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ADOPTION OF SUGARCANE VARIETIES IN THE SUGARCANE GROWING AREAS OF PAKISTAN

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ABSTRACT: Sugarcane is an important crop of Pakistan in various ways. The present study aimed to indirectly investigate into the potential of saving land and water resources by re-allocating sugarcane area to relatively more productive recommended sugarcane varieties. Secondly, this exercise shall also provide feed-back to researchers in sugarcane crop as well as sugar mills for assessing the types of varieties performing better, relative to others. The study document the extent of adoption of recommended sugarcane varieties in Pakistan. The study was based on the primary data collected through a formal survey of sugarcane growers in the different agro-ecological conditions in three provinces of Pakistan during 2007-08. The major study findings showed that nearly one-fifth of total farm area was allocated to sugarcane crop by sample farmers with more than 70% and 76% of total sugarcane areas were devoted to recommended varieties during 2006-07 and 2007-08, respectively. More than 25 sugarcane varieties were cultivated by sample farmers in Pakistan. Majority of the farmers planted only one variety. Among recommended varieties, Thatta-10 and CP-77-400 were relatively the most commonly planted. Thatta-10 in Sindh, HSF-240 in Punjab and CP-77-400 in Khyber Pakhtoonkhwa Province (KP) captured significantly large area than other varieties. Based on varietal adoption indicators, although improvements were registered for most of the indicators, however, their magnitude was quite small indicating slowness of varietal diffusion. Very high variations in varietal diffusion indicators were also observed across provinces, farm size and tenancy status categories.In conclusion, despite that major proportion of total sugarcane area was planted under recommended varieties, the varietal diffusion process among sugarcane growers all over the country was taking place on informal grounds and was extremely slow. Therefore, strong institutional efforts from agricultural extension department as well as sugar mills are needed to rapidly diffuse the more recently released varieties among the farmers. The sugarcane growers in KP are suggested to increase varietal diversity on their farms to avoid any risk of complete crop failure due to any reason. Sugar mills in all three provinces are suggested to take serious note of status of adoption of different sugarcane varieties through a collective action in their respective provinces. Activities like planting demonstration plots of promising varieties on farmers' fields, launching special sugarcane varietal promotion campaigns for spreading desirable varieties during planting seasons and active involvement of provincial departments of agricultural extension in their efforts of varietal promotion are some suggestions put forward for encouraging cultivation of newly released recommended sugarcane varieties in the area.

Key Words: Sugarcane; Recommended Varieties; Varietal Diffusion; Adoption Indicators; Farming Categories; Pakistan.

INTRODUCTION

Sugarcane is an important cash crop of Pakistan. It stands at the fifth position in its acreage and production and almost 15th position in sugar production in the world. Sugarcane is mainly grown for manufacturing sugar and other sweeteners (*Shakar* and *Gur)* and its by-products are used as fodder, in chipboard and paper industries. It is an important source of household income and employment for the farming community also in its comparatively ad-

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vantageous areas. The share of sugarcane in total agricultural value added and GDP are 4.5% and 0.9%, respectively (GoP, 2008). Although both the sugarcane area and production were increased in past two decades, but in a cyclical fashion (GoP, 2007). In sugarcane growing areas, about 64% of total area under this crop has been planted by farm sizes ranging from 1 to 10 hectares (GoP, 2000). Currently, there are 77 sugar mills in the country with a distribution of 41 mills in Punjab, 29 mills in Sindh and 7 mills in NWFP. These mills crushed nearly 74% of total sugarcane produced in the country to produce 3.52 mt of white sugar (GoP, 2007).

Recommended sugarcane varieties play a significant role in increasing cane productivity. Sugarcane breeders at public and private research institutions in Pakistan are working to develop high yielding, more sugar recovery rate and disease resistant varieties. In addition to sugar mills, provincial agricultural extension departments are also working to disseminate promising sugarcane cultivars. The varietal diffusion information is useful to stakeholders from different perspectives like breeders can use it to reform their breeding agenda in terms of more adaptability of their varieties to local conditions; plant protection scientists and institutions can plan their experimentation and future activities; output procuring agencies (e.g. sugar mills) can plan their procurement strategies from different geographical areas; other marketing agencies (inputs supplying, plant protection related agencies, etc.) can plan their area and farm specific activities; and finally, the policy makers may use this information in designing more targeted policy incentives to promote the diffusion of desired varieties. The adoption of a new agricultural technology is important for evaluating the impact of agricultural research investments (Norton and Davis, 1981; Jahnke et al., 1986; CIMMYT, 1993; Collinson and Tollens, 1994) and for guiding technology development to satisfy the needs of the clients. Technology adoption brings potential impact at the farm household level (Sanginga, 1998). According to Rogers (1983), adoption is a decision to make use of an innovation as a best course of action available. Feder et al. (1985) defined adoption as the degree of use of a new technology when a farmer has full information about the technology and its potential. On the other hand, aggregate adoption is the process by which a new technology spreads or diffuses within a region. A distinction exists between adoption at individual household level and aggregate adoption within a targeted region.

In the past, Technology Transfer Institutes of PARC used to carry out varietal diffusion monitoring surveys of major crops as a regular activity to provide feedback to biological scientists and development practitioners. The need of such activity has been felt again in the policy making circles, annual planning meetings of biological scientists, technical advisory committee meetings and other high level meetings of the national agricultural research system (NARS). This study was carried out to provide updated information on the status of sugarcane varietal diffusion in sugarcane growing areas of Punjab, Sindh and Khyber Pakhtoonkhwa provinces.

The specific objectives of this study were: to determine sugarcane varietal composition at farms of different categories and ecologies in Pakistan; examine the sugarcane varietal adoption from various perspectives by using various indicators to suggest strategies of further promoting the adoption of recommended sugarcane varieties in the study area and suggest formal and informal measures to promote the adoption of recommended varieties in the study area.

MATERIALS AND METHODS

The study was based on the primary data collected through a formal survey of sugarcane growers in the different agro-ecological zones in the three provinces of Pakistan. The universe of the study comprised sugarcane growers in southern Sindh, central Punjab and central Khyber

Pakhtoonkhwa. A multi-stage cluster sampling technique was used to select sample sugarcane growers. At the first stage, five sugarcane growing districts were selected. At the second stage, two tehsils from each district were selected and four to five villages from each tehsil were selected randomly. As a result, a total sample of 400 sugarcane growers was obtained. Twelve questionnaires had been discarded due to incomplete and serious inconsistencies in the information gathered, thus data for 388 observations were analyzed. The district-level composition of the sample by various zones included, Mirpur Khas, Badin Districts in southern Sindh; Faisalabad, Jhang Districts in central Punjab and Mardan District in central Khyber Pakhtoonkhwa .

Data Treatment Methods

Information in the form of discussion and published material (e.g. brochures) were gathered by consulting researchers in the public and private sector, extensionists and other experts worked on sugarcane crop to finalize the recommendation status of sugarcane varieties being planted on farmers' fields. This information was utilized to estimate sugarcane varietal diversity on farmers' fields. Besides carrying out the standard cross-tabulation analysis, following Iqbal et al. (2002), the indicators of adoption were also estimated in terms of crude adoption rate, intensity of adoption and participation index. The crude adoption rate was defined as the proportion of the farmers cultivating recommended sugarcane varieties (RSVs) and used to examine the rate of adoption in the aggregate. The intensity of adoption was estimated in terms of ratio of area under RSVs to the total sugarcane acreage. This indicator would show the extent of farmers' confidence in the recommended varieties. The participation rate is the product of crude adoption rate and intensity of adoption. The participation rate shows the aggregate community level index ranging its value from 0 to 1. The participation rate shall attain its lower extreme value equal to zero, when none of the farmer in the community is planting any area under recommended varieties. It shall attain the value equal to one, when all the farming community allocates entire area of the crop under consideration to recommended varieties.

Acknowledging that using the seed of newly released varieties as one of the basic requirements for increasing sugarcane yield and to quantify the extent of diffusion of new sugarcane varieties, a variable named weighted average varietal age (or varietal age) was constructed as follows:

$$\text{Weighted average varietal age} = \sum_{i-1}^{n} PAV_{wi} \times AGEV_{wi}$$

Where

PAV_{wi} = Percent of total sugarcane area occupied by its *ith* variety

$AGEV_{wi}$ = Period in years of *ith* sugarcane variety since its release (for non-recommended having no release record and unauthenticated varieties the period was taken as zero) [$i = 1, 2, 3, \ldots\ldots\ldots\ldots n$]

This index was also used by Heisey (1990) and Hartell et al. (1998) for estimating the contribution of wheat breeding efforts in Pakistan. The minimum value of weighted average varietal age of a crop in a farming community shall be one, if all the sample farmers planted entire area under the variety in its release year. As farmers devote more proportionate area to old varieties, the weighted average varietal age tend to increase. In this way, this index captures both the oldness of genetic material and land allocation patterns to different varieties.

The Inverse Herfindahl index (Escalante and Barry, 2001; Hanson and Simons, 1995; Hill, 1973) was used to estimate sugarcane varietal diversity as:

$$\text{Sugarcane varietal diversity } (SVD) = \sum_{i-1}^{m} (S_i^{\alpha})^{1/(1-\alpha)}$$

where S_i is the share of the *ith* variety in total sugarcane area, and α is the diversity parameter, that $\alpha \geq 0$ and $\alpha \neq 1$. For $\alpha = 2$, the index becomes $1/\sum S_i^2$ or the inverse of the Herfindahl Index that is commonly used to measure industry concen-

tration (Escalante and Barry, 2001; Hanson and Simons, 1995; Hill, 1973). As approaches 1, the index becomes the Entropy-Index, which is calculated as $\sum S_i \ln S_i$ where ln is the natural logarithm (Tauer, 1992). In this study, we have used value of á=2. The minimum value of this index would be 1, when all the area of the crop under consideration is planted under one variety. As the number of varieties planted increases with changes in proportionate area under these varieties, the value of this diversity index would also increase. Thus the higher is the value of this diversity index, the larger is the varietal diversity present on sample farms.

The last varietal diffusion indicator used was possession of the seed of most popular variety. This indicator is used to find the proportion of farmers in an area already have seed of a popular variety and that community can have access to that seed in an informal manner. Therefore, the higher is the proportion of farmers in a community having seed of most popular variety, the lesser institutional efforts are needed to spread the seed of that variety in that community.

Finally, based on farm size, the sample farmers were classified into three categories as small (<12.5 acres), medium (12.5 to 25 acres) and large (above 25 acres). Based on the extent of owned land involved in operational holding, the farmers were also classified into owners (i.e. solely operating on owned land), owner-cum-tenants (i.e. cultivating some rented-in or shared-in land in addition to owned land), and tenants (i.e. cultivating rented-in or shared-in lands only) operators.

RESULTS AND DISCUSSION

Area Allocated to Sugarcane Crop

Overall, nearly one-fifth of farm area (19%) was allocated to sugarcane crop by the sample farmers. The farmers of Khyber Pakhtoonkhwa cultivated sugarcane on 41% area and were allocating more than one-third proportion of their land holding for sugarcane. The proportion of farm area under sugarcane declined from small to large farm sizes. The tenant farmers devoted larger proportion of farm area (25.3%) to sugarcane than the owner-cum-tenant or owner operators (Table 1). It can be concluded that sample farm households from categories like central Khyber Pakhtoonkhwa, small farm size and tenants were more dependent on sugarcane crop for their crop sector income than their respective counterparts.

Number of Sugarcane Varieties Planted

The number of varieties cultivated is

Table 1. Farm size, and area allocated to sugarcane by sample sugarcane growers during 2007-08

Zone/Farm category/Tenure	Farm size (acres)	Area under sugarcane (acre)	Sugarcane share in farm area (%)
Cropping zone			
Southern Sindh	74.45	13.22	17.76
Central Punjab	27.48	4.68	17.03
Central NWFP	12.80	5.25	41.02
Farm category			
Small (<12.5 acres)	7.26	2.35	32.37
Medium (12.5 to 25 acres)	18.75	4.37	23.31
Large (25 acres and above)	89.30	15.62	17.49
Tenure			
Owner	52.99	9.55	18.02
Owner-cum-tenant	26.36	5.94	22.53
Tenant	17.49	4.43	25.33
All Farms	42.21	8.04	19.05

Source: Survey data, 2007-08

a crude indicator of genetic diversity on farmers' fields as well as a mean of avoiding risk of complete crop failure which may happen if only one variety is planted. In total, sample farmers found cultivating more than 25 sugarcane varieties. Various categories of sample farmers were examined in terms of number of varieties simultaneously cultivated (Table 2). About three-fifth of the farmers had planted only one variety whereas one-third had planted two varieties. A very small proportion of the farmers planted three or more varieties. Across cropping zones, all sample farmers from Khyber Pakhtoonkhwa planted only one variety, whereas, one variety plantation was relatively more common in Punjab and two varieties plantation in Sindh. Across farm size groups, plantation of one variety became less common as farm size increases and opposite was observed for plantation of two varieties. Across tenancy status categories, the plantation of one variety became less common while examining from tenants to owner operators, opposite was observed for cultivation of two varieties.

Sugarcane Varieties Planted on Sample Farms

More than 25 sugarcane varieties were cultivated by sample farmers in the study area during 2006-07 and 2007-08. These cultivars were grouped as recommended and non-recommended varieties in different provinces. The 17 varieties under cultivation from recommended group were: Thatta-10, CP-77-400, BL-4, HSF-240, SPSG-26, SPF-234, Gulabi-95, CPF-237, NIA-98, L-113, PR-1000, HSF-242, L-116, CP-43-33, SPF-213, L-118 and COJ-84. The non-recommended varieties found on farmers' fields were Triton, CPF-238, SPSG-79, CO-1148, CP-70, CO-245, Bansi, Pona and others. Overall, more than 70% of total sugarcane area was planted under recommended varieties during 2006-07, which was improved by nearly 6% in 2007-08 (Table 3).

In Sindh, more than four-fifth of total sugarcane area was planted under recommended varieties during both the years. Among them, the largest proportionate area was planted under varieties like Thatta-10 followed by BL-4, SPSG-26, CPF-234, Gulabi-95, NIA-98, L-113, PR-1000 and L-116. In non-recommended group, the proportionate varietal area in declining order was Triton, CP-70, Bansi and Pona. In Punjab, 30.4% of total sugarcane area was planted under recommended varieties during 2006-07 and an increase of 21% took place in 2007-08. From the recommended group, the varieties mostly planted were HSF-240, CPF-237, SPSG-79, CP-77-400, HSF-242, CP-43-33, SPF-234, SPF-213,

Table 2. Percent distribution of sample sugarcane growers of different categories planting by number of varieties planted during 2006-07 and 2007-08

Zone/Farm category	One variety		Two varieties		Three varieties		Four or more varieties	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Cropping zone								
Southern Sindh	38.1	39.5	55.1	53.7	5.4	4.1	1.4	2.7
Central Punjab	66.2	52.8	27.4	35.8	5.7	9.4	0.6	1.9
Central NWFP	100.0	100.0	-	-	-	-	-	-
Farm category								
Small (<12.5 acre)	85.3	83.1	14.7	16.9	-	-	-	-
Medium (12.5-25 acre)	59.6	53.5	36.4	42.4	4.0	4.0	-	-
Large (> 25 acre)	44.4	37.5	45.0	46.7	8.6	11.2	2.0	4.6
Tenure								
Owner	49.2	46.2	44.0	46.2	6.0	6.0	0.8	1.6
Owner cum tenant	81.7	69.5	14.6	19.5	2.4	7.3	1.2	3.7
Tenant	94.6	91.1	5.4	8.9	-	-	-	-
All Zones/ All Farms	62.7	57.6	32.1	35.1	4.4	5.4	0.8	1.8

Source: Survey data, 2007-08

Table 3. Percent area under different sugarcane varieties by cropping zones

Variety/Category	Southern Sindh		Central Punjab		Central KP		Overall	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Recommended								
Thatta 10	51.35	48.91	0.00	0.00	0.00	0.00	31.10	29.94
CP-77-400	0.00	0.00	2.13	3.86	97.73	97.80	14.05	13.63
BL-4	13.18	15.96	0.00	0.00	0.00	0.00	7.98	9.77
HSF-240	0.00	0.00	21.91	36.75	0.00	0.00	5.62	9.50
SPSG-26	4.50	6.60	0.32	0.57	0.00	0.00	2.81	4.19
SPF-234	4.04	4.19	0.91	0.85	0.00	0.00	2.68	2.79
Gulabi-95	4.72	2.26	0.00	0.00	0.00	0.00	2.86	1.38
CPF-237	0.00	0.00	4.30	4.96	0.00	0.00	1.10	1.28
NIA-98	1.23	1.17	0.00	0.00	0.00	0.00	0.75	0.71
L-113	0.43	1.14	0.00	0.00	0.00	0.00	0.26	0.70
PR-1000	0.80	0.90	0.00	0.00	0.00	0.00	0.48	0.55
HSF-242	0.00	0.00	0.16	2.06	0.00	0.00	0.04	0.53
L-116	0.60	0.81	0.00	0.00	0.00	0.00	0.36	0.49
CP-43-33	0.00	0.00	0.00	1.19	0.00	0.00	0.00	0.31
SPF-213	0.00	0.00	0.35	0.67	0.00	0.00	0.09	0.17
L-118	0.00	0.00	0.32	0.28	0.00	0.00	0.08	0.07
COJ-84	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.05
Sub-total	80.85	81.94	30.38	51.41	97.73	97.80	70.25	76.10
Non-Recommended								
Triton	16.94	16.17	0.16	0.28	0.00	0.00	10.30	9.97
CPF-238	0.00	0.00	56.24	37.74	0.00	0.00	14.41	9.76
SPSG-79	0.00	0.00	4.89	4.29	0.00	0.00	1.25	1.11
CO-1148	0.00	0.00	4.24	2.80	0.29	0.28	1.13	0.76
CP-70	1.33	1.20	0.00	0.00	0.00	0.00	0.81	0.73
CO-245	0.73	0.00	0.00	0.00	0.00	0.00	0.44	0.00
Bansi	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.35
Pona	0.13	0.12	0.00	0.00	0.00	0.00	0.08	0.07
Others	0.00	0.00	4.10	3.48	1.97	1.92	1.32	1.15
Sub-total	19.15	18.06	69.62	48.59	2.27	2.20	29.75	23.90

Source: Survey data, 2007-08

SPSG-26, L-118 and COJ-84. The non-recommended varieties' spread in decreasing order of percent sugarcane area planted in Punjab was CPF-238, SPSG-79, CO-1148 and Triton. In Khyber Pakhtoonkhwa, nearly 98% of total sugarcane area was under CP-77-400, the only recommended variety. From the non-recommended group, CO-1148 was the only major variety planted in Khyber Pakhtoonkhwa (Table 3).

As per expectations, the proportionate area under recommended sugarcane varieties increased from small to large farm size groups. Large sized farmers planted relatively more area under Thatta-10, BL-4, HSF-240 and CP-77-400. The small and medium sized farmers devoted relatively more area to CP-77-400, Thatta-10, BL-4 and HSF-240. From non-recommended category, the more area occupying varieties on medium and large farms were Triton and CPF-238, whereas, on small farms, CPF-238 and SPSG-79 were relatively the most planted (Table 4). It can be concluded that varietal choice from recommended group varied by farm size category. CP-77-400 was dominant on small and medium farms while Thatta-10 was relatively more planted on large farms. This implies that in the efforts to disseminate recommended varieties, small and medium farmers should be specially targeted in consonance to GoP (2000), about 64% of the total sugarcane area has been planted by these farmers.

Considering distribution of sugarcane varieties across tenancy groups, the area under recommended sugarcane varieties was much higher on tenants and owner-operators' farms than the owner-cum-ten-

Table 4. Percent area under different sugarcane varieties by farm size groups in Pakistan during 2006-07 and 2007-08

Variety/Category	Small		Medium		Large		Overall	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Recommended								
Thatta 10	7.08	8.06	14.18	16.04	37.62	34.94	31.10	29.94
CP-77-400	43.41	42.11	21.67	21.88	8.75	8.89	14.05	13.63
BL-4	4.22	4.13	5.91	5.57	8.88	11.17	7.98	9.77
HSF-240	6.13	7.65	6.43	12.53	5.38	9.18	5.62	9.50
SPSG-26	0.00	0.41	1.97	1.06	3.34	5.18	2.81	4.19
SPF-234	2.22	2.27	1.44	0.80	2.99	3.20	2.68	2.79
Gulabi-95	0.53	0.52	0.00	0.00	3.74	1.73	2.86	1.38
CPF-237	2.22	1.96	2.50	3.18	0.67	0.87	1.10	1.28
NIA-98	0.00	0.00	0.26	0.27	0.94	0.88	0.75	0.71
L-113	0.00	0.00	0.39	0.40	0.27	0.83	0.26	0.70
PR-1000	0.00	0.00	0.79	0.80	0.48	0.57	0.48	0.55
HSF-242	0.00	0.00	0.26	0.27	0.00	0.64	0.04	0.53
L-116	0.00	0.00	0.00	0.27	0.48	0.59	0.36	0.49
CP-43-33	0.00	0.37	0.00	0.40	0.00	0.28	0.00	0.31
SPF-213	0.11	0.41	0.00	0.00	0.11	0.18	0.09	0.17
L-118	0.00	0.00	0.00	0.00	0.11	0.09	0.08	0.07
COJ-84	0.00	0.00	0.00	0.13	0.00	0.05	0.00	0.05
Sub-total	65.91	67.91	55.81	63.57	73.76	79.27	70.25	76.10
Non-Recommended								
Triton	3.70	2.89	5.98	7.29	12.03	11.26	10.30	9.97
CPF-238	16.40	16.77	31.58	24.49	10.64	6.32	14.41	9.76
SPSG-79	0.84	0.62	1.58	2.06	1.24	1.00	1.25	1.11
CO-1148	5.65	4.86	3.22	1.79	0.12	0.11	1.13	0.76
CP-70	0.00	0.00	0.00	0.00	1.08	0.95	0.81	0.73
CO-245	0.42	0.00	0.26	0.00	0.48	0.00	0.44	0.00
Bansi	0.00	0.41	0.00	0.27	0.00	0.36	0.00	0.35
Pona	0.84	0.83	0.00	0.00	0.00	0.00	0.08	0.07
Others	6.23	5.71	1.58	0.53	0.65	0.74	1.32	1.15
Sub-total	34.09	32.09	44.19	36.43	26.24	20.73	29.75	23.90

Source: Survey data, 2007-08

ants. Between 2006-07 and 2007-08, the largest improvement in percentage points in recommended varieties' area was noticed on owner-cum-tenants' farms which may imply that they were relatively more active in varietal replacement process. Thatta-10 was relatively dominant recommended variety on owner operated farms while CP-77-400 variety was relatively more planted on other two tenancy categories' farms. In non-recommended group, Triton and CPF-238 had occupied relatively higher proportion in the total sugarcane area (Table 5). This concludes that owner-cum-tenants and tenants have little access to recommended varieties and perhaps varietal choice is strongly influenced by tenancy status.

Monitoring Changes in Sugarcane Varietal Diffusion

Six different indicators were used to examine changes in sugarcane varietal diffusion on individual farm and the farming community levels during two consecutive years, 2006-07 and 2007-08. These were percent adopters of recommended varieties, adoption intensity (or proportion of total sugarcane area under recommended varieties), participation index of varietal adoption, weighted average varietal age on sample farms, varietal diversity index on sample farms and percent farmers possessing seed of the most popular recommended variety among farming class. Overall, an improvement was noticed between 2006-07 and 2007-08 for indicators like percent

Table 5. Percent area under different sugarcane varieties by tenancy status

Variety/Category	Owners		Owner-cum-Tenant		Tenants		Overall	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Recommended								
Thatta 10	39.39	38.16	2.82	2.33	6.99	8.42	31.10	29.94
CP-77-400	4.94	4.91	31.28	29.97	68.41	69.86	14.05	13.63
BL-4	10.15	12.56	1.41	1.38	0.00	0.00	7.98	9.77
HSF-240	4.39	5.25	12.68	28.67	3.37	8.15	5.62	9.50
SPSG-26	3.67	5.52	0.00	0.00	0.00	0.00	2.81	4.19
SPF-234	3.32	3.50	0.90	0.74	0.00	0.00	2.68	2.79
Gulabi-95	3.74	1.82	0.00	0.00	0.00	0.00	2.86	1.38
CPF-237	1.36	1.53	0.38	0.69	0.00	0.00	1.10	1.28
NIA-98	0.98	0.94	0.00	0.00	0.00	0.00	0.75	0.71
L-113	0.34	0.92	0.00	0.00	0.00	0.00	0.26	0.70
PR-1000	0.63	0.72	0.00	0.00	0.00	0.00	0.48	0.55
HSF-242	0.05	0.17	0.00	2.33	0.00	0.00	0.04	0.53
L-116	0.48	0.60	0.00	0.00	0.00	0.54	0.36	0.49
CP-43-33	0.00	0.12	0.00	1.27	0.00	0.00	0.00	0.31
SPF-213	0.12	0.14	0.00	0.37	0.00	0.00	0.09	0.17
L-118	0.11	0.10	0.00	0.00	0.00	0.00	0.08	0.07
COJ-84	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.05
Sub-total	73.67	76.96	49.47	68.06	78.77	86.97	70.25	76.10
Non-Recommended								
Triton	13.08	12.92	0.90	0.32	2.07	1.63	10.30	9.97
CPF-238	8.99	6.62	39.19	24.15	17.48	8.15	14.41	9.76
SPSG-79	0.48	0.43	5.64	4.50	0.00	0.00	1.25	1.11
CO-1148	1.00	0.59	1.47	1.06	1.68	1.90	1.13	0.76
CP-70	1.06	0.97	0.00	0.00	0.00	0.00	0.81	0.73
CO-245	0.58	0.00	0.00	0.00	0.00	0.00	0.44	0.00
Bansi	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.35
Pona	0.11	0.10	0.00	0.00	0.00	0.00	0.08	0.07
Others	1.04	0.95	3.33	1.92	0.00	1.36	1.32	1.15
Sub-total	26.33	23.04	50.53	31.94	21.23	13.03	29.75	23.90

Source: Survey data, 2007-08

adopters of recommended varieties, adoption intensity, participation index and varietal diversity index. At the same time, a decline of nearly one year in the varietal age and a minor reduction in the percent farmers possessing seed of most popular recommended variety was noticed (Table 6). Although the improvements in most of the indicators were noticed, however, their extent was quite small like 0.1 in participation index and 0.09 in varietal diversity index vis-à-vis a decline of nearly one year in the varietal age. All this indicates that varietal diffusion process within farming community is extremely slow pointing out a need of strong institutional input for speeding up the diffusion of latest released more yielding improved varieties.

Across cropping zones, despite significant improvements were noticed in terms of percent adopters of recommended varieties, adoption intensity, participation index and percent farmer having the most popular varieties' seed, Punjab was far behind Khyber Pakhtoonkhwa and Sindh provinces. However, in terms of varietal age and varietal diversity index, latest released sugarcane varieties were not only present on sample farms in Punjab, they were also devoting significant area to these varieties (Table 6).

Making comparison by farm size category revealed that the proportion of farmers possessing recommended varieties, adoption intensity, participation index, varietal diversity index and percent farmers possessing seed of the most popular variety were much higher among large farmers than their counter parts in both the years. However, varietal age on their farms

Table 6. Monitoring changes in adoption indicators across zones, farm size and tenancy categories in 2006-07 and 2007-08

Adoption Indicators	Cropping zones			Farm size groups			Tenancy categories			Overall
	Sindh	Punjab	NWFP	Small	Medium	Large	Owner	OCT	Tenant	
2006										
Rec. Var. Adopters (%)	95.24	35.85	95.12	63.50	61.62	83.55	75.50	51.81	78.57	70.88
Adoption Intensity (%)[1]	80.85	30.38	97.73	65.91	55.81	73.76	73.67	49.47	78.77	70.25
Participation Index	0.77	0.11	0.93	0.42	0.34	0.62	0.56	0.26	0.62	0.50
Varietal Age (years)	13.50	1.56	10.46	6.99	6.49	9.89	8.87	5.22	8.23	8.00
Varietal Diversity Index	1.53	1.31	1.00	1.12	1.33	1.52	1.44	1.17	1.04	1.33
Most popular recomm. variety seed (% farmers)	68.03	27.04	95.12	40.15	13.13	46.05	38.15	32.53	67.86	25.77
2007										
Rec. Var. Adopters (%)	95.92	55.35	93.90	67.15	73.74	92.76	82.33	66.27	82.14	78.87
Adoption Intensity (%)[1]	81.94	51.41	97.80	67.91	63.57	79.27	76.96	68.06	86.97	76.10
Participation Index	0.79	0.28	0.92	0.46	0.47	0.74	0.63	0.45	0.71	0.60
Varietal Age (years)	14.22	2.75	11.41	7.56	7.70	10.93	9.82	6.03	9.13	8.92
Varietal Diversity Index	1.53	1.46	1.00	1.13	1.39	1.62	1.49	1.33	1.06	1.39
Most popular recomm. Variety seed (% farmers)	67.35	42.14	93.90	40.15	14.14	44.74	37.75	34.94	67.86	25.52

[1] *Adoption intensity is same as percent area under recommended sugarcane varieties*

was quite high indicating that they are devoting much larger area to old recommended varieties. From the two remaining classes, the small sized farmers seem to be more dynamic in sugarcane varietal diffusion process than medium sized farmers (Table 6).

By tenancy groups, tenants and owner operators were better position in terms of proportion of farmers having recommended varieties, recommended varieties' adoption intensity and participation index. However, varietal age on owner-cum-tenant (OCT) farms was much lower than their counterparts, whereas, varietal diversity index declines from owners to tenant operators. A much higher proportion of tenants possess the most popular recommended variety seed (Table 6).

From the above discussion it can be concluded that a great variation exists in adoption and allocation of total sugarcane area to different recommended varieties across farming categories like cropping zones, farm size and tenancy status. This signifies a need of deeper analysis into the factors affecting adoption and spread of seed of recommended varieties among farming communities of different categories.

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