

## **Sugarcane Variety Development Programme at Bangladesh Sugarcrop Research Institute: A review**

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### **ABSTRACT**

The research was carried out at breeding division of Bangladesh Sugarcrop Research Institute (BSRI) from 1990 to 2014 to develop high yielding and high sugar content varieties of sugarcane with wide adaptability. Germplasm collection and conservation is the prerequisite of variety development programme. Till 2014 BSRI has collected and maintained 1113 germplasm from different sources, of which 302 are flowering. Average 11,610 grams of fuzz (true seed) were produced annually by utilizing these flowering germplasm in crossing programme. On an average annually 55,663 progeny were produced from the fuzz and transplanted in the field. Of them 1621 clones were selected from progeny by a series of trials at different stages through multidisciplinary approaches. Only the promising clones in Zonal Yield Trial-III (ZYT III) are evaluated by the field evaluation committee and finally release as a variety by National Seed Board (NSB). With the fullest sincerity and diligent research the breeders have developed twenty four high yielding sugarcane varieties in the last 25 years.

**Key words:** Fuzz, Progeny, Test stage, Field evaluation, Germplasm

### **INTRODUCTION**

Development of improved sugarcane varieties have been a major factor in sustaining a competitive sugarcane industry in Bangladesh. Sugarcane breeding efforts in Bangladesh are the result of collaborative effort among 11 research divisions of BSRI. The ultimate goal of sugarcane breeding is to develop commercial variety(s) with high production potential in respect of cane and sugar having good ratooning potential, tolerant to pest and diseases, drought, salinity, water-logging and flood stress conditions. Significant progress has been made in Bangladesh in improving sugarcane varieties, particularly with regard to high sucrose content and earliness to maturity. So far, BSRI has developed 46 sugarcane varieties for commercial cultivation all over the country. Following the release of sugarcane varieties Isd 33, Isd 37, Isd 39, BSRI Akh 41, BSRI Akh 42, BSRI Akh 43, BSRI Akh 44 in 2002 to 2014, Bangladesh achieved a substantial increase in cane and sugar yield and ratoon crop longevity. Increase in the levels of tolerance to sugarcane red rot disease and adverse climatic conditions such as drought, flood, waterlogged and salinity has also been achieved.

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More recently breeders of BSRI have developed a red rot tolerance higher cane and sugar yielding variety BSRI Akh 43 using a highly red rot disease susceptible non-flowering variety following plant tissue culture technique (Alam *et. al.*, 2015). Development of sugarcane variety is mainly associated with the hybridization followed by a series of clonal selection. In this crop, large hybrid populations are produced from a single cross where selections are made. Introduction of foreign and local germplasms followed by selection is another procedure of variety development. Mutation breeding is also practiced in variety development programme. Limited number of flowering germplasm is the main constraint of sugarcane breeding in Bangladesh. At BSRI, about 1132 sugarcane germplasms are being maintained in the germplasm bank of which about 80% do not flower at all. Due to non-flowering habit it is not being possible to make the desirable crosses among the genotypes. So, it limits the scope of hybridization. Besides, red rot disease is a major constraint in genetic resource collection and maintenance in Bangladesh though this is not major disease in other sugar producing country of the world. In Bangladesh the environment is conducive for red rot disease incidence; whenever a high sucrose content variety is brought from abroad and cultivated in our environment it becomes susceptible to this disease as because high sucrose content is highly positively co-related to red rot pathogen. For this disease many imported genotypes have already been degenerated (about 40%) and some are on the way of degeneration. Due to limited manpower and lack of own radiation source, it is not being possible to strengthen the radiation (mutation) experiment. Marker assistance breeding and development of transgenic sugarcane variety will be the future strategy of sugarcane breeding. For this, training of the related scientists should be arranged in abroad and side by side laboratory facilities of BSRI to be improved. The objective of this review is to represent the overall activities of sugarcane breeding at BSRI.

## MATERIALS AND METHODS

### Materials

Institute bred, local and exotic collection of sugarcane germplasm of BSRI were used as research materials in this study.

### Methods

**Germplasm collection and preservation:** Imported germplasm were evaluated for three generations at Quarantine Station, Joydebpur. After quarantine formalities the materials were brought at BSRI for further evaluation in the field condition. In case of local collection, it was performed in the month of September-October from the listed area of the country. Later on, the collection was sealed out in the list to avoid the duplication of germplasm. The collected materials has labeled with local name, location, date of collection, flowering habit, etc and planted in pots to multiply. The newly collected germplasm were evaluated by a task force of Breeder, Entomologist and Pathologist. After evaluation, all the selected germplasm has been planted in a furrow of 3m long with 18 two-eyed setts. Thus, they were conserved in the germplasm bank of BSRI. The flowering ones are continuously maintained in breeding nursery with intensive care to use in hybridization programme.

**Technique of Cross Marcotting of selected population:**

Sawdust and transparent polythene sheets is used as rooting media and wrapping material, respectively in marcotting. Marcotting is done after initiation of flag leaf from the plant.

**Identification of male and female plants:**

After emergence of flower, part of inflorescence was brought in the laboratory before anthesis. Unburst anthers from spiklet was crushed in a drop of 5% KI solution on glass slide and observed under microscope (Alam, 2013). The pollen grains stained completely dark colour were considered as fertile, it was counted and % were calculated. The flower with above 30% pollen viability was considered as male and below 30% as female parent (Alam, 2013).

**Preparation of cross materials and hybrids:**

The selected parents, when its flag leaf was initiated in the field, it was marcotted to develop root at marcotted portion. After development of flower, selected plants were cut under the marcotted area and were taken to the crossing shed for crossing with desired parents. Flower of male was shaken over the female at 7 am in the morning to confirm pollination up to one week.

**Collection and storing fuzz (true seeds) :**

After maturity of the flowers, marked by fluffy condition, the arrows (inflorescence) were harvested, and seeds were collected in brown paper bag. The seeds were then dried in the sun, stripped, bagged in polythene bag and stored in deep fridge at  $-20^{\circ}\text{C}$ .

**Sowing of fuzz and raising of seedlings:**

In the month of July seeds were sown in a sterilized media (soil, pressmud and sand in 2 : 2 : 1 ratio) in plastic tray inside the glasshouse. When the seedlings attained a height of 2-3" the trays with seedlings were transferred to the seedling nursery bed allowing them to grow in natural condition. The seedlings were fertilized, sprayed with fungicide and watered as and when required.

**Pricking off seedlings in the nursery bed:**

After one month the seedlings were pricked off in cell-u-pack with pulverized sterilized media. Foliar application of nitrogen fertilizer was done weekly to provide normal growth of seedlings. They were also watered and sprayed with fungicide and insecticide as and when necessary. Leaf trimming was also done in every week (Nahar, 1997).

**Transplantation of seedlings in the experimental field:**

In the second week of November of the same year the crosswise seedlings of crosses raised in the seedling nursery bed, were transplanted in the field by maintaining 45 cm plant to plant distances.

**Selection:**

At maturity, seedlings are selected on the basis of different characteristics such as number of millable cane, height, thickness, crack, aerial root, solidness, leaf colour, disease and pest infestations for plantation in first line trial - 1m 4m test stage. Next year, selection is made considering the same characteristics including field brix%. Only the good appearing clones showing equal or better field brix comparing to the check variety are selected for advancement. The selected clones are planted in the second line trial at 4m 4m test stage against one/two check variety. In the next year, the clones are evaluated on the basis of mentioned characteristics including juice analysis and estimated cane yield. The clones showing good chewing qualities are also be selected from this stage. Only the clones showing equal or better performance in comparison to the check variety are selected for next trial.

## **RESULTS AND DISCUSSION**

The achievements of last 25 years are summarized as following:

**A. Achievement in commodity:**

**a. Germplasm collection and conservation**

With a view to develop high yielding varieties of sugarcane, BSRI has been initiated to collect and maintenance of sugarcane germplasm from home and abroad since 1954 and in 1990 the number of collection was attained in 542 (BSRI Annual Report 1990).

**Table 1. Status of germplasm collection and conservation at BSRI during last 25 years**

| Year | Source of collection |            |           | Germplasm Status |             |             |
|------|----------------------|------------|-----------|------------------|-------------|-------------|
|      | Exotic               | Indigenous | BSRI Bred | Incorporate      | Degenerated | Grand Total |
| 1990 | 2                    | 13         | 44        | 12               | 11          | 542         |
| 1991 | 6                    | 4          | 152       | 5                | 23          | 524         |
| 1992 | 9                    | 11         | 43        | 139              | 11          | 652         |
| 1993 | 9                    | 10         | 72        | 26               | 10          | 668         |
| 1994 | -                    | 8          | 78        | 81               | 3           | 746         |
| 1995 | 6                    | 20         | 35        | 38               | 5           | 779         |
| 1996 | 1                    | 17         | 5         | 32               | -           | 811         |
| 1997 | 20                   | 21         | 33        | 4                | 18          | 797         |
| 1998 | 2                    | 5          | 8         | 26               | 7           | 816         |
| 1999 | 5                    | 6          | 21        | 2                | 21          | 797         |
| 2000 | 17                   | 51         | 15        | 16               | 11          | 802         |
| 2001 | 27                   | -          | 10        | 15               | 6           | 811         |
| 2002 | 10                   | 26         | 42        | 11               | 3           | 819         |
| 2003 | 45                   | 3          | 8         | 44               | 6           | 857         |
| 2004 | 18                   | -          | 11        | 8                | -           | 865         |
| 2005 | 32                   | -          | 99        | 12               | 2           | 875         |
| 2006 | 9                    | 1          | 57        | 105              | -           | 980         |
| 2007 | 0                    | -          | 52        | 8                | -           | 988         |
| 2008 | 0                    | -          | 71        | 19               | 3           | 1004        |
| 2009 | 3                    | -          | 118       | 31               | 5           | 1030        |
| 2010 | 0                    | 2          | 72        | 61               | -           | 1091        |
| 2011 | 0                    | -          | 39        | 25               | 11          | 1105        |
| 2012 | 12                   | -          | 19        | 15               | 19          | 1101        |
| 2013 | 1                    | 1          | 32        | 4                | -           | 1105        |
| 2014 | 7                    | 1          | 19        | 8                | -           | 1113        |

Germplasm collection and conservation is continues work and till 2014 BSRI has collected 1113 germplasm from different sources. Among the materials 1071 are *Officinarum* and 42 *Spontaneum* and *Erianthus* species. Again, among the *Officinarum* species 320 are exotic, 179 are local and 572 are institute bred. All the germplasm are being maintained in the germplasm bank of BSRI. However, germplasm collection from the last 25 years are presented in Table 1. The table revealed that from the year of 1990 to 2014 BSRI has collected 1603 germplasm of which 241, 200 and 1162 were exotic, local and BSRI bred, respectively. After evaluation at BSRI condition out of 1603 germplasm, 747 were included in germplasm bank and at the same time 175 were degenerated from the bank.

**b. Crossing activities**

Hybridization programme is always directly related with the number of flowering germplasm. The higher number of flowering germplasm increases the scope of hybridization which in turn increase the number of variability. However, a view of the crossing activities of the last twenty five years is shown

**Table 2. Crosses of germplasm to produce hybrid seeds (fuzz)**

| Year | No. of germplasm flowered | No. of Pollen parent | No. of Pistil parent | No. of crosses made | No. of arrows pollinated | Fuzz produced (gms) |
|------|---------------------------|----------------------|----------------------|---------------------|--------------------------|---------------------|
| 1990 | 110                       | 44                   | 66                   | 258                 | -                        | 4905                |
| 1991 | 103                       | 45                   | 56                   | 240                 | 618                      | 2848                |
| 1992 | 115                       | 65                   | 84                   | 413                 | 1048                     | 5033                |
| 1993 | 106                       | 46                   | 65                   | 419                 | 933                      | 5322                |
| 1994 | 96                        | 49                   | 79                   | 391                 | 917                      | 5483                |
| 1995 | 86                        | 41                   | 75                   | 276                 | 658                      | 4562                |
| 1996 | 108                       | 48                   | 71                   | 356                 | 897                      | 6214                |
| 1997 | 86                        | 38                   | 48                   | 230                 | 467                      | 3745                |
| 1998 | 103                       | 45                   | 61                   | 309                 | 630                      | 3865                |
| 1999 | 138                       | 63                   | 75                   | 445                 | 1038                     | 5328                |
| 2000 | 119                       | 51                   | 68                   | 434                 | 1060                     | 4926                |
| 2001 | 118                       | 56                   | 62                   | 391                 | 955                      | 3706                |
| 2002 | 142                       | 68                   | 74                   | 425                 | 956                      | 6052                |
| 2003 | 153                       | 62                   | 91                   | 671                 | 1729                     | 8658                |
| 2004 | 141                       | 55                   | 86                   | 662                 | 1564                     | 8959                |
| 2005 | 149                       | 57                   | 92                   | 765                 | 1898                     | 13,531              |
| 2006 | 153                       | 59                   | 94                   | 747                 | 1961                     | 12,442              |
| 2007 | 173                       | 61                   | 112                  | 870                 | 2342                     | 16,427              |
| 2008 | 169                       | 64                   | 105                  | 763                 | 2071                     | 12,345              |
| 2009 | 177                       | 71                   | 106                  | 798                 | 2153                     | 15,906              |
| 2010 | 187                       | 72                   | 115                  | 543                 | 1591                     | 10,559              |
| 2011 | 183                       | 71                   | 112                  | 757                 | 2150                     | 14,807              |
| 2012 | 175                       | 62                   | 113                  | 828                 | 2334                     | 15,899              |
| 2013 | 189                       | 70                   | 119                  | 896                 | 2265                     | 15,927              |
| 2014 | 220                       | 74                   | 146                  | 735                 | 2133                     | 14,010              |
|      | 164                       | 64                   | 100                  | 686                 | 1811                     | 11,610              |

in Table 2. It is seen that on an average 164 germplasm were found to flower every year where 64 and 100 germplasm were used as pollen and pistil parents, respectively.

Using the flowering germplasm 1811 arrows were pollinated and 686 cross-combinations were made annually. Finally, 11,610 grams of fuzz were produced. Table 2 also shows that number of crosses increases gradually year by year due to increasing number of flowering germplasm.

#### **Sowing of fuzz, raising of seedlings and their survivability in the field**

Seeds (fuzz) were sown on a sterilized media in plastic tray inside the glasshouse. After germination when the seedlings become of 2-3 inch, the trays with seedlings were transferred to the seedling nursery bed. One month aged seedlings were pricking in cell-u-pack and nursing them till to attain at 6-8 inches in height. In the second week of November of the same year the seedlings were

**Table 3. Year wise seedlings production and its survivability in the field**

| Year    | No of Seedlings produced | No of Seedlings transplanted in field | No of Seedlings Survived in the field |
|---------|--------------------------|---------------------------------------|---------------------------------------|
| 1990    | -                        | 80,126                                | -                                     |
| 1991    | 88,320                   | 81,797                                | 78,221                                |
| 1992    | 39,000                   | 37,529                                | 36,433                                |
| 1993    | 83,243                   | 76,326                                | 72,623                                |
| 1994    | 1,08,780                 | 1,03,717                              | 96,584                                |
| 1995    | 90,271                   | 77,882                                | 73,903                                |
| 1996    | 40,000                   | 38,500                                | 36,457                                |
| 1997    | 44,020                   | 38,198                                | 35,707                                |
| 1998    | 66,250                   | 55,010                                | 52,629                                |
| 1999    | 20,372                   | 18,457                                | 16,902                                |
| 2000    | 47,971                   | 43,248                                | 41,433                                |
| 2001    | 65,575                   | 54,439                                | 50,959                                |
| 2002    | 26,523                   | 24,376                                | 22,680                                |
| 2003    | 28,530                   | 26,980                                | 25,434                                |
| 2004    | 30,943                   | 28,260                                | 26,949                                |
| 2005    | 81,260                   | 65,000                                | 62,100                                |
| 2006    | 70,000                   | 65,325                                | 61,646                                |
| 2007    | 90,339                   | 81,577                                | 76,573                                |
| 2008    | 1,42,320                 | 1,25,295                              | 1,19,532                              |
| 2009    | 67,200                   | 53,927                                | 51,673                                |
| 2010    | 1,35,656                 | 1,19,742                              | 1,13,839                              |
| 2011    | 55,600                   | 51,117                                | 49,399                                |
| 2012    | 72,990                   | 67,840                                | 66,017                                |
| 2013    | 31,592                   | 28,616                                | 27,399                                |
| 2014    | 55,102                   | 51,032                                | 48,353                                |
| Average | 55,663                   | 49,364                                | 46,970                                |

transplanted in the field by maintaining 45 cm plant to plant and 100 cm row to row distance. Every year on average 55,663 seedlings were produced, among them 49,364 were transplanted in the field and finally 46,970 were survived and evaluated in the next year (Table 3). The Table 3 also showed that the highest 1,42,320 seedlings were developed and 1,19,532 were survived at field in the crossing year of 2007-2008 and the lowest 20,372 were developed and 16,902 were survived in the crossing year of 1999-2000. (BSRI Annual Report 2007-2008 and 1999-2000)

**Evaluation of clone at different test stages:**

Seedlings produced from the true seeds (fuzz) are needed to evaluate in different stages. Such as seedling are assessed in seedling stage, 1m x 4m stage and 4m x 4m stages and clones are evaluated on the basis of different selection criteria. Due to large number of population selection pressure at these stages is very high. However, the average results on the evaluation of seedlings

**Table 4. Evaluation of clones at different test stages**

| Year    | seedling stage | selected | 1m x 4m stage | selected | 4m x 4m stage | selected |
|---------|----------------|----------|---------------|----------|---------------|----------|
| 1990    | 93,000         | 2,950    | 4,098         | 635      | 352           | 87       |
| 1991    | 80,127         | 2,458    | 2,902         | 188      | 545           | 72       |
| 1992    | 78,221         | 2,834    | 2,458         | 355      | 215           | 55       |
| 1993    | 36,433         | 2,545    | 2,834         | 293      | 355           | 100      |
| 1994    | 76,246         | 3,342    | 2,545         | 234      | 301           | 84       |
| 1995    | 77,509         | 2,722    | 3,284         | 210      | 236           | 56       |
| 1996    | 74,128         | 2,659    | 2,114         | 191      | 210           | 71       |
| 1997    | 31,733         | 1,486    | 2,819         | 236      | 200           | 73       |
| 1998    | 36,079         | 2,188    | 1,518         | 205      | 235           | 73       |
| 1999    | 52,629         | 3,152    | 2,183         | 148      | 206           | 74       |
| 2000    | 17,021         | 1,132    | 3,152         | 486      | 148           | 67       |
| 2001    | 41,433         | 1,736    | 1,132         | 189      | 486           | 80       |
| 2002    | 50,959         | 1,496    | 1,736         | 285      | 189           | 62       |
| 2003    | 22,680         | 1,155    | 1496          | 197      | 285           | 63       |
| 2004    | 25,434         | 879      | 1,155         | 238      | 197           | 68       |
| 2005    | 26,949         | 1,156    | 879           | 289      | 238           | 73       |
| 2006    | 63,062         | 2,173    | 1,156         | 160      | 289           | 70       |
| 2007    | 61,646         | 2,886    | 2,173         | 365      | 160           | 69       |
| 2008    | 81,777         | 1,286    | 2,886         | 225      | 365           | 79       |
| 2009    | 1,19,532       | 1,771    | 1,286         | 359      | 225           | 78       |
| 2010    | 51,673         | 740      | 1,771         | 234      | 359           | 53       |
| 2011    | 1,13,839       | 1,690    | 740           | 147      | 234           | 75       |
| 2012    | 49,399         | 1,938    | 1,690         | 307      | 147           | 49       |
| 2013    | 66,017         | 1,125    | 1,938         | 354      | 307           | 69       |
| 2014    | 48,353         | 1,727    | 1,125         | 161      | 354           | 74       |
| Average | 54,022         | 2,051    | 2,043         | 268      | 274           | 71       |

and clones for the last 15 years in different test stages are given in Table 4. The table revealed that on an average every year 46,646 seedlings have been evaluated and 1526 clones were selected for the plantation at 1m x 4m test stage. Simultaneously, 268 clones from 1m x 4m test stage were selected for 4m x 4m test stage.

**Clone evaluation in yield trials:**

The clones found better in different test stages are again evaluated and selected in different yield trials like Preliminary Yield Trial (PYT), Advance Yield Trial (AYT), Zonal Yield Trial (ZYT) – I, II and III (Mannan, 2001). Only the promising clones in ZYT-III are evaluated in the field by the members of field evaluation team of technical committee of NSB. However, the results on the evaluation of clones for the last 25 years at different yield trials are presented in Table 5. From the table it is clear that every year approximately 69, 25, 9, 7 and 5 clones were evaluated in PYT, AYT, ZYT-I, ZYT-II and ZYT-III trials, respectively.

| Year    | PYT | AYT | ZYT-I | ZYT-II | ZYT-III |
|---------|-----|-----|-------|--------|---------|
| 1990    | -   | 17  | 9     | 5      | 6       |
| 1991    | 87  | 25  | 11    | 7      | 6       |
| 1992    | 88  | 22  | 9     | 6      | 7       |
| 1993    | 64  | 21  | 7     | 4      | 6       |
| 1994    | 99  | 16  | 7     | 7      | 4       |
| 1995    | 84  | 20  | 9     | 4      | 7       |
| 1996    | 56  | 30  | 11    | 6      | 4       |
| 1997    | 71  | 21  | 9     | 4      | 6       |
| 1998    | 72  | 20  | 7     | 5      | 4       |
| 1999    | 84  | 21  | 10    | 8      | -       |
| 2000    | 67  | 23  | 11    | 8      | 6       |
| 2001    | 80  | 22  | 11    | 8      | 6       |
| 2002    | 62  | 23  | 9     | 7      | 5       |
| 2003    | 63  | 25  | 11    | 7      | 5       |
| 2004    | 68  | 22  | 6     | 4      | 4       |
| 2005    | 73  | 25  | 10    | 5      | 4       |
| 2006    | 70  | 25  | 7     | 6      | 4       |
| 2007    | 69  | 28  | 8     | 6      | 5       |
| 2008    | 79  | 25  | 8     | 4      | 4       |
| 2009    | 78  | 22  | 10    | 4      | 5       |
| 2010    | 53  | 28  | 8     | 8      | 7       |
| 2011    | 75  | 25  | 8     | 6      | 5       |
| 2012    | 49  | 29  | 9     | 7      | 5       |
| 2013    | 69  | 26  | 9     | 9      | 6       |
| 2014    | 74  | 32  | 9     | 9      | 5       |
| Average | 69  | 25  | 9     | 7      | 5       |

With a great hope and aspiration, during the last 25 years, 24 sugarcane varieties such as Isd 20, Isd 21, Isd 22, Isd 24, Isd 25, Isd 26, Isd 27, Isd 28, Isd 29, Isd 30, Isd 31, Isd 32, Isd 33, Isd 34, Isd 35, Isd 36, Isd 37, Isd 38, Isd 39, Isd 40, BSRI Akh 41, BSRI Akh 42, BSRI Akh 43 and BSRI Akh 44 has been released (Table 6). The varieties are being commercially cultivated all over the country and having tolerant potentiality against different stress condition like drought, flood, salinity and waterlog. In the midst of these 24 varieties, BSRI Akh 41 and BSRI Akh 42 are suitable for chewing purposes and popular to the cane growers and consumers. The varieties are suitable for making quality goor also. Along with this the clones I 57-07, I 290-08, I 127-09 are in pipe line to release as variety. The BSRI bred varieties are popular to the farmers of mill zones as well as in the non mill zones.

Table 6. Year wise variety release with potentials

| Release Year | Name of Released Variety | Parentage                 | Average Cane yield (t ha <sup>-1</sup> ) | Recovery (%) | Red rot disease reaction |
|--------------|--------------------------|---------------------------|------------------------------------------|--------------|--------------------------|
| 1990         | Isd 20                   | Co 1148 x Misrilal        | 111                                      | 11.00        |                          |
| 1991         | Isd 21                   | F 31-762 x Co 969         | 98                                       | 12.10        |                          |
| 1992         | Isd 22                   | CP 50-72 x I 110-66       | 101                                      | 11.34        |                          |
| 1993         | Isd 24                   | Co 6502 x I 110-66        | 89                                       | 10.98        |                          |
| 1994         | Isd 25                   | I 4-71 x I 166-66         | 112                                      | 10.05        |                          |
| 1995         | Isd 26                   | Mutant of Isd 16          | 97                                       | 11.80        |                          |
| 1996         | Isd 27                   | CP 70-1133 x Poj 2878     | 104                                      | 12.40        |                          |
| 1997         | Isd 28                   | Co 1158 x Co 530          | 119                                      | 11.30        |                          |
| 1998         | Isd 29                   | Isd 16 x CP 50-72         | 93                                       | 10.87        |                          |
| 1999         | Isd 30                   | I 24-76 x I147-77         | 77.78                                    | 13.56        | R-MR                     |
| 2000         | Isd 31                   | I 322-86 x CP 50-72       | 90.10                                    | 11.21        | R-MR                     |
| 2001         | -                        | -                         | -                                        | -            | -                        |
| 2002         | Isd 32                   | I 327-86 x I 101-66       | 104.13                                   | 11.97        | MR                       |
|              | Isd 33                   | Co 631 x I 144-86         | 98.83                                    | 12.78        | R-MR                     |
|              | Isd 34                   | Introduced                | 93.41                                    | 12.88        | R-MR                     |
| 2003         | Isd 35                   | I 322-86 x CP 70-1133     | 94.38                                    | 12.24        | R-MR                     |
|              | Isd 36                   | CP 70-1133 x ?            | 88.67                                    | 13.20        | R-MR                     |
| 2004         | -                        | -                         | -                                        | -            | -                        |
|              |                          |                           |                                          | pol (%) cane |                          |
| 2005         | -                        | -                         | -                                        | -            | -                        |
| 2006         | Isd 37                   | CoK 31 x CP 50-72         | 100.78                                   | 13.36        | MR                       |
| 2007         | Isd 38                   | I 273-91 x Isd 28         | 113.11                                   | 13.85        | MR                       |
| 2008         | -                        | -                         | -                                        | -            | -                        |
| 2009         | Isd 39                   | BC 5 x Isd 25             | 101.19                                   | 13.30        | R                        |
|              | Isd 40                   | Isd 27 x Isd 24           | 103.32                                   | 13.24        | R                        |
| 2010         | -                        | -                         | -                                        | -            | -                        |
| 2011         | -                        | -                         | -                                        | -            | -                        |
| 2012         | BSRI Akh 41 (Chewing)    | Co 775 x ?                | 139.55                                   | 12.10        | R                        |
| 2013         | -                        | -                         | -                                        | -            | -                        |
| 2014         | BSRI Akh 42 (Chewing)    | Introduced                | 169.57                                   | 11.11        | MR                       |
| 2014         | BSRI Akh 43              | Somatic variant of Isd 18 | 118.36                                   | 12.30        | MR                       |
| 2014         | BSRI Akh 44              | I 273-91 x Isd 20         | 106.91                                   | 12.42        | MR                       |

To enhance the opportunity of increasing genetic gains of the BSRI breeding programs, need to establish a dedicated introgression program. Interest in utilization of wild germplasm resurfaced across sugarcane breeding programs of genome composition became possible using molecular marker and cytological technologies. The narrow genetic diversity among breeding populations has increased the need to utilize wild germplasm using introgression.

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