowledge gap, the following questions were answered: How has the policy affected the business/operations of seed companies, agro-dealers and farmers?; Are the farmers aware of the innovation, or policy?; Do the farmers use SEEDCODEX?; What factors determines the use, or otherwise of the new authentication system among farmers?; What are the challenges various stakeholders in the seed industry are facing with regards to the new certification and authentication system and the suggested ways froward?

In the light of the foregoing, the general objectives were to assess the use and impact of the new seed authentication policy on the seed industry in Nigeria while the specific objectives were to describe how the new authentication policy has affected the business/operations of Seed Companies, agro-dealers and farmers, assess farmers' awareness of the authentication policy, describe the pattern of the farmers' use of the authentication code, determine socioeconomic and other factors affecting the use of SEEDCODEX, describe the reservations and challenges of farmers on the introduction and the use of the new system, estimate farmers' willingness to pay extra for certified quality seeds, determine factors affecting farmers willingness to pay for certified quality seeds, and finally highlight possible improvement/innovations which may be added to the policy. The study is expected to come up with recommendations aimed at enhancing the effectiveness of the new

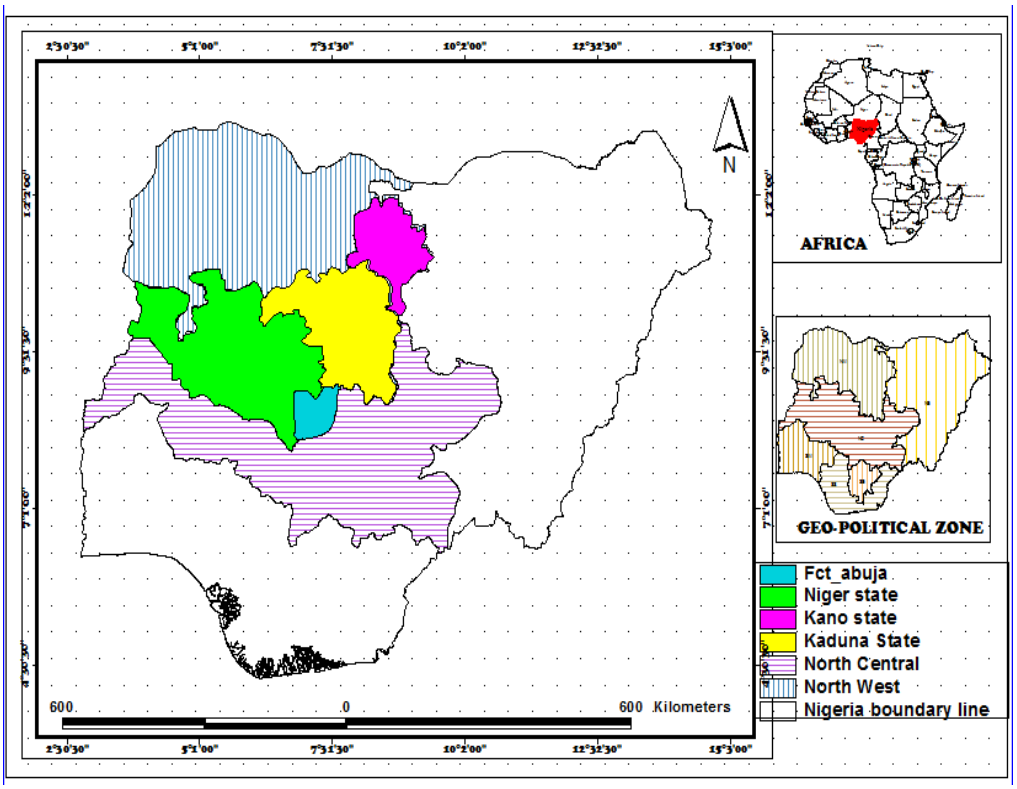
seed authentication system in ensuring only certified quality seeds are purchased and planted by farmers in Nigeria. The far reaching impact is improved agricultural crop yield and food security in the country.

## Methodology

*Study Area*

The study was conducted in the North-West and North-Central geopolitical zones of Nigeria (Figure 1.) due to the high concentration seed companies, agro-dealers and farmers growing most of the crops covered under the mandate of NASC. While seed companies and agro-dealers were randomly selected across states in the two geopolitical zones, farmers were selected from two States from each of the two geopolitical zones. To this end Kano and Kaduna States were selected from the North-West region while Niger State and the Federal Capital Territory (FCT) were selected from the North Central region.

**Graph 1.** Map of Nigeria Showing the Study Area




Source: FWFGL, 2022.

*Data Collection, Sampling Techniques and Sample Size*

Well-structured and pre-tested questionnaires were used to elicit information from various actors in the seed value chain, following Boadu et al. (2018). Mostly, qualitative and some quantitative data gathering were employed. Both primary and secondary data were utilized. The secondary data were obtained from existing documents obtained from the NASC reports on the agency's official website and others obtained from the records of seed companies. The primary data were collected through personal interview of selected seed company operators, agro-dealers/seed retailers and crop farmers. Forty-four (44) seed company operators, fifty-seven (57) agro-dealer/retailers and two hundred and eleven (211) crop farmers representing various actors in the agricultural seed value chain were selected. It should be noted that due to the need to comply with COVID-19 protocols and to avoid excessive travels, data for the evaluation study were collected from the selected respondents via telephone interviews from March 8th to April 4th, 2022.

*Data Analysis*

As certain survey limitation appeared that data collection exersice was negatively affected by mobile network connection, as the telephone lines of some selected respondents' were not connecting, while some whose calls went through failed to pick several calls put across to then and never called back.

The data collected from were analysed using:

(i) **descriptive analyses** such as frequencies, percentages and charts.

(ii) **Independent sample tests** was used to assess the impact of the certification system on sales and yield of farmers. The test procedure is given thus:

$$t = \frac{\overline{X_i} - \overline{X_j}}{\sqrt{\frac{S_i^2}{n_i} + \frac{S_j^2}{n_j}}} \quad \text{where } i \neq j \qquad (1)$$

Where for instance $\overline{X_i}$ = mean value of a variable before SEEDCODEX

$\overline{X_j}$ = mean value of a variable after SEEDCODEX;

$S_i^2$ = sample variance of variable before introduction of SEEDCODEX;

$S_j^2$ = sample variance of variable after introduction of SEEDCODEX;

$n_i$ = number of observations in the group before SEEDCODEX;

$n_j$ = number of observations in the group after SEEDCODEX.

The distribution follows a student t distribution with $n_i+n_j-2$ degree of freedom.

(iii) **Contingent Valuation Method (CVM):** This was used to estimate Willingnesss to Pay (WTP) of crop farmers for certified quality seed. Here, since payment question is going to be open ended, WTP figures reported by the respondents was averaged to produce an estimate of mean WTP.

(iv) **The Tobit (censored) Regression model** was used to determine socioeconomic and other factors affecting farmers' willingness to pay for certified quality seeds.

It has been established in literatures that for data sets with a substantial number of zero values for the dependent variable (as it may happen with the willingness of farmers to pay extra for truly certified quality seeds), OLS estimates will be biased downwards. Tobit regression analysis which has been built to accommodate such type of data was carried out using the maximum likelihood estimation technique.

Generally, the Tobit model (also called censored regression) is defined as:

$$Yi = \beta_1 X_i + ui \text{ if RHS} > 0 \qquad (2)$$

$$Yi = 0 \text{ if otherwise, where } X_i = X_1, X_2 \ldots\ldots\ldots\ldots X_n$$

The variables were defined as:

Y = WTP values (percentage value of expressed extra pay);

$X_1$ = age of farmer (in years); $X_2$ = years of farming experience (in years);

$X_3$ = farmer's educational level (years spent in school);

$X_4$ = gender (female =1, 0 if otherwise);

$X_5$ = farm size (ha);

$X_6$ = extension contact (1 if yes, 0 if otherwise);

$X_7$ = access to credit (1 if famer has access, 0 if otherwise).

(v) **Binary Logit regression model** – This was used to determine factors affecting use of SEEDCODEX by farmers.

The Logit model is stated thus:

$$L_i = \left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_i X_i \qquad (3)$$

Where $P_i$ =1 if famer uses the authentication code and 0 if otherwise. The $X_i$ is the vector of explanatory variables and $i$ in the explanatory variable ranges from 1 to

m, where m represents the number of explanatory variables in model. Regressors included were farmers' age, farming experience, extension contact, education, membership of farmers' association, gender and access to credit.

## Results with Discussion

This section is presented in the three sub-sections covering the main actors in the Nigerian seed industry, namely seed companies, agro-dealers, and farmers.

### *Seed Companies*

*Awareness, Cost of Production and Perceived Advantages:* Next table (Table 1.) presents the results of the awareness assessment of the seed companies about SEEDCODEX and results show that 98% of the seed companies were aware while 2% claimed not to be aware of the new seed certification system. The table revealed that majority (95.4%) of the company operators who were aware of SEEDCODEX first got aware of the policy from NASC officials while only 2.3% claimed to have been aware through other company operators.

**Table 1.** Distribution of seed companies by awareness of SEEDCODEX system

| Description | Freq | Percent |
|---|---|---|
| **Awareness of SEEDCODEX** | | |
| Aware | 43 | 98 |
| Not Aware | 1 | 2 |
| **Total** | **44** | **100** |
| **Channel of Awareness** | | |
| NASC | 42 | 95.4 |
| Other Company Operators | 1 | 2.3 |
| Not Applicable | 1 | 2.3 |
| **Total** | **44** | **100** |
| **Has SEEDCODEX increased cost of seed production** | | |
| Yes | 34 | 77.2 |
| No | 5 | 11.4 |
| Not Applicable | 5 | 11.4 |
| **Total** | **44** | **100.0** |
| **Perceived Advantages of SEEDCODEX** | | |
| Sanitizes the seed agricultural seed market | 38 | 86.5 |
| Assures of quality and prevents faking | 19 | 43.2 |
| Shows that there is monitoring | 1 | 2.3 |
| Protect the business | 1 | 2.3 |

Source: Okelola et al., 2022.

Majority (77.3%) of seed company operators posited that the introduction of SEEDCODEX has increased their cost of production. Majority of Seed Company operators (86.5%) opined that the introduction of SEEDCODEX will sanitize agricultural seed market, while 43.2% stated that it will assure farmers of the quality of the seeds purchased and prevents faking (Table 1.).

*Challenges Encountered in the Use of SEEDCODEX and Suggested Solutions*

Results in Table 2. revealed that 40.9% of the Companies opined that the introduction of the new label system has led to increase in their output, while 34.1% perceived otherwise. Those reported as "*Not Applicable*" which were 22.7% were those who have not started using the certification system, or those who just commenced operation with the new system and therefore did not have history of previous production to compare with the present.

In terms of challenges encountered by companies in the use of SEEDCODEX labeling system, the most stated challenge (18.2% of the sampled seed companies) opined that the labels were too costly given the fact that same label cost is incurred for small packages such as 1 kg or 2 kg of seed, and larger packages such as 50 kg and 100 kg bags. About 16% mentioned "*delay in the delivery of the SEEDCODEX label to seed companies*" as a major problem, while 13.6% complained about the rate at which the labels detach from bags used for packaging the seeds. Other problems stated included difficulties in generating the code, non-response to codes, network problem, the need to go to Abuja (the country's capital) for the code, and situations where company's accounts are debited after payment for SEEDCODEX via the central payment system (Remita), but the process is not completed thereby necessitating refund. This was described as a tideous experience which is not only frustrating but discouraging.

*Suggested Solutions:* Company operators suggested reduction of cost of label, the use of more adhesive labels to avoid falling off of labels from seed bags, timely delivery of SEEDCODEX labels to companies because supply of agricultural inputs are time bound . Failure to deliver agricultural seeds in good time was said to be accompanied by substantial loss of customers' good will and loss of revenue. Additional burben of the need to activate self-completion label generation online was also mentioned. It is worthy of note that majority of Seed company operators (65%) perceived that agro-dealers like SEEDCODEX label system, while 20.5% opined that agro-dealers were indifferent to it.

*Production Activities of the Companies*

Production output of different crop seeds: Table 3. presents the summary statistics of the production activities of the seed companies. It shows that average quantity of maize produced in the last production season was 427 t, rice was approximately 487 t, soybean was 468 t, cowpea was highest at 687 t, though, produced by very few companies among those sampled. Furthermore, average quantity of sorghum and millet produced were 114 t and 145 t respectively.

**Table 2.** Distribution of Companies by impact on output and challenges faced with SEEDCODEX

| Descriptions | Frequency | Percent |
|---|---|---|
| **Has the introduction of SEEDCODEX increased output?** | | |
| No | 15 | 34.1 |
| Yes | 18 | 40.9 |
| Cannot say | 1 | 2.3 |
| Not applicable | 10 | 22.7 |
| **Challenges faced in the use of SEEDCODEX** | | |
| Not easy to generate | 3 | 6.8 |
| Non-response to codes | 3 | 6.8 |
| Network problem | 1 | 2.3 |
| Label falling off from bag | 6 | 13.6 |
| Delay in delivery | 7 | 15.9 |
| Label too costly | 8 | 18.2 |
| Debiting without result & waiting for refund | 1 | 2.3 |
| The need to go to Abuja to receive the codes | 1 | 2.3 |
| No problem | 13 | 29.5 |
| **Suggested solution to identified challenges** | | |
| Make the process of generating the code easier | 3 | 6.8 |
| Response to code message should be spontaneous | 2 | 4.5 |
| Network services should be improved | 2 | 4.5 |
| Make label more adhesive | 6 | 13.6 |
| Educate end users | 2 | 4.5 |
| Reduce cost of label | 8 | 18.2 |
| Timely Delivery | 6 | 13.6 |
| Enable online generation of codes | 2 | 4.5 |
| Make codes available at zonal offices | 1 | 2.3 |

Source: Okelola et al., 2022.

*Comparative Outputs Before and After Introduction of SEEDCODEX*

Next table (Table 4.) presents detailed results of the t-test for the difference of mean outputs before and after the introduction of SEEDCODEX. Considering the t-values and p-values of the tests there was no significant difference between the mean output

before and after the introduction of SEEDCODEX for all the crop seeds considered. This is because the probability values were above the 5% which is the maximum value required to reject the null hypotheses of *"no significant difference between mean outputs before and after the introduction of the certification system"*. The non-significance of SEEDCODEX on output might be linked to the fact that most farmers were yet to be aware and imbibe the use of SEEDCODEX to the extent of insisting on SEEDCODEX labelled seeds which is expected to raise demand for certified seeds and stimulate increased production.

**Table 3.** Summary of sampled Seed Companies' production activities

| Crop | Number of Companies producing & saher in sample | Yearly minimum output (kg) | Yearly maximum output (kg) | Mean output (kg) | Standard Deviation | Selling price/ kg |
|---|---|---|---|---|---|---|
| Maize | 38 (86.4%) | 5,000 | 4,000,000 | 427,000 | 890,348.15 | 476.84 |
| Rice | 38 (86.4%) | 2,000 | 4,500,000 | 487,079 | 924,289.19 | 543.95 |
| Soybean | 11 (25%) | 2,000 | 4,000,000 | 468,384 | 1,178,467.30 | 572.73 |
| Cowpea | 6 (13.6%) | 10,000 | 4,000,000 | 687,000. | 1,623,097.66 | 700.00 |
| Sorghum | 4 (9.1%) | 15,000 | 300,000 | 113,750 | 127,891.56 | 467.50 |
| Millet | 2 (4.5%) | 90,000 | 200,000 | 145,000 | 77,781.75 | 510.00 |

Source: Okelola et al., 2022.

**Table 4.** Summary of T-Test for the difference of mean output of seeds before and after the introduction of SEEDCODEX

| Crops | Mean Before | Mean After | Std Dev before | Std Dev after | t-value | p-value | Conclusion |
|---|---|---|---|---|---|---|---|
| Maize | 482696 | 548087 | 1047489 | 1184639 | -0.198 | 0.844 | No sig. diff |
| Rice | 550038 | 631038 | 1029244 | 1086753 | -0.276 | 0.784 | No sig diff |
| Soybean | 438700 | 512200 | 1082558 | 1232915 | -0.142 | 0.889 | No sig diff |
| Cowpea | 710400 | 816800 | 1559456 | 1779553 | -0.101 | 0.922 | No sig diff |
| Sorghum | 38333 | 51666 | 32145 | 37527 | -0.467 | 0.665 | No sig diff |

Source: Okelola et al., 2022.

### *Agro-Dealers (Seed Retailers)*

Next table (Table 5.) showed that all the agro-dealers interviewed were aware of SEEDCODEX labels. Majority (54.4%) got aware of the label system in 2020. which was a year after the commencement of the policy. This seems a fair rate of information flow and different actors in the seed value chain interviewed commended NASC for its efforts. Results show that majority (80.7%) of the agro-dealers got aware of SEEDCODEX through Seed Companies while few others became aware by seeing the label on seed packages; and some reported getting

the information from other agro-dealers. Majority (73.7%) of the sampled agro-dealers opined that SEEDCODEX labelled crop seeds were "*fairly available*". This assertion is a bit different from the report of Teressa (2019), who reported that a substantial gap exists between the production and supply of commercial seed and farmers' demand in Ethiopia. About 46% of the agro-dealers posited that they buy the SEEDCODEX labelled seeds to satisfy their customers. A portion of agro-dealers (45.6%) stated that the labelling system assures agricultural seed buyers of the quality of seeds. Surprisingly, equal percentage (45.6%) of the dealers stated that the new certification label has no advantage (Table 5.).

**Table 5.** Agro-Dealers and SEEDCODEX

| Description | Frequency | Percentage |
|---|---|---|
| **Awareness about SEEDCODE** | | |
| Yes | 57 | 100.0 |
| **Year of awareness about SEEDCODEX** | | |
| 2019. | 6 | 10.5 |
| 2020. | 31 | 54.4 |
| 2021. | 15 | 26.3 |
| 2022. | 5 | 8.8 |
| **Channels of Awareness about SEEDCODEX** | | |
| Seed Companies patronized | 46 | 80.7 |
| Saw it on seed packages | 5 | 8.8 |
| Other agro-dealers | 6 | 10.5 |
| **Ease of getting the labelled seeds** | | |
| Readily available | 10 | 17.5 |
| Available | 5 | 8.8 |
| Fairly available | 42 | 73.7 |
| **Total** | **57** | **100.0** |
| **Motivations for stocking SEEDCODEX labelled seeds** | | |
| To ensure farmers' acceptability | 26 | 45.6 |
| To be able to compete with other agro-dealers | 15 | 26.3 |
| No response | 26 | 45.6 |
| **Perceived advantages of SEEDCODEX** | | |
| No Advantage | 26 | 45.6 |
| Assures of quality of the seeds | 26 | 45.6 |
| No response | 5 | 8.8 |
| **Total** | **57** | **100.0** |
| **Has introduction of SEEDCODEX increased prices of packaged seeds?** | | |
| Yes | 26 | 45.6 |
| No | 31 | 54.4 |
| **Total** | **57** | **100.0** |

| Description | Frequency | Percentage |
|---|---|---|
| **Has introduction of SEEDCODEX increased sales?** | | |
| No | 31 | 54.4 |
| Yes | 26 | 45.6 |
| **Total** | **57** | **100.0** |

Source: Okelola et al., 2022.

Majority (54.4%) of the agro-dealer reported that the introduction of SEEDCODEX has not increased prices of packaged seeds. Since most company operators complained that the policy had increased cost of production it may be taken that the burden of the extra cost of labels is borne by seed companies. In the same vein, as in the case prices, majority (54.5%) opined that the introduction of the SEEDCODEX labelling policy has not increased sales (Table 5.).

*Sales Activities of Agro-Dealers*

In Table 6. is presented the summary statistics of yearly sales activities of the selected agro-dealers. The table presents yearly minimum and maximum sales, average sales, standard deviations and selling price per kilogramme. Results showed that average agro-dealer sells about 12.4 t of maize yearly at 495.61 NGN/kg, 14.6 t of rice at 430 NGN/kg, 6.5 t of soybean at 597.45 NGN/kg, about 8 t of cowpea at 725 NGN/kg, and about 1.9 t of sorghum at 350 NGN/kg.

**Table 6.** Summary of the yearly sales activities of Agro-Dealers

| Crop | Number of Agro-Dealers & share in sample | Yearly minimum sales (kg) | Yearly maximum sales (kg) | Mean sales (kg) | Standard deviation | Mean selling price/kg |
|---|---|---|---|---|---|---|
| Maize | 57 (100%) | 5,000 | 25,000 | 12,421 | 5,745.18 | 495.61 |
| Rice | 35 (61.4%) | 5,000 | 50,000 | 14,600 | 18,080.84 | 430.00 |
| Soybean | 24 (42.1%) | 3,000 | 20,000 | 6,528 | 5,610.63 | 597.45 |
| Cowpea | 33 (57.9%) | 3,500 | 17,500 | 8,085 | 5,716.52 | 725.00 |
| Sorghum | 16 (28.1%) | 1,700 | 2,500 | 1,925 | 1,095.29 | 350.46 |

Source: Okelola et al., 2022.

*Impact of the Introduction of SEEDCODEX on Agro-Dealers' Sales*

Next table (Table 7.) presents the results of the independent sample t-test for the difference of two means of sales before and after the introduction of SEEDCODEX. Given the fact that the absolute values of the test statistic were higher than the test critical value at 5%, the null hypothesis of "no significant difference" was reject for maize and rice. The computed t-value for maize was -2.43 while the critical value at 5% is 1.96. Therefore the null hypothesis was rejected while the alternative hypothesis

of the existence significant difference was accepted. The implication is that average agro-dealer sells more maize seeds after the introduction of SEEDCODEX than before the introduction. Same illustration is applicable to sales of rice seeds. Meanwhile, such conclusion should be drawn and relied upon with some cautions. The significant increase may not be absolutely due to the introduction of the new policy. In fact, it may be due to general increase in awareness on the side of the farmers about the need to plant certified seeds other than grains or some other exogenous factors. However, there were no significant difference between the means of the remaining three (3) crops before and after the introduction of the policy.

**Table 7.** Summary of T-Test for the difference of mean sales of seeds before and after the introduction of SEEDCODEX

| Crops | Mean Before | Mean After | Std dev before | Std dev after | t-value | p-Value | Conclusion |
|---|---|---|---|---|---|---|---|
| Maize | 10308 | 13404 | 4389 | 4800 | -2.43 | 0.019 | Sig. diff |
| Rice | 4,333 | 5,667 | 976 | 487 | -4.76 | 0.000 | Sig diff |
| Soybean | 6,245 | 6,528 | 4,990 | 5,620 | -1.39 | 0.421 | No sig diff |
| Cowpea | 7,951 | 8,085 | 5,305 | 5,717 | -1.08 | 0.492 | No sig diff |
| Sorghum | 1,893 | 1,925 | 996 | 1,095 | -1.48 | 0.239 | No sig diff |

Source: Okelola et al., 2022.

*Challenges with SEEDCODEX Labeled Seeds and Suggested Solutions*

Next table (Table 8.) presents the distribution of agro-dealers by the challenges being faced in the sales of SEEDCODEX labelled crop seeds. It is worthy of note that majority (65%) of the agro-dealers stated that there was no challenge with SEEDCODEX while 35% stated that there was always delay in the supply of stock from companies on the excuse of waiting for delivery of SEEDCODEX labels. Agro-dealers complained that this usually cause a lot of delay in their supply and sales. Since agricultural production is time bound, farmers are not likely to wait till agro-dealers receive their supplies before planting, therefore, farmers most times go elsewhere. This result in the loss of customers' goodwill and loss of sales on the part of the agro-dealers.

**Table 8.** Challenges and Solution to SEEDCODEX

| Description | No. of Agro-Dealers | Percentage |
|---|---|---|
| **Challenges of SEEDCODEX labeling** | | |
| Delay in the delivery of labels to companies also affect us | 20 | 35.1 |
| No Problem | 35 | 64.9 |
| **Total** | **57** | **100.00** |
| **Solutions to the identified problems** | | |
| Timely delivery of SEEDCODEX labels | 20 | 35.1 |

| Description | No. of Agro-Dealers | Percentage |
|---|---|---|
| Educate Famers | 5 | 8.8 |
| Not Applicable | 32 | 56.1 |
| **Total** | **57** | **100.00** |
| **Perceived response of farmers to SEEDCODEX labels on packaged seeds** | | |
| Like | 26 | 45.6 |
| Indifferent to it | 31 | 54.4 |
| **Total** | **57** | **100.00** |

Source: Okelola et al., 2022.

With a view to addressing the usual delays in supply due to delay in the delivery of SEEDCODEX labels to companies, 35% of agro-dealers suggested timely delivery of the labels to the companies by NASC while companies were also advised to make their requests far ahead of the peak of the supply period for each planting season. In addition, some (8.8%) of the agro-dealers suggested that farmers should be more enlightened on the importance of SEEDCODEX (Table 8.). Since agro-dealers directly deal with farmers and are expected to have perceived their reactions to the new certification system, they were asked to rate the responses of their customers to SEEDCODEX label on seed packages. Majority (54.4%) of the agro-dealers perceived that farmers felt indifferent to the labels while 45.6% perceived that farmers like the ideas behind the policy.

### *Farmers Results with Discussion*

*Socio-economic Characteristics*

In Table 9. is shown the distribution of farmers by age. Cumulatively, about 70% of the farmers are less than 50 years old and this implies that they are still economically active. This is further corroborated by their average age of 46.6 years. Majority (83.9%) of the farmers are male as expected. This is more so as most females in these zones are more culturally, or perhaps religiously conditioned to work and carry out their businesses around their homes. This is in addition to the nature of farm work which appears energy demanding which most women are not comfortable with (Table 9.). Majority (95.3%) of the farmers are married. This is not surprising as being married is seeing as a sign of maturity and responsibility, and it confers micro-leadership on individuals. High number of married farmers may be due to the fact that most farmers in developing countries still strongly rely on cheap available family labour to perform farm operations. Hence, getting married and having many children is a means of getting the required cheap family labour. The household is defined as a group of persons, usually family, either nuclear or extended living together as a unit and feeding in the same pot with the same head, usually the husband. Further, 42.2% of the households contain 6-10 persons, while the average number of persons per households was 8.6.

A noticeable group (40.8%) of farmers attended but did not complete primary school. In Table 9. is revealed that the level of education among the farmers is generally low. Meanwhile, the level of education is high enough to enable farmers comprehend new technology with adequate extension services. About 40% of the farmers have between 11-20 years of farming experience with overall average of 21.5 years. The number of years of farming experience is high enough to widen the scope of the farmers to apply accumulated on-the-job knowledge to enhance their productivity. Majority of the farmers (84.4%) have at least one contact with extension agents, while the rest, 15.6% claimed they have never had such contact since they started farming.

**Table 9.** Socioeconomic characteristics of farmers

| Description | Freq. | % | Description | Freq. | % |
|---|---|---|---|---|---|
| **Locations (States)** | | | **Household Size** | | |
| FCT (Abuja) | 55 | 16.1 | 1 -5 | 69 | 32.7 |
| Kaduna | 64 | 30.3 | 6 – 10 | 89 | 42.2 |
| Kano | 54 | 25.6 | 11 – 15 | 30 | 14.2 |
| Niger | 38 | 18.0 | 16 – 20 | 11 | 5.2 |
| **Total** | 211 | 100.0 | 21 – 25 | 10 | 4.7 |
| **Age of Farmers** | | | 26 – 30 | 2 | 0.9 |
| 21 – 30 | 15 | 7.1 | **Total** | **211** | **100.0** |
| 31 – 40 | 60 | 28.4 | **Mean = 8.6 persons** | | |
| 41 – 50 | 72 | 34.1 | **Cooperative Membership** | | |
| 51 – 60 | 37 | 17.5 | Members | 134 | 63.5 |
| 61 – 70 | 21 | 10.0 | Non-members | 77 | 36.5 |
| 71 – 80 | 6 | 2.8 | Total | 211 | 100.0 |
| **Total** | 211 | 100.0 | **Farmers' Association** | | |
| **Mean Age = 46.6 yrs** | | | Members | 163 | 77.3 |
| **Gender of Farmers** | | | Non-members | 48 | 22.7 |
| Female | 34 | 16.1 | **Total** | **211** | **100.0** |
| Male | 177 | 83.9 | **Farming Experience** | | |
| Total | 211 | 100.0 | 1 -10 | 48 | 22.7 |
| **Marital Status** | | | 11 -20 | 88 | 41.7 |
| Single | 6 | 2.8 | 21 – 30 | 35 | 16.6 |
| Married | 201 | 95.3 | 31 – 40 | 23 | 10.9 |
| Widow | 2 | 0.9 | 41 – 50 | 11 | 5.2 |
| Separated | 2 | 0.9 | 51 – 60 | 5 | 2.4 |
| **Total** | **211** | **100.0** | 61 – 70 | 1 | 0.5 |
| **Educational Level** | | | **Total** | **211** | **100.0** |
| No formal education | 5 | 2.4 | **Mean = 21.5 yrs** | | |
| Pry Sch not completed | 86 | 40.8 | **Extension Contact** | | |
| Pry Sch Completed | 24 | 11.4 | Yes | 178 | 84.4 |
| Junior Sch not completed | 11 | 5.2 | No | 33 | 15.6 |
| Junior Sch completed | 11 | 5.2 | **Total** | **211** | **100.0** |

| Description | Freq. | % | Description | Freq. | % |
|---|---|---|---|---|---|
| Senior Sch not completed | 23 | 10.9 | **Number of Extension Contact in the last 12 months** | | |
| Senior Sch completed | 34 | 16.1 | None | 79 | 37.4 |
| OND/NCE | 17 | 8.1 | One | 34 | 16.1 |
| **Total** | 211 | 100.0 | Two | 58 | 27.5 |
| **Access to Credit** | | | Three | 31 | 14.7 |
| Yes | 145 | 68.7 | Four | 8 | 3.8 |
| No | 66 | 31..3 | Five | 1 | 0.5 |
| **Total** | **211** | **100.0** | **Total** | **211** | **100.0** |

Source: Okelola et al., 2022.

The frequency of extension contact is important for knowledge and information transfer which are expected to boost agricultural productivity and efficiency. Majority (68.7%) of the farmers claimed to have access to credit in one form or another. This is expected to improve their farming activities and perhaps may encourage them to search for quality crop seeds which will give them higher yield in order to enhance their ability to pay back their loan and maintain their future credit worthiness (Table 9.).

Majority of the farmers (52.1%) reported getting credits for their farming activities from friends, or family. About 38% of the farmers used cooperative societies as their source of credit for farming activities. Other sources of credit reported by few farmers are local money lender, government intervention programmes (e.g. Anchor Borrowers Programme), microfinance and commercial banks. Stable sources of credit are *sine qua non* to agricultural development.

*Knowledge and Use of SEEDCODEX*

This section presents results of general assessment of awareness, knowledge, use, perceptions and other ancillary issues related to SEEDCODEX from the farmers point of view. This is to guide policy monitoring and controls aimed at improving the expected impact of the new system. Result in Table 10. shows that 55% of the farmers buy seeds either directly from Seed Companies or from Agro-Dealers. About 41% of them use previous years' harvest crops (which can be termed as grains) while some of them get seeds from local markets and produce buyers. This shows a lot of gaps between the ideal and reality in the seed procurement practices by crop farmers. The results suggest that most farmers still plant grain as seeds which has implication on productivity. Only around 30.8% of farmers claimed to have heard about SEEDCODEX labels. This also leaves a great gap in the downstream information flow regarding SEEDCODEX and demand aggressive rise of awareness about the new certification policy. Andriamiandrisoa and Nishikawa (2011) reported that farmers in Madagascar procure seeds from different sources

and this behavior makes it difficult for the government to estimate effective demand for certified seeds. Around 11.4% of farmers in the present study reported that they heard about SEEDCODEX for the first time in 2020, while 10.9% of them became aware in 2021.

Only 16.6% of all farmers (or 53.8% of those who claimed to be aware) got informed by other farmers, while 14.2% of them (which represents 46.2% of those who are aware) were informed by agro-dealers they patronize (Table 9.). None of the farmers became aware of the new label system through extension agents. This may be a pointer to the need to carry extension agents along in the dissemination of information regarding SEEDCODEX and other seed related information.

Furthermore, only 24.2% of all famers (78.5% of those who are aware) do scratch open the code embedded in label (Table 9.). Because there is the likelihood that a farmer may scratch open the code but may fail to use it, the assessment went further to inquire about the use of the code. Only 6.6% of all famers (21.5% of' those who are aware of SEEDCODEX) do send the code to the designated number for verification of the authenticity of the seeds being bought. Some others claimed they use the code occasionally (13.7% of all farmers), while 2.4% rarely send it. It is worthy to note that 8.1% of them (26.2% of farmers who claimed to be aware) never sent the code for confirmation of the seeds quality they purchase (Table 9.). This calls for more enlightenments in order create the needed awareness among farmers who are supposed to be the end users or the main beneficiaries of the policy.

Farmers who claimed to be aware but who do not use the code all the time gave reasons for the practice. Three main reasons were that "*the code has no meaning to me"* (4.7% of all farmers), "*seeing the silver seal is enough"* (1.4%) and "*seeing the code is enough for me"* (18%). Again, this reveals the need for vigorous awareness among the farmers. Farmers were asked to state reasons they purchase labeled seeds. About 19% claim that it was in bid to be sure they were buying quality seeds while 18.5% stated that it was because they wanted good yield (Table 10.). Some few others mentioned *"prevention of pest and diseases"* (6.2%), *"because other farmers were buying it"* (7.6%), *"to enhance food production"* (6.2%) and *"to prevent excessive weed"* (7.6%). This corroborates the report of Boadu et al. (2018) which reported that farmers in Ghana opined that the use of certified seed yam would help to improve yield because of minimum or no disease/pest infestation. Cumulatively, 28.9% of farmers rated availability of SEEDCODEX packaged seeds as "*available*" (Table 10.).

In assessing the impact of the policy on yield only about 21% of farmers perceived that yields have increased since the introduction of SEEDCODEX while 14%

felt otherwise (Table 10.). Farmers were asked to state the major problems or challenges they perceived or are facing with SEEDCODEX. About 16% stated *"network problem"* while 13% mentioned *"unreliable results"*. Very negligible group of farmers (0.9%) mentioned "*none response to codes when sent"* (Table 10.). It should be noted that the above stated challenges are farmers' perception which may not be objective. Farmers opined that in order to overcome the earlier stated problems, corrective actions must be taken. Farmers therefore suggested that response to code message should be spontaneous (14.7%), concerned agencies should ensure improvement in the network service (10%) and that results should always be consistent with the quality of the seeds (1%), (Table 10.).

**Table 10.** Awareness and Knowledge about SEEDCODEX

| Descriptions | Freq | % | Description | Freq | % |
|---|---|---|---|---|---|
| **Sources of Seeds Planted** | | | **Reasons for buying labelled Seeds** | | |
| Company | 9 | 4.3 | To ensure I'm buying quality seeds | 41 | 19.4 |
| Agro-Dealers | 107 | 50.7 | To have good yield | 39 | 18.5 |
| Fellow Farmers | 38 | 18.0 | To prevent pest and disease | 13 | 6.2 |
| Previous Year Harvest | 86 | 40.8 | As other farmers are buying it | 16 | 7.6 |
| Produce Buyers | 37 | 17.5 | To enhance food production | 13 | 6.2 |
| Local Markets | 18 | 8.5 | To prevent weed | 5 | 2.4 |
| **Have you heard about SEEDCODEX** | | | **Ease of getting labeled seeds** | | |
| Yes | 65 | 30.8 | Readily available | 18 | 8.5 |
| No | 146 | 69.2 | Available | 22 | 10.4 |
| **Total** | **211** | **100** | Relatively Available | 21 | 10.0 |
| **When farmers first heard about SEEDCODEX** | | | Not Applicable | 150 | 71.1 |
| 2019 | 4 | 1.9 | **Has SEEDCODEX increased yield?** | | |
| 2020 | 24 | 11.4 | Yes | 43 | 20.4 |
| 2021 | 23 | 10.9 | No | 30 | 14.2 |
| 2022 | 14 | 6.6 | Not Applicable | 138 | 65.4 |
| Not Yet | 146 | 69.2 | **Challenges with SEEDCODEX** | | |
| **Total** | **211** | **100** | Non response to codes | 2 | 0.9 |
| **SEEDCODEX information Sources** | | | Network problem | 34 | 16.1 |
| Agro-Dealers | 30 | 14.2 | Unreliable results | 28 | 13.3 |
| Other Farmers | 35 | 16.6 | **Solutions to problems** | | |
| Not Yet | 146 | 69.2 | Response should be spontaneous | 31 | 14.7 |
| **Do you Scratch the code silver cover?** | | | Networks should be improved | 21 | 10.0 |
| No | 14 | 6.6 | Result should align with seed quality | 2 | 1.0 |
| Yes | 51 | 24.2 | Not applicable | 157 | 74.4 |
| Not Applicable | 146 | 69.2 | **Total** | **211** | **100** |
| **Total** | **211** | **100** | **Willingness to Pay for Quality Seeds** | | |
| **How frequently do you use code?** | | | Not willing to pay | 53 | 25.1 |
| Always | 14 | 6.6 | Willing to pay | 158 | 74.9 |
| Occasionally | 29 | 13.7 | **Total** | **211** | **100** |
| Rarely | 5 | 2.4 | **Reasons for not willing to Pay** | | |

| Descriptions | Freq | % | Description | Freq | % |
|---|---|---|---|---|---|
| Not at all | 17 | 8.1 | Seed companies should bear the cost | 29 | 13.7 |
| Not applicable | 146 | 69.2 | Retailers should bear the cost | 3 | 1.4 |
| **Total** | **211** | **100** | The code does not guarantee quality | 11 | 5.2 |
| **Reasons for not using code always** | | | | | |
| The code has no meaning to me | 10 | 4.7 | | | |
| Seeing the silver seal suffices | 3 | 1.4 | | | |
| Seeing the code suffices | 38 | 18.0 | | | |
| Not Applicable | 160 | 75.8 | | | |
| **Total** | **211** | **100** | | | |

Source: Okelola et al., 2022.

*Willingness to Pay for Quality Certified Seeds*

Famers were asked if they are willing to pay extra to obtain quality and truly certified seeds. Majority (74.9%) of them were willing to pay extra price for quality and certified seeds (Table 11.). Maredia et al. (2019) reported that farmers were willing to pay substantially more for cowpea seeds they rated higher compared with those they rated lower in Ethiopia and Tanzania. On the contrary, Mastenbroek et al. (2021) reported that only 14% of farmers were willing to pay for certified seed of an open pollinated maize variety in Northern Uganda. In the present study, among those who were not willing to pay extra for quality certified crop seeds, 13.7% believe the seed companies should bear the cost of certification, 5.2% had the opinion that code does not guarantee better quality seeds while 14% stated that agro-dealers should bear the cost of certification (Table 11.). The opinion of some farmers that the code does not guarantee quality also calls for more enlightenment for the farmers.

*Estimation of Willingness to Pay*

The average analysis of the expressed amount farmers were willing to pay (Table 11.) revealed that average farmers was willing to pay extra 26.82% of the present price to obtain high quality certified seeds. This is useful for investors in the seed industry and for policy guide. The WTP figure reported in this study aligns with the 26% of WTP reported by Boadu et al. (2018) in study that assessed the perception of farmers regarding the quality of planted seed yam in Ghana.

**Table 11.** Willingness to pay Analysis

| Element | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| WTP amount | 211 | 0.00 | 100.00 | 26.8246 | 27.38808 |

Source: Okelola et al., 2022.

*Impact of SEEDCODEX on Yield*

In Table 12. are presented the results of tests of the difference of two means of crop yields to compare the mean yields before and after the introduction of SEEDCODEX with a view to assessing the impact of the new policy. Results show that there has not been any significant difference in the yield of maize, rice and sorghum since the introduction of the policy considering their probability values which was above the 5% (0.05) maximum required to reject the null hypothesis of "no significant differences" in the average yields before and after the policy shift. Contrastingly, there were significant differences in the averages before and after the introduction of SEEDCODEX for soybean and cowpea. The probability values for the t-test in the soybean yield is 0.042 while that cowpea is 0.038. Hence, it was concluded that there were significant differences in the yields of only soybean and cowpea before and after the intervention.

**Table 12.** Summary of T-test for the difference of mean yield before and after the introduction of SEEDCODEX

| Crops | Mean Before | Mean After | Std dev before | Std dev after | t-value | p-Value | Conclusion |
|---|---|---|---|---|---|---|---|
| Maize | 2,419 | 2,575 | 2060 | 2381 | -0.71 | 0.480 | No Sig. diff |
| Rice | 2,364 | 2,7775 | 1,175 | 1148 | -1.67 | 0.098 | No Sig diff |
| Soybean | 1,245 | 1,301 | 1005 | 1308 | -3.07 | 0.042 | Sig diff |
| Cowpea | 850 | 1,050 | 579 | 641 | -2.08 | 0.038 | Sig diff |
| Sorghum | 1,055 | 1,125 | 984 | 7091 | -1.39 | 0.312 | No sig diff |

Source: Okelola et al., 2022.

*Factors Affecting the Use of SEEDCODEX*

There is the need to determine factors affecting the use or non-use of SEEDCODEX code among famers. Since there are only two possible outcomes, a binary logit regression model (equation 3) was estimated and results are presented in Table 13. Results show that age of the farmer ($P$=0.01), educational level ($P$=0.01), access to credit ($P$=0.05) and farm size ($P$=0.05) significantly affected the likelihood of the actual use of the certification code. While age came up with negative sign the remaining three regressors came up with positive coefficients. The negative value of age implies that older farmers are less likely to send the code for confirmation of quality of the seeds they bought, i.e. as older is the farmer the lower is the likelihood of using the code. Marginal effect analysis shows that a percent increase in age of an average farmer results in 0.2% decrease in the probability of using the code. This result aligns with that of Boadu et al. (2018) who reported negative relationship between age of farmers and preference for certified seed yam in Ghana but contradicts those of Ndambiri

et al. (2013) and Gbetibouo (2009) who reported positive relationships between age of farmers and adoption of new agricultural technology in Kenya and South Africa respectively.

Education was positive and significant at 1% risk level. So, increase in educational level of farmers increased the likelihood of using SEEDCODEX. The marginal effect value of 0.12 implies that a percent increase in the educational level of average farmer in the study area results in 0.12% increase in the probability of using the code. Therefore, education is a strong determinant of the use of SEEDCODEX. The importance of education was also brought to the fore among Nigerian small holder rice farmers by Awotide et al. (2012) who also reported that years of formal education significantly increased farmers' probability of having access to certified improved rice seed.

Access to credit was positive and significant at 5% risk level. The positive value of the coefficient implies that farmers who claimed that have access to credit are more like to use the code compared with farmers who do not have access to credit for their farm operation. The marginal effect of access to credit value of 0.178 implies that farmers who have access to credit have 0.178% higher probability of using the code compared with those who claimed not having access to credit.

Farm size was positive and significant at 5% risk level. The positive values implies that increase in farm size increases the likelihood of using the code. The marginal effect value of 0.60 implies that a percent increase in farm size increases the probability of using SEDCODEX by 0.6%. Hence, farmers who cultivate lager area of farmland are likely to use the code. This might have arisen from the risk aversive point of view. Higher farm size implies that the farmer must have invested large sum of money including energy and time on the farm estate. Therefore, the farmer is likely to be more cautious in actions and decision making. Such farmer is likely to take advantage presented by SEEDCODEX to verify the quality of seed to be planted because the potential loss to be incurred in the event of crop failure is high.

**Table 13.** Results of the Logit Regression Model (Dependent variable = Use of label code)

| Variables | Symbol | Coefficient | Std Error | t-values | Marginal effects |
|---|---|---|---|---|---|
| Constant | $B_o$ | -0.8384 | 3.7888 | -0.2213 | - |
| Age | $X_1$ | -2.5026** | 1.1051 | -2.2646 | -0.2080 |
| Gender | $X_2$ | -0.0820 | 0.5615 | -0.1460 | -0.0068 |
| Education | $X_3$ | 1.5024*** | 0.4316 | 3.4809 | 0.1249 |
| Extension | $X_4$ | 0.8379 | 0.7252 | 1.1555 | 0.0696 |
| Farming Experience | $X_5$ | 0.6351 | 0.4290 | 1.4803 | 0.0528 |

| Variables | Symbol | Coefficient | Std Error | t-values | Marginal effects |
|---|---|---|---|---|---|
| Access to credit | $X_6$ | 2.1501** | 1.0876 | 1.9769 | 0.1786 |
| Farm size | $X_7$ | 0.7231** | 0.3393 | 2.1311 | 0.6009 |
| Farmers' Association | $X_8$ | 0.7926 | 0.8936 | 0.8869 | 0.0659 |

Source: Okelola et al., 2022.

Note: ** & *** imply significance at 5% & 1% respectively.

Conclusively, enlightenments aimed at encouraging farmers to adopt the use of SEEDCODEX should focus on older and less educated farmers. Farmers who believe they do not have access to credit and farmers who cultivate relatively small area of land should also be given serious attention in order to encourage them to embrace the use of the label code.

*Factors Affecting Willingness to Pay*

In addition to famers expressing their willingness to pay extra amount over the existing prices, there is the need to go further to use cause and effect analysis to determine socioeconomic factors affecting extra amount farmers are willing to pay in order to obtain quality seeds. To this end, a censored regression model the Tobit model which was specifically suitable for the data set (due to a number of zero WTP values) was estimated. In Table 14. is presented the Tobit regression results and it revealed that age, extension contact, years of farming experience, farm size and membership of farmers' association significantly affected willingness to pay.

Age came up with negative and significant coefficient. The coefficient value of -0.9459 which is significant at 1% risk level implies that increase in age decreases WTP amount. A percent increase in age decreases WTP amount by 0.95%. The implication of this is that older famers are less willing to pay an extra premium to obtain quality certified seed. Older farmers are generally known to be most times lethargic to technological changes as they always have stronger faith in the ways they have been doing things for ages.

Extension contact came up with negative and significant coefficient. It will be recalled that extension contact is a dummy variable and in the quantification of the variable, farmers who claimed to have contact with extension agents were scored one (1) while those who claimed otherwise were scored zero (0). The coefficient value of -0.9367 which is significant at 1% risk level implies that farmers who have contact with extension agents are less willing to pay a premium for quality seed.

Years of farming experience came up with positive and significant coefficient. The coefficient value of 0.2454 which is significant at 5% risk level implies that increase

in years of farming experience by 1% increases WTP by 0.25%. It may be further interpreted that farmers who have been farming for long might have acquired enough experience to enable him know that there is need to buy and plant quality seed as this will greatly affect yield, output, farm income, profit and by extension farming household welfare which is the ultimate aim at the household level. In similar vein, Chete (2021) reported that years of farming experience significantly increased the likelihood of adoption of improved maize seed varieties in Kaduna state Nigeria.

Farm size also retuned significant positive coefficient. The coefficient value of 0.2552 which is significant at 5% implies that a percent increase in farm size increased WTP by 0.25%. The implication of this is that farmers who cultivate larger expanse of farmland are willing to pay more for quality and certified crop seeds. Farmers who cultivate more hectares of land are likely to have invested a lot of money into the farm business and may not wish to lose such investment to crop failure which may arise as a result of unviable or low quality seeds. Hence, they are likely to be willing to pay higher premium for quality and certified seeds as a risk aversive measure.

Membership of farmers' association came up with positive and significant coefficient. The variable in question is a dummy variable in which farmers who claimed to be members of farmers' association were scored 1 while those who claimed otherwise were scored 0. The coefficient value of 0.7576 significant at 1% level implies that being a member of farmers' association increase WTP by 0.76%. Membership of farmers' association represents social capital on its own and farmers in addition get a lot of information at the association meetings and use the opportunity to build network of friends. The level of awareness farmers get from such association may stimulate their understanding of the need to plant certified quality seeds thereby influencing their willingness to pay. In summary, age and extension contact reduce WTP while farming experience, farm size and farmers' association membership increased willingness to pay.

**Table 14.** Results of the Tobit Regression (Censored) Model (Dependent variable = WTP amount)

| Variables | Symbol | Coefficient | Std Error | t-values |
|---|---|---|---|---|
| Constant | $B_o$ | 3.9395*** | 1.2303 | 3.2021 |
| Age | $X_1$ | -0.9458*** | 0.3299 | -2.8671 |
| Gender | $X_2$ | -0.1271 | 0.2035 | -0.6247 |
| Education | $X_3$ | -0.0394 | 0.1303 | -0.3030 |
| Extension | $X_4$ | -0.9367*** | 0.2051 | -4.5674 |
| Farming Experience | $X_5$ | 0.2454** | 0.1195 | 2.0531 |

| | | | | |
|---|---|---|---|---|
| Access to credit | $X_6$ | -0.0295 | 0.1938 | -0.1522 |
| Farm size | $X_7$ | 0.2552** | 0.1067 | 2.3910 |
| Farmers' Association | $X_8$ | 0.7576** | 0.2062 | 3.6738 |

Source: Okelola et al., 2022.

Note: ** & *** imply significance at 5% & 1% respectively

## Conclusion

Nearly all the Seed Companies were aware of SEEDCODEX and are keying into it with credit to the efforts of NASC in sensitization and regulation of the Nigerian seed industry. There has not been significant change (increase) in the output of seed companies since the introduction the new authentication system. Company operators complained that the new system has increased their cost of production but believed it was capable of sanitizing the seed market. In addition to the alleged high cost of the label, delay in the delivery of the labels to companies and weak adhesive nature of the label were identified as key challenges. In the same vein, all agro-dealers were aware of SEEDCODEX mostly through the Seed Companies and are motivated to buy labeled seed in a bid to meet the demand of their customers. The main challenges identified by agro-dealers were the delay in the delivery of seed labels to companies which delay their supply and the weak adhesive nature of the label. Only about half of the farmers buy seeds from agro-dealers while about one-third of the farmers have heard of SEEDCODEX and about a quarter of farmers indeed use the authentication code. Use of the code was significantly determined by age, education, farm size and access to credit. Only cowpea and soybean output have increased since the introduction of SEEDCODEX. Majority of farmers are willing to pay a premium for certified quality seed with a WTP of 26.82% of the existing price. Farmer's age and extension contact significantly reduce WTP while farm size and farming experience increase it. The extra amount of money farmers are willing to pay for certified quality seeds is a good guide for seed companies, other investors in seed business and policy makers. In addition, deliberate effort should be made to make certified quality seed available to experienced farmers and those who cultivate large areas of land, as they are willing to pay extra to aquire such seeds.

NASC may wish to look into the issues raised by companies regarding the high cost of the label and its gumming properties. Flat cost of labels irrespective of weight of seed package, timely delivery of the code labels and the need to educate farmers who are the end-users of the authentication system are other key issues requiring attention. Further research in this area should cover preference for specific varieties of each crop seeds and factors driving such preferences.

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