INTRODUCTION

In ancient times, cotton used to be grown in undivided Bengal now comprising West Bengal under Indian Union and Bangladesh. During the period from the 16th century A.D. to the end of the 17th century, finest quality of cotton cloths were produced in Bengal. The fame of fine quality cloth termed "muslin" (Anon, 1973-74) reached the affluent societies of European and Arab countries. This renowned finest quality of cotton fabrics was produced by the weavers of Bengal. At that time the varieties belonging to species *Gossypium arboreum* race *bengalense* and also race *cernum* were chiefly cultivated. The ginning of cotton and weaving were done indigenously. The Chittagong hill tract and Comilla district including Tripura State of erstwhile united Bengal, i.e., north eastern part of Bangladesh were principal sites of growing cotton.

According to Hutchinson 1937 (c.f. Anon, 1956) though the centre of origin of the species *G. arboreum* is obscure, it is obviously Asian since the area of its greatest variability is found around Bay of Bengal. The centre of origin of *G. arboreum* race *cernum* is definitely North East India. The above noted view of Hutchinson supports the idea that cotton was grown in this State in the ancient past.

With the advent of British rule in India i.e., from the middle of the 18th century onwards this fine textile cottage industry of Bengal could not compete with the relatively coarser cloth produced in the big textile industries of Manchester in Great Britain, as the cost of production in the power driven textile machinery was relatively lower than that produced indigenously in Bengal. As a result, the cultivation of cotton in Bengal gradually declined and it was ultimately replaced by other crops. During the early part of the 19th century A.D., the East India Company, the then ruler of India tried to grow upland cotton (*G. hirsutum* L.) in India. At that time the western part of West Bengal i.e. the districts of Birbhum and Bankura were chosen for cotton cultivation. However, due to non-adaptibility of the introduced cultivars, the attempt failed.

With the turn of history as an aftermath of achievement of independence of the country, the textile and cotton mills in the country got an expanded market due to curbing on importing cotton fabrics from foreign countries. Unfortunately, textile and cotton mills in West Bengal suffered major difficulties in procurement of raw materials from within the State of West Bengal. The Table 1.1 shows the year wise detailed of area and production of different fibre crops including cotton in the State starting from 1961-62 (Anon, 1975).

From the table it is evident that till 1970-71 there was no cotton cultivation in the State of West Bengal. Therefore, all the spinning, textile and cotton mills had to procure raw cotton or cotton yarn from other States and also from foreign

TABLE 1.1

Yearwise area and production of different fibre crops in West Bengal.

Year	Area covered in thousand hectares					Production in thousand tonnes				
	Jute	Mesta	Cotton	Others	Total	Jute	Mesta	Cotton	Others	Total
1960-61	291.5	72.1	-	5.8	369.4	2002.4	398.2	-	18.0	2418.6
1961-62	463.1	137.7	-	5.7	606.5	3378.2	720.8	-	21.3	4120.3
1962-63	434.7	132.8	-	5.5	573.0	3137.7	715.5	-	18.7	3871.9
1963-64	446.1	119.6	-	5.3	571.0	3296.1	715.8	-	19.9	4031.9
1964-65	456.6	86.7	-	4.7	548.0	3645.9	530.8	-	20.7	4197.4
1965-66	403.6	75.2	-	2.9	481.7	2243.5	400.9	-	12.2	2656.4
1966-67	423.4	64.0	-	2.1	489.5	2875.3	318.8	-	9.3	3203.4
1967-68	496.0	56.3	-	2.0	554.2	3853.6	348.8	-	8.2	4210.6
1968-69	268.7	42.0	-	1.7	312.4	1329.5	214.4	-	7.2	1551.1
1969-70	437.5	61.5	-	1.3	500.3	3398.5	337.4	-	6.0	3741.9
1970-71	407.1	66.3	1.3	1.7	476.4	2683.6	384.3	2.0	7.2	3077.1
1971-72	401.1	62.3	5.1	1.7	530.2	3469.1	353.5	1.7	8.5	3832.8
1972-73	367.3	47.9	3.0	1.5	419.7	2712.3	234.2	1.2	7.2	2954.9
1973-74	418.5	69.1	1.3	1.4	490.3	3673.0	364.5	0.4	7.4	4045.3
1974-75	370.2	48.0	0.5	1.5	420.2	2607.8	271.3	0.4	9.0	2888.5

countries. As a consequence, they used to pay higher charges on account of freight and fare. Therefore, they were put to a stiff competition with the mills situated at the traditional cotton growing belts in India i.e., in the States of Gujarat, Maharastra, Andhra Pradesh and Tamilnadu. Table 1.2 attempts to give a detailed picture about the quantity of cotton twist and yarn imported by West Bengal from different States from the year 1971 to 1974 counting 1961 and 1966 as the base year for supplying raw materials to different textile manufacturing units within the State (Anon, 1975). Table 1.3 presents certain economic parameters on industrial scale about the working of cotton mills in this State.

From the last column of Table 1.2 it can be seen that total material imported from other States increased upto the year 1972. After that, a sharp fall in procurement quantity is observed. From Table 1.3 again it is clear that future expansion of the industry not only halted since the year 1961 but also the condition deteriorated in certain sectors of the industry. Paying higher rates for procurement of raw material may be one of the principal causes for such deterioration and increasing imports from other States.

Considering such a dismal situation of economic development of the State, the Department of Agriculture, Government of West Bengal (India) decided to grow cotton again in the State and efforts in this direction commenced in the year 1970. But it was not an easy job since there was heavy pressure on land for cultivation of food crops to meet the requirement of large population. Cotton

TABLE 1.2

Import of Cotton twist and yarn in quintals by the State of West Bengal during the year 1961, 1966 and annually between the period 1971-1974 from different States of Indian Union.

Year	Assam	Bihar	Orissa	U.P.	Punjab	M. P.	Maharastra	Tamilnadu
1961	-	56	583	2998	12987	20291	22999	31066
1966	124	857	9924	22860	19258	1440	17463	18372
1971	-	3860	626	3614	4297	1196	14489	103643
1972	-	4137	10342	5093	8255	285	21074	98210
1973	-	735	1798	2889	3817	2388	19484	81196
1974	-	290	14	935	2077	21	16703	54609

Year	Kerala	Gujrat	Karnatak	J & K	Himachal Pradesh	Other States & Territeries	Total
1961	193	-	3893	-	-	532	95,598
1966	300	6214	3817	-	-	1183	102,012
1971	12288	11373	5506	-	-	14912	176,786
1972	8666	14506	4087	-	-	16741	191,396
1973	14574	14863	4259	-	-	7345	155,348
1974	4918	12344	681	-	-	3308	95,900

TABLE 1.3

Details of working of cotton mills in West Bengal in different years (The year 1961 and 1966 are taken as the base years)

Item	Years					
	1961	1966	1971	1972	1973	1974
a) Number of mills	40	35	41	42	40	40
b) Number of spindle installed	623266	815585	932346	942687	943946	955870
c) Average number of spindles at work daily	500584	624336	369535	491670	659716	630476
d) Number of looms installed	10941	10453	9979	9812	9680	9680
e) Average number of looms at work daily	8901	7602	3148	5073	7311	6045
f) Average number of workers employed daily	44023	43076	23661	32904	43949	43576
g) Quantity of cotton consumed in candies of 355.6 kg	124788	-	104850	152580	367845	365858
h) Total production of cotton piece goods (cloth) (Metres 0.00)	258075	-	114564	156754	193496	191671
Kilograms('000)	-	-	11156	16549	20850	21421
i) Total production of cotton yarn ('000 kg)	-	-	26929	28682	54528	56193

could not be considered as a replacement of rice in the State. After careful considerations, coastal saline belt was chosen as the area for reintroduction of cotton cultivation in West Bengal for the following reasons :-

i) cotton can tolerate the soil salinity well. Barkat, Fachry, Kahil (1971) showed that row cotton yield of <u>G. barbadense</u> L. increased when the soil salinity increased from 180 to 200 ppm. These led to the consideration that cotton is one of the most suitable crops for growing as a second crop after rice in the coastal saline belt of the State.

ii) the large expansion of land in the area has got no irrigation facility and due to high clay content of the soil, moisture is retained during the dry season. Consequently, cotton having very extensive tap root system may grow well with available soil moisture.

iii) in the absence of irrigation and drainage facilities in this area the perplexing question of utilization of land after growing of the winter rice may be solved with cotton as a second crop after rice.

iv) as the area is in close proximity to the sea (Bay of Bengal) the temperature does not go down very much during winter season, thus facilitating the growing of cotton as a second crop after rice. Also, the pre-monsoon showers which generally occur in that area in the month of February-March would be expected to be beneficial to the cotton crop.

While implementing such programme, the cultivation of cotton got a set back due to the fact that low drainage facilities of that area caused water logging in a vast portion during monsoon with water failing to recede from the field easily which consequently delayed land preparation for cultivation of cotton after harvest of rice. Delayed sowing resulted in delayed boll bursting of the crop and production of cotton at the time of harvest was seriously hampered by rain during monsoon. The crop was also subjected to heavy attack of spotted boll worm (Earias fabia Stoll.) which gets alternate host in the crops like Abelmoschus esculentus etc grown in the vicinity.

Therefore, in order to make cultivation of cotton crop an economic success, breeding of suitable variety keeping in view of yield, adaptibility and ease of cultivation accounts a major approach to the problem. This naturally calls for consideration of a number of attributes for genetic manupulation and improvement which would obviously lead us to quantitative breeding.

When quantitative characters are involved in a crop improvement programme, it is very difficult to select genetically desirable donor parents because heritable differences are often masked by non-heritable or environmental variations. The problem then turns to the determination of the best indicator of the genotypic value of any individual line. When a breeder likes to improve a crop plant the improvement of yielding ability of that crop will be the first and foremost point to think of. Yield is, however, a complex character and is affected by other observable characters of the plant, both genetic and non genetic. It is, therefore, necessary to take into account such component of characters and their contribution to the genetic architecture on which yield improvement programme is based. Therefore, a suitable analysis is required for estimation of the nature and magnitude of genetic and non-genetic variations of such component of characters and their resultant viz., yield.

Johannsen (1909) pioneered on the study of heredity and environmental components of variation which was later elaborated by application of biometrical devices by Wright (1921) and Fisher (1918). Studies of genetic parameters gradually utilized in ascertaining the extent of heritability of variable characters and in predicting gains from selection.

Estimation of genetic parameter is not at all sufficient specially when a breeder is confronted with the situation of attempting modifications of genetic bases of several characters simultaneously or work towards genetic modification of one or two characters without effecting any change or very little change in the hereditary make up of other desirable characteristics. Hence the evaluation of genetic correlations proves to be very helpful. However, it is realised that when improvement is directed towards a complex trait like yield, simple correlation based on observable characters alone cannot solve this problem because it only measures the direct effect of characters on yield but the former character may also be subjected to variation by other characters. Wright (1921) pioneered the discussion of the problem critically.

The methodology of path coefficient analysis thus come into existence. To quote from Wright (1934) "This method is baded on the construction of a qualitative diagram in which the variables, whether actually measured or not, are represented as additively and completely determined by others, and these in turn by more remote ones until an array of ultimate factors is arrived at, all correlations among which are assumed to be known." This method was further elaborated by Tukey (1954), Johnson, Robinson and Comstock (1955) and Dewey and Lu (1959). The method was then widely adopted by various breeders in different crop plants.

The necessity of such investigations into correlations in conjunction with path co-efficient analysis has also been rightly felt in breeding work with different species of cotton.

Thus, Venkata Raman and Santhanam (1962), Siva Subramanium (1962), Khan (1963), Kamalanathan and Ponnaiya (1964), Venkata Raman (1963), Baluch (1963), EL Latif and EL Mazar (1970), Balakataiah and Butany (1971), Singh, Govil and Chaturvedi (1971), Patil and Mensinkai (1972), Babdzhanov and A mauturdyev (1971), Nagubin and Suvlatav (1972), Singh (1973), Balakataiah (1973), Chandranath (1973), Vadogreeva (1975) established relations between different attributes in the direction towards the improvement of yield, earliness and also the improvement of quality of fibre.

The second effort was made to assess a collection of varieties quantitatively for choosing desirable parents for hybridization programmes. The knowledge of genetic diversity amongst the population is essentially required by a breeder for such assessment. Mahalanabis 'D^2 statistic (c.f. Rao, 1952) is a powerful tool for measuring quantitative divergence (Arunachalam and Ram, 1967; Singh and Bains, 1968 and Bhaumik, 1971). Besides, the D^2 statistics also permit measurement of relative contribution of individual characters to total divergence (Murty and Arunachalam, 1966). Thus, the study of generalized distance also helps in assessing genetically diverse parents for greater likelihood of yielding promising segregates when selections of parents or lines based on single attribute may not be useful as it is based on a number of important characters collectively, particularly if the aim is to bring an improvement in a complex quantitative trait (Singh and Bains, 1968), Mahridirtta, Phul and Arora, 1971).

Intra-specific genetic divergence of cotton were estimated by various authors. Thus Savov (1962), Ter Avanesyan (1967), Singh and Bains (1968) and Singh and Gupta (1968) estimated genetic divergence in the varieties or segregates belonging to different species of cotton.

During initial trials with cultivation of cotton in coastal belts of West Bengal, it was found that the crop registered a low yield record due to the fact that since the crop has been introduced to be grown as a second crop after rice in this area, late planting in December-January and onset of rains at harvest time i.e., by the end of May acted adversely on yield. The crop was also affected by premature square and flower shedding due to temporary drought condition during the months of February-March if one or two nor'western showers, which is a common phenomenon of that area do not occur during those months. It was, therefore, felt that under such circumstances the total monetary return from cotton may be augmented if bast fibre could also be extracted from cotton plants besides growing short duration varieties.

The above idea was rooted because of the fact that the State of West Bengal has a traditional industry of Jute, a bast fibre crop. In Table 1.1 it has been shown that annual production of Jute fibre is around 3 million tonnes covering about 0.4 million hectares of land which is about 6 per cent of total cultivable area. The production of kenaf fibre is about 0.3 million tonnes covering an area of about 0.05 million hectares. Since the beginning of British rule i.e., end of eighteen century, a number of Jute Mills was established. Since then the industry developed by leaps and bounds. The present position of this industry given in Table 1.4 (Annon, 1975). This picture leads one to the contention that if suitable device for extracting of bast fibre from cotton plant could be achieved it could get a market within the Jute industry on at least complementary basis.

Besides, as the genus *Gossypium* belongs to the family malvaceae, like the other fibre yielding species of this family e.g., *Hibiscus cannabinus*, *Hibiscus sabdariffa* and *Abelmoschus esculentus*, it was expected that it may yield commercially usable bast fibre. If this bast fibre proves to be qualitatively satisfactory to some useful extent it has a possibility of being mixed with Jute fibre in spinning vegetable fibre yarn.

Extraction of bast fibre at the boll bursting stage is difficult as the periderm formation in cotton is very much conspicuous and due to adherance of bast bundle with wood. Kirby (1952), while describing the condition of bast fibre during different stages of growth of Kenaf plant (H. cannabinus), explained that during the period of anthesis cambial activity ceases in the part of the stem situated below the flowering nodes. By the time the tenth flower has opened cambial activity has completely ended in the vegetative internodes. In the Kenaf the lowest flower buds on the stem open first and in theory the apical meristem should be able to grow indefinitely. Parenchymatous cells which remain between the phloem and xylem and also the cambial cells becomes differentiated into either phloem or xylem and further secondary growth is not possible in the stem. Afterwards the woody cells, on the one hand, and the phloem (bast) which contains the fibre bundles, on the other, are no longer separated by a sheet of parenchymatous cells, but have grown or merged together at the fruiting stage. It is, therefore, much more difficult to remove bark from the woody portion of the stem. This may be of considerable importance when it is proposed to remove the bark from the stem by some form of ribonning machine.

In case of cotton (Gossypium spp.) such types of problem are also encountered.

Hence, studies were also directed in these lines and attempts were made to standardize the technique of bast fibre isolation and comparing its physical properties and qualities in relation to Jute fibre.

The results obtained are presented in this dissertation and their probable significance is discussed.

TABLE 1.4

Working of Jute Mills in West Bengal.

Description	1960	1965	1970	1971	1972	1973	1974	1975
1) Number of operational units as on 1st January	96	78	70	70	70	62	62	62
2) Number of spining spindles at work as on 1st January	1,124,000	1,419,248	1,270,193	1,282,270	1,366,374	1,385,658	1,426,129	1,428,230
3) Number of looms at work as on 1st January	59,248	69,950	67,207	68,433	71,096	75,198	80,049	80,889
a) Hessian	-	-	39,050	37,652	39,507	41,392	43,929	47,665
b) Socking	-	-	15,787	19,042	20,108	20,369	21,826	21,590
c) Broad loom	-	-	12,370	11,739	14,481	13,437	14,294	11,634
4) Average daily number of person employed ('000)	198	239	215	226	231	239	230	235
5) Consumption of Raw jute ('000 bales (July-June)	6,122	7,382	5,474	5,599	6,422	5,939	5, 270	5,268
6) Total production of jute goods ('000 tonnes)(July-June)	1,045	1,285	937	946	1,100	1,005	903	901