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Estimation of Farmers' Willingness-to-Pay for Quality Planting Material of Greater Yam (*Dioscorea alata* L.)

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ABSTRACT

Greater yam being a commercial tuber crop in Odisha state occupying a prominent place in food basket, the importance of meeting the planting material demand of the farmers, was realized by the ICAR-Central Tuber Crops Research Institute and initiated mass efforts to multiply the high-yielding and disease-resistant varieties of yam to supply to farmers as quality planting materials.. As the farmers' willingness to pay for the planting material depends on their assessment of the utility of each attribute of it, a research investigation was carried out in Odisha to estimate the utility value of each yam planting material attribute from the farmers' perspective. The utility values for each planting material attribute were estimated through a choice-based conjoint analysis. Results indicated that yield had the highest utility level (30 t/ha = 5.20 and 25 t/ha = 2.60), followed by planting material price (Rs. 30/kg = 1.147) and culinary quality (excellent quality = 0.794). The marginal WTP for the yield 30 t/ha versus 25 t/ha was Rs 4.54/kg. It clearly shows that the farmers were willing to pay an additional amount of Rs 4.54/kg for a quality yam planting material that gave a higher yield than their variety.

INTRODUCTION

The Greater yam or yam (*Dioscorea alata* L.), is commercially grown in Odisha state and occupies an important role in the food basket. Traditional local landraces like *Hatikhoj* and *Odisha Elite* dominate the yam area, owing to local preference and high market price (Sivakumar et al., 2009). As the yam is propagated through tubers, farmers need a sizable quantity (2 t/ha) of planting materials. The yam planting materials are primarily obtained through informal system, where the farmers source their tubers from their last harvest, exchange with other farmers, or purchase from the local markets. However, the quality of planting material is poor due to the narrow choice of varieties, high level of damage in the tubers, and disease susceptibility of local landraces (Sivakumar et al., 2009). Past studies conducted on potato (Reema et al., 2020; Rajavardhan et al., 2020) and mustard (Layek et al., 2021) established that the seed or planting materials are procured at higher rates, thereby escalating the cost of production. In this context, there is a pressing need for the research and extension agencies to supply quality planting material of high-yielding yam varieties to the farmers at an affordable price during the planting season.

Quality planting material is considered an essential input for the commercial production systems. The farmers are likely to buy the materials that possess attributes desired by them. These farmers' varietal preferences are essentially their perceived "utilities'' attached to the specific varietal attribute. The consumer choice theory (Lancaster, 1966), states that the consumers' decision to buy a good or product is determined by its attributes rather than the product *per se*. The Choice-based Conjoint analysis (CA) employs an experimental approach for measuring consumers'

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preferences for a specific product or service attribute (Raghavarao et al., 2010). The CA is widely used in agricultural studies to elicit varietal preferences of the farmers. Baidu-Forson et al., (1997) employed choice-based conjoint analysis for designing a hypothetical groundnut variety for the farmers of Niger in West Africa. Their work revealed that farmers preferred groundnut varieties resistant to diseases, short duration, and yielded more pods than the local landraces. An Indian study on sorghum and pearl millets (Basavaraj et al., 2015) has employed conjoint analysis to identify the drought tolerance and maturation time as key varietal attributes. Another consumer preference study on bell peppers (Frank et al., 2001) indicated that the consumers demanded green bell peppers enriched with Vitamin C with affordable price. Recent work on (Marenya et al., 2021) maize varieties demonstrated significant gender differences in the valuation of varietal attributes.

The objective of the present study is to design a series of hypothetical yam planting material profiles using a combination of farmer preferred attributes, and then estimate the farmers "willingness-to-pay" for each profile based on the estimated attribute utilities. This conjoint model will help the yam seed producers to fix the price for the "yam planting materials" from the farmers "willingness-to-pay" estimates.

METHODOLOGY

A random utility model on yam planting material was developed. This model assumes that the utility of planting material as a function of the farmer's preferred seed attributes, such as yield, variety, and culinary quality (Sivakumar et al., 2009) along with the planting material price (Fuglie et al., 2006). The utility model assumes that the overall utility gained by the farmer by using the yam planting material obtained from an individual or firm, is the function of the utilities derived from each attribute of the yam planting material. This relationship was specified as follows:

U = *U* (planting material price, variety, yield, culinary quality)

Where, *U* = Overall profit utility derived from a combination of yam quality planting material attributes; planting material price is the cost of per kilogram of yam seed tuber; variety refers to anthracnose disease-resistant variety; yield is tuber yield per hectare expressed in tonnes and culinary quality refers to the taste of cooked tubers. In this model, the ideal effects of the attributes on the utilities are specified as (i) increase in planting material price decreases its utility (i.e., δU/δ planting material price < 0), (ii) level of anthracnose disease resistance of yam planting material increases its utility (δU/δ disease-resistant yam variety > 0), (iii) increase in tuber yield enhances its utility (δU/δ yield > 0), and (iv) the culinary quality of yam increases its utility (δU/δ culinary quality > 0).

Two hundred yam farmers, who had a minimum of 10 years experience in yam cultivation, were randomly selected from four villages from Ganjam and Nayagarh districts of Odisha through simple random sampling method. An interview schedule was prepared to collect yam production system and respondents' demographic characteristics information. During the data collection, the cards containing hypothetical yam quality planting material profiles were presented (Brusch et al., 2002) and each respondent was asked to rank them according to his/her preference. The data were analyzed to estimate part-worth /utilities using the CONJOINT procedure of statistics software SPSS Ver. 17. After calculating the utilities, the farmer's willingness to pay for each attribute was estimated using the following formula (Louviere et al., 2000).

$$WTP_j = \left| \frac{\beta_j}{\beta_l} \right|$$

Where, *WTPj* represents the farmers' willingness to pay for the j[th] planting material attribute, β_j is the estimated coefficient of the j^{th} attribute, and β_l is the estimated coefficient of planting material price holding all other potential influences constant (Louviere et al., 2000).

RESULTS AND DISCUSSION

Random utility model for yam planting material

Based on the random utility model, the attribute levels of quality yam planting materials were decided (Table 1). The planting material price levels were chosen based on the Govt. prices followed in Odisha. The lower yield level, i.e., 25 t/ha, represents the farmers' existing yield potential of local landraces cultivated. In comparison, 30 t/ha was the average yield potential of improved yam varieties released by ICAR-CTCRI. Since the local landraces are susceptible to anthracnose disease that causes a yield loss of up to 40%, this level was identified as disease susceptible. The culinary quality level of "Good" represents the taste of existing popular landraces.

Table 1. Quality yam planting material attributes selected for the conjoint experiment

Attributes	Attribute levels	
	1	2
Planting material price (Rs/kg)	20	30
Variety	Disease susceptible	Disease resistant
Yield (t/ha)	25	30
Culinary quality	Good	Excellent

The Choice-based conjoint analysis enabled the researcher to create several hypothetical combinations of planting material combinations using factorial design, on which the consumers' utility values were estimated. The Orthogonal Main-Effect Plans suggested by Addelman (1962) were used to develop the orthogonal factorial design with a minimum efficient set of combinations of yam planting material attributes. An orthogonal array was consisting of eight yam planting material profiles was created (Table 2). Each attribute profile indicated a hypothetical yam quality planting material profile, and a total of eight yam types were generated for the study.

The majority of the respondents were male (70.83%), belonging to the 18 to 40 years age group (46.67%), matriculate (49.17%), and had 15 to 20 years experience in yam cultivation (37.50%). Many respondents cultivated yam under commercial production system (72%), while the rest followed a subsistence system (28%). Under commercial production system, yam is cultivated in deep vertisols, under unstacked conditions following scientific input management practices recommended by ICAR-CTCRI. Under subsistence production, yam is grown in the Alfisols under staked conditions with minimal inputs.

Table 2. Yam quality planting material profiles generated through the orthogonal array

Profile	Planting material price (Rs/kg)	Variety	Tuber yield (t/ha)	Culinary quality
1	30	Disease Resistant	30	Excellent
2	20	Disease Resistant	30	Good
3	30	Disease Susceptible	30	Good
4	30	Disease Resistant	25	Good
5	20	Disease Resistant	25	Excellent
6	30	Disease Susceptible	25	Excellent
7	20	Disease Susceptible	25	Good
8	20	Disease Susceptible	30	Excellent

Utility or part-worth of yam quality planting material attributes

Initially, the data were checked to assess its suitability for conjoint analysis based on correlations between observed and expected preferences. The results exhibited significant correlations with the expected preferences (Pearson's R = 0.987, p= 0.001; Kendall's tau = 0.987, p = 0.001), confirming that ranked data collected from the respondents were appropriate for the selected respondents conjoint model (Topcu, 2009).

The part-worth or utility coefficients for each level of the factor estimated through the conjoint procedure are displayed in Table 3. Among all attributes, yield has the highest utility levels (30 t/ha = 5.20 and 25 t/ha = 2.60), followed by planting material price (Rs. 30/kg = 1.147) and culinary quality (Excellent quality = 0.794). The disease resistance in yam variety had lowest level utility values (Disease resistant = 0.007; Disease susceptible = -0.007).

Data displayed in Table 3 also indicate the relative importance of each planting material attribute in a farmer's purchase decision. The yield was higher rated among other attributes, which influenced about 50% of the farmers' purchase of quality planting material. As perceived by the farmers, the culinary quality had 26% influence while planting material price had 18% contributions to farmers' purchase decision. However, the disease resistance of a variety had a negligible impact (4.8%) on farmers' decisions.

As expected, the farmers preferred higher yield as the primary criteria for designing a quality yam planting material. Past studies conducted by Anantharaman & Ramanathan (2002) and Ramanathan et al., (2006) in Kerala as well as by Nedunchezhiyan et al., (2006) in Odisha showed that the farmers sought high yielding yam varieties suitable for mixed cropping systems or under unstacked conditions. The results are consistent with past studies and indicate the need for promoting high-yielding yam varieties. Since the commercial yam farmers predominantly grow the local landraces that are poor yielders (15–20 t/ha) and vulnerable to genetic erosion in repeated cultivation. In view of the massive demand for high-yielding varieties, there is a need to accelerate the technology transfer efforts to popularize improved yam varieties in Odisha.

Another significant result of this study was the farmers' choice of culinary quality of yam ahead of disease resistance. Anantharaman and Ramanathan (2002) reported the preference for good culinary quality in a study conducted among tribal farmers of Kerala. The tribal farmers preferred yam varieties with good culinary qualities, good tuber shape, and tuber size. Similarly, Vernier & Dansi (2000) also reported that the farmers of Benin, Africa chose improved white yam varieties with good sensory quality for cultivation. In general, the culinary quality of yam is largely determined by its optimal sweet taste in boiled form. This research study subjectively determined the culinary quality levels based on their local preferences. There is a need to optimize the sugar content of yam tubers to match farmers' needs. The improved yam varieties released by ICAR-CTCRI contain lower levels of sugars (0.8–1.5%) than popular local landraces (Sivakumar et al., 2009). It is high time for the yam breeders to screen high yielding varieties for optimal sugar content as preferred by the farmers.

According to consumer theory, consumers seek quality good which provides the highest utility at a lower price. However, the respondents of this work assigned higher utility for the planting material price of Rs 30/kg, which is contradictory to facts. However, the preference for high planting material prices indicates the desperation of farmers to pay a higher price of yam quality planting material. As the farmers of Odisha faced an acute shortage of quality yam planting material during planting season and procured the planting material of low-yielding local landraces at higher prices, they preferred to pay a higher price for quality planting material.

Total utilities of yam quality planting material profiles

The total utilities of yam quality planting material profiles were calculated to identify the preferred hypothetical quality yam planting material. For example, the total utility of a hypothetical quality yam planting material that is disease resistant, provide tuber yield of 30 t/ha, has excellent culinary quality, and is sold for Rs 30/kg is calculated as follows:

TU = α (Constant) + U (Planting material price) + U (Variety) + U (Yield) + U (Culinary quality);

TU = -0.882 + 1.147 + 0.007 + 5.20 + 0.794 = 6.266

Table 3. Results of conjoint analysis

Planting material attributes	Levels	Utility/part-worth	Relative importance (%)	Standard error
Planting material price	20	0.574	18.91	0.741
	30	1.147		0.971
Variety	Disease susceptible	-0.007	4.80	0.370
	Disease resistant	0.007		0.370
Yield	25	2.60	49.62	0.741
	30	5.20		0.971
Culinary quality	Good	0.397	26.67	0.741
	Excellent	0.794		0.971
Constant		-0.882		0.960

Table 4. Total utilities of quality yam planting material profiles under the orthogonal array.

Profile	Planting material price (Rs/kg)	Variety	Yield (t/ha)	Culinary quality	Total utilities	Rank
1	30	Disease Resistant	30	Excellent	6.266	1
2	20	Disease Resistant	30	Good	5.296	4
3	30	Disease Susceptible	30	Good	5.855	3
4	30	Disease Resistant	25	Good	3.269	6
5	20	Disease Resistant	25	Excellent	3.093	7
6	30	Disease Susceptible	25	Excellent	3.652	5
7	20	Disease Susceptible	25	Good	2.682	8
8	20	Disease Susceptible	30	Excellent	5.679	2

Total utilities for other profiles were also calculated in the same way and displayed in Table 4. The yam profile estimates displayed in Table 4 indicate that, the farmers preferred hypothetical yam quality planting material profile 1 i.e., a quality planting material that is disease resistant, provides a tuber yield of 30 t ha^{-1}, has excellent culinary quality, and is sold for Rs 30/kg. Profiles 8, 3, 2 were similarly weighed as their total utilizes ranged from around five to six (i.e., 5.29 – 5.84). Profiles 6, 4, 5, and 7 were least preferred. These hypothetical yam quality planting material profiles provide an optimal combination of preferred varietal attributes, which will help the yam breeders to understand the farmer preferred combinations and develop varieties with a specified level of attributes.

Developing hypothetical planting material or variety profiles are widely used in designing breeding programs. Banerjee et al., (2007) generated two hypothetical cotton planting materials packaged and evaluated among Mississippi farmers in the USA. They identified lint yield and fiber quality as significant determinants of planting material selection. Similarly, Baidu-Forson et al., (1997) employed a hypothetical profile approach for developing groundnut variety profiles in Niger. After identifying groundnut planting material profiles, they concluded that conjoint analysis provided accurate estimates for farmers' preferences and urged the breeders to incorporate the needs in a breeding program.

Marginal Willingness-to-Pay for planting material attributes

In general, individual preferences mostly determine willingness to pay, but importantly, willingness-to-pay also reflects their ability to pay. The marginal willingness to pay is the maximum level of the consumer's price for buying the next unit of the product. Using the Louviere method (Louviere et al., 2000) of using utility scores of each attribute, the MWTP was estimated. Since disease resistance was least preferred, it was omitted from analysis (Table 5). The planting material price was not included as it would provide repetitive estimates.

The marginal WTP for the yield 30t/ha versus 25 t/ha is Rs 4.54/kg. It clearly shows that the farmers are willing to pay an additional amount of Rs 4.54/kg for a quality yam planting material that gives a higher yield than their own planting material/variety.

Table 5. Estimated Marginal Willingness to Pay from conjoint model

Variable	Marginal Willingness-to-pay (Rs)
Yield (30 t/ha Vs 25 t/ha)	4.54
Culinary quality (Excellent Vs. Good)	1.69

The marginal WTP for excellent culinary quality versus good quality is Rs 1.69. This result indicates that the farmers were willing to pay an extra of Rs 1.69 per kg of planting material for a culinary quality that is better than their local landraces. These estimates provide a framework for deciding on the price of quality planting material yam tubers and help the planting material producers to identify a profitable price based on attributes. The conjoint analysis has revealed new insights into the pricing of yam quality planting materials. The yam farmers derive the maximum benefits when they use a planting material that will provide a yield level of 30 t/ha; and the yam famer looks for a planting material tuber that will produce a minimum of 25 t/ha while visits a planting material trader to buy quality yam planting material. Suppose if they find planting material tubers that will provide a 30 t/ha yield, they have a 50% probability of buying the planting material even if it is disease susceptible and has the same level of culinary quality as his planting material and the farmers were willing to pay an extra amount of Rs 4.54/kg for a planting material that yields 30 t/ha instead of 25 t/ha, and the farmer will incur an additional cost of Rs 1.69/kg if its culinary quality is better than his/ her planting material.

CONCLUSION

The present study on quality yam planting material has brought new insights into the pricing strategy for marketing quality seeds and planting materials. Though several extension research studies identified farmers' preferences for varietal attributes in the past, the present research investigation provides a model, which will enable the extension agencies, agripreneurs, small businesses and Farmers Producers Organizations, who are engaged in quality seed production, to fix price of their produce based on utilities derived by the farmers and other stakeholders. This model will also help the breeders to decide on the breeding objectives, based on the utilities derived from the stakeholders from specific varietal attributes.

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