

Exploitation of *G. herbaceum* Cotton for improving Agricultural Output and Economy of Coastal Agroecosystem Funded from NATP

I. Details of the Project

- 1. Title of the Project:** **Exploitation of *G. herbaceum* Cotton for
improving Agricultural Output and Economy of Coastal
Agroecosystem**

- 2. Code No.** **No.F.AED (A&H) / 2000 / PSR / P-16**

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- 4. Mode of Research:** **Production System Research (PSR)**

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II. Executive Summary

NATP Coastal Agro-ecosystem Project on Exploitation of *G. herbaceum* Cotton for improving Agricultural Output and Economy of Coastal Agroecosystem

Cotton is the most important textile raw material in our country, with increasing global market share in cotton textiles and apparels accounting for as much as one-third of the total export earnings of the country. *G. herbaceum* cotton is one of the four commercially cultivated species of cotton in India and is known for its tolerance to harsh conditions. *G. herbaceum* cotton occupies 8% of the total cotton area and is cultivated mainly in Gujarat and Karnataka. However, low yielding ability, late maturity, small boll size, and relatively poor fibre quality attributes are some of the draw backs observed in popularizing *G. herbaceum* cotton that need to be tackled for better economic returns to farmers.

Coastal agro-ecosystem comprising the States of Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh and Union Territory of Pondicherry has good potential for the cultivation of *G. herbaceum* cotton known for tolerance to salinity and drought. Thus, there is a potentiality to revive the coastal agriculture with *G. herbaceum* cotton in the existing cropping system, as well as in the sparsely cultivated and coastal sandy loams. With this background, the network research project was formulated and subsequently sanctioned under **NATP (Coastal Agroecosystem)** with the objective of identifying **useful *G. herbaceum* cotton germplasm and high yielding cultivars suitable for coastal agriculture** and further utilizing the same in coastal tracts for enhancing production of cotton and improving economy of coastal agro-ecosystem and the farming community.

It has been proposed under the NATP Coastal Agro-Ecosystem Project to utilize *G. herbaceum* cotton cultivars being grown in Ghed and coastal saline soils of Gujarat for the benefit of coastal agro-ecosystem in other States. There are also good gene pools of

G. herbaceum available in Gujarat, Karnataka and Tamil Nadu. Rapid screening of this germplasm for their adaptation and realization of yield potential in saline coastal tracts has started yielding good results. The Project was designed to bring about significant expansion in the area of cotton, enhancement in cotton production, revival of coastal agriculture and vitalization of coastal rural economy. Towards this goal, attempts have been made by the Project personnel of various participating centres in bringing out significant findings and relevant information pertaining to the stated objectives of the Project. *Various field trials, laboratory experiments and On Farm Trials in farmers' fields have been carried out and the significant findings are summarized as follows:*

- ★ High yielding ability of desi cotton hybrid **G. Cot. DH - 7** could be demonstrated in coastal areas of Gujarat (Khapat- 10-14 q/ha, Dhanduka 7q/ha and Danti-24 q/ha), Karnataka (Brahmavar- 5-7 q/ ha and Ankola- 7-9 q/ha), Tamil Nadu (Kovilpatti 4-9 q/ha, Pattukotai- 12q/ha and Paramakudi – 13 q/ha) and Andhra Pradesh (Konanki – 8-12 q/ha and Uppugundur- 6-12 q/ha) even under marginal and stress conditions.
- ★ **G. Cot DH 9** exhibited its high yielding ability and better adaptability in coastal areas of Gujarat (Khapat- 14 q/ha, Dhanduka- 6 q/ha and Danti- 31 q/ha), Karnataka (Brahmavar- 5-7 q/ ha and Ankola- 6-7 q/ha), Tamil Nadu (Kovilpatti- 4-8 q/ha) and Andhra Pradesh (Konanki- 7- 13 q/ha and Uppugundur 5 - 21 q/ha).
- ★ G. Cot. DH - 7 and G. Cot DH 9 registered very high yields with a mean performance of 40-42 q/ha over three years in coastal areas of Karaikal (Union Territory of Pondicherry). These desi hybrids are being popularised through appropriate extension programme.
- ★ Stability analysis over three years indicated the stability of desi cotton hybrids viz., G. Cot DH 7 & G. Cot DH 9 for higher yields

- ★ G.Cot DH 9 with a mean fibre length of 27.4 mm and bundle strength of 20.8 g/tex may be suitable for spinning up to 30s counts. Among the *G. herbaceum* varieties, G.Cot. 17 and G.Cot. 23 hold promise to spin up to 20s count yarn.
- ★ A better economic return to coastal farmers due to cultivation of desi cotton hybrids was evident in demonstration trials under the Project with a cost benefit ratio of 1: 1. 8 (*a net profit of Rs 5000 - Rs. 12000 per hectare depending upon location and resource utilization*).
- ★ *G. herbaceum* genotype **RAHS.14** was found saline tolerant, high yielding (6-9 q/ha) even under very adverse conditions, early and well adapted at many locations. This genotype can be promoted in coastal areas of peninsular India for enhancing cotton productivity and income of farmers.
- ★ The high yield potential of *G. herbaceum* cultures viz., DB 3-12, G.Cot.13 and G.Cot.21 could be demonstrated at several locations even under very adverse situations with average yield of 6-8 q/ha during the Project period.
- ★ The yield superiority of pre-release varieties viz. RAHS.132, RAHS.14, RAHS.131 and GBhv 202 could be observed at many locations of Andhra Pradesh, Gujarat, Karnataka and Tamil Nadu.
- ★ *G. herbaceum* genotypes RAHS.14, RAHS.119, RAHS.101 and hybrids G.Cot. DH-7 and G. Cot DH-9 yielded around 6 - 9 q/ha in highly saline areas of Ankola, wherein sea water intrusion was seen and crops like Greengram and Blackgram failed.
- ★ Economical yields could be obtained in coastal areas of Goa by sowing *G. herbaceum* genotypes and desi hybrids in September.
- ★ Productivity of *G. herbaceum* genotypes could be further enhanced by growing under protective management situation as seen in large scale trials at Raichur and Dharwad.

- ★ Nutrient and spacing requirements have been worked out for economic yields of *G. herbaceum* varieties and *desi* cotton hybrids.
- ★ The performance of *G. herbaceum* genotypes RAHS.132 and RAHS.14 under rainfed situation in Paramakudi (Tamil Nadu) was superior with mean yield of 15 q/ha. In the large scale demonstrations in Karnataka, *G. herbaceum* cultures were seen yielding 8q/ha under dry farming situation as compared to 5q/ha by *G. hirsutum*.
- ★ *Desi* hybrid cotton-based intercropping experiments conducted at Coimbatore brought out the superiority of intercropping system of *Desi* cotton hybrid (G.Cot. DH-9) with intercrops like Black gram, Cowpea and Onion. **Intercropping helped in realization of cost benefit ratio of 1:2** as compared to 1:1.8 by sole crop of *desi* cotton hybrid. A net cotton equivalent yield of 23 to 25 q/ha could be obtained in cotton intercrop system as compared to 19q/ha in sole crop of *desi* hybrid cotton.
- ★ Cotton cv.LRA 5166 (*G. hirsutum*) was found best suited to coastal agroecosystem of Sundarbans. **A low cost technology for growing cotton seedlings in Pai nursery has been developed for transplanting of cotton seedlings and survivability in coastal areas of Sundarbans, West Bengal.** Suitable Integrated Pest Management strategies for cotton have been developed for coastal areas of Sundarbans, West Bengal.
- ★ *G. herbaceum* genotypes exhibited steady state maintenance of metabolic status with higher levels of soluble protein, reducing sugar content and phenolics in leaves during crop growth at Coimbatore. Higher levels of metabolically important enzymes like Nitrate Reductase and Peroxidase were noticed in *G. herbaceum* genotypes during crop growth at Coimbatore and helped them overcome biotic and abiotic stresses.
- ★ Phenological studies brought out the suitable growth period of *G. herbaceum* cotton crop specific to coastal locations.

★ Morphological, physiological and biochemical aspects of tolerance to abiotic stress conditions have been studied at Central Institute for Cotton Research, Coimbatore, ANGRAU, Lam, Guntur, UAS, Dharwad and GAU, Surat with useful traits being identified in select *G. herbaceum* genotypes. The promising *G. herbaceum* genotypes have been deployed in breeding programmes for further improvement in agronomic attributes and adaptability.

NATP funded Project on “*Exploitation of G. herbaceum cotton for improving agricultural output and economy of coastal agroecosystem*” led to the identification of *two high yielding desi cotton hybrids* and *five G. herbaceum varieties* well adapted to coastal agroecosystem. *Several promising genotypes of G. herbaceum with desirable characteristics have also been generated from the Project work.* Basic mechanisms of resistance in *G. herbaceum* cotton have been studied. Besides, the physiological and biochemical aspects of growth and development have been evaluated. Nutrient requirements for *G. herbaceum* genotypes have been worked out. *The On Farm Trials in farmers’ fields revealed the superiority in yield of desi cotton hybrids / G. herbaceum varieties and improved economic returns in G. herbaceum cotton cultivation in coastal agroecosystem.*

III. Research Objectives and Rationale

Cotton is the most important commercial crop playing a significant role in Indian economy, both in terms of providing employment to about 60 million people and production of wealth. Cotton dominated textiles account for one-third of total export earnings of the country. Cotton is cultivated in 8 - 8.5 m ha with a production of 140 – 150 lakh bales. However, the stagnation observed in productivity of cotton at 300 - 330 kg lint /ha in India calls for concerted efforts. In order to meet growing demands for cotton in the coming years, special attempts are essential from all angles, including impetus to desi cotton varieties / hybrids and expansion of cotton cultivation in non-traditional areas.

Cotton is a very predominant commercial crop grown essentially for its fibre; and seed as a by-product is utilized for vegetable oil and as cattle feed. *G. herbaceum* cotton is one of the four commercially cultivated species of cotton in India and is known for its tolerance to harsh conditions. However, low yield potentiality, late maturity, small boll size and poor fibre quality attributes are some of the draw backs observed in popularizing *G. herbaceum* cotton that need to be tackled for better economic returns to farmers.

By nature, cotton plant adds huge amounts of leaf litter and root residues which maintain and add to soil fertility. It has also been noticed that *G. herbaceum* cotton can accommodate many intercrops and is a good candidate to be a member crop of Coastal Ecosystem. *G. herbaceum* cotton is tolerant to salinity, drought and well adapted to marginal soils which are as bad as desert sands. Gujarat is having a vast pool of *G. herbaceum* genotypes. Hence, there is good scope for evaluating and introducing the adaptable types to different States all along the coastal line in Indian Peninsula. Vast saline coastal tract either remains barren or sparsely cultivated. It is expected that through the concerted efforts, *G. herbaceum* cotton could be introduced in about three lakh hectares of land in the coastal agro-ecosystem. It will improve the economic condition of marginal farmers and will add to the employment opportunities in the coastal farm holdings. Coastal Agricultural system in the States of Karnataka, Gujarat, Andhra Pradesh and Tamil Nadu are suitable for growing *G. herbaceum* cotton. Currently, Gujarat is the major state growing *G. herbaceum* cotton under three different situations:

- a) In the Ghed area, where sea water intrudes and the water is brackish
- b) In the coastal desert sands with salinity and drought
- c) In the inland black cotton soil where salinity and drought are major problems

Utilization of *G. herbaceum* cotton cultivars of Ghed and coastal desert areas of Gujarat will benefit the coastal agro-ecosystem in other States. The second major *G. herbaceum* growing state is Karnataka, followed by Tamil Nadu. The existing cropping systems in coastal areas are based on salt tolerant paddy, casuarina, coconut, cashew and other plantation crops.

The main focus of this NATP Funded Project is to bring sizable amount of underutilised lands in the coastal areas into *G. herbaceum* cotton cultivation.

There are good gene pools of *G. herbaceum* available in Gujarat, Karnataka and Tamil Nadu. Rapid screening of this germplasm for their adaptability and yield potential in saline coastal tracts can yield good results. For immediate utility, the promising *G. herbaceum* varieties released by Gujarat and Karnataka need to be taken up for adaptive trials to assess their yield potentiality. *G. herbaceum* cotton could be tried as inter crop in existing cropping systems of the coastal region and also as the component of Agroforestry. Cotton will add to the soil fertility by way of rich organic matter and will give additional income to the farmer besides additional man days of work, which the farming communities of the coastal agro-eco-system are lacking.

G. herbaceum cotton has ready market in the present cotton fibre scenario where export oriented denim textiles need short fibres with high micronaire. Seeds of *G. herbaceum* cotton seeds are rich in protein and can be used as a high value by-product like valuable cattle feed, poultry feed and fish meal. Thus, *G. herbaceum* cotton suits well to the coastal agro-ecosystem. Many of the *G. herbaceum* types have long duration (200-250 days) and the boll weight is generally low. Efforts are needed to identify *G. herbaceum* with short duration and increased boll weight. *G. herbaceum* are slow growing types and they can readily accommodate fast growing inter crops. In parts of coastal Karnataka, North Kanara and South Kanara districts, wetland and upland paddy is the predominant crop. The land remains fallow during rest of the year. *G. herbaceum* cotton can be tried either as a paddy-cotton intercrop or as a second crop to *kharif* paddy. In southern Tamil Nadu, vast saline alkaline lands are remaining barren. Local uppam cotton is cultivated to a limited extent as a mixed crop with indigo and pulses. There is scope for expanding *G. herbaceum* cotton area, if suitable high yielding salt tolerant varieties are identified.

In coastal Andhra Pradesh, rice and cashew are predominant crops. In cashew orchards, *G. herbaceum* cotton can be introduced for sustaining soil fertility and increasing farm income. In the saline alkali soils, the paddy lands remain fallow after the harvest of paddy during October. Here also *G. herbaceum* cotton can be tried as second crop in rabi /

summer. In the coastal region of Karaikal, *G. herbaceum* cotton can be cultivated as rice fallow crop with limited availability of water. Thus, *G. herbaceum* cotton can be introduced in problem soils in coastal agricultural eco-system for its rejuvenation and prosperity.

G. herbaceum cotton is known to exhibit variable response to soil and agro-climatic conditions. Hence, its phenology, growth, duration, dry matter production and yielding ability will differ considerably over locations. Therefore, adaptive trials with promising genotypes and cultivars will be needed in selecting appropriate variety for the location. Rapid screening of *G. herbaceum* germplasm will also be beneficial both in long and short term perspectives. Hence, there is a need for large number of trials and screening by the participating centres. *With this background, specific objectives were framed for achieving the goal of exploitation of G. herbaceum cotton for economic improvement of coastal agro ecosystem as mentioned below:*

OBJECTIVES

1. Screening of *G. herbaceum* germplasm and the segregating materials to select efficient location specific genotypes for the coastal agricultural eco-systems of different states.
2. Testing the efficiency of the released *G. herbaceum* varieties and pre-release cultures in the adaptive trials at participating centres to evaluate and recommend suitable *G. herbaceum* genotypes for immediate cultivation.
3. Exploration and collection of indigenous native *G. herbaceum* from coastal area. During this exploration, early maturing *G. hirsutum* and *G. barbadense* types if any will also be collected.
4. To develop package of practices for yield maximization of the potential genotypes.
5. To integrate useful physiological and biochemical traits in crop management practices.
6. To introduce *G. herbaceum* cotton in the existing cropping system as sequential (summer crop) and as intercrop in field crop situations in orchards and in Agroforestry systems.
7. To monitor soil fertility improvement over a period with cultivation of *G. herbaceum* cotton.
8. To increase farmers' income and standard of living in the coastal Agro Ecosystem, especially in the holdings of the problem soils (saline sandy soils).
9. To develop suitable package of practices for *G. hirsutum* and *G. arboreum* genotypes adapted to coastal agroecosystem of Sundarbans in West Bengal.

IV. Methods and Results

G. herbaceum cotton is known to exhibit variable response to soil and agroclimatic conditions. Hence, its phenology, growth, duration, dry matter production and yielding ability will differ considerably over locations. Rapid screening of *G. herbaceum* genotypes for saline and drought tolerance and integrating the useful physiological and biochemical traits in crop management practices is beneficial, both in long and short term perspectives. Adaptive trials with popular cultivars and evaluation of promising germplasm lines were undertaken in order to select appropriate *G. herbaceum* genotypes for specific location.

Significant findings of various experiments conducted by participating centres have been presented in detail under the broad scope of set objectives of the Project. Major research findings of various experiments, multi location trials, On-farm trials, laboratory evaluation are consolidated and presented in the following sections from an overall view of accomplishments emanating from the entire Project. Besides, emphasis has also been given to significant findings on select experiments pertaining specifically to certain centres, having overall impact on the outcome of the Project

4.1 Yielding ability of *G. herbaceum* genotypes/hybrids in coastal areas

In order to recommend suitable *G. herbaceum* genotypes for immediate cultivation in coastal areas and improvement in economy of the coastal farmers, it is essential to test the efficiency of already released *G. herbaceum* varieties and hybrids in adaptive trials at participating centres. In this regard, multi locational trials were laid out using *G. herbaceum* varieties like G.Cot.13, G.Cot.17, and G.Cot.21, G.Cot.23 and *desi* Cotton hybrids G. Cot DH-7 and G. Cot DH-9 (identified and released by GAU, Surat, Gujarat) and DB 3–12, Jayadhar, RAHS.14, RAHS.131 (identified by UAS, Dharwad, Karnataka). In addition, promising pre-release cultures were also evaluated in the multi-location trials over three years for further utilization in coastal agro ecosystem.

The yielding ability and yield contributing parameters were evaluated through multi location trials conducted at centres *viz.*, Surat, Porbandhar, Khapat, Danti, Ratia (Gujarat), Goa, Brahmavar and Ankola (Karnataka), Kovilpatti, Paramakudi and Pattukottai (Tamil Nadu), Karaikal (Union Territory of Pondicherry), Konanki and

Uppugundur (Andhra Pradesh). The performances of individual genotypes over locations during the Project period are presented in **Fig. 1 - 10**.

The superior yield performance in terms of seed cotton yield of desi cotton hybrid **G. Cot. DH-7** could be demonstrated in coastal areas of Gujarat (Khapat – 10 - 14 q/ha, Danti – 24 q/ha and Dhandhuka - 7 q/ha), Karnataka (Brahmavar - 5-7 q/ ha and Ankola – 7 – 9 q/ha), Tamil Nadu (Kovilpatti - 4 – 9 q/ha, Pattukottai - 12 q/ha and Paramakudi - 13 q/ha) and Andhra Pradesh (Konanki – 8 – 12 q/ha and Uppugundur – 6 - 12 q/ha). (**Fig. 1a-c**) (**Plate 1**).

G. Cot. DH-9 exhibited its high yielding ability and better adaptability in coastal areas of Gujarat (Khapat - 14 q/ha, Dhandhuka - 6 q/ha and Danti – 31 q/ha), Karnataka (Brahmavar 5 -7 q/ ha and Ankola- 6 – 7 q/ha), Tamil Nadu (Kovilpatti- 4 - 8 q/ha) and Andhra Pradesh (Konanki - 7-13 q/ha and Uppugundur- 5 - 21 q/ha). (**Fig 2a - c**) (**Plate 2**).

Desi cotton hybrids **G. Cot. DH-7** and **G. Cot. DH-9** registered very high yields with a mean performance of 40 – 42 q/ha over three years in coastal areas of Karaikal (Union Territory of Pondicherry). These desi hybrids also exhibited good amount of stability for yield. As regards varieties, **DB 3-12** recorded highest seed cotton yield of 28 q/ha, followed by **G.Cot.13** (25 q/ha) and **RAHS.14** (24 q/ha) (**Fig 3**). In general, the mean performance of many *G. herbaceum* genotypes over three years at Karaikal was characteristically higher with yield levels ranging between 22 - 42 q/ha (**Fig 4**).

As regards the mean performance of *G. herbaceum* genotypes in different locations situated in the coastal agro ecosystem, moderate yielding ability of 6 - 11 q/ha could be observed even under adverse situations prevailing during crop growth (**Fig 5**). *G. herbaceum* genotype **RAHS.14** was found saline tolerant, high yielding, early and well adapted at many locations. This genotype can be promoted in coastal areas of peninsular India for enhancing cotton productivity and income of farmers, especially under severe salinity stress conditions (**Fig 6**).

The high yield potential of *G. herbaceum* varieties viz., **DB 3-12**, **G.Cot.13** and **G.Cot.21** could be demonstrated at several locations even under adverse situations in marginal soils (**Fig 7, 8 and 9**). A promising strain of *G. herbaceum* viz., **RAHS.131** has been identified under marginal conditions with a yielding ability of 5 - 8 q/ha in coastal areas. (**Fig 10**).

G. herbaceum genotypes RAHS.14, RAHS.119, RAHS.131 and hybrids G.Cot.DH-7 and G.Cot.DH-9 yielded around 6 - 9q/ha in highly saline areas of Ankola, wherein sea water intrusion was seen and crops like green gram and black gram failed. (Fig 11).

4.2 Yield potential of *G. herbaceum* lines under rainfed and irrigated conditions

In the evaluation trial of new *G. herbaceum* lines under protective management conditions, RAHS 17, RAHS 22, RAHS 30 and RAHS.131 recorded seed cotton yield ranging between 14 – 18 q/ha, while *hirsutum* and *arboreum* genotypes yielded around 8– 13 q/ha (Table 1). The productivity of *G. herbaceum* genotypes was seen substantially enhanced by growing them in protective management situation, wherein limited irrigation and application of fertilizers recommended for rainfed situation were resorted to.

Table 1: Performance of select *G. herbaceum* lines under irrigated and rainfed situations (Seed Cotton Yield in kg/ha)

Genotype	Irrigated		Mean	Rainfed		Mean	Overall Mean
	Dharwad	Raichur		Dharwad	Raichur		
RAHS – 17	2044	1558	1801	234	252	243	1022
RAHS – 25	1248	1479	1364	368	469	419	892
RAHS – 22	1507	1458	1483	395	236	316	900
RAHS – 30	1671	1575	1623	328	310	319	971
RAHS-132	956	1745	1351	415	495	455	903
RAHS-131	1160	1643	1402	424	332	378	890
RAHS.14	1404	1001	1203	434	337	386	795
AKA-235 (<i>G. arboreum</i>)	1060	1366	1213	404	195	300	757
Sahana (<i>G. hirsutum</i>)	1573	866	1220	291	33	162	691
CD @ 5%	481	158		98	64		
CV %	19	6.7		15	10		

4.2.1 Large scale evaluation of *G. herbaceum* genotypes under protective management situation

Large scale evaluation of ninety two cotton genotypes comprising *G. hirsutum* as well as *G. herbaceum* lines was carried out at Raichur, Karnataka by providing protective irrigation and intensive management. Plant protection was taken up only to control bollworms with three sprays. As a group, *G. herbaceum* genotypes performed better than *G. hirsutum* genotypes and clear indication was evident about suitability of *G. herbaceum* genotypes in situations wherein only limited irrigation was possible (Table 2). By virtue of their responsiveness to protective irrigation and higher level of tolerance to pests, the *G. herbaceum* genotypes have the potentiality to compete with *G. hirsutum* genotypes / hybrids in the peripheral belts of canal areas (tail end regions of canal areas).

Table 2: Performance of *G. herbaceum* and *hirsutum* genotypes at Raichur

Genotypes	Species	No. of bolls/ plant	No. of Monopodia /plant	No. of Sympodia/ plant	Plant height (cm)	No. of nodes /plant	Seed cotton yield (Kg/ha)
RAHS – 119	<i>G. herbaceum</i>	46.5	0.66	17.3	123.3	24.3	1625
RAHS – 14	<i>G. herbaceum</i>	43.0	1.16	20.0	144.0	22.0	1601
H – 221	<i>G. herbaceum</i>	33.5	1.00	8.0	131.6	33.6	1512
H – 129	<i>G. herbaceum</i>	35.0	0.83	17.7	163.8	33.8	1506
DB 3 - 12	<i>G. herbaceum</i>	23.9	2.83	21.4	134.7	31.2	1337
RAH – 221	<i>G. hirsutum</i>	15.9	1.62	25.2	148.3	-	1304
RAH 101	<i>G. hirsutum</i>	10.8	1.0	20.3	72.7	23.3	1205
RAMPBS-155	<i>G. hirsutum</i>	13.3	0.71	12.8	138.2	-	864
CD 5%		3.0	0.38	5.2	11.0	3.1	298
CV %							13

4.2.2 Large scale demonstration of *G. herbaceum* genotypes under rainfed situation

The potential *G. herbaceum* lines such as RAHS-14, RAHS-131, RAHS-130, RAHS-132, RAHS-129, RAHS-125, RAHS-119, RAHS-101, AH-22 along with check DB 3-12 and Jayadhar were evaluated in large plots and compared with the best *G. hirsutum* varietal lines like RAH-100, RAH-221, RAMPBS-155 in Raichur.

In the large scale demonstrations, *G. herbaceum* lines viz. RAHS-131, RAHS-119, RAHS-130, RAHS-129, RAHS-132 and RAHS-14 recorded more than 7.5 q / ha seed cotton yield under rainfed situation as compared to 5.3 – 5.9 q/ha by *G. hirsutum* cultivars. This points out the potentiality of *G. herbaceum* cotton in withstanding the severe moisture stress and recording reasonably high productivity.

4.3 Stability Analysis of desi Cotton

In order to identify stable *desi* cotton genotypes, stability analysis was carried out involving thirteen *desi* cotton genotypes tested over all the three years in Karaikal.

These genotypes were evaluated for stability over three years (Feb – Aug. 2001, 2002, 2003 seasons) under rice fallow situation in randomized complete block design with three replications. The irrigation water used in the study, is saline alkaline as indicated by high SAR and RSC (EC= 2.44 dS/m, pH=9.45, SAR= 21.40 and RSC=8.60 meq/l). The data on days to initial flowering, plant height, number of sympodia, number of bolls/plant, mean boll weight and single plant yield were recorded on ten randomly selected single plants per replication. The data were analyzed as per the model suggested by Finlay and Wilkinson (1963) and the results are presented in **Table 3, 4 and 5**.

The individual as well as the pooled analysis of variance showed that the mean squares due to genotypes and G x E interaction were significant for all the characters studied. The mean (X) and regression coefficient (b_i) for five yield contributing characters viz., initial flowering, plant height, number of sympodia, number of boll/plant and mean boll weight revealed that the two *desi* cotton hybrids G.Cot.DH-7 and G.Cot.DH-9 were stable over three years, while the variety DB3-12 was found suitable for favourable environments, since it had significant (b_i) value coupled with higher mean under coastal saline alkaline situation.

Table 3. Pooled analysis of variance over the seasons for six character

Source of variation	df	Mean Square					
		Initial flowering (days)	Plant height (cm)	Number of sympodia	Number of bolls	Mean boll weight (g)	Single plant yield (g)
Genotype	12	15.55**	67.89	4.87**	71.98**	0.221**	608.01**
Environment	2	375.45**	5232.13**	9.20**	198.86**	0.017	2506.74**
Genotype x Environment	24	18.69**	141.11*	1.00**	26.68**	0.004	247.10**
Error (pooled)	72	1.16	71.39	0.44	12.12	0.009	40.55

Table 4. Analysis of variance for stability for different traits

Source of variation	df	Mean Square					
		Initial flowering (days)	Plant height (cm)	Number of sympodia	Number of bolls	Mean boll weight (g)	Single plant yield (g)
Genotype	12	15.55**	67.89	4.87**	71.98**	0.221**	608.01**
Environment + (Genotype x Environment)	26	46.14**	532.73**	1.63**	39.93**	0.004	420.92**
Environment (linear)	1	751.09**	10464.25**	18.41**	397.72**	0.034*	5013.49**
Genotype x Environment (linear)	12	9.85**	167.33*	0.74	21.46	0.006	230.07**
Pooled deviation (non linear)	13	25.41**	106.05	1.15	29.45**	0.002**	243.82**
Pooled error	72	1.16	71.39	0.44	12.12	0.009	40.55

Table 5. Stability parameters for different traits

Sl. No.	Varieties	Initial flowering (days)		Plant height (cm)		Number of sympodia		Number of bolls		Mean boll weight (g)		Single plant yield (g)	
		Mean	b _i	Mean	b _i	Mean	b _i	Mean	b _i	Mean	b _i	Mean	b _i
1.	RAHS.131	60.89	0.316	126.46	0.338	9.65	0.875	34.04	1.130	1.63	0.869	70.35*	1.505*
2.	V-797	58.33	0.446	122.04	1.227	12.20*	-0.106	40.18*	2.241	2.22*	4.202	70.93*	0.208
3.	RAHS.132	61.89	1.155	133.1	0.225	7.85	1.656	33.22	0.636	1.59	0.043	52.18	0.376
4.	RAHS.14	57.44	0.836	128.7	1.090	10.21*	0.709	42.22*	2.827	2.24*	3.339	98.06*	2.919
5.	DHUMAD	64.00*	1.451	123.49	0.711	7.95	0.330	27.09	0.482	1.51	0.218	51.57	0.634
6.	G.COT.21	58.78	0.878	116.5	0.677	7.64	0.388	26.71	0.884	1.48	0.877	48.83	1.036
7.	DDHC 11	59.67	1.034	121.38	0.844	8.18	0.778	28.51	-0.528	1.58	0.524	61.00	0.811
8.	G. COT.13	62.45	0.678	125.35	1.260	8.75	1.418	27.22	0.727	1.54	-0.682	62.91	1.646
9.	DIGVIJAY	63.33*	1.366	119.70	1.674	9.04	1.637	31.18	0.966	1.56	0.530	48.94	0.361
10.	D.B.3-12	63.67*	1.081	126.92	0.999	8.13	0.068	29.16	1.355	1.56	2.742	55.90	1.476
11.	RAHS 129	61.89	0.912	127.60	1.783	8.58	2.289	32.38	0.783	1.73	-0.129	60.03	0.507
12.	G.COT.DH.7	64.11*	1.865	121.26	1.219*	7.80	1.718	30.08	1.195	1.32	0.040	49.11	1.318
13.	G.COT.DH.9	63.00	0.982	131.43	0.956	9.42	1.239	28.18	0.302	1.61	0.439	50.03	0.202
	Mean	61.50		124.92		8.88		31.55		1.66		59.60	
	SE (mean)	3.71		7.58		0.791		3.994		3.150		11.492	
	SE of b _i		0.690		0.378		0.940		1.021		0.861		0.828

4.4 Fibre quality attributes of *G. herbaceum* cotton genotypes grown in different locations of coastal agroecosystem

The yield enhancement in cotton has to be accompanied with matching fibre qualities so that the farmers cultivating the specific genotypes are paid their due price. Hence, the fibre quality attributes assume greater significance in the evaluation of cotton genotypes. The data on fibre quality attributes viz., 2.5% Span length, Micronaire and Fibre strength are presented in **Tables 6, 7 and 8.**

A. 2.5% Span length: Among the desi cotton hybrids, G. Cot DH-9 recorded the higher mean fibre length of 27.4 mm, followed by G. Cot DH 7 with 23.4 mm. among the *G. herbaceum* varieties, G. Cot 17 recorded high mean fibre length of 22.6 mm, followed by G. Cot 23 with 21.9 mm. (**Table 6**).

Table 6. Fibre quality attributes of *G. herbaceum* genotypes (2.5% Span Length in mm)

Genotype	Karaikal	Konanki	Khapat	Danti	Uppugundur	Kovilpatti	Mean
G. Cot DH 7	23.15	22.93	23.50	23.80	23.30	23.53	23.4
G. Cot DH 9	29.5	24.70	27.80	28.70	24.73	28.87	27.4
G. Cot 13	21.4	21.80	24.40	-	22.90	19.35	22.0
G. Cot 17	20.8	24.00	23.40	-	23.60	21.10	22.6
G. Cot 21	21.15	21.10	25.00	21.10	21.50	19.80	21.6
G. Cot 23	21.55	21.95	22.80	-	22.10	20.90	21.9
RAHS.14	19.7	23.05	22.10	21.30	21.00	19.03	21.0
RAHS.131	18.85	21.70	24.00	19.50	21.10	19.43	20.8
DB 3-12	18.8	21.13	21.50	22.40	20.37	18.93	20.5

B. Micronaire value : As regards micronaire, there was not much variation. Moderately high micronaire ranging from 4.2 to 5 was recorded among all the entries tested (**Table 7**).

Table 7. Fibre quality attributes of *G. herbaceum* genotypes (Micronaire value)

Genotype	Karaikal	Konanki	Khapat	Danti	Uppuguntur	Kovilpatti	Mean
G. Cot DH 7	5.95	3.70	5.60	5.50	3.40	4.90	4.8
G. Cot DH 9	5.45	3.30	4.20	4.80	3.10	4.07	4.2
G. Cot 13	6.25	3.90	3.90	-	3.50	4.55	4.4
G. Cot 17	6.05	3.70	4.80	-	3.70	3.60	4.4
G. Cot 21	6.35	3.90	5.20	6.70	3.80	4.80	5.1
G. Cot 23	6	4.20	4.40		3.90	4.20	4.5
RAHS.14	6.5	0.00	5.00	6.40	-	5.10	4.6
RAHS.131	6.45	0.00	5.20	6.60	-	4.67	4.6
DB 3-12	6.05	3.70	4.30	6.40	3.30	5.03	4.8

C. Fibre strength (g/tex) : Among the hybrids, G.Cot DH-9 recorded fibre strength value of 20.8 g/tex (**Table 8**). Amongst *G. herbaceum* varieties, G.Cot.17 (19.4 g/tex) and G.Cot.23 (18.9 g/tex) were found promising.

Table 8. Fibre quality attributes of *G. herbaceum* genotypes (Fibre strength g/tex)

Genotype	Karaikal	Konanki	Khapat	Danti	Uppuguntur	Kovilpatti	Mean
G. Cot DH 7	19.1	19.2	18.1	19.1	19.3	20.63	19.2
G. Cot DH 9	23.6	19.8	17.1	19.8	20.7	23.57	20.8
G. Cot 13	17.05	20.4	17.3	-	19.4	16.90	18.2
G. Cot 17	18.55	20.5	20.2	-	19.5	18.20	19.4
G. Cot 21	17.25	19.1	15.6	14.8	20.5	16.35	17.3
G. Cot 23	17.85	19.6	19.4	-	19.3	18.50	18.9
RAHS.14	18.05	-	16	17.5	-	17.07	17.2
RAHS.131	17.7	-	18.2	12.8	-	16.93	16.4
DB 3-12	19.05	19.8	20.7	15.7	20.6	17.33	18.9

From the overall fibre quality attributes, it may be summarized that G. Cot. DH-9 with a mean fibre length of 27.4 mm and bundle strength of 20.8 g/tex may be suitable for spinning up to 30s counts. Among the *G. herbaceum* varieties, G. Cot.17 and G.Cot. 23 hold promise to spin up to 20s count yarn.

4.5 Evaluation of new germplasm lines and segregating materials for identification of suitable genotypes of *G. herbaceum* cotton for coastal agroecosystem

At Surat, 20 new germplasm lines collected from Ghed area were evaluated. Cultures S-8, Kalyan, Wagad V-1-1993, Vijay, Kalagin exhibited higher yielding ability with a mean seed cotton yield ranging from 23 - 40 g/plant. At Dhandhuka also, promising germplasm materials have been identified.

At Guntur (Andhra Pradesh), 137 lines including germplasm lines and synthetic cultures were evaluated. Many promising lines possessing higher yield and ginning out turn (G.O.T), better fiber length with desirable morphophysiological attributes were identified. Culture GBhv 228 recorded 34.7% GOT, followed by Digvijay P30 (34.6%). Digvijay P9 and P4 recorded higher yield per plant (53 - 55 g/plant). Further selections have been made from the germplasm collection for yield and other useful characteristics in salt tolerance and drought resistance for deployment in future breeding programme.

During 2002, four F₃ bulks viz., GSDH 509, GSDH 496, GSDH 568 and GSDH 551 were evaluated in two rows of six meters length at Konanki and Uppugundur. Out of them, only one superior single plant could be selected in GSDH 568.

At TNAU, Kovilpatti (Tamil Nadu), several single plants from segregating materials supplied by GAU, Surat, have been selected based on superior agronomic characters for further utilization in the breeding programme. As regards fibre quality parameters of pre-release cultures, GBhv 171 recorded maximum bundle strength of 19.3 g/tex, while RAHS.14 and DDHC 11 registered maximum elongation percentage **(Table. 9)**

Table. 9. Fibre quality parameters of pre release cultures (ARS,Kovilpatti).

Variety	2.5% Span length. (mm)	Uniformity ratio %	Micronaire value	Bundle strength 1/8" (g/t)	Elongation %
G.Bhv-171	18.3	54	3.8	19.3	5.7
G.Bhv-180	20.6	53	4.0	18.0	4.8
G.Bhv-215	20.5	51	4.3	18.4	4.3
G.Bhv-531/92	18.9	53	4.4	17.5	5.8
RAHS.14	17.7	55	4.8	18.4	6.2
RAHS 129	15.2	60	4.9	16.1	5.2
RAHS.131	18.4	54	4.2	17.3	5.4
RAHS.132	16.2	57	4.9	16.3	5.7
DDHC 11	20.5	51	4.5	18.9	6.1
G. Cot. 21	18.5	54	4.3	17.4	4.8

At Karaikal, (Pondicherry), variations were observed for plant height, petal colour and stem pigmentation in the segregating materials. Five progenies were selected based on their superiority in each segregating material during rice fallow 2001. The seeds obtained from selected genotypes of the segregating materials during first year failed to germinate. Hence, they could not be evaluated. Segregating materials of six crosses were received during the second year. The details of the crosses are as follows:

GSDH 496 F₂ ; (GBHV 200 X AKA 84012); F₃, (2101/97 X GBHV 202); F₃, (Western x Vijay) ; F₂, (3200 – 1 X GBHV 179) ; GSDH 509 F₂.

Variations were observed for plant height, petal colour, stem pigmentation, number of bolls, number of sympodia etc. Selection of promising lines was made. In the third year also, the selection was continued and as much as 25 single plant selections were made from six crosses and these 25 SPS will be forwarded and selection exercised until it reaches homozygosity.

Germplasm Evaluation at Karaikal (2003): Seventeen genotypes of *G. herbaceum* were received from Main Cotton Research Station, Surat, Gujarat and they were raised during rice fallow 2003. Observations viz., days to initial flowering, days to 50 per cent flowering, number of sympodial branches and number of bolls per plant was recorded. The results are presented in **Table 10**. Range of days to initial flowering falls between 60 days (2087WR and 3652) and 68 days (Kalyan). Similarly, days to 50% flowering ranges from 67 days (6 genotypes) to 70 days (Barav Digvijay). Kalagin possesses higher number of sympodial branches (9)

followed by Barav Deshi (8). Barav Digvijay recorded lesser number of four sympodia per plant. Higher number of bolls per plant was observed in Barav Deshi (46), followed by Kalyan (42) and Kalagin (41). The genotypes S-8 (Achhalia), Broach – 9, Digvijay,1449 – Samdhiar, Vijay and Gh 458/1165 registered more than 30 bolls per plant.

Table 10. Mean performance of germplasm lines for different characters

Sl. No.	Genotypes	Days to initial flowering	Days to 50% flowering	No. of sympodia	No. of bolls per plant
1.	Broach – 9	61	67	7	37
2.	Kalyan	68	68	7	42
3.	1449 Samdhiar	67	68	7	37
4.	Gh – 458/1165	63	68	7	38
5.	7502	61	68	6	31
6.	1314 Viramgam	61	67	6	30
7.	2340/58	67	67	5	23
8.	Vijay	64	67	7	37
9.	Surati local	65	69	5	27
10.	3652	60	67	5	28
11.	2087 WR	60	68	6	33
12.	Kalagin	65	67	9	41
13.	3200 - HSP	61	66	6	32
14.	S-8 (Achhalia)	67	69	6	41
15.	Digvijay	61	69	7	35
16.	Barav Digvijay	61	70	4	24
17.	Barav deshi	61	67	8	46

4.6 Exploration and collection of indigenous *G. herbaceum* lines

Thirty *G. herbaceum* germplasm lines have been collected during visits to Surat, Viramgam, Dharwad, Akola, Aurangabad, Nanded, Hisar and Sriganganagar. Among the germplasm lines collected, twenty germplasm lines were seen to perform moderately with yielding ability of 30 – 45 g per plant.

4.7 Development of package of practices for yield maximization of potential *G. herbaceum* genotypes/hybrids

4.7.1 Nutrient and spacing requirements for *G. herbaceum* at Kovilpatti (Tamil Nadu)

Two hybrids *viz*; G. Cot DH-7 and G.Cot.DH-9 and one variety DB 3-12 were tested at two spacing *viz*; 90 x 30 and 60 x 30 cm and three manurial level (120:60:60, 90:45:45 and 60:30:30 NPK/ha) under split plot design. Among the three entries, the hybrid G. Cot DH-7 was found superior and the spacing of 90 x 30 cm was found to be better than 60 x 30 cm. Among the manurial levels, 60:30:30 NPK/ha recorded higher yield. Nevertheless, it was on par with 90:45:45 NPK/ha.

4.7.2 Agronomic requirements of RAHS-14

The agronomic requirements of RAHS-14 were worked out at ARS, Ankola. Three fertilizer levels *viz.*, F1: 60:30:30 NPK kg/ha, F2: 40:25:25 NPK kg/ha, F3: 80:40:40 NPK kg/ha and 3 spacing levels *viz.*, S1: 60 x 20 cm, S2: 60 x 30 cm, S3: 90 x 30 cm were tried. Fertilizer dose were main treatments while spacing were the sub treatments. Among different fertilizer levels tried in the coastal belt at Ankola, application of 60:30:30 kg NPK/ha resulted in significantly higher yield (7.85 q/ha) than application of 40:25:25 kg NPK/ha (6.53 q/ha). However, application of 80:40:40 kg NPK/ha recorded on par yield level (7.80 q/ha). Among different spacing levels tried, 60 x 30 cm recorded significantly higher yield (7.83 q/ha) than the wider spacing level of 90 x 30 cm.

Among different interaction levels F1 S1 (60:30:30 kg NPK/ha @ 60 x 20 cm) (8.15 q/ha) and F1S2 (60:30:30 kg NPK/ha @ 60x30cm) (3.30 q/ha) were significantly superior interactions over F1S3 (60:30:30 kg NPK/ha @ 90 x 30 cm) (7.10 q/ha). F2S2 (40:25:25 NPK kg/ha @ 60 x 30 cm) recorded significant interaction with F2S3 (40:25:25 NPK kg/ha @ 90 x30 cm) but on par with F2S1. (40:25:25 NPK kg/ha @ 60 X 20 cm). F3S2 (80:40:40 NPK kg/ha @ 60 X 30 CM) recorded significant higher interaction effect over F3S3 (80:40:40 NPK kg/ha @ 90 X 30 CM).

Application of recommended fertilizer levels 60:30:30 kg NPK/ha and maintaining spacing level of 60 x 30 cm was found more suitable for cultivating RAHS-14 in coastal ecosystem. (**Table. 11**)

Table.11 Effect of fertilizers and spacing on seed cotton yield of RAHS-14 (q/ha)

Treatments	S1	S2	Se	Mean
F1	8.15	8.30	7.10	7.85
F2	6.40	7.00	6.20	6.53
F3	7.90	8.20	7.30	7.80
Mean	7.48	7.83	6.86	7.39
	SEM+	CD at 5%		
Main plot	0.126	0.493		
Sub plot	0.173	0.534		
Interaction	0.275	0.85		

F1: 60:30:30 NPK kg/ha,

S1: 60 x 20 cm

F2: 40:25:25 NPK kg/ha,

S2: 60 x 30 cm

F3: 80:40:40 NPK kg/ha

S3: 90 x 30 cm

4.7.3 Agronomic requirements of *G. herbaceum* hybrids (Guntur)

It was observed that the desi hybrid G. Cot DH-9 recorded maximum kapas yield of 814 kg/ha. Among the spacings, 60 x 30 cm was found superior with 799 Kg/ha. Among the fertilizer levels tried, 120:60:60 Kg N P K / ha has given highest kapas yield of 816 Kg/ha. (Table 12)

Table 12. Yield and ancillary data of *G. herbaceum* hybrids as influenced by different treatments

Treatment	Plant height (cm)	No of monopodia	No of Sympodia	No of bolls	Boll Weight (g)	Seed Cotton Yield (Kg/ha)
S1 (90x30)	140	1.05	10.5	12.4	1.82	799
S2 (60x30)	125	1.4	9.8	13.0	1.83	780
Varieties						
G. Cot DH-7	126	1.3	10.0	10.9	1.72	714
G. Cot DH-9	130	2.6	10.3	16.1	1.93	814
Fertilizer levels						
120-60-60 Kg NPK/ha	142	1.3	11.3	16.9	1.86	816
90-45-45 Kg NPK/ha	129	1.5	9.9	12.1	1.83	763
60-30-30 Kg NPK/ha	112	1.3	9.4	11.2	1.81	713

4.7.4 Optimization of fertilizer requirement for *G. herbaceum* hybrids/variety (Karaikal)

Two experiments were conducted during February – July 2002 and 2003 to study the relative performance of *desi* cotton hybrids and cotton cultivars under different levels of fertilizers in the coastal region of Karaikal. The details of the experiments are as follows:

Year Details	2002	2003
Entries	G.Cot.DH-7, G. Cot. DH-9 & DB 3-12	G. Cot. DH-9, DB 3-12, MCU 7 & ADT 1
Design	FRBD	FRBD
No. of rows	6	6
Spacing	90 x 30 cm	90 x 30 cm
Fertilizer	F1: 120:60:60 NPK kg/ha F2: 90:45:45 NPK kg/ha F3: 60:30:30 NPK kg/ha	F1: 120:60:60 NPK kg/ha F2: 90:45:45 NPK kg/ha F3: 60:30:30 NPK kg/ha
Replication	3	3
Row length	4 m	4 m

All the cotton genotypes recorded significantly taller plants at 120:60:60 kg NPK ha⁻¹ than that of unfertilized control throughout the crop period. The LAI on 120 DAS ranged from 2.51 to 3.34 in first experiment and 0.50 to 0.98 in the second experiment. The fertilizer levels were found to influence the LAI significantly in both the experiments (**Table. 13**). The *desi* hybrids registered more dry matter production than *Gossypium hirsutum* cultivars in both the experiments as observed on 120 DAS. The *desi* hybrids and *desi* variety registered significantly more number of sympodia plant⁻¹ than *Gossypium hirsutum* cultivars. The impact of fertilizer levels on the number of sympodia plant⁻¹ was not consistent (**Table. 14**). In both the experiments, *desi* hybrids and *desi* variety registered significantly more number of fruiting points and higher boll setting percentage than *Gossypium hirsutum* cultivars. The fertilizer levels were found to increase the fruiting points significantly. The highest number of fruiting points and boll setting percentage were recorded at 120:60:60 kg NPK/ha followed by 90:45:45; 60:30:30 kg NPK ha⁻¹ and the lowest fruiting points and boll setting percentage were recorded in unfertilized control.

The number of bolls/plant was higher in *desi* hybrids and *desi* variety than the *Gossypium hirsutum* cultivars in both experiments. The fertilizer levels were found to influence the number of bolls significantly in both the experiments as observed on 120 DAS, with more number of bolls at fertilized plot than the unfertilized control plot. In the first experiment, the highest kapas yield of 34.77 q ha⁻¹ was recorded by G.Cot.DH-9, which was *on par* with that of G. Cot. DH-7 (34.71 q ha⁻¹) and they were significantly superior to DB 3-12 (26.76 q ha⁻¹) and the lowest kapas yield was obtained by MCU.7 (21.73 q ha⁻¹) (**Table. 15**). Similarly, the *desi* hybrid and *desi* variety registered significantly higher kapas yield than *Gossypium hirsutum* cultivars in the second experiment, wherein G. Cot. DH.9 registered 10.84 q ha⁻¹ and it was significantly superior to that of DB 3-12 (9.21 q ha⁻¹) and MCU.7 (9.21 q ha⁻¹) and the lowest yield was recorded in ADT.1 (6.22 q ha⁻¹) (**Fig. 12**).

The Bartlett's earliness index was significantly higher in MCU.7 and ADT.1 and it was the lowest in DB 3-12. The Bartlett's earliness indices were not influenced by fertilizer application in both the experiments. The 2.5 % span length was the highest in G. Cot. DH.9 followed by MCU.7 and G.Cot. DH-7 and the lowest in DB 3-12 (**Table 16**). Neither cotton genotypes nor fertilizer application brought about any perceptible change in available NPK status, EC or p H of the soil after harvest of cotton crop (**Table 17**).

It is concluded that both the hybrids *viz.*, G.Cot.DH-7 and G.Cot. DH-9 were superior to the three varieties *viz.*, DB 3-12, MCU.7 and ADT.1 in terms of net income and B: C ratio at all levels of fertilizers. For the hybrids, application of 120:60:60 kg NPK ha⁻¹ was economical. Among the varieties, the *desi* variety DB 3-12 was better than the ruling varieties MCU.7 and ADT.1 and a fertilizer dose of 90:45:45 kg NPK ha⁻¹ was optimum for DB 3-12. Therefore, the *desi* hybrids *viz.*, G.Cot DH.7, G.Cot. DH.9 and *desi* variety DB 3-12 will be more economical than the ruling *Gossypium hirsutum* varieties (MCU.7 and ADT.1) in the coastal region of Karaikal during summer season under irrigated condition.

Table 13. Effects of treatments on days to 50 % flowering, plant height and leaf area index

Treatments	Day to 50 percent flowering		Plant Height (cm)						Leaf Area Index					
			Expt I			Expt II			Expt I			Expt II		
	Expt I	Expt II	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS
COTTON CULTIVARS (C)														
C ₁ : G.COT.DH. 7	73.75	-	43.27	99.66	100.92	-	-	-	1.20	1.74	3.34	-	-	-
C ₂ : G.COT.DH. 9	68.42	67.50	42.95	92.15	93.08	53.33	70.23	79.22	0.84	1.73	2.63	0.63	0.88	0.97
C ₃ : DB 3-12	73.42	72.33	42.30	90.16	92.33	48.54	68.11	78.93	1.05	1.72	3.10	0.60	0.78	0.96
C ₄ : MCU.7	64.92	62.25	32.01	72.31	71.70	35.97	47.94	53.25	0.73	1.47	2.51	0.94	0.96	0.98
C ₅ : ADT. 1	-	50.83	-	-	-	31.79	34.20	50.32	-	-	-	0.43	0.49	0.50
FERTILIZER LEVELS (F)														
F ₁ : Control	68.92	63.50	35.07	69.63	67.33	34.43	42.02	55.57	0.79	1.16	1.69	0.48	0.52	0.72
F ₂ : 60:30:30 kg NPK ha ⁻¹	73.25	66.33	40.95	91.78	91.89	44.87	55.31	63.41	1.03	1.51	2.74	0.64	0.69	0.74
F ₃ : 90:45:45 kg NPK ha ⁻¹	65.58	59.58	41.12	92.23	96.58	44.97	61.20	68.98	0.96	1.99	3.32	0.76	0.95	0.99
F ₄ : 120:60:60 kg NPK ha ⁻¹	72.75	66.50	43.39	99.94	102.23	45.34	61.95	73.76	1.04	1.99	3.83	0.72	0.78	0.88

Table 14. Effects of treatments on dry matter production, number of monopodia, sympodia and bolls plant⁻¹

Treatments	Dry Matter production (Kg ha ⁻¹)						Number of monopodia plant ⁻¹				Number of sympodia plant ⁻¹				Number of bolls plant ⁻¹			
	Expt I			Expt II			Expt I		Expt II		Expt I		Expt II		Expt I		Expt II	
	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	90 DAS	120 DAS	90 DAS	120 DAS	90 DAS	120 DAS	90 DAS	120 DAS	90 DAS	120 DAS	90 DAS	120 DAS
COTTON CULTIVARS (C)																		
C ₁ : G.COT.DH. 7	546	2840	4485	-	-	-	4.18	4.62	-	-	-	11.38	-	-	8.91	33.08	-	-
C ₂ : G.COT.DH. 9	244	2568	3884	410	1337	1591	2.52	2.88	2.52	2.75	10.75	10.77	11.85	14.55	6.98	30.98	15.51	17.57
C ₃ : DB 3-12	411	2252	3325	397	995	1459	3.26	3.52	3.45	3.69	10.25	10.53	10.77	12.80	6.56	28.73	11.10	14.63
C ₄ : MCU.7	456	2439	2582	299	1157	1223	1.90	1.97	1.29	2.65	7.16	7.25	9.98	10.09	6.32	18.41	10.82	11.10
C ₅ : ADT. 1	-	-	-	331	898	991	-	-	1.10	1.45	-	-	6.73	8.70	-	-	5.33	4.85
FERTILIZER LEVELS (F)																		
F ₁ : Control	380	1577	2436	281	886	944	2.61	2.69	1.75	2.40	9.67	10.01	8.78	10.43	6.93	19.28	8.33	8.95
F ₂ : 60:30:30 kg NPK ha ⁻¹	459	2807	3096	395	1032	1162	3.11	3.29	2.18	2.57	9.38	9.85	9.62	11.17	7.08	26.42	10.88	12.70
F ₃ : 90:45:45 kg NPK ha ⁻¹	471	2388	4247	371	1169	1572	2.98	3.58	2.17	2.38	10.00	10.08	10.58	12.43	7.58	28.82	11.23	13.73
F ₄ : 120:60:60 kg NPK ha ⁻¹	526	3327	4496	390	1300	1586	3.17	3.41	2.50	2.95	9.89	10.27	10.46	12.00	7.17	36.70	12.32	12.77

Table 15 Effects of treatments on boll weight, kapas yield, bartlett's index, ginning percentage, seed and lint index

Treatments	Boll weight (g)	Kapas Yield (q/ha)		Bartlett's earliness index		Ginning percentage		Seed Index		Lint index	
		Expt I	Expt II	Expt I	Expt II	Expt I	Expt II	Expt I	Expt II	Expt I	Expt II
COTTON CULTIVARS (C)											
C ₁ : G.COT.DH. 7	1.47	34.71	-	--	--	36.22	-	6.83	-	0.71	-
C ₂ : G.COT.DH. 9	1.82	34.77	10.84	0.71	0.51	32.69	32.37	8.63	8.53	0.54	4.09
C ₃ : DB 3-12	1.42	26.76	9.21	0.62	0.45	34.93	32.03	5.96	5.91	0.76	3.08
C ₄ : MCU.7	3.26	21.73	9.11	0.76	0.65	30.31	29.64	9.41	9.39		3.97
C ₅ : ADT. 1	-	-	6.22	0.54	0.72	-	29.60	-	10.25	-	5.13
FERTILIZER LEVELS (F)											
F ₁ : Control	1.75	19.45	6.63	0.66	0.57	33.38	31.94	7.27	8.22	0.66	3.93
F ₂ : 60:30:30 kg NPK ha ⁻¹	1.98	29.62	8.79	0.67	0.61	34.87	32.57	7.79	8.46	0.67	4.10
F ₃ : 90:45:45 kg NPK ha ⁻¹	2.13	32.54	9.42	0.65	0.58	33.13	29.48	7.98	9.08	0.65	4.19
F ₄ : 120:60:60 kg NPK ha ⁻¹	2.12	36.34	10.53	0.65	0.58	32.78	29.64	7.79	8.32	0.65	4.07

Table 16. Effect of treatments on quality parameters

TREATMENTS	2.5 % span length (mm)	50 % span length (mm)	Uniformity Ratio	Micronaire (μ /inch)	Strength (Gms /tex)	Elongation %
COTTON CULTIVARS (C)-Expt I						
C ₁ : G.COT.DH. 7	24.82	12.30	49.55	5.23	17.54	5.00
C ₂ : G.COT.DH. 9	25.24	13.34	52.85	5.20	18.00	6.10
C ₃ : DB 3-12	24.20	12.71	52.52	5.35	17.58	5.50
C ₄ : MCU.7 ADT. 1	25.21	12.59	49.94	5.50	17.65	5.90
FERTILIZER LEVELS (F)-Expt I						
CONTROL	29.93	14.92	49.84	4.73	18.15	5.40
60:30:30 NPK Kg /ha	29.77	15.21	51.09	4.78	19.59	6.10
90:45:45 NPK Kg /ha	30.35	15.36	50.60	4.91	18.87	6.40
120:60:60 NPK Kg/ha	29.95	15.04	50.21	4.63	18.80	5.30
COTTON CULTIVARS (C)-Expt II						
C ₁ : G.COT.DH. 7	22.52	11.41	50.66	5.33	14.39	7.60
C ₂ : G.COT.DH. 9	22.26	11.09	49.82	6.22	14.15	5.70
C ₃ : DB 3-12	21.28	10.49	49.29	6.58	14.33	7.80
C ₄ : ADT 1	21.46	10.86	50.60	6.27	13.82	8.10
FERTILIZER LEVELS (F)-Expt II						
CONTROL	26.57	13.60	51.18	3.85	18.47	5.40
60:30:30 NPK Kg /ha	27.14	14.26	52.54	4.07	17.50	5.40
90:45:45 NPK Kg /ha	26.55	13.77	51.86	4.30	18.12	5.30
120:60:60 NPK Kg/ha	26.14	13.72	52.48	3.98	18.00	5.70

Table 17. Effect of treatments on post harvest soil nutrient status (kg ha⁻¹) - Expt.1

TREATMENTS	Nitrogen	Phosphorus	Potassium
COTTON CULTIVARS (C)			
C ₁ : G.COT.DH. 7	145	5.23	427
C ₂ : G.COT.DH. 9	145	5.24	448
C ₃ : DB 3-12	149	6.26	466
C ₄ : MCU.7	156	7.19	469
SE d	7	1.59	21
CD (P=0.05)	NS	S	NS
FERTILIZER LEVELS (F)			
F ₁ : Unfertilized control	148	4.31	451
F ₂ : 60:30:30 kg NPK ha ⁻¹	143	5.82	445
F ₃ : 90:45:45 kg NPK ha ⁻¹	157	7.44	463
F ₄ : 120:60:60 kg NPK ha ⁻¹	148	6.34	450
SE d	7	1.59	21
CD (P=0.05)	S		NS
INTERACTION (C X F)			
SE d	9.15	3.18	42.20
CD (P=0.05)	NS	NS	NS

4.8 Integration of Physiological and biochemical traits into crop management practices

4.8.1 Evaluation of *G. herbaceum* varieties at Coimbatore

Four *G. herbaceum* varieties viz. G.Cot. 21, G.Cot.17, DB 3-12 and Jayadhar were used to study the morphological, physiological and biochemical characteristics and yield attributes. Phenological evaluation by adopting to different dates of sowing revealed that the crop sown during March and April exhibited better growth as compared to crop sown during December and January. (**Fig 13 & 14**) It was seen that varieties G.Cot.21 and G.Cot.17 produced maximum number of fruiting bodies of 213 and 197 per plant, respectively. These genotypes were seen to possess better boll weight and boll number as compared to Jayadhar. (**Table. 18**)

Table 18. Biometrical traits of select *G. herbaceum* varieties

Variety	Height cm.	Number of Sympodia	Total number of fruiting points	Squares or bolls shed	Bolls / Plant
G.Cot. 21	163	31	213	88	49
DB 3-12	146	30	192	45	63
G.Cot. 17	159	33	197	80	56
Jayadhar	146	30	190	93	23

Similarly, better yield realization of 99 and 103 gm. per plant was evident in G.Cot. 21 and G.Cot. 17 respectively. However, Jayadhar recorded lowest yield among the varieties tested. (Table 19). It was seen that G.Cot. 21 had better dry matter production as compared to other varieties (Table 20).

Table 19. Yield and yield attributes of select *G. herbaceum* varieties

Variety	Yield/Plant (g)	Av. Boll weight	GP	Seeds / Boll	Lint Index	Seed Index
G.Cot. 21	99.0	2.04	37	22	3.4	5.7
DB 3-12	84.0	1.35	36	19	2.5	4.5
G.Cot. 17	103.1	1.85	36	19	3.4	5.7
Jayadhar	39.0	1.69	39	19	3.4	5.4

Table 20. Dry Matter distribution in select *G. herbaceum* varieties

Variety	Root	Stem + Sympodia	Leaf	Bur	Total Kapas
G.Cot. 21	28	113	44	39	99
DB 3-12	15	65	35	39	84
G.Cot. 17	22	91	47	42	103
Jayadhar	20	90	32	26	39

4.8.2 Physiological and productivity attributes of released *G. herbaceum* varieties and prerelease cultures

G.Cot 13 exhibited its high yielding ability with production of more number of fruiting bodies and good bolls. Pre-release cultures GCHV-820-91 and RBDV 14 were also seen high yielding with 55 – 64 g per plant. *G. herbaceum* culture GCHV-820-91 recorded highest number of bolls (34 per plant) with mean boll weight of 2 g. (Table 21).

Table. 21. Productivity attributes of *G. herbaceum* cotton (2002)

Genotypes	Plant Height (cm)	Sympodia (No.)	Boll Number	Boll Weight (g)	Yield (g/plant)
GBHV 189	122	19	17.3	2.12	36.2
GCHV 346	116	21	20.6	2.25	46.4
GCHV 820 91	115	17	34.3	1.90	66.1
G.Cot 13	86	17	33	1.96	64.6
G. Cot. 21	102	18	25	1.68	42.0
Dig Vijay	92	18	22.3	1.90	42.4
RBDV 14	117	20	21.6	1.77	55.9
RAHS 129	121	22	23.6	2.05	48.4
Mean	108	21	25.9	1.97	50.2

In general, *G. herbaceum* cultures evaluated in this trial maintained 17 – 21 sympodial numbers, average boll number of 20 – 25 per plant with mean boll weight ranging between 1.68 – 2.25 g. The mean yielding ability of other *G. herbaceum* cultures was in the range of 35 – 50 g per plant.

4.8.3 Evaluation for useful physiological and biochemical traits in *G. herbaceum* genotypes

Nine *G. herbaceum* cultivars were seen to possess higher Nitrate Reductase activity ranging between 3.8 – 4.9 $\mu\text{m}/\text{h}/\text{g}$ F.w. at 25 days and 2.3 – 5.1 $\mu\text{m}/\text{h}/\text{g}$ F.w. at 35 days stage. A moderate level of NR activity was seen in 70 and 110 days after sowing stage with a range of 1.2 – 2.8 as compared to *G. hirsutum* cultivars showing a decline in activity. The steady state maintenance of soluble protein content and reducing sugar content levels of *G. herbaceum* cultivars viz. G.Cot. 13, G.Cot.17, G.Cot. 21, Kudakoti, Digvijay, Pusopati, Jayadhar, RAHS.119 and GShv 384 / 92 during growth period was discernible. The range for total phenolic content in leaves was observed to be 2.08 – 3.03 mg / g at 25 days and 2.65 – 4.17 mg / g at 70 days old plants of *G. herbaceum* cultivars. The activity of metabolically important protective enzyme viz., Peroxidase was studied during crop growth in *G. herbaceum* germplasm lines. There was wide variability for Peroxidase activity among *G. herbaceum*

germplasm lines, both under field and controlled conditions, with the range being 94 – 190 and 29 – 83 optical density units per minute per gram fresh weight, respectively.

Desi hybrids G.Cot.DH-7 and G.Cot.DH-9 exhibited better growth recording higher plant height at 75 days after sowing stage and maintained continuous plant growth at 100 days after sowing stage as compared to other *G. herbaceum* varieties and promising germplasm lines (**Fig. 15**). The desi hybrids and some *G. herbaceum* genotypes like DDHC 11 and Wagad produced maximum number of nodes and leaves per plant (**Fig. 16 and Fig. 17**). The performance of desi hybrids was again noticed to be consistent leading to better yield realization also.

A good amount of variability was seen among the *G. herbaceum* cultures for reducing sugar content, soluble protein content and total phenolics at 30, 90, 120 and 150 days after sowing stage during 2001-2002 (**Fig. 18, 19 and 20**). Most of the *G. herbaceum* cultures maintained a better metabolic status by way of moderately higher NR activity (2-4.5 $\mu\text{moles/hr/g}$ fresh weight) and uniform distribution of peroxidase activity in subtending leaves during growth stages (**Fig. 21 and 22**). Many cultures maintained equally higher activity of NR during 2002-2003 also, as seen during previous years (**Fig 23 and 24**).

4.8.4 Evaluation of promising *G. herbaceum* lines for seed oil content

Select *G. herbaceum* germplasm lines evaluated for seed oil content revealed a range of 15 to 18%. Further screening of working collection of germplasm for seed protein and seed oil is under progress.

4.8.5 Salinity stress tolerance in *G. herbaceum* cotton

CICR, RS, Coimbatore:

It was seen that germination percentage, shoot length and root length remain marginally affected with increasing levels of NaCl salinity stress from 0 to 12 dS/cm. However, shoot length was affected due to 12 EC levels of NaCl salinity stress in G.Cot.13, G.Cot. 21 and DB 3-12 to an extent of 15-20% with marginal decline in germination percentage. On the other hand, the effect brought about by Na₂SO₄ salinity stress was more profound with parameters like germination percentage, shoot length and root length being affected by higher magnitude at 12 EC levels as compared to corresponding stress levels due to NaCl salinity. The decrease brought about by 12 EC levels of Na₂SO₄ stress ranged between 25-30% for shoot length and 24-32% for root length.

Biochemical mechanisms of tolerance to abiotic stresses: G herbaceum cultivars maintained better metabolic profile during germination and early growth phase by way of maintaining efficient Nitrate Reductase activity, Soluble protein accumulation, Reducing sugar content and higher peroxidase activity under controlled conditions and even under higher levels of salinity stress. Higher levels of peroxidase activity in *G. herbaceum* seedlings subjected to salinity stress helped them in overcoming the impact of stress by protective action. The specific activity of acid and alkaline phosphatase increased moderately with increasing levels of salinity stress without any perceptible damage to the subcellular organelles. This was reflected in maintenance of better integrity of sub-cellular membranes even under stress which led to only marginal decline of 5-15% in the fresh weight of seedlings at higher levels of stress. In general, *G. herbaceum* genotypes exhibited better tolerance to salinity stress as compared to popular *G. hirsutum* cultivars.

Thirty *G. herbaceum* cultures were screened during early growth stages for their response to salinity stress. Salinity levels of 12 EC levels were seen hampering root and shoot growth as noticed during earlier experiments. Genotypes RAHS.14, RAHS.131, Dhumad, Wagad and G. Cot DH-7 were seen to tolerate higher levels of NaCl and Na₂SO₄ stress as compared to Jayadhar and DB 3 -12.

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In general, seed cotton yield was decreased with increase in salinity levels. Among the genotypes, RAHS.14 had the highest seed cotton yield at all the salinity levels. Total dry matter also decreased with increase in salinity level in all the genotypes. The cv. RAHS-14 recorded higher total dry matter at all the salinity levels, while Jayadhar and Dhumad had lower percent reduction in dry matter at higher salinity level.

It was seen that the number of bolls per plant and boll weight were reduced with increase in salinity level (**Table. 22**). The genotypes RAHS-14 and Jayadhar had higher boll number but Dhumad showed greater reduction in both boll weight and boll number. The genotype RAHS-14 would be better suited for salinity stress conditions.

Table. 22. Effect of salinity stress on yield and yield attributes at Gangavati

Entries	Yield (g/Plant)	Number of bolls / plant	Boll weight	Plant height (cm)	Total dry matter (g / plant)
DHUMAD	30.70	13.70	2.16	74	125
RAHS-14	39.58	17.31	2.28	78	153
JAYADHAR	39.05	17.19	2.25	78	147
CD at 5%	0.507	0.337	0.059	2.0	8.1

During second successive year, evaluation of salt tolerance of *G. herbaceum* genotypes was taken up on research farm at ARS, Gangavati. The saline soil is characterized by a natural gradient which ranges from 4 to 16 dS/m. During first year evaluation, RAHS-14 had recorded highest seed cotton yield and even during second year of evaluation, RAHS-14 recorded highest seed cotton yield followed by DDHC-11. (Table 23) (Plate 4)

Table 23. Effect of different levels of soil salinity on Seed cotton yield (kg/ha) of *G. herbaceum* and *G. arboreum* cotton genotypes at Gangavati

<i>G. herbaceum</i>	ECe (dS/m)		Mean	<i>G. arboreum</i>	ECe (dS/m)		Mean
	4-6	6-8			4-6	6-8	
RAHS.14	981	771	876	PA 183	910	708	809
DDHC 11	911	611	761	AK 235	802	434	618
DB 3-12	843	595	719	MDL 2463	776	520	648
Gchv 875	789	573	681	DLSA 17	736	524	630
Jayadhar	768	549	659	PA 255	726	466	596
Gchv-350	722	428	575	J Tapti	696	542	619
Gchv 149	697	387	542	CINA 310	693	490	591
Gcot21	668	431	550	AK9431	669	470	569
Mean	797	543	670	Mean	751	519	635
	EC	Var.	E x V		EC	Var.	E x V
SEm±	026	052	073		024	048	068
CD5%	075	150	NS		069	138	NS
Salinity Regime	Promising genotypes identified						
	<i>G. arboreum</i>			<i>G. herbaceum</i>			
4-6	PA 183,AK235,MDL 2463			RAHS.14,DDHC 11,DB 3-12			
6-8	PA 183,DLSA 17, MDL 2463			RAHS.14, DDHC 11, DB 3-12			

Taking into account of both these species, *G. herbaceum* variety RAHS-14 recorded highest mean seed cotton yield of 876 kg/ha, followed by *G. arboreum* variety PA-183 (809 kg/ha) and *G. herbaceum* variety DDHC-11(761 kg/ha).

Detailed tolerance study was conducted using RAHS.14 and Jayadhar under natural gradient. Different yield components, physiological parameters, biophysical and biochemical characters were evaluated. RAHS-14 exhibited superior performance over Jayadhar in terms of yield, boll weight, number of bolls/plant, total dry matter, leaf area, photosynthetic rate, stomatal conductance, catalase activity, total chlorophyll content, proline content, sugar content, K/N ratio. All these point to higher vigour and physiological efficiency of RAHS-14 under saline situation. (Table. 24)

Table: 24. Performance of RAHS-14 under various salinity levels (ds/m) at Gangavati - S₁=1.0, S₂ = 4.8, S₃ = 8.5, S₄= 14.8

Characters	Salinity levels									
	S ₁		S ₂		S ₃		S ₄		Mean	
	RAHS-14	Jayadhar	RAHS-14	Jayadhar	RAHS-14	Jayadhar	RAHS-14	Jayadhar	RAHS-14	Jayadhar
A. Yield and yield components										
1. Yield (g/plant)	50.36	47.07	41.78	39.72	34.68	33.00	25.44	23.53	38.07	35.83
2. Boll weight (g)	2.38	2.31	2.29	2.23	2.15	2.10	2.10	2.07	2.23	2.18
3. No. of bolls per plant	21.26	20.29	18.19	17.75	16.17	15.77	12.17	11.30	16.95	16.28
B. Physiological characters										
1. Total dry matter (g/plant)	187.20	182.73	172.91	166.70	141.23	134.05	104.44	98.40	151.45	145.47
2. Leaf area (dm ² /plant)	104.66	103.30	99.39	98.13	84.13	83.41	70.35	67.37	89.63	88.05
C. Biophysical characters										
1. Photosynthetic rate (μ mol. CO ₂ m ⁻² S ⁻¹)	30.54	29.08	28.14	27.60	25.10	24.37	19.06	18.83	25.71	24.97
2. Transpiration rate (m.mol.H ₂ O m ⁻² S ⁻¹)	8.73	8.92	8.25	8.38	8.00	8.10	7.77	7.97	8.19	8.34
3. Stomatal conductance (μ mol. CO ₂ m ⁻² S ⁻¹)	0.307	0.294	0.283	0.264	0.232	0.223	0.217	0.200	0.260	0.245
D. Biochemical characters										
1. Catalase activity (Units.g ⁻¹ fr.wt.)	233	231	232	230	228	226	218	205	228	223
2. Peroxidase activity (Δ OD/sec / mg protein)	0.936	0.959	0.969	0.981	1.077	1.093	1.172	1.221	1.039	1.064
3. Total Chlorophyll content (mg g ⁻¹ ft. wt)	0.984	0.968	0.979	0.959	0.877	0.849	0.821	0.797	0.915	0.893
4. Proline content (mg g ⁻¹ dry wt)	56.18	52.49	59.77	56.93	76.07	71.09	94.47	85.39	71.62	66.48
5. Sugar content (mg/g dry. Wt.) (mg g ⁻¹ dry wt)	24.53	21.11	27.61	23.37	30.33	28.74	32.60	30.89	28.77	26.03
6. K/Na ratio	14.94	14.01	4.49	3.88	3.01	1.97	2.53	1.79	7.22	5.86

Screening of *G. herbaceum* lines against salinity stress under field conditions at Bharuch

Twelve entries including G, Cot 21 and G. Cot. 23 were screened for salinity tolerance under field conditions in saline soil at Aladar, Taluk Vagara and District Bharuch. GVhv – 348, GBhv 221 and GBhv 191 out yielded superior check as regards seed cotton yield (**Table. 25**)

Table: 25. Growth attributes and yield of *G. herbaceum* lines at Bharuch

Entry	No. of Bolls / plant	Seed cotton yield (kg/ha)	Mean Staple Length	Growth and Vigour
GVhv - 235	16	677	16.3	Medium
GVhv – 275	15	756	21.5	Medium
GVhv – 346	16	693	18.7	Medium
GVHv – 348	26	1031	16.3	Good
GVhv – 350	14	538	20.0	Medium
GBhv – 221	27	1002	22.5	Good
GBhv – 198	13	569	25.0	Medium
GBhv – 228	17	767	23.2	Medium
GBhv – 233	18	747	24.5	Medium
GBhv – 191	20	942	21.8	Medium
G. Cot. 21 (C)	15	693	19.0	Medium
G. Cot 23 (C)	14	611	20.4	Medium
CD @5%	4.1	220	7.8	Medium

Screening for Salinity tolerance at RARS, Lam, Guntur

Fifteen entries of *G. herbaceum* cotton were evaluated for salinity tolerance at Guntur.

Root Shoot ratio: Based on the mean root shoot ratio, the entries G Cot 21, G. Cot. 17 and Jayadhar can be categorized as saline tolerant genotypes.

Nitrate reductase activity in leaves: NR activity was estimated in cotton leaves at 90 DAS. At 8 EC, the entries Dhumad, G.Cot 13, G. Cot. 23 and Jayadhar recorded highest NR activity indicating their superiority in performance to rest of the varieties.

Proline accumulation in leaves: Under salinity stress conditions, proline is accumulated in the leaves and squares of cotton and they were estimated at 90 DAS. In both the leaves and squares, more proline accumulation was seen with increased salinity. The entries Dhumad, Jayadhar, G. Cot. 17 and G. Cot. 21 accumulated more proline in leaves and squares indicating their tolerance, both for salinity and drought.

Based on the root shoot ratio, proline accumulation in leaves and squares and NR activity, the entries viz., Dhumad, Jayadhar, G. Cot. 17 and G. Cot. 21 can be categorized as salinity and drought tolerant genotypes.

Screening for salt tolerance at Karaikal

Detailed studies were conducted to screen eight *desi* cotton varieties/genotypes viz., G.Cot.DH 9, G.Cot. 21, DB 3-12, Jayadhar, G.Cot. 23, G.Cot. DH 7, RAHS.132 and RAHS.14 along with two *hirsutum* varieties MCU 7 and SVPR 3 for salt tolerance. Salt solution of different concentrations was prepared as suggested by Sajjid (1988) by dissolving MgCl₂, NaCl, CaCl₂, and Na₂SO₄ in distilled water in the ratio 1:4:5:10 to give an EC of 12.5 dSm⁻¹. This solution was further diluted with different quantity of distilled water to give various EC values of 0, 4, 8 and 12 dSm⁻¹.

The seeds were allowed to germinate for a period of 14 days at room temperature; the germination count was taken and length of root and shoot was measured. Vigour index was computed as suggested by Perry (1978) which is as follows: *Vigour index = (Seedling length/fresh weight) x germination percentage.*

Among the genotypes, the *desi* cotton genotypes had more tolerance than *hirsutum* varieties. This was clearly observed in the mean tolerance indices of *desi* cotton varieties viz., RAHS.132 (80.63), G. Cot. 23 (79.81), RAHS.14 (77.30), and G.Cot.21 (75.32) than *G. hirsutum* varieties MCU7 (44.06) and SVPR 3 (52.74). Superiority of *desi* cotton genotypes under salt stress was also observed in the vigour components in terms of speed of germination, seedling length, dry weight of seedling and vigour index (**Table. 26**)

Summing up the detailed evaluations carried out at various centres, it could be concluded that desi cotton genotypes, especially G. Cot 17, G.Cot 21, Dhumad, Jayadhar, RAHS.14, RAHS.131 and desi cotton hybrids G. Cot DH 7 and G. Cot DH 9 possess inherent physiological and biochemical potential to tolerate stress conditions like salinity and suitable for cultivation in coastal saline tracts. Since the emergence and initial establishment decides the crop stand under field conditions, selection of varieties with higher salt tolerance index is a preferable character for breeding programme in cotton. These genotypes have since been deployed appropriately in breeding programme.

Table 26. Mean performance of seed characters under different levels of salt solutions

Variety	Salt Conc.	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Vigour Index (VI 1)	Salt tolerance Index	Mean Salt tolerance Index
G.Cot.DH.9	0	92	46.00	4.97	7.25	1124		58.39
	4	80	34.91	4.47	5.42	791	70.37	
	8	76	27.57	3.97	4.93	676	60.14	
	12	76	24.91	3.36	3.24	502	44.66	
MCU 7	0	88	20.56	10.24	10.55	1830		44.06
	4	84	28.01	5.39	8.60	1175	64.21	
	8	84	38.0	4.15	4.91	761	41.59	
	12	76	31.05	2.81	3.55	483	26.39	
G.Cot.21	0	96	19.88	6.95	8.83	1515		75.32
	4	93	22.16	6.42	7.16	1263	83.37	
	8	92	22.09	5.87	6.39	1128	74.46	
	12	92	35.87	4.98	6.24	1032	68.12	
DB 3-12	0	100	47.73	5.92	8.34	1426		57.64
	4	84	17.09	5.31	6.17	964	67.60	
	8	76	26.89	4.71	5.89	806	56.52	
	12	72	23.21	4.43	5.23	696	48.81	
Jayadhar	0	80	14.50	5.85	8.21	1125		64.74
	4	76	22.35	4.69	7.49	926	82.31	
	8	72	13.77	4.30	6.72	793	70.49	
	12	72	6.57	2.60	3.87	466	41.42	

Table. 26 Contd..

Variety	Salt Conc.	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Vigour Index (VI 1)	Salt tolerance Index	Mean Salt tolerance Index
G.Cot. 23	0	100	50.00	4.89	6.55	1144		79.81
	4	96	44.80	4.29	6.51	1037	90.65	
	8	92	38.00	4.20	5.92	931	81.38	
	12	92	31.27	3.57	4.81	771	67.40	
SVPR3	0	84	29.21	7.35	11.28	1565		52.74
	4	76	27.01	4.89	7.34	930	59.43	
	8	74	20.60	4.32	7.43	863	55.14	
	12	72	31.24	3.05	6.44	683	43.64	
G.Cot.DH.7	0	84	28.54	7.11	8.18	1284		50.75
	4	82	22.04	3.92	5.21	749	58.33	
	8	80	12.33	3.50	5.02	682	53.12	
	12	76	31.82	2.18	4.71	524	40.81	
RAHS.132	0	96	28.37	5.95	7.17	1260		80.63
	4	92	31.05	5.05	7.08	1116	88.57	
	8	92	19.71	4.26	6.66	1005	79.76	
	12	92	17.95	3.70	6.38	927	73.57	
RAHS.14	0	84	21.82	4.95	8.56	1135		77.30
	4	84	17.04	4.78	7.35	1019	89.78	
	8	82	10.97	4.11	6.23	848	74.71	
	12	80	20.10	4.04	5.52	765	67.40	

4.8.6 Screening for drought tolerance

Konanki: The yield differences among the fifteen entries screened under field conditions at Konanki for tolerance was found to be significant. Maximum seed cotton yield of 2033 kg / ha was recorded by G. Cot. DH-9 followed by G. Cot. DH-7 (1917 kg / ha), RAHS.14 (1767 kg / ha) and DDHC 11 (1691 kg / ha) and are found to be at par with each other. Maximum boll weight of 2.23 g was recorded by GBHV 125, followed by RAHS.14 (2.11 g) and G. Cot. DH-9 (2.0 g). Maximum ginning percentage of 34.6% was recorded by G. Cot. DH-7 (**Table 27**).

Table. 27. Yield and physiological characteristics of *G. herbaceum* entries (Konanki)

Name of the Variety	Seed Cotton Yield (Kg / ha)	Days to 50% flowering	Plant height (cm)	Boll weight (g)	Ginning percent (%)
GBHV 171	990	71	72.7	1.7	33.2
RAHS 129	758	68	75.0	1.6	33.9
RAHS.14	1767	73	116.7	2.1	34.2
RAHS 135	1427	78	100.0	1.8	33.1
RAHS.131	1524	72	108.3	1.9	33.8
Dhumad	1093	75	103.3	1.5	33.2
GBHV 215	975	76	93.3	2.2	34.1
DDHC 11	1691	70	90.3	1.7	33.6
GBHV 202	1419	76	78.3	1.8	33.8
GSHV 531 / 32	748	76	85.0	1.7	33.9
G.Cot GH 9	906	72	73.3	1.7	34.2
GBHV 180	747	75	85.0	1.8	33.7
G. Cot DH-7	1917	73	85.0	1.5	34.6
G. Cot DH-9	2033	76	100.0	2.0	33.2
CD 5%	376				

Surat: Leaf area and dry matter per plant at 90 and 135 DAS also showed significant differences amongst the cultures. G. Cot. DH-9 registered highest dry matter both at 90 and 135 DAS. Amongst the promising cultures, GBhv 178, GShv 531/92, GBhv 171 exhibited greater dry matter, particularly at 135 DAS. Specific leaf weight (SLW) was significantly high in G.Cot DH.9 and at par with that in G.Cot DH.7 at 90 DAS. Relative Water Content (RWC) did not differ significantly amongst the genotypes. **(Table 28).** Biochemical parameters viz., Nitrate reductase activity and proline accumulation in leaves was found to significantly differ amongst genotypes. Pooled results for yield (2000-2002) exhibited significant differences. G.Cot. DH.9 out yielded all other genotypes, which was at par with G.Cot. DH 7. GBhv 198, GShv 531/ 92 and RAHS.131 were promising amongst genotypes, yet significantly lower than G.Cot DH.7 and G.Cot.DH.9. Therefore, *Desi* hybrids G.Cot DH.7 and G.Cot DH.9 were the two best cottons under drought situation with *G.herbaceum* lines RAHS.131 and RAHS.14 registering good yields under drought stress.

Dhandhuka:

Compared to the superior check G.Cot. DH.9 (1148 kg/ha), none of the entries proved to be significantly superior in seed cotton yield. Only one entry RAHS.131 (1089 kg/ha) significantly surpassed another check Digvijay (763 kg/ha) in seed cotton yield. The variety G.Cot.17 recorded highest lint yield (436 kg/ha), followed by the entry RAHS.131 (410 kg/ha). The GOT values of these entries ranged from 31.0 to 46.4% as against 32.7% of G.Cot DH.9 and 46.7% of Digvijay. In fibre quality parameters, these entries have short to medium staple (19.2 to 27.1 mm) with coarse to medium fine (5.7 to 4.6 mv), average to medium in maturity (0.73 to 0.85) and fibre having very low to average strength (13.3 to 20.7 g/tex).

Khapat:

The trial consisted of 17 entries including G. Cot DH-9 and Digvijay as checks with three replications under rainfed conditions of Khapat. As compared with superior check G.Cot. DH.9 (1233 kg/ha), none of the entries proved to be significantly superior in seed cotton yield. However, four entries viz., RAHS.14 (1271 kg/ha), RAHS 221 (1048 kg/ha), DLSA 8 (1170 kg/ha) and DLSA 24 (1000 kg/ha) significantly surpassed another check Digvijay (709 kg/ha) in seed cotton yield.

Table 28. Screening of *G.herbaceum* genotypes for drought tolerance (135 DAG)

Varieties	Leaf area	Dry matter (g/pl)	Specific leaf wt.	R.W.C. %
G.Cot.13	6949	136	7.20	78.5
G.Cot.17	10270	151	5.84	70.4
G.Cot.21	8633	123	6.37	73.0
G.Cot.23	7958	136	6.63	74.5
Dhumad	10303	154	4.88	69.6
Wagad	6940	104	7.40	72.3
Digvijay	11746	171	5.59	71.9
V 797	7365	144	6.83	78.0
G.Cot. DH 7	6458	193	6.41	71.2
G.Cot. DH.9	11280	318	5.53	65.4
GBhv 171	14674	205	5.68	70.9
GBhv 180	7862	241	7.97	63.6
GBhv 202	5208	112	7.94	76.8
GBhv 198	8049	165	5.87	62.9
GBhv 531/92	12374	236	5.24	65.6
RAHS.131	4875	175	12.25	70.3
RAHS 129	7339	126	6.82	73.5
RAHS.132	6407	193	6.94	72.1
RAHS.14	8161	116	5.76	79.3
DDHC 11	8667	172	6.25	71.4
Jayadhar	5108	174	6.86	77.0
DB 3-12	5450	201	6.46	74.0
S.Em.+	488	28	0.63	8.21
CD @ 5%	1392	80	1.86	NS
CV%	10.2	28.6	16.9	19.8

4.9 Phenological studies on *G.herbaceum* cotton

4.9.1 GAU, Surat

In this trial conducted at Surat, G.Cot. 17, G.Cot. 21, Jayadhar and DB 3-12 were evaluated. Physiological parameters measured after 100 days after germination (DAG) indicated that leaf area was drastically reduced when sowing was taken up later than August. As the sowing was delayed, the days required for 50% flowering and boll bursting were increased. Shorter day length and increasing temperature adversely affected the growth and phenology of *G.herbaceum* varieties as seen from reduced leaf area and biomass (**Table. 29**).

Table. 29 Phenological behaviour of *G.herbaceum* varieties at Surat

Varieties	Aug.2000	Sept. 2000	Oct. 2000	Nov. 2000	Dec. 2000
Leaf area cm ² (100 DAG)					
G.Cot. 17	8389	801	295	251	219
G.Cot.21	3919	825	286	58	290
Jayadhar	7495	834	236	-	-
DB 3-12	6908	1415	439	571	216
Biomass (g) 100 DAG)					
G.Cot. 17	113	20.4	13.0	3.73	3.0
G.Cot.21	61	25.9	9.3	2.38	4.18
Jayadhar	111	19.9	8.8	-	-
DB 3-12	109	29.0	14.1	7.08	3.85
Plant height (cm)					
G.Cot. 17	103	69	66	28	22
G.Cot.21	106	76	49	18	26
Jayadhar	94	75	51	-	-
DB 3-12	109	84	66	45	27
Days to 50% flowering					
G.Cot. 17	87	98	159		
G.Cot.21	140	161	160		
Jayadhar	80	92	103		
DB 3-12	83	89	115	127	
Days to 50% boll bursting					
G.Cot. 17	147	163			
G.Cot.21	200	211			
Jayadhar	141	134			
DB 3-12	141	145	154		

During 2002, physiological parameters monitored after 100 days after sowing indicated that the leaf area, biomass and plant height was drastically reduced in later than August sowing in all four varieties. However, April sown crop produced maximum leaf area, biomass and plant height. Bright sunny days and irrigation

appeared to have contributed to it. It was more than that in July or August sowing which encountered cloudy days and shorter day lengths.

Days required to 50% flowering as well as boll bursting, contrary to leaf area and biomass, increased as the sowings were delayed beyond August. Sowing after March upto July reduced the days required for flowering and boll bursting. On an average, minimum days to 50% flowering were observed in August sowing and 50% boll bursting in June sowings.

4.9.2 PAJANCOA, Karaikal

To study the phenology of *G. herbaceum* Cotton under Karaikal situation, two varieties viz., G. Cot. 13 and DB 3-12 were taken for monthly sowing in cement pots. *G. hirsutum* variety viz., SVPR 3 was also included as a third entry, for comparing the phenological traits of both *hirsutum* and *G. herbaceum* varieties.

The date on days to squaring, days to flowering and mean boll weight are presented in **Table 30**. The observations revealed that March 2001 sown crop took 58 days for flowering as compared to December 2000 sown crop, which flowered in 78 days. Similarly the days to 50% flowering also reduced by 20 days for the March 2001 sowing (72 days), as compared to the December sown crop (99 days). *G. hirsutum* genotype SVPR 3 (December sown) was found to be one week earlier than the *G. herbaceum* genotypes (65 days) with respect to 50% flowering.

Observation on mean boll weight also revealed the increase in mean boll weight in the December-sown crop compared to the first month-sown crop. January and February month sown crop are also similar in all aspects of December month sown crop except in days to 50% flowering. The *G. hirsutum* genotype SVPR 3 (Sixth month sowing – 65 days) is 15 days earlier than the *G. herbaceum* genotypes (80 days).

From June 2001 sowing onwards, the days to flowering and 50% flowering started to increase in all the three genotypes. In June 2001, flowering started in G.Cot.13 and DB 3 – 12 from 60th day and in SVPR 3 it was from 55th day. Similar pattern was observed in July month sowing also. Days to 50% flowering was observed on 82, 81 and 70 days during June 2001 sowing for G.Cot. 13, DB 3 – 12 and SVPR 3 respectively. During July 2001 sowing, it increased as 84 and 86 days for G.Cot.13 and DB 3 – 12, respectively.

Number of bolls per plant decreased in G.Cot. 13 from 93 (Jan 2001) to 40 (June 2001), for DB 3 – 12 from 89 (Jan 2001) to 40 (June 2001) and for SVPR 3 from 63 (March 2001) to 22 (June 2001). The same trend of decrease in yield in single plant yield also was observed for all the three genotypes. G.Cot.13 recorded single plant yield of 173.4 g during January month sowing and decreased to 53.63 g when the crop was sown during June. Similarly for DB 3- 12 it decreased from 187 g (January sowing) to 44.29g (June sowing).

Pot culture experiment was undertaken from February 2002 to study the phenology of *G.herbaceum* genotypes viz., G. Cot. DH-7, G. Cot. DH-9, G.Cot. 13, DB 3-12 and SVPR 3 (*hirsutum* variety for comparison). Observations on days to square formation, days to flowering and days to 50% flowering were recorded. Sowing was taken up on 9th of every month and two sowings were taken up. In February 2002 sown crop, minimum days to squaring were observed as 30 days for SVPR 3 followed by 32 days and 42 days for G. Cot. DH-7 and DB 3-12. Days to squaring were in increasing trend as the months increased. In April 2002 sown crop, days to squaring for SVPR 3 was 32 days followed by G.Cot.DH-7 (36 days), G.Cot.DH-9 and DB 3 – 12 (37 days and G.Cot. 13 (39 days). Days to flowering was observed on 49 DAS in SVPR 3 in February 2002 sown crop followed by G. Cot. DH. 9 and DB 3 – 12 (50 DAS), G. Cot. DH-7 and G. Cot. 13 (52 DAS). This trend was maintained in March 2002 month sowing also.

The phenological studies revealed that the best month for sowing cotton after rice is between January and February under Karaikal situation.

Table 30. Phenological traits of *desi* cotton-2001

Sowing month	Entries	Days to squaring	Days to initial flowering	Days to flower from squaring	Days to 50% flowering	Days taken from initial to 50% flowering	Boll weight (g)	No of bolls per plant	Single plant yield(g)
I 09.12.00	G. Cot.13	---	78	---	99	---	1.14	106	---
II 09.01.01	G. Cot.13	50	71	21	94	23	1.21	93	173.4
	D. B.3-12	52	69	17	92	23	1.18	89	187.0
III 09.02.01	G. Cot.13	40	60	20	76	16	1.06	89	128.2
	D. B.3-12	40	62	22	76	14	1.22	75	147.4
IV 09.03.01	G. Cot.13	40	58	18	72	14	1.16	65	100.23
	D. B.3-12	38	58	20	73	15	1.12	72	96.35
	SVPR 3	35	54	19	65	11	1.56	63	100.60
V 09.04.01	G. Cot.13	42	60	18	82	22	1.26	56	100.25
	D. B.3-12	39	58	19	80	22	1.36	46	85.32
	SVPR 3	34	52	18	68	16	1.45	23	99.35
VI 09.05.01	G. Cot.13	41	59	18	80	21	1.12	42	80.45
	D. B.3-12	40	58	18	80	22	1.14	38	66.48
	SVPR 3	34	52	18	65	13	1.60	20	84.36
VII 09.06.01	G. Cot.13	40	60	20	82	22	1.10	40	53.63
	D. B.3-12	41	60	21	81	21	1.11	40	44.29
	SVPR 3	36	55	19	70	15	1.48	22	60.58
VIII 09.07.01	G. Cot.13	41	62	21	84	-	-	-	-
	D. B.3-12	41	60	19	86	-	-	-	--
	SVPR 3	35	54	19	70	-	-	-	-

4.10 Cropping system Approach using *G. herbaceum* cotton

Cotton monocropping is detrimental and yield will decline faster over seasons irrespective of best crop management practices. Hence, diversified cropping systems and crop rotations are to be followed for effective maintenance of soil fertility and sustainability of crop production.

4.10.1 Desi Hybrid Cotton based intercropping trial (CICR, RS, Coimbatore)

Desi Hybrid Cotton based intercropping experiment was conducted at CICR, Regional Station, Coimbatore involving *desi* cotton hybrid G. Cot DH 9 and intercrops like Cow Pea, Onion, Black gram, Pigeon Pea and beet root with Cotton alone as control. The superiority of intercropping system of Desi cotton Hybrid (G. Cot DH 9) with inter crops like Black gram, Cow pea and Onion was evident (**Plate. 3**). Intercropping helped in realization of cost benefit ratio of 1: 2 as compared to 1:1.8 by sole crop of desi cotton hybrid. A net Cotton equivalent yield of 23 to 25 q/ha could be obtained in cotton intercrop system as compared to 19 q/ha in sole crop of desi hybrid cotton.

4.10.2 Performance of released varieties as intercrop in cashew nut orchard at NRC, Puttur

This experiment was conducted in 10 years old cashew nut orchard at NRC, Puttur. The crop stand was good. Vegetative growth was quite promising but reduced reproductive growth led to zero sympodia. Number of bolls observed were restricted to the main stem. Negligible seed cotton yield was realized (2.5 – 13.75 g / plot).

4.10.3 Cropping System trial at Guntur

The performance of *G. herbaceum* genotypes in rice fallows was evaluated at Konanki during Rabi 2001-2002 at Konaki. G. Cot DH 9 outyielded other genotypes by yielding 9 q/ha.

Table18. Performance of cotton genotypes in rice fallows (Konanki)

Genotypes	Plant Height (cm)	No. of Sympodia	No. of Bolls / Plant	Seed Cotton Yield (kg / ha)	2.5 % Span length (mm)
DB 3-12	110	5.8	7.2	490	19.6
G. Cot DH-7	135	10.2	22.0	815	22.8
G. Cot DH-9	130	9.7	25	940	23.1
Krishna	127	13.6	16	780	25.0

4.10.4 Intercropping trials at Karaikal

An intercropping experiment involving desi cotton hybrid was conducted during rice fallow 2003 with one *desi* hybrid (G.Cot DH-9) and two *hirsutum* varieties (MCU 7 & ADT 1). Two intercrops viz., Black gram (ADT 3) and Green gram (Virinjipuram 1) were raised at two proportions (one row of intercrops and two rows of intercrops). Recommended dose of 60: 30: 30 Kg NPK ha⁻¹ was applied to the cotton crop and no fertilizer was applied to the intercrop.

The intercrops were harvested between 56 and 70 days. The seed cotton were harvested in five pickings. Seed cotton yield was high in sole crops than that of intercropped cotton except DH 9 which gave slightly higher yield (1305 kg/ha) when intercropped with one row of black gram than its pure stand (1278kg/ha). The variety ADT 1 and MCU 7 registered kapas of 1095 and 1275 kg/ha respectively as pure crop. Both under sole crop as well as under intercropping condition G. Cot. DH-9 *desi* hybrid recorded more seed cotton yield than MCU 7 and ADT 1 (**Plate 3**).

Hence, it can be inferred that the seed cotton yield and black gram yield were found to be higher in the treatment combination of G. Cot DH-9 with one row of black gram with same level of input (60:30:30kg/ha NPK) as recommended for cotton varieties under rice fallow situation.

4.11 Development of suitable package of practices for cotton in coastal agroecosystem of Sundarbans in West Bengal

Cotton is cultivated in coastal tracts of South and North 24 Parganas districts, commonly known as Sundarbans, with the land being low to medium lying and soil salinity ranging between 2 – 8 mmhos/cm. After harvest of paddy, a non-traditional crop like Cotton can be grown successfully under problematic conditions such as drought and soil salinity prevalent during rabi-summer season. Hence, special attempts were made through this NATP project for development of suitable package of practices for coastal agro ecosystem of Sundarbans in West Bengal.

4.11.1 Influence of Nitrogen on productivity of *G. herbaceum* cotton in coastal agroecosystem of Sundarbans (West Bengal)

The treatments comprised of six varieties belonging to *G. hirsutum* & *G. herbaceum* (G.Cot 16, G. Cot 10, Surat dwarf, G. Cot DH-7, G. Cot DH 9 and LRA 5166) and 3 levels of Nitrogen (40 Kg/ha, 60 kg/ha and 80 Kg/ha). A general dose of 40 Kg P₂O₅/ha and 30 Kg K₂O/ha were applied uniformly as SSP and MOP. Surat dwarf produced higher seed cotton yield (788 kg/ha), followed by G. Cot 16 (627kg/ha) and G. Cot 10 (595 kg/ha). The yield increased significantly with increase in N level in both *G. herbaceum* and *G. hirsutum* cotton genotypes. Application of 40 and 80 kg N/ha increased the yield by 22 and 64%, respectively over 20kg N due to overall improvement in yield contributing components.

4.11.2 Performance of *G. hirsutum* cotton cultivars under saline coastal agro ecosystem of Sundarbans

Field data on growth, yield and ancillary characters were taken and also fibre qualities of different *G. hirsutum* cotton varieties were tested with the help of CIRCOT, Mumbai. Maximum number of bolls per plant (10.5) and seed cotton yield (11.4 q/ha) was recorded in cv. LRA 5166.

4.11.3 Standardizing the optimum level of phosphorous for different cotton varieties

Plant growth and yield data indicated that LRA 5166 and Vikram are the suitable cotton varieties under rainfed situation in coastal saline Bengal. Application of 40 Kg P₂O₅/ha produced significantly higher yield in LRA 5166 over control but it was on par with 30 Kg P₂O₅/ha. Considering the cost benefit ratio, 30 Kg P₂O₅/ha is the economical dose for rainfed cotton in Sundarbans.

4.11.4 Development of Low cost technology for raising cotton seedlings for subsequent transplantation

Soil type, soil media and the sheet materials used had significant effect on shoot, root and survivability of cotton seedlings. Soil media (75% soil + 25% organic manure with jute fibre mixture) led to better shoot growth and it also recorded higher survivability (96.2%) in the main field. It is a low cost technology for raising of cotton seedlings in *Pai nursery* suitable for coastal area of Sundarbans.

4.11.5 Integrated Nutrient Management (INM) practices for transplanted cotton

Different types of Nutrient Management practices were tried. The treatments comprised of application of chemical fertilizer (Nitrogen in the form of urea) and also combined with organic manure through different sources like FYM (cow dung), Vermi compost and Azotobacter. A general dose of 40 Kg P₂O₅/ha and 30 Kg K₂O/ha were applied in each plot as a basal dose. Nitrogenous fertilizer @ 80 Kg/ha is applied as chemical as well as combination of chemical and organic sources.

Growth and yield of cotton varied significantly with source of N. Plant height and yield attributes were significantly higher when 25% N was applied through vermi compost along with 75% N in the form of chemical fertilizer and around 13q /ha seed cotton could be harvested in both 2002 and 2003 seasons (Table. 19). However, higher values of agronomic efficacy of the system were noticed when 25% N was substituted through vermicompost or FYM along with 75% N as chemical fertilizer or 50% N substituted through vermi compost + Azotobacter.

Table. 19. Growth and yield of transplanted Cotton (Sundarbans, WB)

Treatments	Plant Height (cm)	Bolls /plant	Seed cotton yield (kg/ha) (Mean of 2002 & 2003)	Cost Benefit Ratio
100% N as chemical fertilizer	85.5	9.26	1099	1.0 : 1.40
75% N as chemical fertilizer + 25 % N as FYM	83.9	8.96	1045	1.0 : 1.42
75% as chemical fertilizer +25% N from Vermi compost	88.2	11.33	1307	1.0 : 1.49
50% N from chemical fertilizer +25% from FYM+ Azotobacter	79.5	8.19	904	1.0 : 1.18
50 % N as chemical fertilizer + 25% from vermin compost + azotobacter	81.1	9.29	1099	1.0 : 1.30
Control	73.4	6.41	568	1.0 : 0.9
CD @ 5%	4.14	0.93	269	

Net monetary return was maximum (Rs. 8670/ha) from 25% N through vermi compost along with 75% N through chemical fertilizer. Highest total monetary return was noticed in the treatment 25% N through vermi compost along with 75% N through chemical nitrogenous fertilizer due to higher seed cotton yield over FYM combination. The cost benefit ratio was maximum (1.49) with application of 75% through chemical along with 25% through vermi compost, followed by 100%

chemical nitrogen treatment (1.4) and 75% as chemical fertilizer in combination with 25% N as FYM. Application of 2.5 tonnes /ha (as source of 25% N) vermi compost along with 75% N as chemical fertilizer was found more remunerative in transplanted cotton under rainfed condition during rabi-summer season of coastal agroecosystem of Sundarbans.

4.11.6 Development of suitable IPM module for sustainable cotton production in coastal agroecosystem of Sundarbans (West Bengal)

Suitable Integrated Pest Management (IPM) module was followed comprising use of certified seed, soil application of *Trichoderma viridae*, judicious fertilizer and water management, removal of weeds serving as alternate host, application of botanical pesticides like Azadiractin, spraying NPV, application of need based soft insecticides for the control of cotton pests. Incidence of sucking pests like jassids, thrips and boll worms like *Helicoverpa sp. and Earias sp.* were below ETL level on IPM plot as compared to non IPM plot. As a result, the seed cotton yield recorded under IPM plot was 12.5q/ha as compared to 8.4q/ha in non IPM plot. The net profit recorded from IPM plot was Rs. 6970 per ha.

4.12 Monitoring of soil fertility improvement with cultivation of *G. herbaceum*

The aim was to study the impact of applied fertilizer to cotton on the succeeding rice crop. After the harvest of cotton in October 2002, a medium duration rice variety (TRY.2) was transplanted on 27.11.2002 in cotton plots in the respective treatments without disturbing the bunds and the lay out. The spacing adopted for rice was 20 x 10 cm. Another plot with recommended dose of nitrogen was also raised where cotton was not a preceding crop, just to compare the performance of rice crop after cotton crop as well as to compare the performance of rice crop without preceding cotton crop. The number of productive tillers per hill and total number of tillers per hill were recorded at the time of harvest. The crop was harvested on 25.02.2003. The total number of tillers per hill ranged from 3.66 to 5.13 and that of productive tillers per hill ranged from 2.93 to 4.47 under different treatments (**Table. 20**)

There was drastic reduction in the grain and straw yields of unfertilized rice crop when it was raised after cotton crop that was applied with different levels of fertilizer as compared to that of rice crop raised with recommended dose of fertilizer when the preceding crop was not cotton. There was no significant difference in the

reduction of straw as well as grain yield of rice (TRY.2) due to varieties or hybrids of cotton (**Table. 21**). However, there was a significant variation in reduction of straw yield due to fertilizer levels applied to the previous crop of cotton with the highest straw yield of 2.46 t ha⁻¹ due to the residual effect of 120: 60: 60 kg N P K ha⁻¹ applied to the preceding cotton crop. As far as variations in grain yields are concerned, there was no significant difference due to different levels of fertilizer applied to the cotton crop. In other words, it may be stated that the fertilizers applied to preceding cotton crop did not have positive residual effect on the grain yield of succeeding rice crop.

The interaction between cotton cultivars and fertilizer levels applied in the preceding cotton crop did not influence the grain and straw yield of succeeding rice crop.

Table 20. Residual effect of preceding *G. herbaceum* cotton crop and different levels of fertilizers applied to the cotton crop on the productive tillers hill⁻¹, grain and straw yield t ha⁻¹ of the succeeding rice crop

<i>TREATMENTS</i>	Productive tillers m ⁻²	Grain yield t ha ⁻¹	Straw yield t ha ⁻¹
DH-7 CONTROL	3.67	0.458	1.57
60:30:30 NPK Kg /ha	3.67	0.811	1.88
90:45:45 NPK Kg /ha	3.57	0.964	1.82
120:60:60 NPK Kg/ha	3.73	0.758	2.23
DH-9 CONTROL	3.53	0.740	1.76
60:30:30 NPK Kg /ha	3.8	0.799	1.81
90:45:45 NPK Kg /ha	4.47	0.752	1.94
120:60:60 NPK Kg/ha	2.93	0.799	2.25
DB-3-12 CONTROL	3.2	0.575	1.79
60:30:30 NPK Kg /ha	3.2	0.517	1.59
90:45:45 NPK Kg /ha	3.67	0.917	1.76
120:60:60 NPK Kg/ha	3.27	0.693	1.94
MCU-7 CONTROL	3.2	0.740	1.93
60:30:30 NPK Kg /ha	3.2	0.694	1.63
90:45:45 NPK Kg /ha	4	0.681	1.82
120:60:60 NPK Kg/ha	2.93	0.658	2.10
Rice crop with recommended dose of fertilizer (without cotton as previous crop)	7.2	2.997	3.52

Table 21. Residual effect of preceding *G. herbaceum* cotton crop and the fertilizers applied to the cotton crop on the succeeding rice crop in (Feb-October) – rice (November-Feb) cropping system

Treatments	Straw yield t/ha	Grain yield t/ha
Cotton Cultivars (C)		
C1: G.COT.DH 7	1.88	0.75
C2: G.COT. DH 9	1.94	0.77
C3: DB 3-12	1.77	0.68
C4: MCU .7	1.87	0.69
SE d	0.10	0.10
CD (P= 0.05)	NS	NS
Fertilizer Levels (F)		
F1: Un fertilized control	1.76	0.63
F2: 60:30:30 kg NPK ha ⁻¹	1.73	0.71
F3: 90:45:45 kg NPK ha ⁻¹	1.84	0.83
F4: 120:60:60 kg NPK ha ⁻¹	2.13	0.73
SE d	0.1	0.1
CD (P=0.05)	0.20	NS
Interaction (Cx F)		
SE d	0.20	0.19
CD (P=0.05)	NS	NS
Rice crop with recommended dose of fertilizer (without cotton as previous crop)	3.52	2.99

4.13 On-Farm trials for appropriate adoption and economic benefits to farmers

On Farm trials in farmers' fields of improved varieties/hybrids offer a better platform for evaluation of true genetic potential of the varieties, besides serving as a vehicle for transformation of innovative technologies to realizable results.

4.13.1 On farm Demonstration of Salt tolerant *G. herbaceum* variety RAHS-14:

The yield performance of RAHS.14 was evaluated under farmers' fields in Koppal and Raichur districts. A moderate yield of 4 q/ha could be obtained even under very adverse situations. Similarly, large scale demonstrations of RAHS.14 in Bheemaranagudi revealed the superiority of the genotype with yielding ability of 7 q/ha under higher salinity stress (8-12 dS/m) prevalent during crop growth.

The potential *herbacum* genotypes RAHS-14 & RAHS 13 were evaluated in farmers' fields in the coastal regions.

Situation- I: *Receding moisture situation in rice fallow system:*

Brahmavar: Two farmers were chosen for conducting demonstration of *G.herbaceum* varieties RAHS-14 and RAHS-131 were compared in 5 gunta plots. In first demonstration, RAHS-131 recorded higher seed cotton yield of 690 kg/ha, while RAHS-14 recorded 580 kg/ha. In second demonstration RAHS-131 recorded higher yield of 540 kg/ha as compared to 460 kg/ha of RAHS-14. Thus RAHS-131 recorded higher overall yield of 615 kg/ha as compared to 520 kg/ha of RAHS-14. Thus in receding moisture situation of rice fallow condition, RAHS-131 yielded better than RAHS-14.

Situation- II: *Sea inundated saline situation:*

Ankola: Three demonstrations were laid out on farmers' fields. All of them represented the situation where land was inundated with back waters of sea and hence was saline. RAHS-14 recorded higher mean seed cotton yield of 618 kg/ha as compared to 565 kg/ha of RAHS-131.

Comparison of productivity of *G.herbaceum* varieties on farmers' fields

Situation I: Rice fallow situation

Location: Brahmavar

	Variety	Seed Cotton yield kg/ha
I	RAHS-131	690
	RAHS-14	580
II	RAHS-131	540
	RAHS-14	460
Average	RAHS-131	615
	RAHS-14	520

Situation-II: Sea inundated saline situation: (Ankola)

Name of the Farmer	Seed Cotton yield kg/ha	
	RAHS-14	RAHS-131
1. Anwar Pasha	645	590
2. Raja vitthal Joshi	620	575
3. J.N. Naik	590	532
Average	618	565

4.13.2 Economics of on farm / large scale demonstrations with G.Cot.DH-9 in Andhra Pradesh

The details of various On Farm Demonstration conducted in farmers' fields for popularization of desi cotton hybrid G. Cot DH-9 are presented below. It is evident that the farmers could get a net income of Rs. 3000 – Rs. 9000 per acre through cultivation of desi cotton hybrid G. Cot DH-9 (Table 22).

4.13.3 TNAU, Tuticorin

The genotypes G. Cot DH-9 was tested along with local check variety K 11 in five farmer's holding at two different villages representing the coastal ecosystem in Vilathikulam taluk of Tuticorin district.

S.No.	Farmer's name	Village	Taluk	District
1.	Th.Thandapani	K.Kumareddiyapuram	Vilathikulam	Tuticorin
2.	Th.M.Shanmugaraj	K.Kumareddiyapuram	Vilathikulam	Tuticorin
3.	Th.Kondu Reddiyar *	K.Kumareddiyapuram	Vilathikulam	Tuticorin
4.	Th.T.Chennappa Reddiyar	M.Shanmugapuram	Vilathikulam	Tuticorin
5.	Th.P.Perumal Reddiyar	M.Shanmugapuram	Vilathikulam	Tuticorin

* Trial vitiated due to very less population

The entry G. Cot DH-9 recorded higher seed cotton yield (387 kg/ha) than check in three out of four farmer's holdings. It also recorded the maximum 2.5% span length value (30.3 mm), which is classified as long staple category where as the local check K 11 recorded 24.8 mm, which falls under medium category (Table 23).

POPULARISATION OF RAHS.14: Two hundred kilogram of RAHS.14 seeds, obtained from University of Agricultural Sciences, Dharwad, was distributed to fifteen progressive farmers for popularizing the entry. A *Farmers' Mela* was conducted on 01.07.2003 at Agricultural Research Station, Kovilpatti. Pamphlets explaining the crop production and protection techniques and the salient features of this drought tolerant variety, which can also withstand salinity up to 4-8 ds/m was prepared and distributed among the farmers. The tolerance of this genotype to sucking pests, bollworms, *Alternaria* leaf spot, grey mildew and resistance to rust were also explained. The crop production and protection techniques were explained to farmers

by the scientists. Further popularization of this genotype in coastal districts like Thiruvarur, Nagapattinam, Thanjavore, Ramanathapuram and Thoothukudi is being taken up.

4.13.4 On Farm Demonstrations at Karaikal

Ten numbers of On Farm Demonstrations were organised during 2002 involving two *desi* hybrids viz., G. Cot DH-7 and G. Cot DH-9 with two checks MCU 7 and SVPR 3, while only four numbers could be organised in 2003 with only one hybrid G. Cot DH 9 and a check SVPR 3. The results of the demonstrations are furnished in **Table 23 and Table 24**.

During first year both the hybrids were found to be superior to the checks. Data on seed cotton yield recorded over locations revealed that the hybrid G.Cot.DH. 9 recorded the highest seed cotton yield of 23.38 q/ha with yield increase of 36% and 49% yield over MCU7 (17.19 q/ha) and SVPR 3 (15.67 q/ha). G.Cot.DH. 7 recorded the highest seed cotton yield of 22.03q/ha with a yield increase of 28% and 41% yield over MCU 7 and SVPR3. In 2003 G. Cot DH-9 was found superior to the check SVPR3. On an average G. Cot DH-9 recorded 17.81 q/ha as against the check SVPR3 (15.88q/ha) with a yield increase of 13%. The on farm demonstrations at Karaikal helped the farmers in and around the coastal region to have first hand knowledge about cultivation of *desi* cotton hybrids / *G. herbaceum* cotton genotypes (**Plate 5**).

Table.22. Details of On Farm Trials in Andhra Pradesh

Name of the operation	Cost of cultivation/ac. (Rs)							
	Location 1	Location 2	Location 3	Location 4	Location 5	Total	Mean	Percent of total expenditure
Preparatory cultivation	750	1100	1100	330	300	3580	716	8.88
Seeds and sowing	750	750	650	700	650	3500	700	8.68
Intercultivation and weeding	833	1500	1300	780	780	5193	1039	12.89
Fertilizers	500	1800	1800	1785	1950	7835	1567	19.43
Pesticides	1000	3000	3000	3090	3000	13090	2618	32.47
Harvesting	2000	600	600	1890	2025	7115	1423	17.65
Total operational expenses	5833	8750	8450	8575	8705	40313	8063	
	Gross income/ac. (Rs)							
Good kapas (kg/ac.) (Rate per quintal) (Rs)	613 Rs.12,260	500 @ 2000 Rs.10,000	500 @2000/- 10,000	630 @2200/- Rs.13,860	675 @2200 Rs.14,850	2918	584 @2080 12147	
Bad kapas (kg/ac.) (Rate per quintal) (Rs)	260 @ 1000 2,600	100 @1200 1,200	100 @1200/- 1,200	-----			92 @ 1133 1042	
Total income (Rs)	14,860	11,200	11200	13860	14850		13189	
Net income (Rs)	Rs.9,027	2450	2750	5285	6145		5126	

Location 1

Sri Danda Anjaneyulu
S/o Venkateswarlu
Lingaraopalem, Guntur district.

Location 2

Sri Bhukya China Balu Naik,
S/o Somla Naik,
Cheruvukommu-palem,
Nandigam mandal,
Krishna Dt.

Location 3

Sri Bhukya Balu Naik
S/o Chandra Naik,
Cheruvukommu-palem,
Nandigam mandal,
Krishna district.

Location 4

Sri Badavula Lakshmi-narayana
S/o Sree Ramulu,
Temidadapadu,
Karam-chedu Mandal,
Prakasam district
523 170

Location 5

Sri Dasari Phillip,
S/o Devaiah,
Temida-dapadu,
Karam-chedu mandal,
Prakasam district
523 170

Table. 23. Fibre quality of *G.herbaceum* entries under OFT (Tamil Nadu)

S. No.	Characters	K. Kumareddiyapuram				M. Shanmugapuram				Mean	
		Mr.S.Thandapani		Mr.M.Shanmugaraj		Mr.P.Perumal Reddiyar		Mr.T.Chennappa Reddiyar			
		G. Cot DH-9	K 11	G.Cot DH 9	K 11	G.Cot DH 9	K 11	G.Cot DH 9	K 11	G.Cot DH 9	K 11
1	2.5% staple length (mm)	29.5	24.4	30.0	24.6	29.9	25.6	31.9	24.7	30.3	24.8
2	Uniformity ratio (%)	50	52	49	49	50	49	46	52	49	51
3	Micronaire value	5.1	5.2	5.0	5.0	5.1	5.1	5.0	5.1	5.0	5.1
4	Bundle strength 1/8" (g/t)	23.9	23.4	23.1	21.7	23.4	22.8	23.4	21.7	23.4	22.4
5	Elongation (%)	4.7	5.7	4.1	6.0	4.5	5.4	4.5	5.9	4.5	5.7

Table. 24. Seed cotton yield of on farm demonstration plots in Karaikal region-(2002)

Sl. No.	Name of the Farmer and Location	Date of sowing	Seed Cotton yield (q/ha)			
			MCU 7	SVPR 3	G. Cot. DH. 7	G. Cot. DH. 9
1.	Shrimathi A. Sakunthala, Vadamattam	16.02.2002	12.00	10.25	9.25	8.75
2.	Shri S.Govindasamy, Vathiyar Iruppu	02.03.2002	15.50	18.50	24.00	28.00
3.	Shri G. Thiyagarajan, Saravanan Iruppu	14.02.2002	15.75	13.25	14.75	14.75
4.	Shri R. Balakrishnan, Poovam	20.02.2002	20.00	18.00	23.00	21.00
5.	Shri S. Renganathan, Varichikudy	23.02.2002	21.00	18.20	24.50	21.50
6.	Shri S. Baskaran, Konnakavely	16.02.2002	22.00	18.50	26.00	24.00
7.	Shri. K. Balakrishnan, Neravy	11.02.2002	17.00	24.00	37.50	50.00
8.	Shri M. Jayasankar, Kannapoor	27.02.2002	16.25	13.75	13.60	16.48
9.	Shri. M. Dharparanyam, Pettai	13.02.2002	12.90	12.90	13.70	20.68
10.	Shri. A. Irudhayaraj, Melasubbarayapuram	21.02.2002	19.50	27.80	34.00	28.60
	Mean Over Locations		17.19	15.67	22.03	23.38

Table.25. Seed cotton yield of on farm demonstration plots in Karaikal region-(2003)

Sl. No.	Name of the Farmer and Location	Date of sowing	Seed Cotton yield (q/ha)	
			SVPR 3	G.Cot. DH- 9
1.	Shri. Sampath, Thiruvengaadu	13.02.2003	16.25	18.25
2.	Shri. A. Kannan, Kottapaady	15.03.2003	15.0	16.75
3.	Shri. A. Durairaj, Kottapaady	12.03.2003	17.0	18.5
4.	Shri. A. Irudhayaraj, Melasubbarayapuram	18.04.2003	15.25	17.75

4.13.5 Demonstration of high yielding desi cotton hybrid G. Cot DH-9 in Gujarat

On Farm trials were organised by the participating centre in Bharuch and Surat districts in select villages. An average yield of 10 – 18 q/ha could be realised by the farmers due to high yielding nature of the desi cotton hybrid and appropriate intervention measures suggested by the Scientists.

Table. 26. on Farm Trials of desi cotton hybrid G. Cot. DH-9 in Gujarat

Name of farmer	Village,Taluka & District	Area covered (ha)	Variety under Demonstration	Seed cotton Yield(Kg/ha)
Pandya Balkrishna Pranshankar	Dora Amod Bharuch	0.40	G.Cot.DH-9	1735
Manilal Madhubhai	Mirjapur Olpad Surat	0.40	G.Cot.DH-9	1330
Ishwarbhai Khushalbhai	Pardi-Jhankhari Olpad Surat	0.40	G.Cot.DH-9	1260
Patel Kanubhai Hirabhai	Tegava Amod Bharuch	0.60	G.Cot.DH-9	917
Patel Rameshbhai Gopalbhai	Pipaliya Amod Bharuch	0.40	G.Cot.DH-9	1125
Gulam Usman shekh	Ashanabad Olpad Surat	0.60	G.Cot.DH-9	1815

Seed production programme of *G. herbaceum* hybrid G. Cot DH 7 was under taken by farmers in the districts of Amreli and Rajkot. The farmers evinced keen interest in seed production programme and harvested good quality hybrid seeds for further distribution.

V Interdisciplinary Team Work

NATP Project on “**Exploitation of *G. herbaceum* cotton for improving agricultural output and economy of coastal agroecosystem**” revolved around Interdisciplinary Team Work, wherein the teams of scientists belonging to different disciplines like Plant Breeding, Agronomy, Plant Physiology, Plant Biochemistry, Entomology and Soil Science have all contributed to the overall development of implementable technologies in popularizing *G. herbaceum* cotton in coastal agro ecosystem. As this is the first venture of such kind in the country, the team of scientists have worked zealously in identifying popular desi cotton hybrids and *G. herbaceum* cotton genotypes suitable to coastal farming, nutrient requirements of the crop in problematic soils, suitable cropping system approaches specific to location, basic and applied aspects of stress tolerance in *G. herbaceum*, development of control measures for pests in cotton specific to coastal areas and economic benefits of *G. herbaceum* cultivation to farmers in coastal areas.

Multilocation trials during the Project period, evaluation of *G. herbaceum* genotypes for salinity and drought tolerance at Surat, Dharwad, Guntur and Coimbatore, experiments on nutrient requirements of *G. herbaceum* genotypes at Karaikal, Kovilpatti, Dharwad and Guntur, Cropping system experiments at Coimbatore, Guntur, Karaikal and development of package of practices for Sundarbans (West Bengal) are the result of intense collaborative work and interdisciplinary approach of the Project personnel. This has led to identification of technologies / desi cotton hybrids and *G. herbaceum* cotton genotypes well suited to coastal agro-ecosystem in the country. Frequent interaction among scientists of different centres has also led to midcourse corrections in carrying out the tasks and also exchange of germplasm material and segregating lines, besides conduct of evaluation trials under field and laboratory conditions.

VI Project Activities / Outputs

1. List the important outputs and impact of the project. Also indicate shortfalls in relation to original proposal

- a) High yielding ability of desi cotton hybrid **G.Cot. DH-7** and **G.Cot. DH 9** was seen in coastal areas with matching returns to farmers of coastal agro eco system.
- b) Superlative performance of desi cotton hybrids G. Cot. DH - 7 and G. Cot DH 9 in coastal areas of Karaikal (Union Territory of Pondicherry). These desi hybrids are being popularised through appropriate extension programme.
- c) Stability analysis over three years indicated the stability of desi cotton hybrids viz., G. Cot DH 7 & G. Cot DH 9 for higher yields
- d) G.Cot DH 9 with a mean fibre length of 27.4 mm and bundle strength of 20.8 g/tex may be suitable for spinning up to 30s counts. Among the *G. herbaceum* varieties, G.Cot 17 and G. Cot 23 hold promise to spin up to 20s count yarn. The farmers stand to gain by way of fair price for their produce.
- e) ***Better economic returns to coastal farmers*** in cultivation of desi hybrids could be seen in demonstration trials under the Project with a cost benefit ratio of 1: 1.8 ***with a net profit of Rs 5000 - Rs. 12000 per hectare depending upon location and resource utilization.***
- f) Development of high yielding saline tolerant *G. herbaceum* genotype **RAHS.14** which can be promoted in coastal areas of peninsular India for enhancing cotton productivity and income to farmers.
- g) Several *G. herbaceum* varieties viz., DB 3-12, G.Cot. 13 and G. Cot 21 and pre-release varieties viz. RAHS.132, RAHS.14, RAHS.131 and GBhv 202 could be identified with average yield of 6 - 8 q/ha during the Project period in coastal locations.
- h) *G. herbaceum* genotypes RAHS.14, RAHS.119, RAHS.101 and hybrids G.Cot.DH 7 and G. Cot DH-9 yielded around 6- 9 q/ha in highly saline areas of Ankola, wherein sea water intrusion was seen and crops like Greengram and Blackgram failed.

- i) Nutrient and spacing requirements have been worked out for economic yields of *G. herbaceum* varieties and *desi* cotton hybrids.
- j) *Desi* hybrid cotton based inter cropping experiment conducted at Coimbatore brought out the superiority of intercropping system of *Desi* cotton hybrid (G. Cot DH 9) with intercrops like Black gram, Cowpea and Onion. Intercropping helped in realization of cost benefit ratio of 1:2 as compared to 1:1.8 by sole crop of *desi* cotton hybrid. ***A net cotton equivalent yield of 23 to 25 q/ha could be obtained in cotton intercrop system as compared to 19q/ha in sole crop of desi hybrid cotton.***
- k) Cotton cv.LRA 5166 (*G.hirsutum*) was found best suited to coastal agroecosystem of Sundarbans. ***A low cost technology for growing cotton seedlings in Pai nursery has been developed for transplanting of cotton seedlings and survivability in coastal areas of Sundarbans, West Bengal.*** Suitable Integrated Pest Management strategies for cotton have been developed for coastal agroecosystem of Sundarbans, West Bengal.
- l) Morphological, physiological and biochemical aspects of tolerance to abiotic stress conditions have been studied and promising *G. herbaceum* genotypes have been deployed in breeding programmes for further improvement in agronomic attributes and adaptability.

Shortfalls: Even though high yielding genotypes and hybrids of *G. herbaceum* cotton well adapted to coastal agro ecosystem have been identified, the problems of smaller boll size, late maturity, slightly inferior fibre qualities compared to quality norms and increased cost of picking continue to be faced by the farmers. The economics of *G. herbaceum* cotton cultivation in the marginal and saline soils of the coastal agro ecosystem needs to be worked out in detail.

2. Technologies / Process / Diagnostic kits developed in the project :

2 a. Technology / product

1. *Name of Technology*

High yielding desi cotton hybrids (G.Cot.DH-7 & G.Cot.DH-9) and G.herbaceum straight varieties viz., DB 3-12, G.Cot. 13, G. Cot 21, RAHS.14 and RAHS.131.

2. *The Problem addressed by the Technology*

Identification of suitable G.herbaceun genotypes for marginal and problematic soils of coastal agro ecosystem

3. *Comparative advantages of the technology*

with respect to the available ones

Better adaptability and stability in yield even under very adverse situations, sustainability of desi cotton cultivation; Amenability for organic cotton cultivation.

4. *Degree of acceptance by farmers / other stake*

holders (e.g. crop area in which the technology has spread, number of industrial units adopting the technology)

Despite enhanced seed cotton yields and economic benefits to farmers in the coastal areas, smaller boll size, late maturity, inferior fibre quality and problems of marketing stand in the way of full acceptance of the technology by the farmers. These need to be addressed.

5. *If Commercialized the list of production units* : - -

6. *Patent filed or not. If filed the result what is the of the application* : - -

2 b. Process : Not Applicable

2 c. Diagnostic Kits Developed : Not Applicable

3. No. of SRF's / RA's employed (in all centres)

Institute	Name	Duration
CICR, RS, Coimbatore	Dr. Rajendra Kumar	27.10.2000 to 14.02.2001
	Dr. A. Subramanian	09.07.2001 to 07.03.2002
	Dr. S. Senthil Vel	05.09.2002 to 20.02.2003
GAU, Surat	Mrs. Madhu Patel	---
UAS, Dharwad	Mr. M.S. Divakara	---
ANGRAU, Hyderabad LAM, Guntur	Ms..N.Chamundeswari	10-4-2001 to 12-9-2001
	Mr. J.Sateesh Babu	29-9-2001 to 13.6.2002
	Mr. K.Venkata Siva Reddy	12.7.2002 to 29.1.2003
Agricultural College, Karaikal, U.T. of Pondicherry	Mr. S. Aravindhan,	14.02.2001 – 25.12.2002
	Ms. C.M.V. Sravanthi	12.03.2003 – 6.6.2003
TNAU, Coimbatore	---	---
Ramakrishna Ashram Krishi Vigyan Kendra. Nimpith Ashram (West Bengal)	---	---

4. Details of Equipments

Lead Centre : CICR, RS Coimbatore.

Equipments list	Purchased	Not purchased	cost (in Rs)
1. Computer and Software	✓		91,950
2. Seed Cabinets		✓	
3. Salinity Meter	✓		47,674
4. Porometer	✓		366428
5. Dissolved Oxygen Meter	✓		47000
6. Photographic Equipment	✓		42,940
7. Cloy Gin	✓		34,143
8. Precision Balance	✓		14,025
9. Refrigerated Centrifuge	✓		1, 09,343
10. Refrigerator	✓		19,493
11. Voltage Stabilizers	✓		14,060
Additional Sanctioned items	-	-	-

Cooperating centres

PAJANCOA, Karaikal

Equipments list	Purchased	Not purchased	Cost
Computer with accessories	✓	-	94,450
Laboratory cloy gin	✓	-	34,200
Refrigerator	✓	-	16,485
Distillation unit	✓	-	39,104
Seed cabinets	✓	-	49,550

TNAU, Coimbatore

Equipments list	Purchased	Not purchased	cost (in Rs)
Originally Sanctioned			
1. Computer and Software	✓	-	91,200
2. Seed Cabinets	✓	-	48,101
3. Precision Balance	✓	-	26,000
Additional Sanctioned items	-	-	-

ANGRAU, Guntur

Equipments list	Purchased	Not purchased	cost (in Rs)
Originally Sanctioned			
1. Computer and Software	✓		97,699.00
2. Seed Cabinets	✓		56,951.00
3. Precision Balance	✓		19,140.00
4. Salinity meter	✓		10,010.00
5. Flame Photometre	✓		36,500.00
Additional Sanctioned items	-	-	-
1. Spectronic 20 D	✓		1,08,000.00

GAU, Surat

Equipments list	Purchased	Not purchased	cost (in Rs)
1. Computer and Software	✓		1,00,990
2. Cloy Gin	✓		32,350
3. Seed Cabinets	✓		42,000
4. Salinity metre	✓		5,875
5. Dissolved Oxygen metre	✓		63,104
6. Elec. Precision Balance	✓		72,500
Additional Sanctioned items	-	-	-

UAS, Dharwad

Equipments list	Purchased
1. Computer and Software	✓
2. Seed Cabinets	✓
3. Elec. Precision Balance	✓
Total	1,75,264

KVK, Nimpith Ashram(Sundarbans, West Bengal)

Equipments list	Purchased
1. Computer and Software	✓
2. Cloy Gin	✓
3. Seed Cabinets	✓
4. Elec. Precision Balance	✓
Total	2,00,000.00

5. Civil Works : NOT APPLICABLE

6. List of Workshops Conducted : NOT APPLICABLE

7. List of training programmes: NOT APPLICABLE

8. On farm trials conducted from inception till March 2003

Year	On station trials	On farm trials	Area covered (ha)	No. of farmers covered	No. of villages covered	No. of dist. covered
2000-01	22	12	5	15	6	4
2001-02	25	18	9	18	17	5
2002-03	16	43	16	43	35	13

9. List of Consultancy services employed: Nil

VII Future Work

(Will the Project lead to future work? Describe)

Yes. The demonstration of high yielding ability of desi cotton hybrids and *G. herbaceum* cotton genotypes in coastal areas has been carried out for the first time in the country covering several locations under the expert guidance of Project Scientists. The Project output has enough indications pointing towards the necessity of conducting further field and laboratory experiments and carrying out in-depth analysis of socioeconomic impact of *G. herbaceum* cotton cultivation in coastal agro ecosystem and also under irrigated and rainfed situation of cotton growing areas of the country.

The economic benefit that will accrue through *G. herbaceum* cotton cultivation in coastal areas can further accelerate the much desired expansion of area under cotton in the country, improvement in economy of marginal farmers, new gene pool evaluation in *G. herbaceum* for adaptability and further enhancement in yield, and by

product utilization and marketing activities. Appropriate planning of research and development work in these directions is a desirable future endeavour in the overall context of agriculture and cotton cultivation in particular. In addition, *G. herbaceum* cotton cultivation is a remunerative option after *kharif* paddy in salinised areas in coastal agro-ecosystem, necessitating further elaborate studies.

Suitable breeding strategies are needed for identification of better parents based on diversity analysis. Further impetus needs to be given for basic studies in development of abiotic stress tolerant genotypes, both through conventional and biotechnological approaches, with matching yield potential, adaptability and above all with better fibre quality attributes. The difficulties experienced by the farmers with regard to smaller boll size, difficulty in picking and relatively lesser price to the produce (seed cotton of *G. herbaceum*) need to be addressed by all concerned. Refinement in desi cotton hybrid seed production technique is another area needing attention in popularization of desi cotton hybrids in coastal areas.

VIII. Publications

1. Popular Articles: 6
2. Referred Journals: Under preparation
3. Manuals: Under process
4. Industrial Materials: --
5. CD's: Under preparation

IX Financial Allocations:

Expenditure

Items of expenditure	CICR- RS Coimbatore	TNAU - Coimbatore	PAJANCOA & RI- Karaikal	ANGRAU - Guntur	UAS - Dharwad	GAU - Surat	KVK, Nimpith, West Bengal
2000- 2001							
Recurring contingencies	1,70,009	67,502	85,426	1,30,950	2,68,664	48,593	1,26,000
Non - Recurring	29,268	91,200	82,285	2,20,299	1,75,264	1,39,215	1,00,000
2001-2002							
Recurring contingencies	97,025	1,23,351	1,53,948	1,82,378	2,32,802	1,57,901	1,29,000
Non - Recurring	71,720	-	1,00,235	1,08,000	-	1,77,604	-
2002-2003							
Recurring contingencies	2,55,061	1,35,675	1,47,089	1,99,617	2,02,966	2,86,951	1,48,000
Non - Recurring	7,15,336	74,260	1,33,554	0.00	-	-	1,00,000
	14,02,759*	4,91,988	7,02,537	8,41,244	8,79,696	8,16,014*	6,03,000

- *inclusive of April to July 03 Expenditure.
- Financial statement as per available figures.

Total Expenditure made out of Sanctioned Budget : Rs. 57, 37,23

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