GENERAL INTRODUCTION

In the southern part of the State of West Bengal there exists a vast tract of coastal soils on the fringe of Bay of Bengal. The total cultivable land in the State is approximately 5.56 million hectares. Coastal lands spread over an area of approximately 1.14 million hectares of which about 0.35 million hectares are under cultivation. These soils occur in a narrow strip along the coastal areas, but in the river deltas these run inside the mainland even upto 50 kilometers. The soil which run inside the main land is gangetic alluvial soils and neutral in reaction. The coastal alluvial soils are suitable for growing of a large number of crops.

The coastal alluvial soils of the State are located between 21°32' and 22°40' north latitude and between 88°05' and 89°00' east longitude. The population of coastal alluvial region is approximately 5 million of which majority of them come under small, marginal farmers and landless agricultural labourers. Economy of the region is overwhelmingly dependent on agriculture. The cultivated area in the region extends over 0.35 million hectares of which hardly 4 per cent is irrigated. The region is, therefore, a monocropped area with more than 85 per cent being cultivated once in the wet season *(Kharif)* with traditional tall indica *(Aman)* rice.

The coastal alluvial soils are silty clay to clay loam in texture. Lack of irrigation facilities is an important physical constraint for successful cultivation of crops in winter and summer seasons. The soils are slightly acidic to alkaline in reaction, the pH ranges between 5.4 and 7.8. The coastal alluvial soils are fairly fertile in respect of available plant nutrients. Micronutrient status of the soil is also moderately high. The climate of coastal alluvial areas in the State is humid sub-tropical where the mean annual rainfall exceeds the evaporative demands. The average rainfall of the region is quite high varying from 1600-1800 mm, however, bulk of the precipitation covering more than 80 per cent occurs during four monsoon months, June to September, the rest of the rainfall is received during remaining period of the year. The lands are mostly clay loam, fertile and have better moisture holding capacity. Due to high rainfall receipts during monsoon, rice is the principal *Kharif* (wet season) crop of the region. More than 80 per cent of the cultivated area in the region is occupied by a single crop of long duration traditional rainfed *aman* (wet season traditional rice) rice during June/July to December every year and majority of lands (more than 80%) remain fallow for 6 to 7 months till the next rice crop in the following year owing to a large number of agro-economic factors.

Thus, the coastal alluvial land is typically a mono-cropped tract of the State. Very limited

irrigation facilities and lack of proper knowledge in appropriate technology of crop production utilizing rice fallows are the major causes for low cropping intensity in the region. Despite the limitations, it has been increasingly felt in recent years that for exploitation of land and human resources and for economic development of less explored Southern part of the State, the question of utilizing more of monocropped rice fields for growing a second or even a third crop must be given serious consideration.

The prevalent agro-climatic conditions of coastal alluvial region of West Bengal are congenial for growing a number of winter crops in rice fallow lands. But due to late harvest of preceding *Kharif (aman)* rice through November to December, sowing of important winter crops like wheat, pulses, oilseeds, etc. in optimum time is practically not possible. In areas where irrigation pose a problem, introduction of commercial crops having the ability to grow successfully on residual moisture may be a way out. Cotton being a deep-rooted and drought tolerant crop, growing of cotton on rice fallows, may be possible as this crop has an inherent potentiality to draw moisture from a deeper zone with the help of its long tap root system (Das Gupta *et al.*, 1974). Furthermore, cotton being a fairly salt tolerant crop (Mass and Hoffman, 1977; Raghuwanshi *et al.*, 1989); it is likely to be more adaptable in coastal lands where soil salinity may pose a problem for introduction of salt - susceptible crops. Moreover, as cotton is grown in tropical and sub-tropical regions all over the world, it is envisaged that this crop could also be grown in coastal alluvial region of West Bengal during December to June when most of the climatic elements are congenial and comparable to those required for successful growth and development of cotton plants. Exploring the possibilities of cotton on rice-fallows would go a long way in increasing agricultural productivity of this less explored region as well as improving the economy of the people of the area in coastal alluvial region of West Bengal.

Cotton is considered as the 'King' of fibre crops. It contributes about 85% of raw material for the textile industry consisting of more than 1000 mills in India. Cotton is one of the important cash crops in India and is grown in approximately 8 million hectares with production of about 13.5 million bales of lint. The average productivity of cotton in India is only 300 kg lint/ha against the global average of 560 kg and that of Israel 1386 kg, Australia 1194 kg, Egypt 966 kg and China 963 kg lint per hectare. Cotton is a leading source of farm income and cotton lint is a primary source of raw material to the textile industry. Cotton is grown in three agro-climatic zones in India namely, northern zone, central zone and southern zone. About 70 per cent of the area under cotton is rainfed and the rest is under irrigated condition.

Low average yield of cotton in India is attributed to the use of low yielding varieties, non

adoption of improved agronomic practices on large scale and predominant rainfed cultivation, etc. Cultivation of cotton is more extensive in relatively drier parts of the country. Nearly 90 per cent of the total annual acreage under the crop is accounted for peninsular (central) and southern zones and remaining is for northern zone. In eastern India, cultivation of cotton has not made any stride. However, cotton in India has made considerable progress with regard to increase in area and production since independence. Inspite of that, India at present faces shortage of cotton to meet the rising demand of domestic needs. Therefore, it is imperative to increase cotton production to meet domestic requirement and to pave way for earning foreign exchange through exports. In eastern India, there is not a single State of worth mention where cotton is grown in large scale. The eastern States are completely dependent on other cotton producing States to meet their cotton requirements. West Bengal at present imports cotton worth rupees more than 100 crores to meet the growing needs of cotton for large number of textile mills of the State. Under the circumstances, it becomes imperative to explore the possibilities of growing cotton in West Bengal.

Cotton is a warm season crop, grown as rainfed or irrigated in India. The sowing season varies considerably from one part of the country to another, owing to differences in climate, soil, varieties grown and nature of cultivation. The sowing of rainfed crop in cotton growing tracts is done with the commencement of monsoon in June to July, whereas the irrigated crop is sown one or two months earlier i.e. April or May. Cotton is mainly grown in monsoon season *(Kharif)*. However, there are few tracts in southern states where cotton is also grown in winter season *(Rabi)* owing to benefits from the preceding South-West monsoon and a few showers of North-East monsoon from October to December. However, the possibilities of growing cotton in winter *(Rabi)* on rice-fallow gangetic alluvial tracts of Southern West Bengal needs investigation.

Cotton being a native of warm climate, limit for its successful cultivation is set by conditions associated with such tracts are a mean annual temperature of over 15.5°C with an annual rainfall ranging from 500-1200 mm and abundant sunshine during the period of boll maturation. Successful germination of seeds requires daily minimum temperature of 15.5°C and above and for plant growth temperature requirement is 26.7° to 32.2°C. Cotton plant can stand even temperature as high as 43.3° to 46.1°C. The soil of Southern West Bengal is alluvial. Most of the cotton areas falling under north zone also represent alluvial soils. Alluvial soils are fairly fertile and the land is level. These are deep soils having loam, sandy loam or clay loam texture with pH ranging from 6.5 to even 10.0. The soils with pH upto 8.5 are generally used for cotton. Permeability and retention of water is fairly good. Thus the prevalent agro-climatic conditions may prove conducive for successful growth, development and production of cotton on rice fallow

coastal alluvial lands of West Bengal. However, there are numerous limitations to our present state of knowledge and experience with regard to various factors responsible for successful introduction and cultivation of cotton in this region. Cotton could be well fitted in regular sequential cropping on the development of appropriate agro-techniques. Furthermore, successful introduction and production of cotton in the region could help the State of West Bengal to achieve self-sufficiency in production of cotton reducing total dependence on import of this raw material from other cotton producing States. Under the circumstances, in view of limited knowledge and experience with regard to agronomic practices, it is imperative that systematic approach of problem oriented research work should be taken up on cotton for its successful growth and yield when grown on rice fallow rainfed lands under coastal alluvial soil conditions of West Bengal and finally to evolve a package of practices based on the results of the investigations.

Determination of suitable sowing time, perhaps, is the primary pre-requisite for successful introduction of cotton on rice-fallow coastal alluvial lands. Sowing time has a predominant effect on cotton cultivation because weather conditions during different stages of growth and maturity vary according to time of sowing. Sowing time should be so adjusted that the crop meets within succession the optimum conditions for its vegetative and reproductive growth and thereby exploits the yield potential. Balanced growth of the crop can be obtained only when cotton is planted at an appropriate time (Gadagi *et al.*, 1990). There is no general principles for fixing optimum sowing period of the crop. The sowing time differs in different places corresponding to different agro-climatic conditions (Mukundan *et al.*, 1993). Sowing time differs from place to place for obtaining highest yield (Vaidya, 1953; Sharma, 1961). Therefore, each tract has to be studied separately on account of different conditions of the soil and season.

Time of sowing plays an important role in productivity of cotton through its effect on plant population, duration for vegetative phases and thus total duration of crop (Mehra *et al.*,1987). Since, the production potential of cotton is largely governed by sowing time (Brar *et al.*,1989), it is of prime importance to determine the optimum sowing time for cotton on rice-fallow coastal alluvial lands in West Bengal.

Selection of specific variety for a certain region as per agro-climatic conditions, is the basic requirement to obtain highest production in cotton. The varieties to be grown in rice fallows should be chosen with reference to the fallow period of the locality, season of growth and habit of the plant (Kalyanaraman and Rangaswami, 1959). Many cotton varieties of *herbaceum* and *arboreum* types are time-bound whereas few *hirsutum* varieties possess wide adaptability. The predominant species cultivated in India is *Gossypium hirsutum* L. which covers largest area

in the country. The species show greater prospect over other species due to higher production potential with better fibre and spinning qualities. Only those varieties which possess wide adaptability and mature earlier within 150 -160 days or even less should be selected for cultivation on rice-fallows. However, before a variety is recommended it becomes imperative to work out its sowing time so that its yield potential is fully realised. Potentiality of cotton genotypes can fully be realised only after determining the suitable sowing date (Namdeo *et al.*, 1991). Thus there is a need of study to find out the best time of sowing for different varieties of cotton on rice-fallows under the agro-climatic conditions of coastal alluvial region of West Bengal.

While determining sowing time, other practices like method of planting should also be considered. Cotton can not be sown earlier than third or fourth week of December on rice fallows due to late harvest of rice as well as late receding of water from low lying rice fields. Late sown *Rabi* (winter) cotton occupies the land till July which may interfere with land preparation for succeeding wet season rice *(Aman)* transplanting, and the out break of monsoon may deteriorate the quality of cotton considerably. Under such circumstances, transplantation of cotton seedlings may give better start to the crop and facilitate its cultivation within a specified period of time mitigating the ill effects, if any, of delayed sowing on rice-fallows.

In view of the above situations, it becomes essential to evaluate the efficiency of planting methods like direct sowing and transplanting on productivity of cotton when its cultivation is to be established and popularised on rice-fallow coastal alluvial lands in non-traditional cotton growing areas of West Bengal.

Further, to exploit yield potential of a genotype under a given set of environmental complexes, determination of optimum crop stand through manipulation of spacing between and within rows is another important consideration for successful introduction and production of cotton. It is an established fact that yield per unit area is directly correlated with the yield per plant and number of plants per hectare and the distance separating the plant rows as well as the plant in each row depend on the inherent vegetative habit of a variety and conditions of soil fertility, soil moisture and cultural practices. Plant population plays an important role which influences the growth and yield of cotton (Swaminathan, 1971). Optimum spacing between plants determines the desired plant stand which is considered the key factor for maximum yield of cotton. Inter-row and intra-row spacing have profound influence on growth, ancillary characters and yield of cotton (Simlote *et al.*, 1967). Improvement of productivity through maneovering plant geometry (Ahlawat *et al.*, 1973; Brar and Singh, 1978; Smith *et al.*, 1978), offers very good scope for increasing the yield levels of cotton. Technique or method of planting whether direct seeding or transplanting

may have certain definite relationship with crop geometry. Thus, it is inevitable to study the response of cotton to plant geometry under different techniques of planting and finally to work out the optimum plant stand for realising highest yield of cotton in rainfed rice-fallow coastal alluvial lands where cotton is to be introduced.

Among the various management factors, supply of plant nutrients play the most important role in increasing crop production. Cotton plant being a heavy feeder needs proper nutrition for its successful cultivation. The possibility of economising chemical fertilizers by using locally available Farm Yard Manure (FYM) is being considered seriously in recent years. Increased prices and limited availability of chemical fertilizers entail search for organic manures as an alternative source to supplement the nutrient requirements of different crops including cotton. Farm Yard Manure increases major and micro-nutrients in soil (Katyal, 1985) and improves physico-chemical properties of soil (Dhar, 1975). Organic manure like FYM may suffice for lower nutrient demand of crop. FYM can increase productivity of crop considerably under appropriate management practices. Moreover, there is likely to be more favourable response of applied nutrients with FYM application. Among the major plant nutrients nitrogen and phosphorus are most important affecting growth and yield of cotton.

The N supply controls new growth and abscission of squares, bolls and leaves (Jones *et al.*, 1974) and application of P helps in the development of seed and lint and hasten maturity in cotton (Jones and Bardsley, 1968). Application of proper dose of nitrogenous and phosphatic fertilizers are the pre-requisite for higher yield of seed cotton (Simlote *et al.*, 1967). Ensured optimum yields of cotton are manifested by judicious use of fertilizers (Jain and Jain , 1981). Hence, the nutrient requirement of cotton particularly when the crop is a new introduction in rainfed rice-fallow coastal alluvial lands needs investigation.

Since cotton is to be introduced on rice-fallow lands in dry season, intercropping may help in achieving maximum profit and stability in production under limited resources, especially, the constraints of soil moisture. In cotton, a long duration widely spaced crop, the vacant interspace between the rows during the initial growth period can be utilized in a better way by growing suitable intercrops (Murande *et al.*, 1981) resulting in better resource utilization and an increase in cropping intensity. Paired row planting of cotton helps in maintaining full population of base crop and creating more interspace for intercrop to obtain additional yield. Paired row planting of cotton and intercropping with short duration pulses, oilseeds, etc. result in more yield and monetary advantages over sole planting of cotton (Kairon and Singh, 1972 ; Birajdar and Nankar, 1978). Hence, there is also a need of studying the suitability of cotton based inter-cropping

system under the agro-climatic conditions of coastal alluvial region in West Bengal.

Information on different agronomic practices for cotton under agro-climatic conditions of coastal alluvial region in West Bengal is practically nil. Hence, sets of experiments have been undertaken since 1989-90 to 1992-93 at the Instructional Farm of Krishi Vigyan Kendra, Ramkrishna Ashram, Nimpith, 24-Parganas (South), West Bengal, India, situated at 22°11' north latitude and 88°29' east longitude with an altitude of 1.3 meters above the mean sea level to study the effect of sowing time and variety, technique of planting and crop geometry, nutrients requirement and intercropping system on production potential of cotton (*Gossypium hirsutum* L.) on rice-fallow coastal alluvial soil conditions of West Bengal.

So, precisely in this investigation, attempts have been made to determine:

(a) Effect of sowing time on production potential of cotton cultivars.

(b) Effect of method of planting and inter and intra-row spacing on productivity of cotton.

(c) Effect of organic and inorganic nutrients on production potential of the crop.

(d) Production potential of cotton grown in sole and intercropping systems.