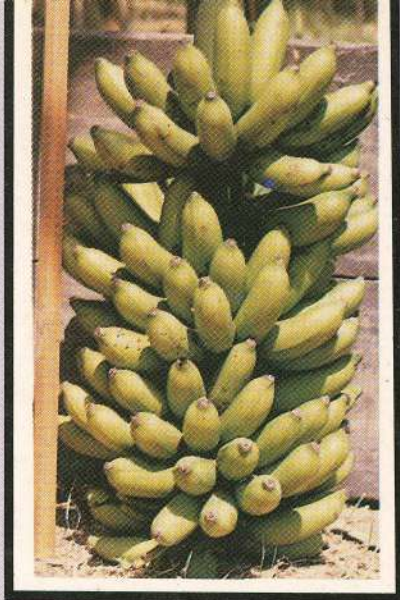




ANNUAL
REPORT
1993-94



भारत
ICAR



NATIONAL RESEARCH CENTRE
ON BANANA
PODAVUR, TRICHY

RMCU

ANNUAL REPORT

1993 - 94



National Research Centre on Banana
Podavur, Trichy (Tamil Nadu) 639 103

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Cover Page Photo : The cover depicts the stages in banana production

Cover design : Mr V. Padmanabhan

Photograph :
(1) A bunch of Rasthali
(2) A field of banana
(3) Banana in flowering
(4) A bunch of high yielding selection
(5) Harvested bunch ready for transport
(Photo : Dr. H. P. Singh)

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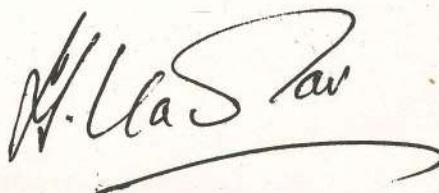
FOREWORD

Banana is a second important fruit industry in India with a total production of 7.79 million tonnes from 3.84 hectare accounting for 24 percent of total fruit production. Production system, cultivars and constraints vary from region to region and so the productivity. Although the country is a largest producer of banana but the share in world trade is invisible.

Owing to the economic significance of banana there has been burgeoning interest resulting in substantial improvement in productivity. However, efforts in combatting diseases and pests by the mobilization of the genetic variability have not been impressive. At the same time biotechnological approaches have created global impact, and has to be utilized meaningfully.

Complexity of banana breeding coupled with threat to the industry by several biotic and abiotic stresses is cause of concern. Establishment of National Research Centre on banana at Trichy is a timely step taken to tackle the problems of banana in the country with missionary zeal. The mandate of NRCB is to conduct basic and strategic research for improvement of banana production and productivity.

In this Annual Report efforts have been made to give genesis of NRCB and also a critical analysis of the current status of banana research in India for strategic planning and research priority. I am confident that this annual report will be of use to all the banana workers.



(I.S. Yadav)

Director

IIHR, Bangalore

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and biotechnological efforts which are directed towards the target of ideal banana. Although, research done through the net work of the AICRP on Tropical Fruits has showed a substantial improvement in the production and productivity (130-140% increase in productivity) in the last decade, yet many of the biotic and abiotic constraints of production have remained unresolved. Therefore, it is appropriate to address the problems through a mission oriented basic and strategic research conducted at the National Research Centre on Banana (NRCB) exclusively working on this crop.

Thus considering the research needs for banana, a task force appointed by the Council, strongly recommended for the establishment of NRCB in Tamil Nadu and consequently the Government of Tamil Nadu issued a Government order for handing over the land at Podavur, near Trichy, for the establishment of NRCB. Land was taken over and the centre started functioning from 21st August, 1993. Although NRCB was sanctioned in VIII plan yet the posts are to be created for its effective functioning. This being the first annual report, efforts have been made to briefly give a genesis of establishment process, development of infrastructural facilities and research achievements. The major mission of the NRCB is to conserve genetic resources of Musa and serve as a national repository of germplasm, develop cultivars having resistance to biotic and abiotic stresses and refine the production technologies suited to the demand and challenges. I am sure this annual report will serve as an appraisal of research needs and activities of NRCB.

During the period under report, although much has not been achieved in research yet the work initiated within the frame work of the project mission, the centre has created a substantial impact which is evident especially in the collection of germplasm, establishment of collaboration with INIBAP, creation of the infrastructural facilities etc.

I wish to express my sincere gratitude to Dr. K. L. Chadha, Dy. Director General (Hort.) for his inspiring encouragement, untiring guidance and support. I also wish to thank Dr. I. S. Yadav, Director, IIHR, Bangalore for his kind co-operation and help in facilitating the work at NRCB. I am also thankful to all those who have directly or indirectly contributed for the speedy progress of NRC on Banana.

Officer-in-charge

NRC on Banana

INTRODUCTION

The complexities of research in banana and plantain and the threat by many biotic and abiotic stresses incited the Task Force appointed by the Indian Council Agricultural Research for the establishment of NRC on banana. The site offered by the Govt. of Tamil Nadu was approved and NRC on banana started functioning w.e.f. 21st August, 1993.

BACKGROUND

Establishment of the National Research Centre on Banana was approved by the Planning Commission vide letter No. 930/86. EE.VII dated 12th January, 1987 and accordingly, a Task Force consisting of Dr. N. Gopalakrishna as the Chairman with Prof. Ranjit Singh, Dr. B. S. Chundawat as Members and Dr. C. P. A. Iyer as Member Secretary was constituted vide letter No. 9(34)/86 EE.VII dated 15th April, 1987 to identify the specific mission/objectives for research in banana, work out the staff requirements and to finalise the site for the establishment of the centre. Task Force was also requested to look into the programmes of the other institutes while deciding the mandate for the NRC (NRC should have the national dimension) and to submit the interim report to place the specific demand for land with the different states.

Terms of reference :

1. To identify specific Missions/Objectives for research in the area and to workout detailed technical programme supported by adequate justification.
2. To work out requirements of staff, infrastructural facilities and other items of support based on the programme outlined and the nature of work involved keeping in view at the same time the resource constraints and
3. To visit sites likely to be offered by the State Government, if required and to make suitable recommendations for the same.

The Task Force visited different Universities and Institutes and also had deliberations with the State officials.

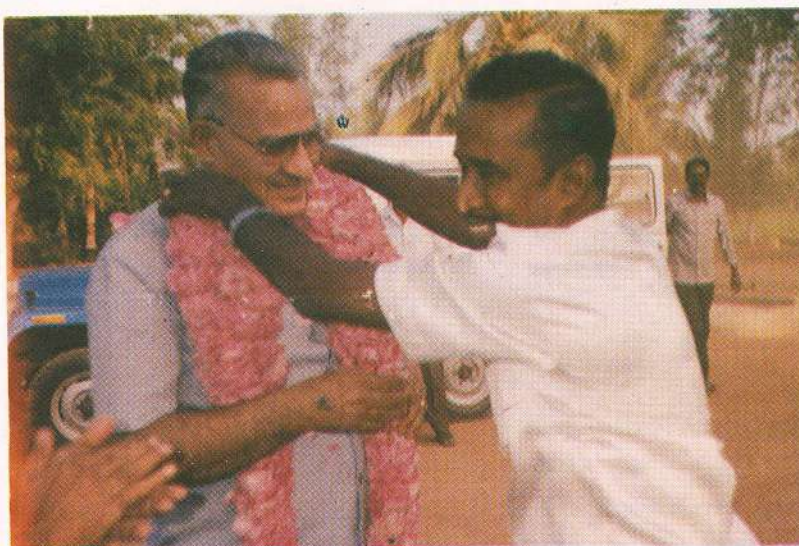
First meeting of the Task Force was held on 9th June, 1987 and subsequently the committee had several meetings and finally the following recommendations were made:

1. There is definitely an urgent need for establishing a NRC on Banana to conduct research on some of the basic aspects of crop improvement, faster multiplication of disease free plants and to get a better insight into the role of various pathogens which are now acting as constraints to high yield.
2. The major objectives that should include in the mission of NRC would be :
 - i) Germplasm collection, both indigenous and exotic and their detailed cytological and taxonomical analysis;
 - ii) Breeding varieties with special reference to resistance/tolerance to Sigatoka leaf spot, Panama wilt, Nematodes, Bunchy Top and Mosaic Virus;
 - iii) Standarization of *in-vitro* techniques for faster propagation of plants and *in-vitro* conservation of germplasms;
 - iv) Use of somaclonal variation for obtaining favourable variation;
 - v) Nutritional studies using isotopes for obtaining information on mother sucker relationship and utilization of tissue analysis and
 - vi) Use of efficient water management system development.

Subsequently, site selection committee was appointed by the Council consisting of Dr. N. Gopalakrishna, Dr. G. L. Kaul and Dr. C. P. A. Iyer for visiting the sites offered by the different state governments and making suitable recommendations, considering the importance of banana in the region and infrastructural facilities etc.

The site selection committee visited Kerala, Karnataka, Assam, Maharashtra, Andhra Pradesh and Tamil Nadu states, and land offered by Govt. of Tamil Nadu at Kumulur in Trichy was selected. After persuasion with the State government, Council asked the Project Co-ordinator (Tropical Fruits) Dr. H. P. Singh to take over the physical possession of the land and look after further developments vide letter No. 9-34/86 E VIII/IAV dated 18th April, 1991. The site was visited by Dr. G. L. Kaul and Dr. H. P. Singh on 6-7 May, 1991. During physical verification of the land, lot of anomalies were pointed out and the State Government was requested to clear

encumbrances. At the same time the land was also not located in the representative region for banana. Thus taking over of land was deferred. Subsequently, State government offered an alternative site at Podavur. The proposed site was visited by Dr. K. L. Chadha, Dy. Director General (Horticulture), Dr. S. Jayaraj, Vice-Chancellor, Tamil Nadu Agricultural University and Dr. H. P. Singh, Project Co-ordinator (Tropical Fruits) on 6-3-1992. The site was found suitable considering the availability of water



Dr. K. L. Chadha, Dy. Director General (Hort) being welcomed during his visit to proposed site for NRC on banana, Podavur, Trichy on 6th March. 1992.

and its proximity to the city and the same was approved for the establishment of NRCB. After the signature on the Memorandum of Understanding by Secretary. ICAR Shri G. C. Srivastava and Special Secretary, Govt. of Tamil Nadu Shri R. C. Panda on 9.12.1992 the lease deed for handing over of land was signed by the two Secretaries on 4th June, 1993. The Govt. of Tamil Nadu issued a G. O. No. 419 dated 8th July, 1993 to hand over the land to Dr. H. P. Singh for the establishment of NRC on banana.

In accordance with above G.O., the Collector Thiru D. Rajendran handed over the land measuring 90.48 acres on 21st August, 1993 vide Proceeding No. RC 65 21989/



Dr. H.P. Singh. Officer-in-charge, NRC on Banana and project Coordinator (Tropical Fruits) with Thiru. S. Rajendran Deputy Commissioner. Trichy, Dr. S. Sankaran, Vice Chancellor TNAU and Dr. Aruzmozli, director, Horticulture, Govt. of Tamil Nadu on the occasion of taking over the land for establishment of NRC on Banana on 21st August, 1993.

92 dated 21st August, 1993. Immediately after taking over of land interim stay order on proceedings was obtained by a group of staff working earlier at the farm from the High Court Judication, Madras vide No, WMP 25904 dated 14th September, 1993. However, anomalies were sorted out by the Collector vide Proceedings No. 21854 dated 2nd Feb, 1994 and thereafter the centre is functioning effectively.

LOCATION

NRC on Banana is located about 14 km away from Trichy (11.50 latitude 74.50 E longitude and 90 m above mean sea level) (Fig-1). The region receives the precipitation of 800-900 mm annually both from North-East and South-West monsoons, climate is tropical with highest mean temperature in April-May. The farm has a total area of 38 ha, the office-cum-laboratory is located in a rented building hired at 44 Ramalingam Nagar, South Extension, Vayalur Road, Trichy. In addition to the farm, efforts are also being made to get about one ha land in city for residential buildings, guest house etc. In the farm two old structures are being repaired for its use as godown and store for farm inputs and produce.

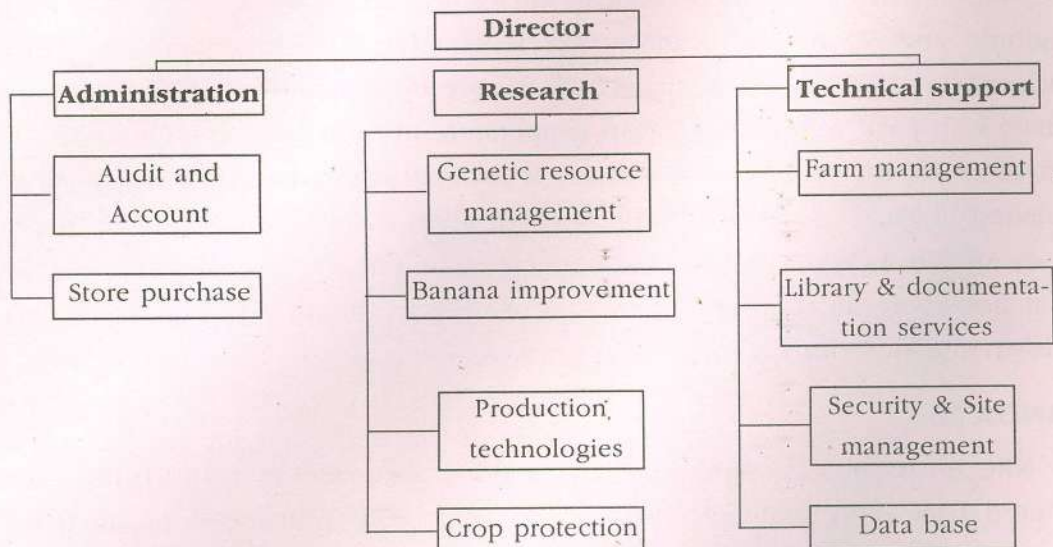
MANDATE

NRC on Banana is established having the commitment to take up the mission oriented basic and strategic research programmes for enhanced productivity of banana. Mandate of the centre is as follows:

- i) Collection and conservation of the genetic resources of banana for its use in improvement through conventional breeding and biotechnology.
- ii) Development of biotic and abiotic stress resistant cultivars having high yield potential with good quality fruits.
- iii) Enhancement of productivity by developing cost effective production technology through inter disciplinary approaches.
- iv) Bio-technological approaches for tackling constraints in banana production and
- v) Serve as national repository of germplasm and informations on banana.

Although Task Force has recommended 10 scientific, 9 technical, 6 administrative, 10 supporting and 2 auxillary staff component, only 6 scientific, 12 technical, 9 administrative, 12 supporting and 3 auxillary positions have been sanctioned. But the order for the creation of the posts is yet to be received. Project Co-ordinator (TF) is presently working as Officer-in-Charge with an additional responsibility, a scientist and a Technical T4 cadre from IIHR have been deployed (staff position in Annexure-1). Process for filling up of the posts will be taken up soon once the posts are sanctioned.

ORGANISATIONAL SET UP



BUDGET

Total outlay for NRC on Banana during the VIII Plan is Rs. 230 lakhs. Statement of sanction and expenditure are given in Table-1.

Table-1

(Rs. in lakhs)

	Eight plan outlay	Actual Expdtr. 1993-94	B.E. for 1994-95
A. Recurring			
1. Pay & Allow	22.84	Nil	4.50
2. T. A	4.70	0.30	0.30
3. Others	80.46	3.96	24.00
TOTAL	108.00	4.26	28.80
B. Non-recurring			
1. Works	122.00	Nil	16.00
Other Items	Nil	Nil	0.20
GRAND TOTAL	230.00	4.26	45.00

LOGISTIC FACILITIES

About the Farm

National Research Centre farm established at Podavur is 14 km south-west of Trichy. It is 2 km from the Thogamalai road and is connected by tar road. Two sides of farm are surrounded by canal and the side has village lands. Presently there is no approach road to farm of its own and land is being acquired for providing approach road.

Total area of farm is about 90 acres. It is believed that originally the present farm was a tank thus top layer of soil is alluvial clay. Western side of farm has a big village drain. Most of the farm land is wet except a few patches having gravelly soil. About 2 acres of land is marshy which has to be improved. The soil pH varies from 7.0 to 8.5.

Two wells are available which have been made functional with suitable renovation. Ground water is being exploited by providing borewells.

Infrastructural development

Office-cum-laboratory was started in a rented building hired at Tiruchy. Bench mark survey, hydrological survey etc., are being carried out and the CPWD is making the estimates for road, small structures, irrigation system etc. Equipments like tractor, power tiller, pumps etc., have been acquired and the requirements are being processed for the procurement. At farm, survey has been completed and plots of required dimension, drainage, bunds etc., are being made.

Computer

The centre has acquired one PC computer along with software packages and a data base for the germplasm collections are being developed.

Library

Plan for the establishment of library which can cater to the needs of banana has been made. Already the centre has been included in the mailing list of INIBAP and NBPGR for information dissemination. Technical documents on banana totalling about 20 have been acquired from INIBAP and two magazines i.e. Info Musa and Musarama are being received from INIBAP.

RESEARCH ACHIEVEMENTS

MISSION - I

Collection, conservation and utilization of Musa genetic resource :

Germplasm collections or assemblage of the genotype for the population representing cultivars, genestocks and species, shall be maintained in the form of plants in the field gene bank. Although India is known to have high genetic diversity in many clones and species of banana, yet the genetic resource management and utilization is far from satisfaction, resultantly many of the valuable genotypes have been lost. There exists a great confusion about synonyms of the varieties/clones all over the country. Undoubtedly, first mission of the centre is recognised to be the collection of all the genetic resources, its conservation and evaluation for taxonomic and agronomic traits, so that a data base can be developed. The biological tools (Isozymes, RAPD, Restriction Fragment Length Polymorphism) shall be given emphasis as an aid for effective characterization and study of the diversity.

Therefore, genetic conservation and exchange of germplasm would be one of the key activities at the centre. The NRCB has made its efforts to collect the germplasm from India and abroad. List of the germplasms available at the different collection centres in the country as well as at transit centre of the INIBAP, Leuven, Belgium have been obtained and efforts are being made to collect these germplasm.

A total of 210 accessions were collected from the different sources (Table - 2). All the precautions were taken to eliminate the major diseases and pests while collecting the germplasm from different sources. Procedure adopted for the collection of these germplasm in the country was visit the centre and mark the germplasm exhibiting freedom from the viruses. From identified mat three suckers of each variety were collected, cleaned of all the soil debris and roots then paring was done (Removal of 0.5 cm outer skin of the rhizome). The pared suckers were shade dried for 24 hrs, then they were dipped in solution containing monocrotophos 0.5% and Bavistin 0.2%. This treatment was essential for elimination of nematodes as well soil borne diseases.

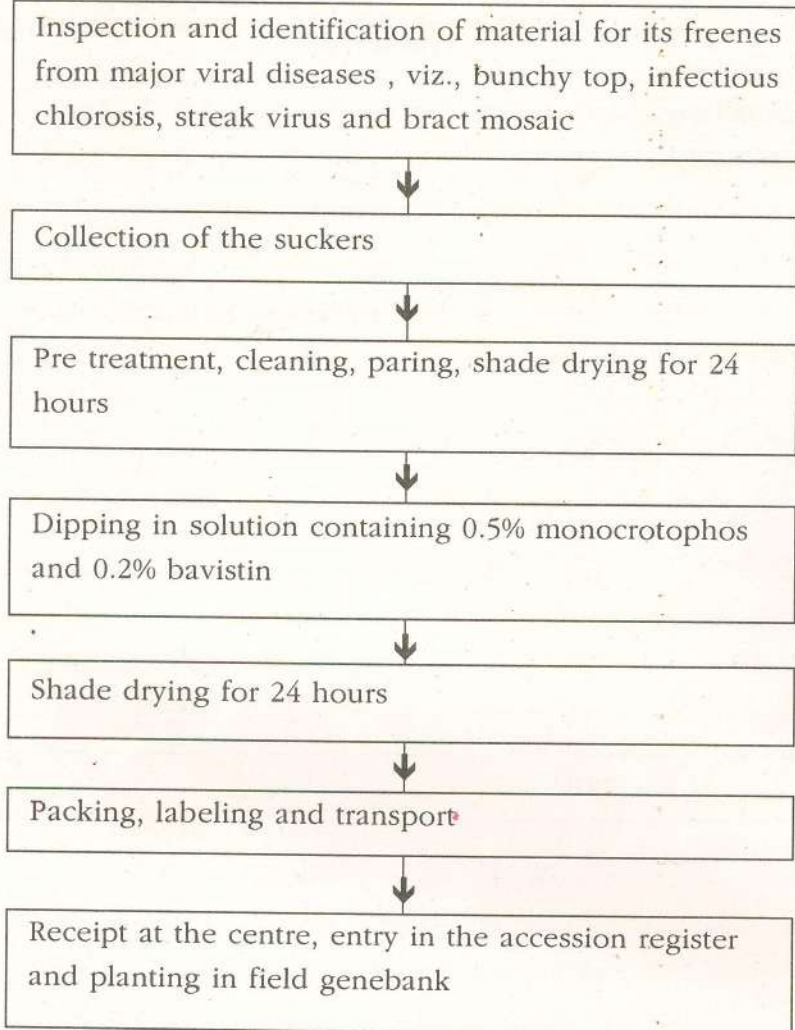
The dipped suckers were again shade dried before packing. The suckers were wrapped first with newspaper and then tied in bags along with the labels. This treatment was effective in eliminating nematodes and many of the soil borne diseases and no damage to the suckers was noticed under delayed transportation (20-45 days). The suckers received at the centre were examined and after entry into the accession register they were planted in the field.

Table - 2

Details of banana accessions collected at NRCB, Trichy

Clone	No.	Source
Musa Sp.	2	Kerala, Assam
AA	7	Bihar and Karnataka
AB	7	
AAA	50	
AAB	60	
ABB	50	
ABBB	1	
Unidentified	33	
TOTAL	210	

Flow chart of germplasm collection in Musa



MISSION - II

Improvement of Banana for yield, quality and tolerance to biotic and abiotic stresses

Many of the commercial varieties have faced serious threat from biotic and abiotic factors resulting in low productivity. Most of the banana varieties are the result of natural hybridization between *Musa acuminata* and *Musa balbisiana* and these two species are ancestor for most of the banana clones. They exhibit varying degree of male and female sterility resulting in seedless fruits. Thus, the breeding programmes directed towards the incorporation of desirable traits in commercial cultivars face enormous problems. Very little has been achieved through the conventional approaches. With the advent of bio-technological approaches viz. embryo rescue, protoplast fusion, somaclonal variation, quick methods of screening etc. the door for faster breeding programmes in the quest for developing a variety resistant to biotic and abiotic stresses with high yielding potential and desired plant type have opened.

Therefore, problem associated with the banana breeding shall be addressed at this centre with major emphasis to develop varieties having resistant to major diseases namely panama wilt, sigatoka leaf spot, nematode etc. Biological indicators will also be used for the quick screening of the germplasm to identify the donor source and for use in breeding programme. Efforts will also be made to collaborate effectively with INIBAP to utilize the experiences gained at global level for the improvement of banana. Some of the hybrids already identified having resistance to fusarium wilt, nematode and sigatoka leaf spot disease by the INIBAP will also be collected for testing.

In this direction, action has been initiated for the collection of four promising hybrids from INIBAP tranist centre located at Leuven and the plants are expected to be shifted shortly. Arrangements are also being made to develop the bio-technology lab and till then facilities of tissue culture lab of IIHR will be utilised for the multiplication of *in-vitro* plants.

MISSION - III

Improved production technologies for higher productivity

Adoption of high density planting, appropriate nutrition, control of insect pests and diseases and management of water have lead to the increased production and productivity. Yet the maximum yield potential of banana has not been achieved in many of the states. Therefore, this centre will address to these problems like production system, canopy management, recycling of nutrients, effecient water management, bio-control and integrated management of insect pests and diseases etc., which can enhance the productivity and reduce the cost.

If is often reported that, India is the largest producer of banana in the world having an annual production of 7.7 tonnes, but its share in the world trade is unrecognised. Therefore, emphasis will also be paid for the refinement of technologies aiming to produce quality fruits with export potential.

Trials for efficient canopy management, recycling of nutrients etc., are proposed to be started.

MISSION - IV

Post harvest characterization of genepool and post harvest technology

Work under this mission shall be started after development of required infrastructure.

INTROSPECTION FOR BETTER PERCEPTION - BANANA

Banana and plantain (*Musa* sp.) are widely grown in India with great socio-economic significance and has long period of domestication as evidenced by its mention in Kautilya's Arthashastra (250 to 300 BC) and its presence in the paintings and sculptures of Ajanta and Ellora (300 - 400 BC). In the cultural heritage of the country, banana is so linked that is indispensable in cultural or religious functions. Currently banana is the second largest fruit industry accounting for 24% of total fruit production (Table - 3). Total production of banana is estimated to be 77.9 lakh tonnes from 3.84 lakh ha which accounts for a monetary turn over of Rs. 30,800 millions annually.

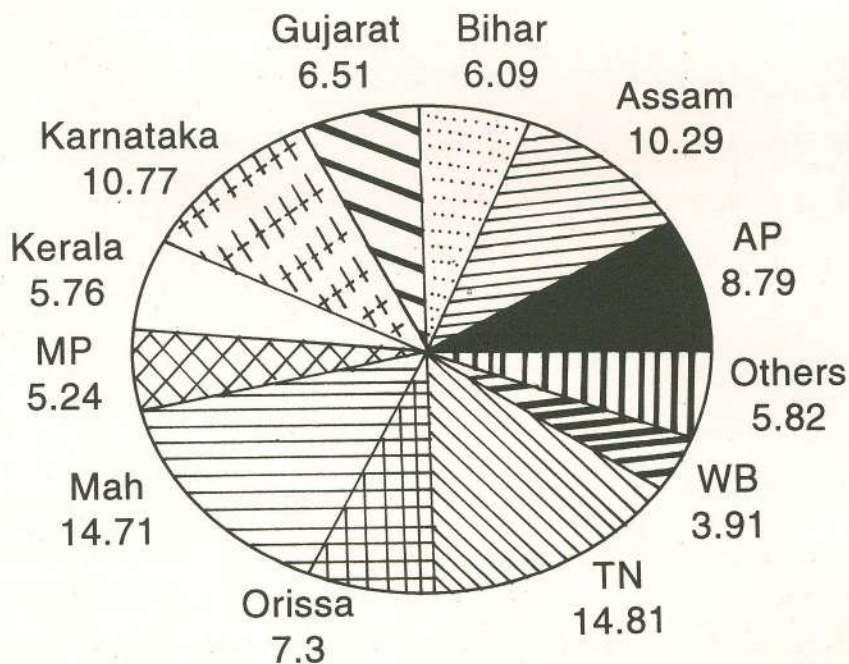
Table - 3

Area, Production and Productivity of Tropical Fruits

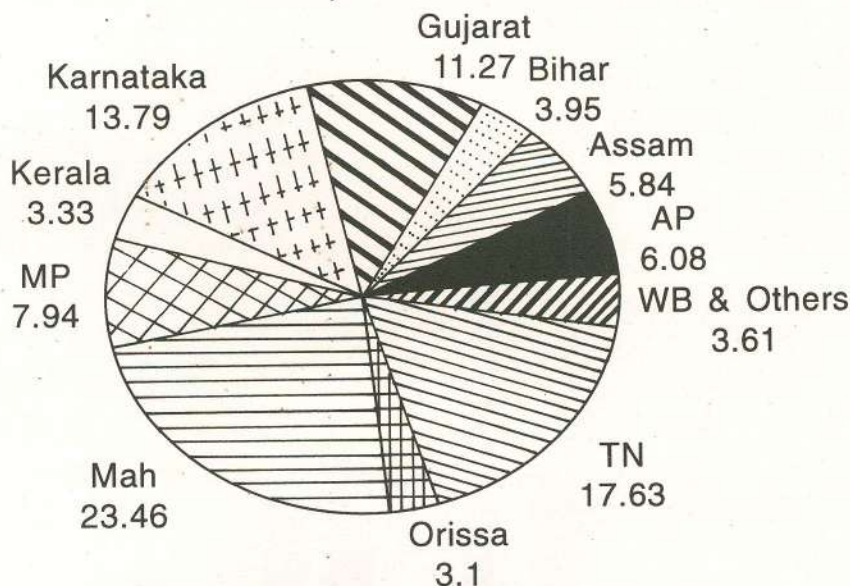
Fruits	Area (lakh ha)	production (lakh tons)	Productively	Per cent share of production
1. Mango	10.77	87.52	8.12	27.29
2. Citrus	3.87	28.22	7.29	8.80
3. Banana	3.84	77.90	20.29	24.29
4. Grapes	0.32	6.66	20.65	2.07
5. Guava	0.94	1.09	11.66	0.07
6. Apple	1.94	11.47	5.99	3.58
7. Sapota	0.27	3.90	14.52	1.22
8. Pineapple	0.57	7.65	13.48	2.39
9. Papaya	0.45	8.05	17.80	2.51
10. Others	9.93	88.19	8.88	27.51
TOTAL	32.90	320.65		

Banana is a dessert fruit for millions and is also used in different regions as staple food owing to its rich and easily digestible carbohydrates. They are rich source of vitamin C and several minerals such as calcium, potassium, phosphorus and magnesium. Banana fruit of cultivar "Bhimkol" is a natural source of baby food in North-Eastern regions owing to high nutritive value. Attributing to its multiple facets of uses from underground stem upto the male flower, referred to as 'Kalpatharu' (like the coconut tree referred to as kalpabriksh). Apart from its use as dessert and culinary purposes, the stem pith is used for its high medicinal values especially for dissolving kidney stones. Properly prepared floret (tepal) forms a delicious side dish while its spathe is made into 'chutney'. Underground stem is a highly relished animal food. Green leaves are exclusively used as eating plates dried leaves for roof tops and dried leaves along with pseudostem sheath forms a natural cooling wrapping material for long distant transport of fresh leaves and fruits. Spathes after shade drying and other pretreatments from good show pieces with a good design. These uses are apart for its nutritious as well as delicious baby food made from banana powder.

Percent contribution of different states to the total area under banana



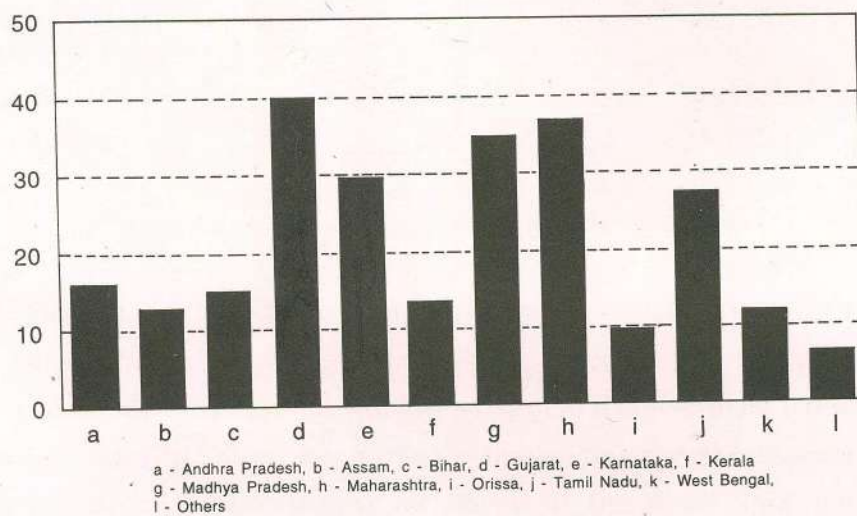
Percent contribution of different states to the total production of banana



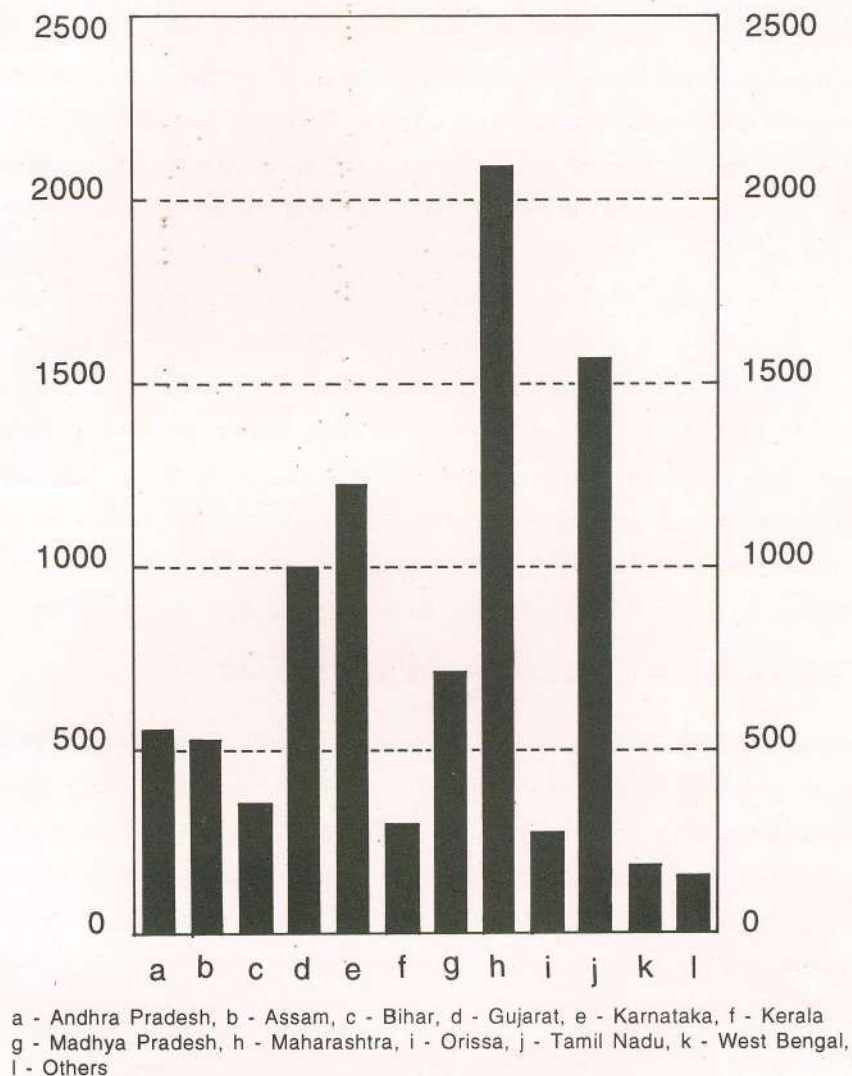
Banana production has registered an index number of 209 per cent in last two decades which has largely been contributed by increased productivity. However, average national yield is much below the potential. There is variation in productivity depending upon the region and system of cultivation (Fig.1-3). There are innumerable factors which limit the yield however, with adoption of improved production technologies it would be possible to double the production from the same cropped area. Investigation to pinpoint the production constraints in different regions for resolving the problems need emphasis in present context for increasing production from unit area.

Major growing area for banana are Kerala, Tamil Nadu, Maharashtra, Gujarat, Assam, Karnataka, Bihar, West Bengal, Andhra Pradesh, Orissa and Madhya Pradesh. These regions have varying agro-ecological and socio-economic conditions resultantly different system of cultivation and cultivars. Thus, production constraints also vary from region to region although many problems are similar. Wide range of cultivars,

**Productivity of banana
in different states**



Production of banana in different states



varying growing conditions and different systems of production have added the complexity of production constraints. Through concerted efforts by all the agencies with priority problems it would be possible to enhance production and productivity.

RESEARCH INFRASTRUCTURE

Banana research in India was started as early as in 1832 to collect and describe the banana accessions. However, systematic attempt to collect and describe the clones was initiated only in 1931. Major emphasis on banana research in India was directed towards description of cultivars from different regions till 1960. Banana research station started at Aduthurai in 1949 also emphasized upon assemblage and identification of parents from breeding.. Subsequently work was continued at Tamil Nadu Agricultural University under the All India Coordinated Research project on Tropical Fruits. In sixties and seventies, work was directed towards nutrition and high density planting at the National Institute (IIHR) as well as under AICRP on Tropical Fruits. At present, research on banana directed towards increased production and productivity is done at Indian Institute of Horticultural Research, Bangalore and under AICRP on Tropical Fruits having 7 centres located across the country. Considering the problems and need for strategic and basic research a National Centre on Banana has been established at Trichy which meets the challenges of banana in the country.

GENETIC RESOURCES AND CROP IMPROVEMENT

Long period of domestication of *Musa* under different agro-ecological conditions has lead to diversity in clones of *Musa*. India is considered to be a major centre of diversity for *Musa* clones especially of AB, AAB and ABB genomic groups. Successful attempts were made to evaluate the clonal situation in South India and a monograph was published by Jacob in 1952. But these attempts lacked the genomic classification system, which is globally acceptable. Few attempts were also made in Tamil Nadu and Kerala to evaluate the accessions and to remove the synonyms, identify the mutants and classify the cultivars using morphotaxonomy under genomic system. But these attempts are not complete and require the attention for characterization of total germplasm available in India using morpho-taxonomy supported by numerical and chemo-taxonomy.

Genetic diversity in genepool is of utmost importance in the improvement programme as a donor source. A total of *Musa* 425 accessions are maintained at different centre in the field genebank. However, through systematic approach more genepool could be added. Some attempts have been made by NBPGRI to collect

clones from North Eastern region and Western ghats and more than 40 exotic collections are available. *In-vitro* conservation also hold promise, which has been successfully demonstrated at NBPGR, New Delhi, Prospection, collection and conservation in field gene bank coupled with *in-vitro* conservation need attention to save the erosion of genepool and its utilization for improvement.

Assemblage have been evaluated partially for its resistance to sigatoka leaf spot, fusarium wilt and nematode. Large number of diploids have been synthesized having resistance to major pests and diseases and can be utilized for the transfer of gene, with the knowledge of their male and female sterility status. Parents for breeding work has been identified and few hybrids like Co.1 at TNAU, Tamilnadu, and H1 and H2 at Kannara (KAU) have been developed but these hybrids have not yet exhibited commercial significance. Moreover, conventional breeding is also very slow especially in banana. The situation warrants for advanced methods which are fast and reliable. At the same time hybrids developed in other part of world may require testing for its adoption for commercial exploitation.

Since most of the cultivated cultivars of banana are the result of natural mutation and selection, intensive evaluation of large number of plants to locate promising clones and its fast multiplication and testing using *in-vitro* propagation hold promise. Attempts made in past few years have resulted in identification of high yielding and early maturing clones in commercial cultivar. Concerted efforts in this direction would bring about the improvement and method will also be useful in selecting disease resistance clones through prospection in different agro-ecological conditions having varying disease pressure. Since, conventional mutation has failed to give promising results even after long period of testing, evaluation of somaclonal variation, induced by mutagen may help in the creation of variability for suitable selection.



A high yielding clone selected in dwarf cavendish.

IN-VITRO CULTURE OF BANANA

Initially, *in-vitro* culture and propagation of banana was tried for faster multiplication of disease free plants but it has become an essential part of genetic improvement programme. Success in *in-vitro* culture of meristem and floral apex of banana has been achieved at Indian Institute of Horticultural Research, Bangalore and Tamil Nadu Agricultural University, Coimbatore. *In-vitro* propagation of banana has achieved a commercial significance in the country with firms i.e., AVT, Cochin;

Indo-American Hybrid Seeds, Bangalore; but the pace of adoption of *In-vitro* plants by growers is very slow, although this technique of propagation has wider adoptability in abroad. This is perhaps due to high cost of *in-vitro* plants compared to conventional method of propagation and traditional farming system. If *in-vitro* plants have to be a reality, it has to be looked upon from the angle of growers as well as producer. Growers would be interested to earn more income to expenditure which is only possible if commercial firms emphasize upon *in-vitro* propagation of only high yielding clones making strict quality control and checking the performance in each batch. Much more research is needed to make *in-vitro* plants acceptable to farmers.

Other than micro-propagation, *in-vitro* culture is used for the exchange of germplasm and *in-vitro* conservation. At NBPGR, New Delhi, about 120 accession have been conserved in *in-vitro* using slow growing media and lower growing temperature than optimal. Problems are encountered in culture of clones having genomic constitution of ABB but through the removal of phenols using antioxidants it has been cultured successfully. However, there is need to test regeneration and genetic stability of clones at different intervals of time before it is commercially adopted.

It is also possible to produce callus from any type of banana vegetative organ and the morphological and histological characteristics of callus vary considerably according to the nature of the explant, the composition of media and culture conditions. The callus has regeneration potential and highly intergenous. In suitable media the callus has potential for embryogenetic callus and can be distinguished through histo-chemical analysis. It is also possible to isolate the cell. Thus through concerted efforts it would be possible to create variability for selection. In hybridization programme zygotic embryo rescue would facilitate in raising large number of hybrids.

Optimistically, *in-vitro* culture with the objectives of micro-propagation, germplasm exchange and conservation, tools in breeding programme has to play significant role in the improvement of banana which can only be achieved if research on *in-vitro* culture of banana is reoriented and strengthened to hit the target.

CLONAL SITUATION

Large number of cultivars totalling about 70 are grown in different parts of the country due to regional preference. Many cultivars have poor yield potential but are grown for its quality and farmers are compensated with higher price of the produce. However, Dwarf cavendish and Robusta known by different names are basis of commercial cultivation owing to high yield, wide market acceptability, short crop duration and high economic returns per unit area. but these cultivars are not common in coastal region due to its high susceptibility to sigatoka leaf spot disease. Poovan is another important cultivar grown commercially in different regions for its wider adaptability, tolerance to drought, and diseases. Nyali Poovan, known as Elakkibale, Ney Poovan, and safed velchi is also grown commercially in many parts of the country. Rasthali (silk banana) commonly known as Malbhog, Amritpani, Rasbale, Mortman in different regions, is significant in commercial production and its success largely depends on higher price it fetches. Virupakshi (Hill banana), Monthan, Karpuravalli, Chakia are also important in some regions. Nendran or Rajeli is grown in Kerala and also in Tamil Nadu. All the varieties have given rise to many mutants but only few mutants have found commercial significance. The clonal situation prevailing in different regions suggests that varietal need cannot be unified and would need regional consideration. Some of the cultivars have also merit with respect to production system. Thus while planning the improvement programme, production system and cultivars have also to be taken into consideration.

PRODUCTION SYSTEM

Depending upon resource availability, cultivars traditions and marketing different production system have been adopted which have their own merit under the situation. In Maharashtra and Gujarat, banana is grown in rotation with one plant crop while tall cultivar is maintained for 4-5 years in other parts of the country. Wet land banana, having deep trenches after every two rows is common in Tamil Nadu and parts of Karnataka. Garden land is widely adopted system of production while planting on hill slope is common in Tamil Nadu, Karnataka and North Eastern regions. Normally, cultivars adopted in this system need low inputs.



Salt toxicity in banana.

Banana is also grown as subsistence crop in homestead garden or as shade or nurse crop. Mixed cropping with arecanut and coconut is practiced in Kerala, Coastal Karnataka, Tamil Nadu, West Bengal and Andhra Pradesh. In commercial planting, banana is invariably managed with high inputs. In reviewing the production system in the country, it is apparent that these systems have their own merit in a given situation and would need improvement through development of production technologies. Most of research accomplishment are on high input plantations and to



Banana intercropped with elephant foot yam.

resolve the problems in different regions it would be of importance to consider the production system.

Influence of time of planting, type and size of planting material and population density for different cultivars have been worked out. In tropical regions, planting is done coinciding with rainfall and harvesting is regulated through the staggering of planting. But in Sub-tropical regions, temperature plays a vital role so the planting time is adjusted to avoid shooting during winter. Significant increase in yield due to

high density planting has been achieved. A density of 4500 plant ha⁻¹ is practiced in Maharashtra on vertisol, while in other states in three crop, cycle 3000-3500 plants are planted. Double row system of planting has also been found economical. These practices are well adopted to conventional method of irrigation; with the change in irrigation system and use of *in-vitro* propagated plants, time of planting and density would need reorientation.

Evidences available suggest that banana responds to N and K applications and field trials have indicated the optimum need of 100-200g N, 45-46 g P₂O₅ and 200-300 g K₂O per plant per year. $\frac{3}{4}$ th dose of N and $\frac{1}{2}$ dose of K₂O in vegetative phase and $\frac{1}{4}$ N and $\frac{1}{2}$ K₂O in reproductive phase are beneficial to obtain higher yields. Attempts have also been made to correlate the leaf nutrient status with yield. However, data are not sufficient to develop soil and plant nutrient status for monitoring the nutrients need. Requirement of nutrients is also influenced by system of irrigation and propagation material. With changing scenario of banana production, efficient nutritional management system needs emphasis for reduced cost of production and increased productivity. Use of fertilizer through drip irrigation, use of slow release fertilizer, liquid fertilizer etc., have to find important role in strategies of research.

Irrigation to banana depends upon the system of production. In coastal region, local cultivars are grown under rainfed conditions while in commercial production system banana is irrigated. System of irrigation depends upon the choice of growers. Invariably, basin irrigation system has been followed but in the last few years drip irrigation has been adopted due to high yield, savings in water, early cropping and labour economy. Mulching with sugarcane thrash @ 5-6 ha⁻¹ or dry leaves is advocated. But many problems associated with drip system of irrigation have remained unresolved. To have a better insight, it is important that much more studies required to be done with drip irrigation especially to understand the physiological behaviour of plants for the ease of manipulation. Fertigation would also need more emphasis.

Investigations carried out at different locations suggested that 62.5 per cent yield loss in tall cultivars and 104 per cent in Dwarf cultivars is caused due to weeds, warranting to keep banana plantation free from weeds. Vegetative phase (1-6 month) is the most critical stage and weed growth during this phase of growth causes considerable loss of productivity. Control of weeds during this period enhances the

fertilizer use efficiency and the yield. Suppression of weeds using intercrop, and control through integrated management resulted in increased production. However, there is a need to work out the dynamics of weed and its management in different system of management which would optimise the productivity and improve the physico-chemical properties of soil.

Under present system of cultivation, yield of banana exhibit plateau in commercial plantation and to enhance the yield exogenous application of growth regulators, wrapping of bunches etc., have to play significant role. Application of 2,4-D at 20 ppm at full flowering stage and covering of bunches during winter season improve the bunch weight and size of finger. However, physiology of response is not well understood which may be associated with cultivars and growing conditions. Therefore, to make this technology acceptable, studies under different system of production and cultivars have to be taken up.

INSECT PESTS AND DISEASES

Situation of insect, pests and diseases in different banana growing regions are well understood. Among the insect pests, banana weevil (Cosmopolite sordidus) is of major concern in Kerala and Assam and chemical control for this pest has been worked out. Mites (Tetranychus sp.) and thrips also cause considerable damage to flowers and fruits but is not alarming with sporadic incidence. Banana aphids (Pentalonia nigronervosa) is wide spread and causes the damage through transmission of banana bunchy top. In North-Eastern regions, Bihar and Bengal problem of scarring beetle is alarming which causes scarring on the fruits by feeding on young flowers and fruits. The fruits affected by this pest have poor market acceptability. In case of severe incidence in growth phase yield has also been reduced. Pseudostem borer (Odoiporus longicollis) affect the tall cultivars which can be controlled by application of systemic insecticides and sanitation of orchard. Other insects are of minor importance. Although, insect and pests problems vary from region to region and suitable control measures are available increased systematic research efforts should be directed towards the investigation on factors causing appearance and development of population so that desired new techniques with emphasis on integrated management could be worked out.



A banana plantation infested with Rhizome weevil (*Cosmopolit sordidus*).

Numerous nematode species parasitise on banana roots and its importance as a problem in banana production is largely depend upon production system, region and cultivars. Although, presence of *Radopholus similis* (burrowing nematode), *Pratylenchus*, *Coffeae*, *Meloidogyne incognita*. (Root knot nematode), *Helicotylenchulus multicintus* and *Helicotylenchulus dihystra*, *Heterodera oryzicola* are reported from different parts of the country, while *Radopholus similis* appear to be wide spread. *Helicotylenchulus* is more serious in North-Easter region while cyst (*Heterodera oryzicola*) nematode is a problem in Kerala only. In Maharashtra, where banana is grown with rotation of jowar, problem of nematode is less significant. Similarly, in wet land system of production nematode is not serious compared to garden land banana. Double paring and treating the sucker with 0.5. per cent monocrotophos, growing of sunnhemp as intercrop and application of neem cakes invariably reduce the population of nematode. Chemical treatment is also suggested. But integration of



Nematode (*Radopholus similis* Thorne) infested roots of banana.

available cultural, biological, chemical and genetic possibilities is better answer which would need the knowledge on plant-parasite-soil interactions.

Among fungal diseases, sigatoka leaf spot (*Mycosphaerella musicola*) in humid tropics or coastal regions is the cause of concern which causes considerable loss in production. Fortunately, the virulent species, (*M fijiensis*) has not been recorded. The disease has received much attention in many banana growing countries as 20-30 per cent of inputs are invested on the control of this disease. However, this disease is



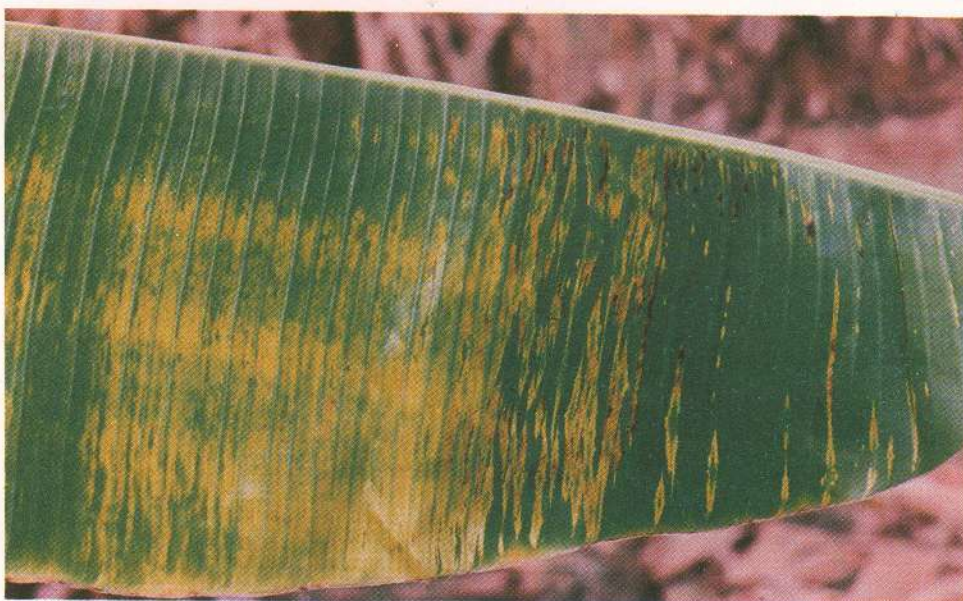
Sigatoka leaf spot (*Mycosphaerella musicola*).

completely absent in many regions of the country. Tolerance to the disease depends upon the cultivar and conditions of growing. The regions where this disease is virulent, susceptible cultivars should not be grown and fungicides are effective in reducing the incidence of disease. Monitoring of disease through forecasting, cultural practices, use of fungicides and genetical manipulation needs better understanding as the disease behaviour is influenced by production system and prevailing weather conditions. Fusarium wilt (*Fusarium oxysporum* f.sp *cubense*) is a serious major threat throughout the country on Rasthali group of banana. Fortunately, Cavendish group of banana is not susceptible to this disease although sporadic incidences has been recorded. Flooding the soil, selection of suckers and injection with carbedazim are effective in reducing the incidence. Solution to the problem is possible only through the genetic manipulation. Interaction of fusarium wilt with nematode also need increased research efforts. Erwinia soft rot, *Collectotrichum gleosporium* and anthracnose are of regional importance.



Healthy and BBT infested flower of banana. Elongation and green colour on tip of bracts in infested flower.

vector viz., Pentalonia nigronervosa, is present in all the regions and even the virus free material do not remain free for long time due to secondary infection. Tetrazolium salt test has been found effective in detecting the virus but its sensitivity to little change in chemical make the test unreliable. Antioxidants are used to enhance the reliability. Quick detections using serological techniques are found effective in other countries shown promise. Vector-virus plant relations, dynamics of virus and vectors, evaluation of period of susceptibility, bio-ecology are some of the important research areas for the effective management of this virus. Infectious chlorosis or cucumber mosaic virus is prevalent in Tamil Nadu, Maharashtra and Andhra Pradesh. The losses caused due to this disease largely depend upon the stage of infection. *In-vitro* plants appear to be more susceptible to this disease. if the spread of disease is not checked, it can be one of the major threat. use of disease free planting material, avoidance of susceptible hosts and control of vectors (*Aphis gossypii* and *A. craccivora*) are some of the approaches for the management of the



Symptoms of infectious chlorosis.

disease. Development of quick disease detection technique using serological tools needs attention.

MARKETING AND EXPORT

By and large, banana produced in the country is consumed in the domestic market. Efforts made in the past have not met with success due to several unexplained reasons. It is often stated that fruit produced in the country is not of export quality but it is not true. The export markets have their standards and to achieve those standards, efforts have to be directed for quality than quantity. Technologies for the production of fruits for export market are available and can be adopted once the market is created. Many of local cultivars viz., Poovan, Kadali and Ney Poovan can have better export market as has been evidenced in the export of fruits from Philippines. Cultivars, climatic conditions and skilled growers favour for the export of banana which can be made into reality with our concerted efforts.

Large volume of banana fruits are marketed through commission agents or contractors. Very negligible percentage of produce is marketed through societies. There is no definite standard for fixing the quality which is normally done by the appearance of bunch, number of hands and finger size. Many a times farmers have to suffer due to distress sale, resulting to low inputs which ultimately decide the productivity. To ensure better returns which will inspire for better technique adoption, there is a need to develop a marketing system and fix a minimum price for the produce.

Banana from Central and Western India is transported to Delhi either by lorry or railway wagon. Due to delay in arrival, large volume of fruits are spoiled. Use of ethylene absorbants, pre-cooling and packing in polythene bags found effective for prolonging the shelf-life showed promise for its use. Integrated approach to marketing coupled with suitable post-harvest technique would bring about a better price for growers. Even though several banana products i.e., banana jam, squash, chips, powder, banana fig etc., have been successfully prepared, only the banana chips have promise which is normally done on home scale. Similarly pseudostem and fruit pits have been used for cattle feed and extraction of fibre but refinements are required for its commercial adoption.

Foregoing the above discussion, it is apparent that banana production constraints and need on research in banana is well understood. Thus, challenges before the National Centre on Banana are many, which have to be addressed in the order of priority. The challenges could be prioritized broadly under 4 missions.

- 1. Collection, conservation, documentation and utilization of genetic resources**
- 2. Improvement of banana for resistant to diseases and nematodes having good agronomic characters ;**
- 3. Improved production technologies for enhanced productivity and**
- 4. post harvest characterization of germplasm and post harvest handling.**

There is a greater awareness for banana research at the global level. INIBAP is committed to banana improvement through support to the NARS and the opportunity can be availed for achieving the goal of NRCB.

ANNEXURE - I

Details of Staff Position

Category of post & Designation	No. of sanctioned	Name of the incubment
<u>Scientific</u>		
1. Director	1	Dr. H.P. Singh (OSD)
2. Principal Scientist	1	Vacant
3. Sr. Scientist (H)	1	Vacant
4. Sr. Scientist (Pl. Path_	1	Vacant
5. Sr. Scientist (Nemt.)	1	Vacant
6. Scientist (H)	2	Dr. S. Uma
7. Scientist (Path)	1	Vacant
8. Scientist (Soil)	1	Vacant
<u>Technical</u>		
1. jr. Garden Supdt. (T5)	1	Mr. Raghu Raman (in-charge)
2. Civil Oversear (T-II-3)	1	Vacant
3. Tech. TII-3	3	Vacant
<u>Administrative</u>		
1. Asstt. Admn. Officer	1	Vacant
2. Asstt. Finance & Accounts Officers	1	Vacant

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