Best-Worst Scaling Approach in Predicting Seed Attribute Preferences among Resource-Poor Farmers in Northern Nigeria

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Abstract:
Because seed demand in African farming communities is associated with chronic poverty, this research sought to elicit seed attribute preferences among resource-poor farmers by utilizing recent advances in best-worst scaling. The study focuses on farmers within and outside intervention sites of the National Special Food Security Programme (NSFSP) in Sokoto and Kebbi States, northern Nigeria. Based on previous literature related to seed attribute preferences, a list of seven seed attributes was compiled. Results reveal that on average the seed attribute of price and channel of delivery were the most important to resource-poor farmers, whereas the attributes of origin, color of seed, size followed by environmental impact were among the least important. Mixed logit estimation results indicate that price, channel of seed delivery, origin, and seed type estimates are statistically significant both within and outside the National food security project in the study locations.

***Keywords**: Best-worst scaling, preferences, seed attribute, mixed logit*

1. Introduction

Seed is the major input in agriculture because only when seed is planted would other inputs be required. Tripp (1998) reported that seeds represent a key technology for the improvement of agricultural productivity. According to Abdoulaye *et al* (2009) seeds are the sources of most food, and therefore have the greatest socio-economic benefit to human welfare. In spite of this, farmers in Nigeria have difficulty in obtaining the necessary inputs on time and in good quality and also they are paying very high prices (Kormawa *et al*, 2000). Hence, understanding farmers' perception and preferences for timing of seed availability is of paramount importance for seed provision and policy.

Tripp (2006) identified different types of demand for seed based on origin of demand including emergency, poverty, seed quality, and demand for seed of new varieties. But a significant proportion of seed demand in African farming communities is poverty related. Seed shortages are caused by poor harvest and or necessity to sell or consume all stocks. Because this demand is associated with chronic poverty, it implies a continuous requirement for some type of off farm seed supply. These farmers lack purchasing power, so it is unlikely that this demand can be addressed by commercial channels.

National seed systems in developing countries are particularly sensitive to the debates, which assumed that governments should play a leading role in the procurement and distribution of agricultural inputs (Shepherd, 1989), and the levels of government contribution to agricultural research and extension (Thirtle and Echeverria, 1994; Rivera, 1996). These have been effectively challenged and reconsidered. However, recent policy changes in many developing countries have sought to encourage commercial seed enterprises. At the same time, public seed companies are being privatized or at least being forced to compete in an open market. The expectation is a more efficient response to farmers' demand for seed. However, concerns are often expressed about the degree to which commercial firms address the needs of resource-poor farmers (Tripp and Pal, 1998).

Input supply, which includes seeds, water, land, fertilizer and agro-chemicals, was identified as one of the strategies for achieving food self-sufficiency in Nigeria. Of all yield-enhancing inputs in crop production, seeds give the most dramatic and most cost-effective return on investment. Improved seeds have provided 50% of the productivity gains in agriculture. The other 50% has come from improvement in management, including timeliness, best use of fertilizer, crop protection measures and equipment (Shobowale, 1994; Gupta, 1994; Joshua, 1999b; Adamu, 2000).

Available literature in Nigeria and international community emphasizes the importance of prompt availability of seeds. The prompt availability of seeds and other inputs often allows farmers to realize maximum production potential (Alene, 2007). Farmers without access to improved seeds at planting time may turn to local varieties, since delaying planting times often lowers their yield (Gachimbi *et al*, 2003). In spite of the importance of the prompt availability of seeds, improved varieties are released slowly and this enhances the dominance of low-yielding local varieties. Furthermore, the availability of improved seed varieties to rural farmers is still very low. Thus, the limited availability of seeds at planting time is often a major constraint to the adoption of improved varieties. Farmers in many communities are yet to have access to improved seeds. Most seeds planted by farmers come from local sources including farmers' own crop, neighbors, and relatives, or from local markets.

Seed is a typical private and tradable good, which is familiar to the resource-poor farmers. Seed prices often rise considerably around planting time, which affect seed purchasing decisions near planting time (Hiroyuki *et al*, 2010). The main seed conceptual framework in Sub-Saharan Africa, including Nigeria, often is built for decisions regarding the actual purchase of seeds (Griffiths, 1994) and selection of seed from their own stock (Wright *et al*, 1994; Lewis and Mulvany, 1997; Rice *et al*, 1998), which affects seed purchasing decisions near planting time. Many African farmers purchase seeds at planting time, when seed prices tend to be higher.

The motivation for this study is due to the fact that one of the less studied issues is farmers' preference for obtaining seeds closer to planting time. Further, empirical information on Nigerian farmers' seed demand is scarce (Hiroyuki *et a*l, 2010), and the actual demand for various seed types in Nigeria is not accurately known (Kormawa *et al*, 2000). Hence, it is important to model poverty-related seed demand relative to demand for new varieties of cowpea. This research focuses on farmers within and outside national food security sites of Sokoto and Kebbi States of northern Nigeria. The food security project identified cowpea producers in selected sites and conducted on-farm trials. The focus on seeds of cowpea is mainly because cowpea is an important crop for food security, nutrition and income as well as means of livelihood to millions of farmers in Nigeria. Further, cowpea is grown in the northern half of Nigeria.

Relatively few economic studies have applied the Revealed Preference (RP) and Stated Preference (SP) models to answer how Nigerian farmers' willingness to pay (WTP) for seeds are affected by the timing of seed availability prior to planting (Horna *et al*, 2005; Hiroyuki *et al*, 2010). Within this limited literature, efforts have not been made to elicit seed attributes that are most or least important to resource-poor farmers in Nigeria. This provides an opportunity to make significant contribution in order to fill the gap in knowledge.

The purpose of the study is to elicit seed attribute preferences among resource-poor farmers in Sokoto and Kebbi States of northern Nigeria.

2. Brief Literature Review

Horna *et al* (2005) used contingent methods to elicit preferences and willingness to pay (WTP) for seed of improved rice varieties in Nigeria and Benin. The varieties ranked by farmers correspond to both lowland and upland rice production. The contingent valuation method was used since seed prices were not available. Open-ended questions were used because farmers surveyed are accustomed to buying rice seed in the market, even though they were exposed to new varieties in the field day activity. The study used a random utility approach and an ordered probit regression was used to estimate the marginal values of attributes, with and without information about seed. WTP for information is derived from the analysis of WTP for rice seed. The results have implications for the best way to finance research and extension services in the areas of intervention, particularly for new rice varieties.

A study conducted by Hiroyuki *et al* (2010) focused on measuring willingness to pay (WTP) for timely availability of seeds through the application of revealed preference (RP) and stated preference (SP) models. In their study RP hedonic price model was estimated using least squares (LS) specification, while the SP choice experiment model was estimated using conditional logic specification. The RP model relies on information of farmers' actual seed purchase behavior (when and how they pay for certain seeds). The SP model relies on the information on farmers' imaginary behaviors in hypothetical situations. Using both models could improve the reliability of the estimated results. The findings generally support the hypotheses. Low-income farmers are generally willing to pay higher prices for cowpea seed if they can buy it closer to planting time. On the other hand, farmers' preferences for rice and maize seeds seem consistent across different purchase times and for different income levels. The findings of the study provide several important research and policy implication in the area of premiums, functioning of market and resale opportunities at planting time in order to better target farmers when distributing improved seeds at planting time.

3. Methodology

This study utilized best-worst experiment methodology. Best-worst scaling is an extension of Thurstone's (1927) paired comparison method, which has a long history in psychological research. According to Lusk and Briggeman (2009) best-worst scaling provides much more information than paired comparisons, so much so, that it is possible to construct individual-level scales and provide a measurement of the underlying construct on a ratio scale.

To elicit peoples' preferences about what it is important to them when making seed purchasing decision, the best-worst scaling method was employed while in- person interview was held with 150 resource poor farmers in Kebbi and Sokoto States. The sample for the study consists of resource-poor cowpea farmers within and outside the National Special Program for Food Security (NSPFS) in Sokoto and Kebbi States, northern Nigeria. In total, data were collected from 150 farmers. Thus, 75 farmers under the NSPFS in Kebbi state while 75 farmers outside the project in Sokoto were randomly selected and interviewed. Attributes considered in this study were price(price farmers are willing to pay for seed), channel of delivery the seed(private versus government sources) , origin(local versus non local), size of size(small versus large size), color(white versus brown), growing length (short versus long period), and environment(environmentally friendly grown seed versus non organic). Balanced incomplete block design (BIBD) designed in R software was used to generate seven block containing four elements each while data were analyzed using SAS programming language. The BIBD has the potential to produce choice set of equal size, while varying across surveys, are constant within a survey. A typical question for this research based on best-worst scaling is presented below:

- Which of the following options would you most and least prefer? (Check only one Option as the most important and one as the least important)

Most important		Least important
☐	Origin (Seed purchased in Nigeria or other markets in neighboring countries)	☐
☐	Color (Planting red, white, brown or green seed purchased)	☐
☐	Growing length (Buying 70 days, 90 days or 120 days maturing seed for planting)	☐
☐	Environment (Buying seed that maximize inorganic fertilizer use and its effect on the environment)	☐

Figure 1: Example of best-worst question

Seven blocks each having four attributes was presented to respondents and asked to select the one they like the most and the one they like the least. Thus, the number of time a given issue is chosen as best and the number of time it has been chosen as worst would be added cross respondent to get the total number of best and worst for each attributes. The difference between the number of times an issue is chosen best and the number of times chosen as worst divided by the number of elements per question or block multiplied by the number of respondents is called the standard score. Thus, the standard score can be expressed as follows:

$$\text{Standard Score} = \frac{\text{Best}-\text{Worst}}{4n} \qquad (1)$$

Where n is the number of respondents and 4 is the number of time attributes appeared in each block. Each respondent will choose a pair of attributes that maximize the differences in his/her best- worst choices. To model the utility of each respondent, we follow the random utility approach which can be expressed mathematically as follows:

$$U_{ijt} = \beta_i V_{ijt} + \varepsilon_{ijt} \qquad (2)$$

Where U_{ijt} is individual i's utility from selecting alternative j in a choice set of k, β_i is individual i's utility parameter vector, V_{ijt} is a vector of attributes related with alternative j, and ε_{ijt} is the random component, allowing research to make probabilistic statement about consumers behaviors (Lusk,2003)

A pair of attributes maximizing the utility difference in each set will be selected by each respondent. Assuming that respondent i. chooses attribute j over attribute k as the best and worst choices respectively. Thus, the probability that a given respondent i. selects attribute j over attribute k is the probability that the difference in utility U_{ijt} and U_{ikt} is bigger than all other J(J-1)-1 possible differences in the choice set given that the difference in unobserved factors, ε_{ijt} and ε_{ikt} are distributed i.id type1 extreme value. Therefore, this probability can be written as follows:

$$\text{Prob}(\text{ j is chosen best and l is chosen worst}) = \frac{e^{U_{ijt}-U_{ikt}}}{\sum_{l=1}^{J}\sum_{m=1}^{J} e^{U_{ilt}-U_{imt}}} \qquad (3)$$

Assuming that farmers are not homogenous, the probability in equation (3) can be further specified using multinomial mixed logit by substituting equation (2) into (3):

$$\text{Prob}(\text{j is chosen the best and k is chosen the worst}) = \frac{e^{\beta_i v_{ist}}}{\sum_{s=1}^{J} e^{\beta_i v_{irt}}} \quad (4)$$

It is important to note that mixed logit is highly flexible model and can appropriate any random utility model (Train, 2003; McFadden & Train, 2000). Estimation of count-based method and multinomial mixed logit will lead basically to the same results.

4. Results

This section presents the results from count-based as well as mixed logit model. Recall that channel of delivery, seed type, color, growing length, price, environmental impact and origin are the attributes considered in this research. The count-based method is the relative importance score calculated as the difference between the number of times an element has been chosen as most preferred and the number of times it has been chosen as least preferred.

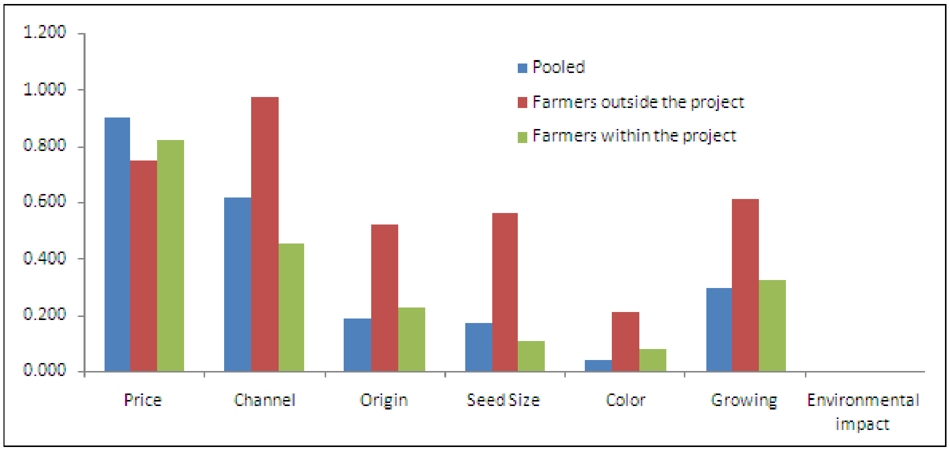

Figure 2: Relative importance score of different seed attributes across different respondents

Results from count-based method shown in figure 2 indicate that channel of seed delivery followed by price are the most preferred attributes for people outside the project while price followed by channel of seed delivery are the most preferred for people within the project. This implies that price and channel of seed delivery are highly ranked preferences relative to environmental impact. However; the pooled results showed that on average price followed by channel of seed delivery are the most important attributes. Results also reveal that environmental impacts followed by color are the least important attribute for people outside and within the project. Overall, environmental impact followed by seed color is the least important attributes considered in this stud. This implies that environmental impact makes people surveyed within and outside the project worst off than anything. Overall, environmental impact generally makes resource-poor farmers worst off than any attributes.

The count-based method is used to rank preference while the mixed logit used to estimate the model. Thus, preference shares are calculated based on the following formula:

$$\text{Prob(option j is chosen)} = \frac{e^{V\beta_j}}{\sum_{k=1}^{J} e^{V\beta_k}} \qquad (5)$$

Where $V_j = V\beta_j$ is utility for option j while $V_k = V\beta_k$ is utility for option k.

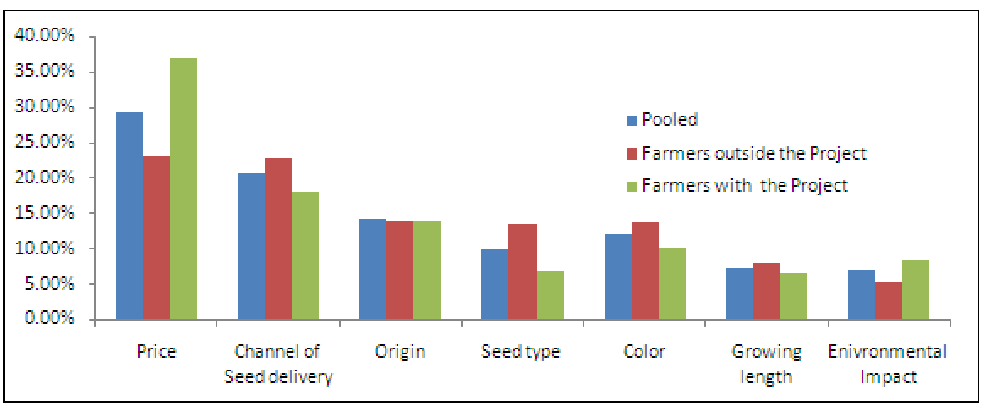

Figure 3: Preference Share for Different Seed Attributes for farmers outside the project

Estimates from the mixed logit were used to calculate the preference shares shown in table 2 and plotted above in figure 3. Results indicate price (36.83%) and channel of seed delivery (17.97%) have the highest preference share while seed size (6.61%) followed by growing length (6.35%) have the smallest preference share among farmers within the project. Farmers within the project prefer price as 4.44 and 2.04 times more than environmental impact and channel of seed delivery, respectively while channel of seed delivery is considered as 2.16 times more important than environmental impact. Similarly, results in figure 3 indicate that price (23.11%) followed by seed delivery channel (22.67%) have the highest preference share while environmental impact(5.38%)

followed growing length(7.8%) have the smallest preference share among farmers outside the project. Farmers outside the project prefer price as 4.30 and 1.02 times more important than environmental impact and channel of seed delivery respectively, while channel of seed delivery considered as 4.22 times more than environmental impact. Overall, price (29.21%) followed by channel of seed delivery (20.57%) have the highest preference share while environmental impact (6.93%) followed by growing length (7.29%) have the smallest preference share among farmers surveyed. Farmers in general prefer price as 4.22 and 1.42 times more important than environmental impact and channel of seed delivery. Further, channel of seed delivery is considered as 2.97 times more important than environmental impact.

5. Conclusions and Recommendations

Best-worst scaling approach was used to elicit seed attribute preference among resource-poor farmers in Northern Nigeria. Balanced incomplete block design (BIBD) method was used to design the questionnaires and 150 farmers were randomly sampled and interviewed. We consider both farmers within and outside the project; thus 75 outside 150 farmers are working with a project while 75 farmers are outside the project. Results indicate that price and channel of seed delivery are the most preferred attributes while environmental impact and seed color are the least preferred attributes. Preference share estimates that price and channel of seed delivery had the highest share while environmental impact and growing length had the smallest preference share among farmers surveyed. These results suggest that farmers outside the project would like to have access to public sector channel of seed delivery to solve seed shortage at planting time while farmers within the project care more about price increase. Replicating this project to cover several areas would help resource-poor farmers to have access to seed and boost production thereby reducing food shortage observed in the study area.

6. Limitation of the study

The main limitation of this study involves hypothetical choices in best-worst scaling, resulting in potential bias in hypothetical valuation questions. Further, the use of random sample of 150 resource-poor farmers is also relatively small, which affect generalization of the results. Finally, the study has not examined the influence of demographic factors on seed attribute preferences of the resource-poor farmers in the two study locations.

7. Appendix

	Pooled Estimates	**Within the Project Estimates**	**Outside the project Estimates**
Price	1.44*** (0.078)	1.49*** (0.109)	1.46*** (0.112)
Channel of Seed delivery	1.09*** (0.079)	0.77*** (0.118)	1.44*** (0.109)
Origin	0.72*** (0.092)	0.51** (0.120)	0.95*** (0.141)
Seed type	0.34*** (0.086)	-0.23* (0.135)	0.91*** (0.124)
Color	0.55*** (0.077)	0.20* (0.110)	0.93*** (0.114)
Growing length	0.05 (0.084)	-0.27** (0.117)	0.37*** (0.123)
Environmental impact	0.00	0.00	0.00
Numbers of respondents	150	75	75
Numbers of Choices	12600	6300	6300
Log-likelihood	-2363	-1143	-1181

Table 1: Parameter Estimates of Seed Attributes relative to Environmental Impact using Mixed logit Model for Pooled, Within and Outside the Project
*Numbers in parentheses are standard errors, *,**,*** are 10%,5%, and 1% significant level respectively*

	Pooled	Farmers outside the Project	Farmers with the Project
Price	29.21%	23.11%	36.83%
Channel of Seed delivery	20.57%	22.67%	17.97%
Origin	14.20%	13.95%	13.87%
Seed Size	9.74%	13.40%	6.61%
Color	12.06%	13.70%	10.08%
Growing length	7.29%	7.80%	6.35%
Environmental Impact	6.93%	5.38%	8.29%

Table 2: Preference Share Across Pooled, Farmers Outside and Within the Project

	Pooled	Farmers outside the project	Farmers within the project
Price	0.902	0.747	0.820
Channel	0.615	0.973	0.453
Origin	0.187	0.520	0.227
Seed Size	0.168	0.560	0.110
Color	0.042	0.207	0.077
Growing	0.295	0.610	0.323
Environmental impact	0.000	0.000	0.000

Table 3: Count-based Preference Ranking relative to Environmental Impact

Variable	Definition	Mean	Standard Deviation
Gender	1 if male; 0 otherwise	1.65	0.61
Age	Age in years	45.5	6.63
Education	1 if obtained Islamic education; 0 otherwise	2.13	1.32
Income	Annual income in thousand Naira	16,874.8	3,267.56
Farming Experience	Farming Experience in years	6.8	3.46

Table 4: Summary Statistics on Demographic Characteristics of Survey Respondents
Number of Observations = 150, Nigerian currency is Naira

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