FINAL RESEARCH PROGRESS REPORT

For

PARB's CGS PROJECT NO. 163

(SUGARCANE PLANT IMPROVEMENT THROUGH TRADITIONAL & MODERN BREEDING TECHNOLOGIES)

Name & Designation of Project Manager:
Rana Zulfiqar Ali,
Director Sugarcane

Name of host institution:
Sugarcane Research Institute, AARI, Faisalabad

(2016)

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Basic Information of the project:

Name of the project	Sugarcane Plant Improvement Through Traditional & Modern Breeding Technologies
Project period (from-to)	01-05-2010 to 31-01-2016
Total project duration	60 months + 9 months extension
Total Project cost	Rs. 27.836 million
Total Expenditures	Rs.
Name of the Project Manager with designation	Rana Zulfiqar Ali, Director, Sugarcane Research Institute, Faisalabad
Phone and Email	041-9201688, directorsugarcane@gmail.com
Host Institute	Sugarcane Research Institute, AARI, Faisalabad
Name and Designation of the Team Leader with Name of the Collaborating institute	**1.** Dr. Muhammad Zaffar Iqbal, Director Agri. Biotechnology Research Institute, AARI Faisalabad. **2.** Dr. Shahid Afghan, Director, Shakarganj Sugar Research Institute, Jhang
Overseas cooperating scientist and organization	Dr. Aruna Wijesuriya, Head of Plant Breeding Division, Sugarcane Research Institute, Uda Walawe, Sri-Lanka

Executive Summary

PROGRESS OF RESEARCH WORK

1. Introduction:

i. Problem to be addressed

The average cane yield and sugar recovery in Pakistan is 50 t/ha and 9.50%, respectively, whereas in India average cane yield is 65 t/ha with a sugar recovery of 10.50%. Varieties with low sugarcane yields coupled with low sugar contents are two major causes of lower sugar production in Pakistan. The most economical, effective and justified approach to enhance sugarcane and sugar yield is to breed and release new varieties that are responsive under low input conditions having resistance to biotic and a biotic stress. We need new approaches to develop sugarcane cultivars capable of producing sugar and other products of economic importance at lower cost.

ii. Relevance of the Project to the problem to be addressed

Sugarcane plant produces flowers and fuzz in the countries near to equator at a range of $0\text{-}20^0$ N and $0\text{-}20^0$ S. Punjab is situated at $30\text{-}35^0$ N, hence viable fuzz production

in Punjab is not possible. Collaboration with SRI, Sri Lanka, which is situated at 11^0 N will help Punjab scientists to produce fuzz of desired combinations and use it for the development of better varieties with desired characters. This project will help in breeding of new sugarcane varieties with better adaptation to Punjab agro-ecological conditions. The existing pace of development of really good varieties will be increased many fold through the creation of better gene combinations by crossing among desired parental lines at a place where these varieties frequently produce flowers and give viable fuzz.

2. Project Objective:

Develop high yielding, early maturing and high sugar content sugarcane varieties

3. Outputs planned for the project:

ITEM	DESCRIPTION
Objective	**Develop high yielding, early maturing sugarcane varieties having tolerance for biotic and abiotic stresses**
SRI, Faisalabad	
Output-1	**Import of cane fuzz**
Output-2	**Evolution of varieties**
Activity-1	Exchange of germplasm
Activity-2	Growing of cane fuzz
Activity-3	Selection of promising seedlings
Activity-4	Development of progenies
Activity-5	Advancement of promising lines
Activity-6	Quality analysis of promising lines
Activity-7	Screening against Insect pests and diseases
Activity-8	Sugarcane zonal trials
Activity-9	NUVYT
Activity-10	Multiplication of promising clones
Activity-11	Submission of approval case of new sugarcane varieties
SSRI, Jhang	
Output-1	**Evolution of varieties**
Activity-1	Exchange of germplasm
Activity-2	Growing of cane fuzz
Activity-3	Selection of promising seedlings
Activity-4	Development of progenies
Activity-5	Advancement of promising lines
Activity-6	Quality analysis of promising lines
Activity-7	Screening of Insect pests and diseases
Activity-8	Sugarcane zonal trials
Activity-9	NUVYT
Activity-10	Multiplication of promising clones

Activity-11	Submission of approval case of new sugarcane varieties
ABRI, Faisalabad	
Output-1	**Import of SSR primers**
Output-2	**Genetic diversity estimation of sugarcane parental lines**
Activity-1	Collection of germplasm
Activity-2	Isolation of DNA
Activity-3	Gel Electrophoreses
Activity-4	Construction of Homology tree
SRI, Sri Lanka	
Output-1	**Hybridization to produce viable bi-parental cane fuzz from local and exotic germplasm**
Activity-1	Exchange of germplasm
Activity-2	Plantation of germplasm
Activity-3	Synchronization of parental lines for flowering
Activity-4	Bi-parental, open pollinated and poly crossing
Activity-5	Supply of viable cane fuzz to collaborating institutes

4. Detailed component wise methodology adopted, data analyzed and results obtained (Attach raw data as annexure)

Project outcome/achievement:

As per the PC-1 of the project, the following methodology was adopted:

Import and growing of cane fuzz

i. Sugarcane fuzz of 50 bi-parental crosses was imported from CanaVialis Brazil/, CSR/BSES Australia, /SRI South Africa by Sugarcane Research Institute, Faisalabad.

ii. Fuzz of each cross was sown at Sugarcane Research Institute, Faisalabad and Shakarganj Sugar Research Institute, Jhang for the selection of desired genotypes.

Exchange of germplasm

Germplasm of 100 new genotypes was exchanged between Sugarcane Research Institute, Faisalabad and Shakarganj Sugar Research Institute, Jhang.

Varietal studies

Varietal trials were conducted. The seedlings raised at these institutes was shared with each other to evaluate under variable environmental conditions.

DNA finger printing.

i. Germplasm was collected from concerned collaborating institutes for study of genetic diversity using most recent molecular markers technology Simple Sequence Repeats (SSR). DNA was extracted using CTAB method.

ii. DNA fingerprinting was done after optimization of PCR protocols for SSR markers based technique. More than 150 SSR primers were used to amplify genomic DNA. The amplified product was run on Gel electrophoresis for separation of DNA fragments. DNA amplified profile was utilized for fragments data collection.

iii. Homology tree was constructed to detect genetic diversity amongst the parental lines using Minitab computer software.

iv. The varieties having high genetic diversity and distinctive traits of economic importance were selected and given to the collaborating institute (Sugarcane Research Institute, Sri-Lanka) having responsibility of breeding and production of fuzz under the proposed project.

Fuzz production

i. Parental lines of the designated crosses based on genetic diversity and desirable traits were sown at SRI Sri Lank for hybridization.

ii. Data on time of flowering, intensity of flowering and pollen viability of parental clones was recorded.

iii. The gender state (male, female or bisexual) of the parental clones was recorded for setting up of cross combinations in crossing work.

iv. Field lantern and solution crossing techniques was used for biparental crosses and polycrosses in the hybridization programme.

v. Night lighting technique was employed in case synchronization of flowering needed.

Project Outcome

Item	Description	5-Year Target	5-Year Achievement
Output-1	Import of cane fuzz	50 bi-parental crosses	1393 bi-parental crosses
Output-2	Evolution of varieties	At least two varieties better than existing ones in economic traits	Project is in progress
Activity-1	Exchange of germplasm	Exchange of 75 genotypes	134 genotypes exported and 113 imported
Activity-2	Growing of cane fuzz	125000 original seedlings	230000 original seedlings
Activity-3	Selection of promising seedlings	12500 original seedlings	21000 original seedlings

Activity-4	Development of progenies	1250 genotypes	1800 genotypes developed
Activity-5	Advancement of promising lines	125 genotypes	300 promising lines
Activity-6	Quality analysis of promising lines	125 genotypes	1000 genotypes analyzed
Activity-7	Screening against insect pests and diseases	125 genotypes	968 genotypes analyzed
Activity-8	Sugarcane zonal trials	Elite line testing at 50 locations	At 68 locations
Activity-9	NUVYT	5 elite lines at one location	40 elite lines at one location
Activity-10	Multiplication of promising clones	100 tons of seed of 3 genotypes	500 tons of 10 genotypes

Year-wise summary of PARB Project 163 activities:

Stage	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Seedlings	6375	5074	21806	58270	23925	17998
Nursery-I	-	878	1425	977	2574	638
Nursery-II	-	-	164 + 20 (DI)	140	300+55 (DI*)	585
Nursery-III	-	-	-	17 + 10 (DI*)	43	12 + 106 (DI*)
Semi-Final Varietal Trial	-	-	-	-	02 + 03 (DI*)	03 + 06 (DI*)

Final Varietal Trial	-	-	-	-	-	2
Disease + Insect	-	-	21 + 8	29 + 29	289 + 47	100 + 40

***Direct introduction**

PERFORMANCE OF PROMISING SRI-LANKAN CLONES

Selected Clones in Nursery-III 2011-12

Germplasm	Tillers (per plant)	Cane Count (t ha^{-1})	Cane Yield (t ha^{-1})	Remarks
SL-96-128	1.09	112046	**121.86**	**Promoted to Semi-final**
HSF-240	1.30	127788	**123.25**	Standard

Selected Clones in Nursery-III 2012-13

Germplasm	Tillers (per plant)	Cane Count (t ha^{-1})	Cane Yield (t ha^{-1})	Remarks
SL-97-142	0.39	83532	**141.65**	**Promoted to Semi-final**
SL-96-175	0.48	82638	**128.10**	**Promoted to Semi-final**
HSF-240	0.46	84023	**108.66**	Standard

Clones in Semi-final (Set-1) 2013-14

Germplasm	Tillers (per plant)	Cane Count (t ha^{-1})	Cane Yield (t ha^{-1})	Remarks
SL-96-128	1.13	100.69	**117.71**	**Retained in Semi-final**
SL-96-234	1.13	97.57	98.61	Rejected
SL-96-278	1.56	102.78	98.26	Rejected

HSF 240	1.65	104.17	**102.43**	Standard

Source: Annual Report 2013-14

Varieties of PARB Project No. 163 at Semi-Final Selection Stage (2015-16):

S2011-SL 62
S2011-SL 392
S2011-SL 809
ESR 97/41
PSR 97/45
VMC 88-354
VMC 87-599
S2011-M 2238-89

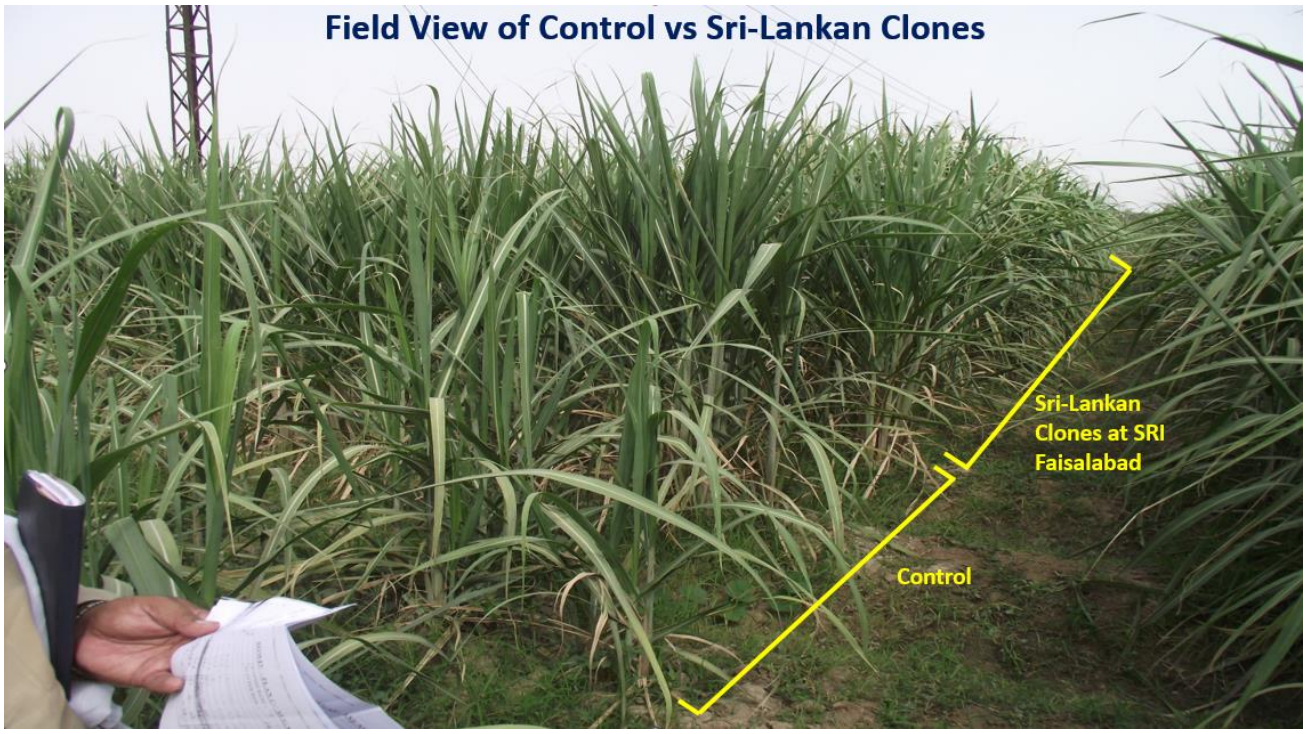
Seedlings Raised from Fuzz Imported from Mauritius

Seedlings Raised from Fuzz Imported from USA

Seedlings Raised from Fuzz Imported from Sri-Lanka

VARIETIES IMPORTED FROM PHILIPPINE


VMC 95-09
VMC 87-599
VMC 86-550
VMC 88-354
BR 97-41


Field View of Control vs Sri-Lankan Clones
Sri-Lankan
Clones at SRI
Faisalabad
Control


Control (CPF-246)


Sri-Lankan Clones

Field View of Sri-Lankan Clones

Cane Formation in Sri-Lankan Clones

5. Component wise salient achievements

1. Sugarcane Research Institute, AARI, Faisalabad

Item	Description	5-Year Target	5-Year Achievement
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6. Overall progress of the problem searched

The outcome of the project is high yielding and better sugar recovery varieties compared to prevailing varieties. It is highly desired to increase cane and sugar yield and it will be adopted with open handed by the miller and farming community

7. Varieties, breeds, vaccines or products developed and patented

The varieties of PARB project, if selected at final stages and approved by Punjab Seed Council will improve cane yield as well as sugar recovery and sugar yield of the province in coming years.

8. No. of national and international papers published

None

9. No. of Ph.D/M.Phil. produced

None

10. Any other achievement

None

11. Current status of commercialization of the project. How many stakeholders adopted this technology along with monitory benefits?

Promising high performance clones having better yield and sugar recovery are near final selection stages and will be provided to millers and farmers after approval for general cultivation – in future.

12. Impact of the project on strengthening of the institutional infrastructure, machinery, equipment and human resources

The project has major impact on strengthening of the institutional breeding program. With collaboration of Sugarcane Research Institute, Uda Walawe, Sri-Lanka, cane fuzz of desired characteristics was produced from Pakistani locally adopted varieties after thorough DNA fingerprinting and genetic profiling.

Moreover, project supported all major research activities of the institute by providing various inputs like fertilizer, pesticides, weedicides and funds for other field operations.

The project also strengthens the institute infrastructure by provision of funds for conference room, rooms renovation, A/Cs, generator, UPS along with research equipment like Growth Chamber, Polarimeter, Phase Contrast Microscope and implements along with support in the form of human resources.

13. Constraints in the:

(a) Implementation of the project

No significant constrain was faced during implementation of the project at respective components

(b) Commercialization of the project

As the sugarcane variety development program needs 10-12 years for thorough testing across several different disciplines, it is not humanly possible to commercialize the germplasm related with PARB project. The imported germplasm needs to be tested against agronomic, entomological, pathological and quality standards, so that final selection is free from known diseases and insects and have quality parameters matching or exceeding existing commercial varieties.

14. Suggestions for future research and development

It is suggested to increase project funding duration to 10 years for proper evaluation and execution of the project milestones and activities with solid output.

Dated: _____ **_____**

(Signature of Project Manager)

Dated: _____ **_____**

(Signature of Head of Organization)