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Understanding Trait Preferences of Farmers for Post-Rainy Sorghum and Pearl Millet in India – A Conjoint Analysis

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ABSTRACT

A study was carried out on two important dryland crops, i.e., post-rainy season sorghum and pearl millet which are staples in Maharashtra, Karnataka, Rajasthan and Gujarat states of India. Both post-rainy (rabi) season sorghum and pearl millet are mainly grown under low rainfall regimes as they are drought tolerant and are prized for grain quality and fodder.

The present study is undertaken to quantify the varietal attributes preferred by the farmers for post-rainy sorghum and pearl millet using conjoint analysis technique. With this knowledge, researchers can focus on the most important features of seeds and design a variety that is most likely to gain acceptance of the target buyers. Further the utility attributes derived from the analysis are used to simulate preferences for new improved cultivars for both the crops that will identify the most preferred variety. The study would thus help in screening new improved cultivars of these crops for preferred attributes and overall preference.

Keywords: Trait preferences, crop variety attributes, utility scores.

JEL: Q16, Q33.

I

INTRODUCTION

Researchers are interested in knowing the attributes of crop varieties that are important to farmers to enable hassle free adoption. Thus, it is very important for researchers to be able to design their crop varieties based on preferred traits and position them to release successful crop varieties (Baidu-Forson *et al*., 1997).

All individuals including farmers while making a decision to purchase a good or a service evaluate attributes of all the competing products before making a final choice. This process is not explicit and the main consideration is perceived value maximisation. In many instances, farmers' varietal preferences based on attributes of a variety are ignored or based on some assumed requirement that eventually leads to rejection or non-adoption of varieties. Hence, uncovering the value assigned to each

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attribute, by different group of farmers is critical in developing varieties by researchers with desired attributes which will increase the adoption rate. Thus it is clear that farmers combine (integrate) information about different attributes of a crop and assign a value to the crop variety. Conjoint analysis is a technique which can empirically elicit information and is known as Information Integration Theory (IIT). IIT has three stages, which include relative attribute valuation, (psychophysical judgment formation) integration into a value proposition and then the response formation. The final choice is based on utility maximisation of the product or service. Varietal selection based on utility stands a better chance of adoption and up scaling on a large scale since it is essentially a consumer centric approach. In this context, a study was undertaken to quantify the varietal attributes preferred by farmers for two important dryland cereal crops, i.e., post rainy sorghum and pearl millet using conjoint analysis technique. The two crops are staples in household consumption basket in the states of Maharashtra, Karnataka, Rajasthan and Gujarat of India. Both post rainy (rabi) season sorghum and pearl millet are mainly grown under low rainfall regimes as they are drought tolerant and are prized for grain quality and fodder (Kelley and Parthasarathy Rao, 1994, Hall, 2000). The crops have critical impact on the livelihood of about 5 million farm households in India. The area under post-rainy season sorghum in India is around 5.7 million ha producing approximately 3 million tonnes of sorghum grain while pearl millet is grown in about 9 million ha[1] with a production 8.3 million tons.

The findings of the study will help researchers specifically breeders to produce crops varieties by prioritising features which are likely to gain acceptance by both producers and consumers. Further the utility attributes derived from the analysis is used to simulate preferences for new improved cultivars for both the crops that will identify the most preferred variety. The study would thus also help in screening new improved cultivars of these crops for preferred attributes and over all preferences.

II

METHODOLOGY

Data and Sampling

Data collection and sampling involves collection of a sample of 75 individuals / households at the minimum and developing orthogonal design of cards to administer for the respondents. The design will aid to present respondents various attribute combinations i.e., product profiles that facilitate effective preference evaluation. Presentations can either be in a written, verbal descriptions or pictorial format(Weiner, 1993; Cattin and Wittink, 1982). The data collection was structured to meet these requirements of conjoint analysis. In this study a pictorial card was developed and respondents were asked to rank it from 1 to 18. Two hold out cards were also inserted to check the accuracy of response.

The Solapur district in western Maharashtra and Jodhpur district of Rajasthan were selected as the study area for the varietal attributes preferred by farmers for the post rainy sorghum and pearl millet respectively as these districts have the highest area under cultivation of these two crops. A sample of 100 farmers each from Solapur and Jodhpur growing post rainy season sorghum and pearl millet were selected to administer the survey. Data was collected with the help of a pre-tested questionnaire that included data on their socio-economic characteristics together with technical details about the crops and varieties grown, extension support and their effectiveness, preferred varieties of post rainy season sorghum and pearl millet and their binding constraints to cultivation. The data was collected during July 2013 (Table 1).

TABLE 1. SAMPLE VILLAGES AND SAMPLE SIZE FOR POST-RAINY SEASON SORGHUM AND PEARL MILLET

Villages Sholapur district (1)	Sample size (2)	Villages Jodhpur district (3)	Sample size (4)
Mandrup	14	Sawant Kakuan	09
Bandrakote	16	Mahalna	38
Kumbhari	25	Kasti	12
Nimbargi	09	Jointra	10
Valsang	18	Rathiki Dhani	01
Vinchur	18	Purkhawas	06
		Lunawas Khara	24
Total	100	Total	100

Conjoint Analysis (CA)

Conjoint analysis as a technique is used for estimating the value people place on the attributes or features that define products (Louviere, 1991). The goal is to understand what specific values of attributes producers consider while making decision pertaining to seed purchase. In the current study, the attribute specific values area analysed for post-rainy season sorghum and pearl millet. CA is also used to predict choices for future products and services. It assumes that a product can be "broken down" into its component attributes (Hair et al., 2006; Rao, 2008). For example, a plant variety has attributes such as high yield, stover quality, grain size and shape, and grain color. The values that individuals place on a crop variety are equivalent to the sum of the utilities they derive from all the attributes making up the crop variety. Further, CA assumes that the preference for a product and the likelihood to purchase it is in proportion to the utility an individual gains from the product. Unlike traditional approaches where respondents are asked to estimate how much value they place on each attribute, CA attempts to break the task into a series of choices or ratings. These choices or ratings, when taken together, allows to compute the relative importance of each of the attributes studied (Mafuru *et al*., 2007).Further, markets continue to change as new varieties enter; new varieties are introduced, etc. In such instances, in the traditional approach a new survey needs to be conducted

every time a major change takes place in the market to find out how people feel about the changes and how it will affect their purchases. With CA, the new product or changes to existing products can be incorporated into the simulation model to obtain predictions of how buyers will respond to the changes. In most markets, these models can maintain their accuracy for two or three years before you need to conduct a mini-version of the original study to determine if any adjustments must be made to the model. Instead of "stated importance", conjoint analysis uses "derived importance" values for each attribute or feature. The ability to use the results to develop market simulations models to evaluate existing varieties into future is the other advantage of using CA technique.

Application of CA technique is done in three phases: collection of trade-off data through a survey, statistical analysis of the data, and simulation. Depending upon the type of conjoint survey conducted, statistical methods like ordinary least squares regression, weighted least squares regression, and logit analysis are used to translate respondents' answers into importance values or utilities (Adane *et al*., 2012).

In the present study conjoint analysis is carried out to evaluate the underlying responses that the respondents consciously or sub-consciously place on each attribute. For example, a rational farmer growing post-rainy season sorghum will prefer yield levels of 1.5 tons to 1.0 tons per hectare if all other things are equal (quality, features, etc.). What researchers do not know about each farmer is his or her level of sensitivity to the yield difference. A farmer who always chooses variety with better stover quality over variety with average stover quality, regardless of yield level, obviously places more value on stover quality than yield level. CA allows the researchers to compute the relative value between these options and all other options considered in the research design.

Attributes and Levels

Listing many attributes for the analysis can greatly increase the burden on the respondents and therefore reduce the accuracy of the response. Similarly, too few attributes can result in critical information missing from the model. Hence, it is important to think critically to identify and list key attributes. In addition to the selection of attributes, individual levels within each attribute are also important. For an attribute like yield, the attribute levels would be specific points like 2 to 3 metric tons per hectare, 1 to 2 metric tons and less than 1 metric ton per hectare and for attributes like color, the attribute levels might be yellow, grey and white. Hence, there must be a balance between too many and too few options. Also, attribute levels must encompass all of the products that exist or expected in near future through research.

The attributes considered in the study have been identified based on discussion with the plant breeders (sorghum and pearl millet), agronomists, economists, sociologists and other scientists working on the crop at International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Hyderabad. Yield is an important

attribute that all farmers will target as it would have a bearing on the commercial viability of the crop variety. Currently the best performance on the farmers' field is 2 metric tons per hectare. Hence it was taken as the upper limit. Dairying is an important activity in the dry tracts, hence farmers growing post rainy season sorghum and pearl millet would use the crop residue or stover as fodder and enhance their incomes through milk production. Since both post rainy sorghum and pearl millet are essentially dryland crops, drought tolerance would be a minimum requirement. Days to maturation is deemed to be an important attribute as the most severe droughts (25 per cent of seasons) were when stress began before flowering resulting in failure of grain setting. Ideally, farmers would prefer to have moisture till 65 days so that flowering is complete. Grain size is considered as other important attribute from marketing point of view as it fetches higher price. Grain color and grain shape are the other important market attributes that the producer concentrates in order to get better market acceptance (Table 2).

TABLE 2. ATTRIBUTES AND THEIR LEVELS FOR POST RAINY SEASON SORGHUM AND PEARL MILLET

Attributes	Levels	
(1)	Post rainy season sorghum (2)	Pearl millet (3)
Yield	> 2 tonnes per hectare	2.5 to 3 metric tonnes/ha
	1 to 2 tonnes/ha	1 to 1.5 metric tonnes/ha
	< 1 tonne/ha	< 1 tonne/ha
Stover	Sweet and palatable	Sweet and palatable
	Average palatability	Average palatability
Plant colour	Pigmented	Not applicable
	Tan	
Drought tolerance	High	High
	Medium	Low
Maturation of crop (flowering)	60 to 65 days	60 to 65 days
	65 to 72 days	65 to 72 days
Grain size	Large (25 gm/1000)	Large (20 gm/1000)
	Medium (10 gm/1000)	Medium (7.5 to 15 gm/1000)
	Small (<8 gm/1000)	Small (<5 gm/1000)
Grain colour	Yellow	Grey
	White	White
Grain shape	Not applicable	Obviate
		Globular
		Hexagonal

Preferences and Utility

Utility, which is subjective and unique to each individual, is the conceptual basis for measuring consumer demand in economic theory. Economic theory states that utility is interpreted as a numerical measurement of the satisfaction derived from the consumption of alternative bundles of commodities. In recent years, the theory of consumer utility has gone beyond the traditional economic theory of consumer demand. According to Lancaster's model of consumer behaviour, the theory on

preferences states that goods are valued for the attributes they possess, and that differentiated products are merely different bundles of attributes (Lancaster, 1966).

Importance Scores

The importance score for factor of attribute 'i' is

Importance =100 x RANGE of utilities of 'i' / Σ of all utility ranges.

where RANGE 'i' is the highest minus lowest utility for factor i.

The importance for each factor is calculated separately for each individual farmer in the study and is then averaged for all the farmers.

Market Simulation

Market simulation is carried out to evaluate the performance of the existing varieties based on estimated utilities of the respondents. The ranking of the estimated utilities will indicate the extent to which the existing varieties are meeting the requirement of the end uses. Varieties which contain those attribute levels for which the farmer respondents have higher utility values produce a higher degree of acceptance. Utilities are calculated by summing up the attribute level utilities.

For each product 'i' used in the simulation, a probability p_i is assigned. The probabilities are all computed based on the predicted score for that simulated product (CIMMYT Economic Program, 1993). Probabilities are averaged across respondents for the grouped simulation results. Bradley-Terry-Luce (BTL) and Logit models are considered to calculate predicted probabilities. The BTL model determines the probability as the ratio of a profile's utility to that for all simulation profiles, averaged across all respondents. The logit model is similar to BTL model but uses the natural log of the utilities instead of the utilities. Only subjects having all positive probabilities are considered for calculations. The predicted probabilities of each of the variety indicate the probability of adoption. The variety with the maximum probability is deemed to be more preferred.

III

RESULTS AND DISCUSSION

Sorghum

The farming practices, constraints in production, extension support and socio-economic background have been documented in this section for post rainy season sorghum.

A list of the varieties grown currently by the farmers reveals that *Maldandi* is the most popular variety grown in the study area accounting for about 73 per cent of the

sample farmers. This is followed by *Dagadi* (9 per cent) and *Phule Chitra* and *Phule Vashuda* with three per cent each.

With regard to the sourcing of seed for cultivation, about 66 per cent of the sample farmers use their own seeds for sowing which is not a healthy practice from crop improvement point of view. The other important sources of seed were Agri-clinics and Government agencies. A variety of crops are grown by the farmers under rainfed conditions in the study villages. Post rainy season sorghum was the most predominant crop grown by as much as 87 per cent of the farmers (Table 3). The other important crops grown in the region were groundnut and pigeon pea as sole crops but their importance can be gauged by the fact that each crop is grown by less than 5 per cent of the farmers, testifying to the overwhelming presence of sorghum.

TABLE 3. CROPS GROWN UNDER RAINFED CONDITIONS IN SHOLAPUR DISTRICT

Crop	Number	Percentage (per cent)
(1)	(2)	(3)
Post-rainy season sorghum	81	87.10
Groundnut	4	4.30
Pigeon pea	3	3.23
Kharif sorghum, Pigeon pea	2	2.15
Maize	1	1.08
Post-rainy season, Sugarcane	1	1.08
Safflower, Sorghum	1	1.08
Grand Total	93	100

In irrigated areas, sugarcane was the most important crop grown by 59 per cent of the farmers. The other important irrigated crops grown were chilly, vegetables and wheat.

The important constraints faced by the famers in the study area are documented in Table 4. Farmers were asked the frequency of each constraint and the degree of impact. The impact was measured on a hedonic scale which ranges from 1 for mild to 5 for severe. The constraints are related to moisture stress, yield variability, labour scarcity, marketing, cost of production, inputs and their poor quality and credit availability. Moisture stress was a universal problem indicated by almost all the

TABLE 4. PRODUCTION CONCERNS OF THE FARMERS GROWING POST RAINY SEASON SORGHUM

Problems	Incidence (per cent)	Impact
(1)	(2)	(3)
Moisture stress	98.02	4.70
Yield variability	67.33	3.37
Labour scarcity	42.57	2.86
Marketing problems	3.96	2.75
Fodder shortage	3.96	2.00
High cost of production	18.81	2.95
Poor input quality	4.95	2.00
Input availability	6.93	2.86
Credit availability	6.93	2.00

Note: Impact has been scored on a hedonic scale ranging from 1 for mild to 5 for severe.

farmers which has high impact as well. The next in importance was yield variability related to moisture stress followed by labour scarcity. Labour scarcity could indirectly be related to moisture stress which leads to out migration resulting in labour shortage. But the impact factor of labour shortage is moderate (2.86) compared to moisture stress and yield variability. High cost of production was another major constraint with an impact factor of 3. Input availability and credit availability were the other problems faced by the farmers of the region.

A cursory look at the socioeconomic profile of the sample farmers revealed that on an average the sample farmers had studied up to the eighth grade owned about 3.65 acres and had experience of 29 years in farming.

Farmers Preference for Varietal Traits of Post Rainy Season Sorghum

The farmers growing post rainy sorghum were asked to indicate their preference with regard to crop yield, stover quality, plant colour, drought tolerance, time taken to maturation, (early maturation will help the crop to withstand late season drought) grain size and grain colour. The first five parameters are the production parameters while the latter two were the market parameters. The importance assigned by the sorghum farmer to each attribute are estimated using conjoint analysis. The utility derived by the farmer from the attributes of post rainy season sorghum are presented in Table 5. The importance score depicted in Figure 1. Perusal of the figure reveals that farmers in the study area assigned the highest importance to yield (22.42 per cent), followed by grain size (20.85 per cent) and grain colour (18.71 per cent). The other traits like stover quality, maturation and plant colour had an importance value

TABLE 5. UTILITIES ATTRIBUTES OF POST RAINY SEASON SORGHUM FOR THE FARMER

Attributes (1)	Utility (2)	Levels (3)
Yield	1.1832	> 2 tonnes per ha
	- 0.4121	1 to 2 tonnes per ha
	- 0.771	< 1 tonne per ha
Stover	0.6597	Sweet and palatable
	- 0.6597	Average palatability
Plant colour	0.1163	Pigmented
	- 0.1163	Tan
Drought tolerance	0.3552	High
	- 0.4552	Medium
Maturation of crop	0.3515	60 to 65 days
	- 0.3515	65 to 72 days
Grain size	0.6716	Large (10 gm/1000)
	- 0.2603	Medium (8 gm/1000)
	- 0.4113	Small (< 5 gm/1000)
Grain colour	- 0.1535	Yellow
	0.8428	White
Constant	8.07	
Pearsons R	0.67	
Kendall's Tau	0.39	

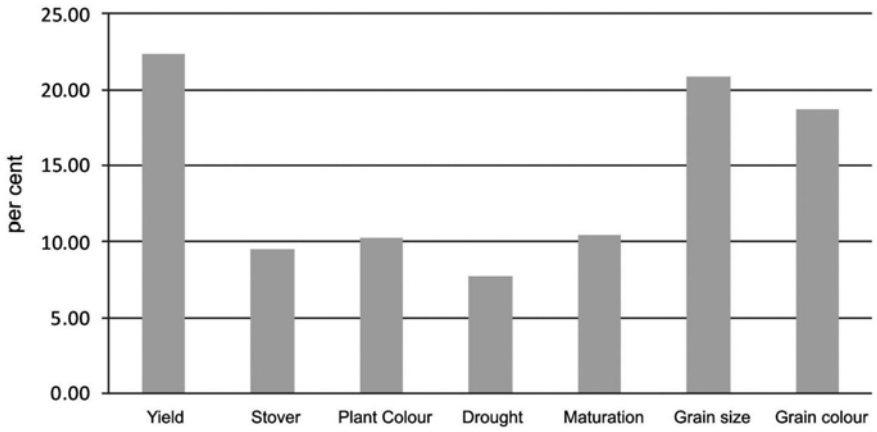

Figure 1. Importance Attached to Selected Varietal Traits Post Rainy Season Sorghum by Farmers in Maharashtra

of around 10 per cent each. Drought tolerance is taken as given for the sorghum crop in general and hence the farmers did not specifically look for this attribute in the variety.

Among the attributes, yield was the most important and yield level of over 2 tons per hectare was desired by the farmers. For grain size, large grain size was preferred with a grain weight of over 10 gm per 1000 grains and in this the white coloured grain was preferred to enhance the look of the cooked *"rotis"*. Large grain size was preferred as it increased the grain weight and reduced the chaff percentage. Early maturation of less than 65 days helped the crop to withstand late drought and also withstand moisture stress during the late season. The farmers preferred a plant with green stalk over tan and a variety that can withstand drought. Sweet and palatable fodder was also a desired trait in the variety as it had a very high utility score of 0.6597 which was next only to grain yield levels of 2 tonnes / ha and more (1.1832), grain colour (0.8428) and grain size (0.6716).

Simulations

Some of the existing varieties including new varieties recently sown on farmers' fields have been included in the simulations in the backdrop of the values attached to the attributes by the farmers growing post rainy season sorghum. The findings on predicted probabilities under three different probability choice models for the seven varieties across the 100 subjects in this study are presented in Table 6.

From the result, it appears that Parbhani Jyoti is the most popular of the simulated varieties as about 44 per cent of the sample farmers would prefer it. This is followed by M-35-1 (*Maldandi*) with a maximum utility of 19 per cent. In addition to these

two varieties *Dagadi* and Phule Chitra should meet with good demand. Akola Kranti and PhuleYashoda do not have attributes that meet farmers preferences.

TABLE 6. POST RAINY SEASON SORGHUM SIMULATION RESULTS

Serial No. (1)	Variety (2)	Max Utility (3)	BTL (4)	Logit (5)
1	Dagadi	11.56	12.50	8.43
2	M-35-1 (*Maldandi*)	18.81	13.39	19.89
3	Parbhani Moti	9.90	15.21	12.04
4	Parbhani Jyoti	43.89	17.42	37.47
5	Akola Kranti	0.99	14.22	4.80
6	Phule Chitra	9.90	15.21	12.04
7	Phule Yashoda	4.95	12.06	5.33

Pearl Millet

Pearl millet is by far the most preferred crop in rainfed conditions while *moong* and *moth* (from green gram family*)* were other crops of some importance in the study area. Among the preferred varieties of pearl millet, HHB 67 was the most popular variety with almost 70 per cent of the farmers growing it. The next in importance was RHB 177, with a patronage of 21 per cent of the famers (Table 7). The important crops grown in the irrigated tracts were cumin, cotton and wheat.

TABLE 7. PEARL MILLET VARIETIES GROWN IN JODHPUR, RAJASTHAN

Variety (1)	Total (2)
HHB 67	70
RHB 177	21
RHB 121	6
Pioneer	2
Proagro	1
Grand Total	100

The constraints faced by the pearl millet farmers will give inkling on their requirement with respect to crop technology. Of the main constraints faced, moisture stress was the top in the list with a high impact of 4.70 out of 5. Lack of credit facilities, yield variability and non-availability of suitable pearl millet varieties in the region were the other major constraints faced by the pearl millet farmers (Table 8).

Farmers Preference for Varietal Traits of Pearl Millet

Like for sorghum an attempt has been made to quantify the features/ traits of pearl millet preferred by the farmers. The varietal traits identified in consultation with the pearl millet crop breeders at ICRISAT were yield, stover quality, drought tolerance, ear head maturation duration, grain size, grain colour and grain shape.

TABLE 8. PRODUCTION AND MARKETING CONSTRAINTS FACED BY THE PEARL MILLET FARMERS

Constraints (1)	Total (2)
Moisture stress	4.70
Lack of credit facilities	3.50
Yield variability	3.06
Lack of proper varieties for region	2.88
Fodder availability	2.75
Poor marketing	2.51
Labour availability	2.41
Lack of proper extension service	2.30
High cost of inputs	2.28
Poor quality of inputs	2.19
Lack of availability of inputs	2.03

Within each varietal trait the important levels were identified and conjoint analysis was carried out on data from a sample of 100 farmers. The specific importance of the levels of each trait is measured in terms of utilities is presented in Table 9. Farmers derive the highest utility from an yield level of 2.5 to 3 metric tons per hectare and prefer a medium grain size of around 7.5 gm/ 1000 grain with a utility score of 0.304, as well as a grain which is obviate in shape. Unlike in sorghum they preferred a variety that produced grain of grey colour and wanted stover to be sweet and palatable. The model yielded a Kendall's tau and Pearsons R of 0.68 and 0.90, respectively.

TABLE 9. UTILITIES OF POST RAINY SEASON SORGHUM ATTRIBUTES TO THE FARMER

Trait (1)	Utility (2)	Levels (3)
Yield	0.2067	2.5 to 3 metric tonnes per ha
	0.1117	1 to 1.5 metric tonnes per ha
	- 0.3183	< 1 ton per ha
Stover	0.2388	Sweet and palatable
	- 0.2388	Average palatability
Drought tolerance	- 0.0163	High
	0.0163	Low
Maturation of crop	0.015	60 to 65 days
	- 0.015	65 to 72 days
Grain size	- 0.2133	Large (12 gm/1000)
	0.3042	Medium (7.5 gm/1000)
	- 0.0908	Small (<5 gm/1000)
Grain colour	0.085	Grey
	- 0.085	White
Grain shape	0.1167	Obviate
	- 0.0408	Globular
	-0.0758	Hexagonal
Constant	8.4725	
Pearsons' R	0.903	
Kendall's Tau	0.667	

The results of the importance score are presented in Figure 2. From the figure it is clear that pearl millet farmers are primarily interested in yield levels and grain size

with importance scores of around 20 per cent each. Grain shape, grain colour and stover quality were next in order of importance with values of 18 per cent, 12 per cent and 11 per cent respectively. Drought tolerance and maturation time were not considered important as it is perhaps taken for granted that pearl millet is inherently tolerant to moisture stress conditions.

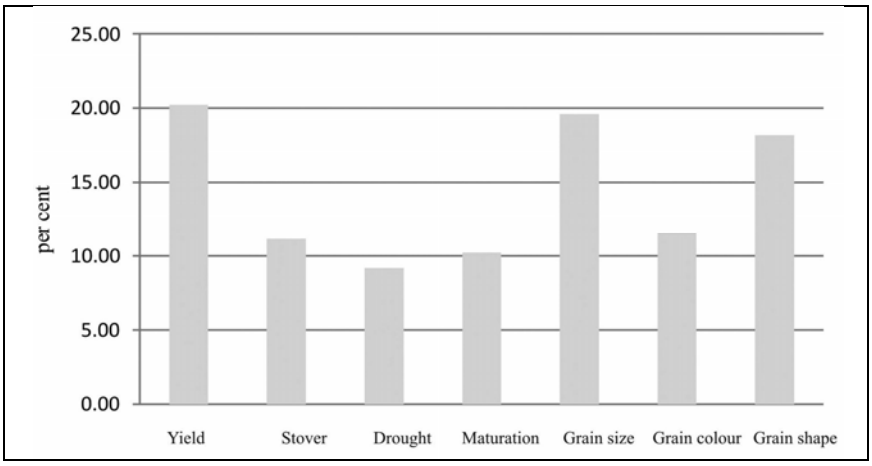

Figure 2. Importance Attached to Selected Varietal Traits of Pearl Millet by Farmers in Rajasthan

Simulations

Some of the existing pearl millet varieties have been analysed in the backdrop of the values attached to each of the attributes by the pearl millet farmers. The results are presented in Table 10 for the five varieties with the predicted probabilities of choosing each of the simulation cases as the most preferred one, under three different probability-of-choice models. From the results it appears that Pioneer 86M86 and RHB 121 are the most popular varieties as of the simulated varieties as about 22 per cent of the sample farmers would prefer each. This is followed by HHB 67 Improved and RHB 177 with a maximum utility of 19.50 per cent. In addition to this Proagro9444 should meet with good demand. Thus, all the varieties / hybrids seem to have good value to the farmers.

TABLE 10. PEARL MILLET SIMULATION RESULTS

Sl. No	Variety	Max utility	BTL	Logit
(1)	(2)	(3)	(4)	(5)
1	HHB 67 improved	19.50	20.41	21.08
2	Pioneer 86M86	22.00	19.33	20.49
3	Proagro 9444	17.00	19.67	16.65
4	RHB 121	22.00	20.20	22.41
5	RHB 177	19.50	20.39	19.37

IV

CONCLUSION

Preference for drought tolerance and maturation were taken for granted for both post-rainy season sorghum and pearl millet as these grown in low rainfall regimes. High yield, palatable fodder, large grain size (over 10 gm/1000 grain) and white grain colour were the most preferred traits by farmers growing post-rainy season sorghum. The utility values were the highest for yield followed by stover quality. Breeding for improved dual purpose varieties of post-rainy season sorghum to be the focus of the breeders. Over 75 per cent of the farmers preferred growing *Maldandi and Dagadi* varieties of post-rainy season sorghum as they give the farmers highest utility. These two varieties are grown on farmer's field for the past two decades. Results from simulation analysis with respect to existing varieties grown by farmers revealed a superior preference for Parbhani Jyoti over *Maldandi* and *Dagadi*. Thus, it is important to ensure seed availability of these improved varieties through extension efforts and increase their adoption.

For pearl millet, in general farmers desired high yields and medium sized grain size of 7 to 10 gm per 1000 grain and obviate shape. Both public and private released varieties/hybrids of pearl millet (HHB 67, RHB 177, Pioneer 86M86, Proagro 9444) and those in pipeline are found to fulfill the farmer trait preferences indicated by utility scores. However, access to improved seed is seen as a constraint. Hence, the delivery mechanism and extension support system has to be strengthened to improve access to improved seed.

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NOTE

1. India is the largest producer of pearl millet in Asia both in terms of both area and production.

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