ANNUAL REPORT
1994 - 95

भाकृअनुप
ICAR

NATIONAL RESEARCH CENTRE ON BANANA

PODAVUR, TRICHY (TAMIL NADU) 620017, INDIA

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

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National Research Centre on Banana
Podavur, Trichy (Tamil Nadu) 639103

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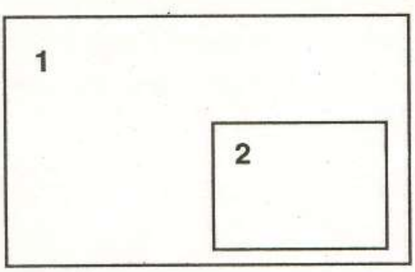
Dr.S.Uma

Cover Page Photo : The cover depicts the symptoms of banana bract mosaic-Virus.

Cover design : Mr.Padmanabhan



1. Symptoms of BBMV on Petiole

2. Pink Streak on pseudostem.

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FOREWORD

Banana, the second important fruit crop in India with respect to area has risen to first position in production during the year with a record production of 10.4 million tonnes. This has been possible due to the increase both in production and productivity. The National Research Centre on Banana (NRCB) with its commitment to overall improvement of production and productivity has started functioning effectively with emphasis on the development of infrastructure and genetic resource management. During the year, the centre also established close linkages with the national and international organisations. Several programmes have been initiated with the collaboration of INIBAP.

Efforts made have resulted in collection of major germplasm of banana totaling 535. Two clonal accessions, one under Rasthali and another under Monthan are also identified superior to the existing cultivars under the groups. The centre has also standardised the protocol for *in-vitro* management of diverse genetic resources of banana from different genomic groups. Two virus diseases namely, Banana Bract Mosaic Virus (BBMV) and Banana Streak Virus (BSV) have been identified with the collaboration of INIBAP. Kokkan disease of Nendran banana, hitherto known as disease of unknown etiology was confirmed to be BBMV. Efforts are also on way for the detailed investigation of these diseases. NRCB on Banana also received wider publicity during the year. In this annual report, brief discription of the work done under four missions are reported. Excerpts of Perspective Planning is also presented. I am sure this annual report will be very useful and informative to all banana workers.

10th August, 1995

(I.S.YADAV)
Director,
Indian Institute of Horticultural Research
Bangalore.

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DIRECTOR'S REPORT

INTRODUCTION

National Research Centre on Banana (NRCB) established in August, 1993 started functioning effectively during the year and has initiated programmes under thrust areas. This research centre is also coordinating International Musa Testing Programme (IMTP) for Fusarium wilt and Sigatoka leaf spot diseases. Endeavours have been made to collect the germplasm and initiate effective research programmes befitting to the mandate of the centre. Impact of the centre is widely felt, evidenced through wide coverage by the National News network. Major emphasis during the year was on the development of infrastructural facilities, and initiation of programmes under the thrust area.

Headquarters of NRCB is located in Trichy and has 36 ha farm in Podavur Village, 14 km south-west of Trichy town.

INFRASTRUCTURAL FACILITIES

Farm Development : Farm development received greater emphasis. Farm layout has been completed, road and drainage channels are being made. Contour map of the farm was also completed. Fencing is in progress and is expected to be completed before mid of the year .

Two tractors and one power tiller have already been acquired in the farm, and temporary structures are being built. Open wells and tube wells are the major source of irrigation water. Survey is being conducted for developing comprehensive irrigation system.

Laboratory facilities/Library : Laboratories at NRCB have been organised into Breeding and Biotechnology Lab., Crop Production and Crop Protection Lab. Required facilities are being created ; equipments for biotech lab have been acquired during the year in addition to other lab equipments. Library was established which is contributing to leading journals and 70 books were accessed.

STAFF AND BUDGET

Posts of B,C,D category (Administrative - 9, Technical - 12, Auxilliary - 3, Supporting - 7) were created during the year of which two posts have been filled up through deployment and arrangements are being made to fill up rest of the posts. Two scientific posts were filled up by deployment and rest of the positions will be filled up as soon as cadre strength is finalised and posts are created.

Sanctioned budget for the financial year 1994-95 was 39 lakhs of which 38.98 lakhs was utilised under the different heads. Allocation for the year 1995-96 is Rs.60 lakhs under different heads.

RESEARCH ACTIVITIES

Research activities of the NRCB has been organised under four major sub-missions namely ; Genetic resource management, Crop improvement, Production technology (Production and Protection) and post harvest characterisation and utilization. The centre has also been sanctioned a project under cess fund for the characterization and documentation of banana germplasm. The salient results of research activities are as under :

Genetic resource management : Genetic resources of banana was enriched through collection from exotic and indigenous sources. Total holding of the centre is 535 accessions. Germplasm are conserved in the field genebank largely, and *in-vitro* conservation has also been attempted. Since the germplasm are planted in batches many of the accessions were still in the growth phase. Thus, evaluation with respect to growth, yield, quality of fruits and reaction to diseases and salinity were recorded. From the evaluation of these germplasms, it has been possible to identify the accessions with different growth habits, maturity group, yield potential, bunch characteristics and reaction to sigatoka leaf spot disease. Incidence of Banana streak virus (BSV) was observed on the accessions from Poovan group, while an accession from monthan group had incidence of Banana Bract Mosaic Virus (BBMV)

In-vitro management of germplasm : Total of 36 accessions were introduced from INIBAP and sub-cultured for further multiplication. However, response to media adopted varied depending upon germplasm. Thus, eight media having different ratio of cytokinin and auxin were evaluated which suggested for the genome specific response to ratio of cytokinin and auxin. The medium containing MS major, (KH_2PO_4 400 mg/l) minor salt BAP (10 μM) + IAA (1 μM) + Sucrose (3%) alongwith MS vitamins, glycine, ascorbic acid (20 mg/) and gelrite (0.2%) were found to be the best for multiplication of diverse genomic group of banana. Reduction in leaf surface area while transplanting improved the survival of plants during hardening.

Utilization of genetic resources : Accession No.0030 from the taxonomic evaluation appeared to fall under AAB silk type. On comparision of this accession with Rasthali (Silk) it was found superior with respect to bunch yield, pulp skin ratio and the quality of fruits. Incidence of wilt in this accession was not observed while 30 % wilt incidence was observed in Rasthali. This accession is being evaluated further for its suitability under the condition. Similarly accession No.0016 has been found superior to local monthan, which requires further evaluation.

Improvement and Production Technology : Three trials for evaluation of hybrids in collaboration with INIBAP have been initiated. Hybrids and other cultivars received from Belgium (INIBAP transit centre) are being multiplied and is expected to be taken up during next year. Trials on the production technologies were initiated during the year. Retention of mother plant after harvest had no significant influence on the growth of daughter suckers.

Crop Protection : Roving survey for disease incidence was conducted in Tamil Nadu and Kerala which has indicated widespread incidence of BBMV,characterised by reddish streaks on the pseudostem which turn brown later and finally into black discoloration. In severe cases orientation of leaves resembles traveller's palm appearance. Necrotic streaks are also observed on male bracts and sometime on fingers. Affected plants produce small bunches and long peduncle, small fruits with unusual curvature. BSV was found to be prevalent especially in poovan group of banana. Since this disease was not known earlier, major emphasis is being paid for the creation of awareness about the disease. In addition to the virus and virus like diseases, sigatoka leaf spot and fusarim wilt were found prevalent.

GENERAL

Dr. R. C. Panda, Secretary (Agri.), Government of Tamil Nadu, visited the research centre and appreciated the efforts and the progress made during the year. Enquiries of the farmers regarding the management of banana were also attended. Awareness was created about the disease threat through coverage in news papers, AIR etc.

ACKNOWLEDGMENT

I wish to express my sincere gratitude to Dr.K.L.Chadha, Dy.Director General (Hort.) for his inspiring encouragement, untiring guidance and suppport. I also wish to express my sincere thanks to Dr.I.S.Yadav, Director, IIHR, Bangalore for his kind cooperation and help in facilitating the work at NRCB. Thanks are also due to those who have directly or indirectly contributed to the speedy progress of the NRCB and assisted in the preparation of this annual report.

H P Singh

10 August, 1995.

(H.P.SINGH)
Officer Incharge
National Research Centre on Banana.

INTRODUCTION

Banana and plantain, reported to be fourth most important global food commodity after rice, wheat and milk in terms of the gross value of production (CGIAR Priorities and Strategies part 1 Section 5.3.5) are of great socio-economic significance in India contributing to 26 per cent of the total fruit production. It is grown in varying agro-ecological conditions under different system of production having regional preference for the cultivars. Research efforts in the past have been largely towards the standardization of production technologies. Conservation and characterization of genetic diversity, improvement of cultivars for resistance to biotic and abiotic stresses, post harvest characterization and production technology for high grade fruit production were not addressed for systematic research. With a growing appreciation for the role of banana in nutrition, and medicinal properties added with high economic returns per unit area, sustainable income to marginal farmers, environmental friendliness and problem of biotic and abiotic stresses have warranted for systematic research. Therefore, on the recommendation of the Task Force appointed by the Indian Council of Agril. Research, the NRCB was established on 21st August, 1993 at Trichy to address the problems through basic and strategic research on bananas in thrust areas.

LOCATION

National Research Centre on Banana is located at Trichy (Trichirapalli) in the State of Tamil Nadu at 10.50 N latitude, 74.50 E longitude and 90 m above mean sea level. 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. Office and laboratory is housed in a rented building at 44, Ramalinga Nagar South Extension, Vayalur Road, Trichy. Farm is located in Podavur Village, 14 km from Trichy town on Thogamalai Road. The State Government has agreed to provide 3 ha land on main road for the construction of office and laboratory building. About 0.80 ha land will also be provided in city for residential building and guest house.

MANDATE

National Research Centre on Banana is committed to take up the mission oriented basic and strategic research programmes for enhanced production and productivity of banana. Followings are the mandate of the centre:

* *To undertake the basic and strategic research for the development of technologies to enhance the productivity and utilization of banana,*
* *To develop improved cultivars through traditional and bio-technological methods and conserve the diversity,*
* *To serve as national repository of germplasm and informations related to banana and plantain and also to disseminate the knowledge to improve the production and productivity,*
* *To provide leadership and coordinate the network for generating location specific varieties and technology for solving specific constraints in banana and plantain production,*
* *To collaborate with relevant National and International agencies in achieving the above objectives.*

ORGANISATION

NRCB is headed by the Director. The organisational structure is given in Fig.1. The centre has sanctioned strength of a Director, 2 Scientists, one each of Asstt. Admn. Officer and Asstt. Fin. & Accounts Officer, and Asstt. Garden Superintendant. Details are given in Annexure-1. Posts under, B,C and D category staff have been created and arrangements are being made to fill up the posts. However, posts under A category (Scientists)have yet to be created. After finalization of cadre strength posts will be created through deployment.

BUDGET

Total outlay for NRC on Banana during the VIII Plan is Rs.230 lakhs. Statement of sanctions and expenditures are given in the table-1. During the financial year allotted budget was fully utilized. Receipts from sale of farm produce was Rs.72,235.

Table -1 : Budgetory allocation and expenditure at NRCB

Heads of expenditure	Allocation during VIII Plan	Actual Expenditure 93-94	Actual Expenditure 94-95	B.E. 95-96
Estt.	26.30	-	1.25	7.70
T.A.	4.70	0.30	0.96	1.50
Rec.Cont.	29.00	0.28	4.91	8.50
Asset				
Works	120.00	-	7.60	27.00
Tools,plants,				
Equpt.	40.20	3.26	22.62	10.10
Furnitures/fixtures	3.50	0.43	1.42	1.50
Vehicle	3.70	-	0.05	2.00
Any others	2.60	-	0.17	1.70
Total	230.00	4.27	38.98	60.00

Receipt : Farm produce : Rs. 72,235/-

LOGISTIC FACILITIES

Farm Development : Farm of NRCB is located in Podavur village 14 km south-west of Trichy, 2 km away from the Thogamalai Road connected by a tar road. Presently there is no approach road to farm of its own. Thirty meters wide and 100 m long land is being acquired to connect the farm to the main road. Total area of farm is 36 ha. Western side of the farm has a big village drain and southern side has canal. Most of the farm land is wet except a few patches having gravely soil. About half an hectare of land is marshy. Water table is very high warranting effective drainage system. Soil pH ranges from 8.0 to 9.5 and many of the plots require reclamation.

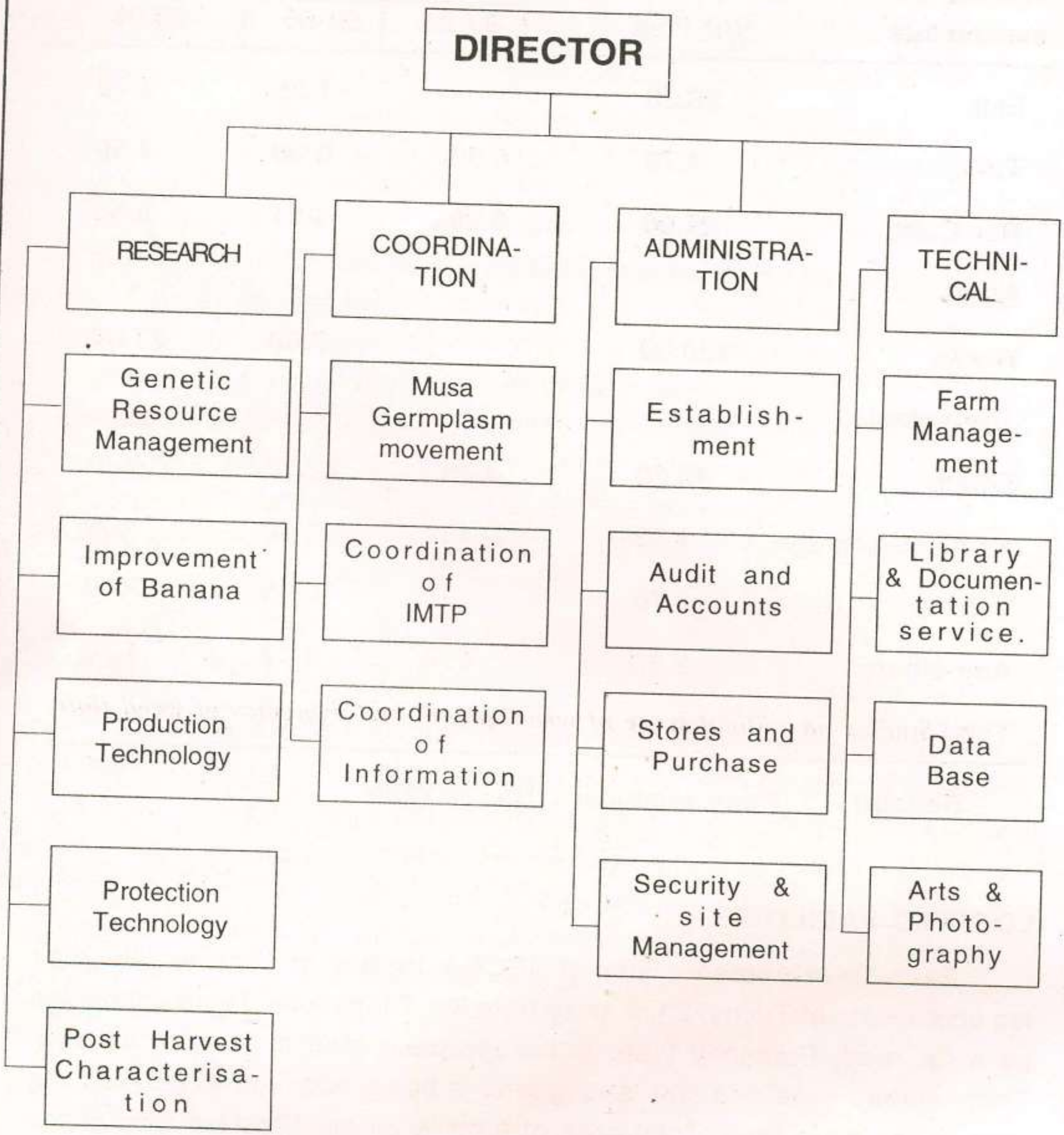


Fig. 1 : Organisational Structure of NRC Banana, Trichy

Two open wells, one bore well and canal are the source of irrigation. Farm survey and contour mapping have been completed for effective management of drainage and irrigation water. Main road, side roads,drainage lines are being developed. Fencing work is in progress which may be completed shortly.

After development of plots (200x100 and 50x50 m), land was effectively utilized by growing banana and rotational crops viz. paddy, sugarcane, black gram, green gram etc.

Infrastructure : Office-cum-laboratory has started functioning in a rented building and required office and laboratory facilities have been created. Breeding and Bio-technology laboratory, Production and Protection laboratory have been established. The centre has acquired a personal Computer alongwith software packages and data base of germplasm is being developed. Arrangements for getting connectivity of E-Mail has been made. The centre is connected by telephones and Fax. Required furniture and fixtures have been acquired.

Scientist recording the data on photosynthesis using Leaf Chamber Analyser (LCA-4)

During the year in addition to tractors and power tiller several laboratory equipments were acquired. The centre has developed working laboratory facilities by acquiring pH meter, conductivity bridge, BOD incubator, microscope, electronic balance, photosynthetic system, audio visual aids etc. Bio-technology laboratory is also being equipped with tissue culture racks, laminar air flow, air conditioners etc.

Computer in use for development of database

At farm, small structures are being erected and main tar road is in the process of construction. As soon as the land at main road is handed over by State Government, action will be initiated for the construction of main laboratory building.

Library : Library of NRCB has been enlisted in mailing list of concerned National and International Institutes. Technical documents on banana and plantain totaling 25 was acquired from INIBAP. Books holding has reached to 68. Most of Indian Journals totaling 11 are received in the library. Efforts are being made to acquire more books and contribute for foreign journals.

RESEARCH ACHIEVEMENTS

1. GERMPLASM MANAGEMENT (Collection, conservation, evaluation and utilization of banana germplasm)

Evolution and long periods of domestication of *Musa* under different agro-ecological conditions have led to the diversity in *Musa* clones and country is credited to have the largest diversity. Therefore, germplasm collections or assemblage of genotypes from the population representing cultivars, genestocks and species; its conservation, evaluation and utilization are the priority activity of the centre.

1.1 GERMPLASM COLLECTION : During the year, intensive efforts were made to collect indigenous and exotic genepool. A total of 284 accessions during the year were collected from Andhra Pradesh, Assam, Bihar, Gujarat, Kerala, Maharashtra and West Bengal. Through exploration five accessions were also collected from Tripura. A total of 36 accessions *(in-vitro* cultures) were introduced from transit centre of INIBAP at Belgium. Thus the centre has enriched the germplasm collection totaling to 535 accessions (Table-2). While collecting the germplasm all the precautions as outlined in Annual Report 1993-94 were adopted.

Table-2 : Details of banana accessions collected at NRCB, Trichy

Musa Clones/sp.	No.	Source of collection
Musa sp.	4	Indigenous - Andhra Pradesh, Assam, Bihar,
AA	14	Gujarat, Kerala, Maharashtra,
BB	2	Tamil Nadu, Tripura, West
AB	25	Bengal
AAA	105	
AAB	125	Exotic - Belgium
ABB	12	
Un-identified	248	
Total	535	

IN-VITRO MULTIPLICATION: In collection and assemblage of germplasm, it is of paramount importance to ensure that germplasm is healthy. For safety movement of germplasm *in-vitro* multiplication and transportation are encouraged. Accessions from different genomic groups responded differently to *in-vitro* multiplications. A total of 35 accessions of banana introduced from Belgium were sub-cultured. One of the

In-vitro propagation of exotic banana accessions

accessions (Yangambi Km5) failed to grow on medium-1, instead it started decaying and other accessions from different genomic groups started producing unorganised leaf like growth. However, in case of FHIA-03, some cultures produced few multiple shoots on medium-1. But the response was not uniform, since some cultures of this clone also produced abnormal leaf like structures on medium-1. A preliminary study was undertaken using 8 media (Table-3) and 10 accessions to develop a protocol for handling germplasm of diverse genomic group. The performance studies of 7 cultures viz., FHIA-01, FHIA-02, FHIA- 03, Yangambi Km5, Saba, Pisang Jari Buaya and Pisang Mas indicated the suitability of medium-8 for *Musa* multiplication. Subsequently, medium 1, 2, 3 and 8 were tested for 32 accessions. In this study also the response was not satisfactory on medium 1 since most of the proliferating shoots started producing unorganised growth of shoot like structures.

Table -3 :	**Composition of different media tried for Banana multi-plication.**
Medium 1 :	MS* major and Minor salts + Thiamine HCl (1 mg/l) + Inositol (100 mg/l) + NaH_2PO_4 $2H_2O$ (340 mg/l) + Adenine sulphate (80 mg/l) + sucrose (3%)+ BAP (22.22 μM) + IBA (24.63 μM) + gelrite. (0.25%)
Medium 2 :	MS* major and minor salts + Inositol (100 mg/l) + Thiamine HCl (1 mg/l) + sucrose (3%) + BAP (11.11 μM)+ gelrite (0.25%)
Medium 3 :	Medium 2 + Adenine sulphate (80 mg/l)
Medium 4 :	MS* major and minor salts + Na H_2PO_4 $2H_2O$ (340 mg/l) + Inositol (100 mg/l) + Thiamine HCl (1 mg/l) + Adenine sulphate (80 mg/l) + sucrose (3%) + BAP (22.22 μM) + gelrite (0.25%).
Medium 5 :	MS* major and minor salts + NaH_2PO_4 $2H_2O$ (340 mg/l) + Inesitol (100 mg/l) + Thiamine HCl (1 mg/l) + Adenine sulphate (80 mg/l) + Sucrose (3%) + BAP (33.33 μM) + gelrite (0.25%)
Medium 6 :	MS* major and minor slats + Inositol (100 mg/l) + Thiamine HCl (1 mg/l) + BAP (20 μM) + IAA (1 μM) + Sucrose (3%) + gelrite (0.25%).
Medium 7 :	MS* major and minor salts + Inositol (100 mg/l) + Thiamine HCl (1 mg/l) + Sucrose (3%) + BAP (22.22 μM) + IBA (5.714 μM) + gelrite (0.25%)
Medium 8 :	MS* major and minor salts (KH_2PO_4 used was 400 mg/l as against 170 mg/l) + MS vitamins, glycine + ascorbic acid (20 mg/l) + Sucrose (3%) + BAP (10 μM) + IAA (1 μM) + gelrite (0.2%).

* : Murashinge and Skoog (1962)

It was inferred from the study that changing the concentration of BAP may help in obtaining better multiplication. However, concentration beyond 5 mg/l (22.22 μM) was inhibitive to the growth. From series of trials with different genomic group it was concluded that media eight was the best (Table-4).

Table 4 : Response of proliferating shoot tips of Banana for *in vitro* multiplication, cultured on different media.

Medium No.	Multiple shoot formation	Extent of roots for these multiple shoots	Shoot growth
1.	+	++	+
2.	+	NIL	+
3.	+	NIL	+
4.	+	NIL	+
5.	++	NIL	+
6.	+++	++	++
7.	+++	++	++
8.	++++	+++	+++

Response categories : + = Poor, ++ = Medium, +++ = Good, ++++ = Very good.

The number of multiple shoots obtained per explant varied from 2-8 depending upon the type of explant used. After one month, these cultures started producing roots. Prolonged culture of these explant on the same medium for 7-8 weeks resulted in browning of the medium and in later stages the explant also started browning. This indicated the phenol secretion by these cultured explants after about 6-7 weeks. The observations also indicated the necessity of sub-culturing before this browning stage for better multiplication. The time taken for browning of the medium was more on medium 8 as compared to other media tested. The rooting response on the medium 8 was better and a better balance between the root and shoot growth was noticed (Table-4). Hence, it was concluded that, for multiplication of diverse group of banana, medium 8 would be appropriate which enabled to multiply the accessions fast. The number of multiple shoots obtained in each clone is presented in table-5. While transferring from rooting medium to pots as well as secondary transplanting, reduction of leaf surface area enhanced the establishment.

Table-5 : No. of shoots multiplied in each accession.

Sl. No.	Name	No.of shoots multiplied	Sl. No.	Name	No.of shoots multiplied
1.	FHIA 01	35	17	M.AC.SSP	48
2.	FHIA 02	70		BURMAN NICOIDES	
3.	FHIA 23	24		TYPE CULCUTTA 4	
4.	FHIA 17	50	18.	GROS MICHEL	55
5.	PV 03.44	30	19.	BLUGGOE	55
6.	PA O3.22	45	20.	WILLIAMS	60
7.	GCTCV 119	50	21.	PISANG CEYLAN	27
8.	GCTCV 215	30	22.	FHIA 23	32
9.	BURRO CEMSA	35	23.	PA 03.22	35
10.	PISANG MAS	80	24.	PV 03.44	30
11.	SABA	60	25.	SH 3436-9	18
12.	PISANG NANGKA	60	26.	YANGAMBI KM5'	55
13.	CULTIVAR ROSE	45	27.	SABA	26
14	YANGAMBI KM5	120	28.	PISANG CEYLAN	29
15.	PISANG JARI	60	29.	PISANG LILIN	30
	BUAYA		30.	PISANG BERLIN	30
16.	PISANG LILIN	54	31.	NIYARMA YIK	30

1.2 GERMPLASM CONSERVATION : Largely, germplasm is conserved in field genebank although *in-vitro* conservation was also attempted.

1.2.1 **Field gene-bank :** Germplasm is conserved in the field gene bank under the prevailing wet land system of cultivation. A spacing of 2.0 x 2.0 was adopted for planting. All the accessions were maintained with uniform cultivation practices. Under this system of cultivation, trenches are maintained after every 3 plants of each accession in a row and after every two rows. Invariably three plants are maintained under each accession. In cases where number of suckers were less than three, they were multiplied and planted. No prophylatic measure for the control of pests or diseases was taken, however, effective control measures were adopted considering the problem.

1.2.2 **In-vitro conservation :** Efforts were made for *in-vitro* conservation of the accessions. A total of 34 accessions were cultured and conserved. Under each accession 3 tubes were maintained. However, this requires frequent sub-culturing. Thus a reduced temperature of 12-13°C has to be maintained to enable to reduce the number of sub-cultures.

1.3 GERMPLASM EVALUATION :

During the year under report preliminary evaluation of germplasm and characterisation were done. Since, planting time varied depending upon the time of collection, evaluation data of only 74 accessions were analysed, which reached to harvesting stage. Evaluation for agronomic characters as well as taxonomic characters were done using IBPRI descriptors.

1.3.1 Growth Characters : Growth of plants measured by plant height, girth, leaf length, leaf breadth, and leaf length- breadth ratio etc. exhibited wide range of variability (Fig.2)

Plant height and girth : Plant height varied from 33.2 to 48.5 cm at 3rd month, 73.6 to 185.2 cm at 5th month, 66.3 to 196.9 cm at 7th month, 110.3 to 120.8 cm at 9th month and 184.2 to 372.5 in 11 th month. Plant girth varied from 12.89 to 44.1 cm at 3rd month, 19.2 to 49.3 cm in 5th month, 29.2 to 56.3 cm in 7th month, 33.7 to 69.7 cm at 9th month and 40.0 to 94.1 cm in 11th month.

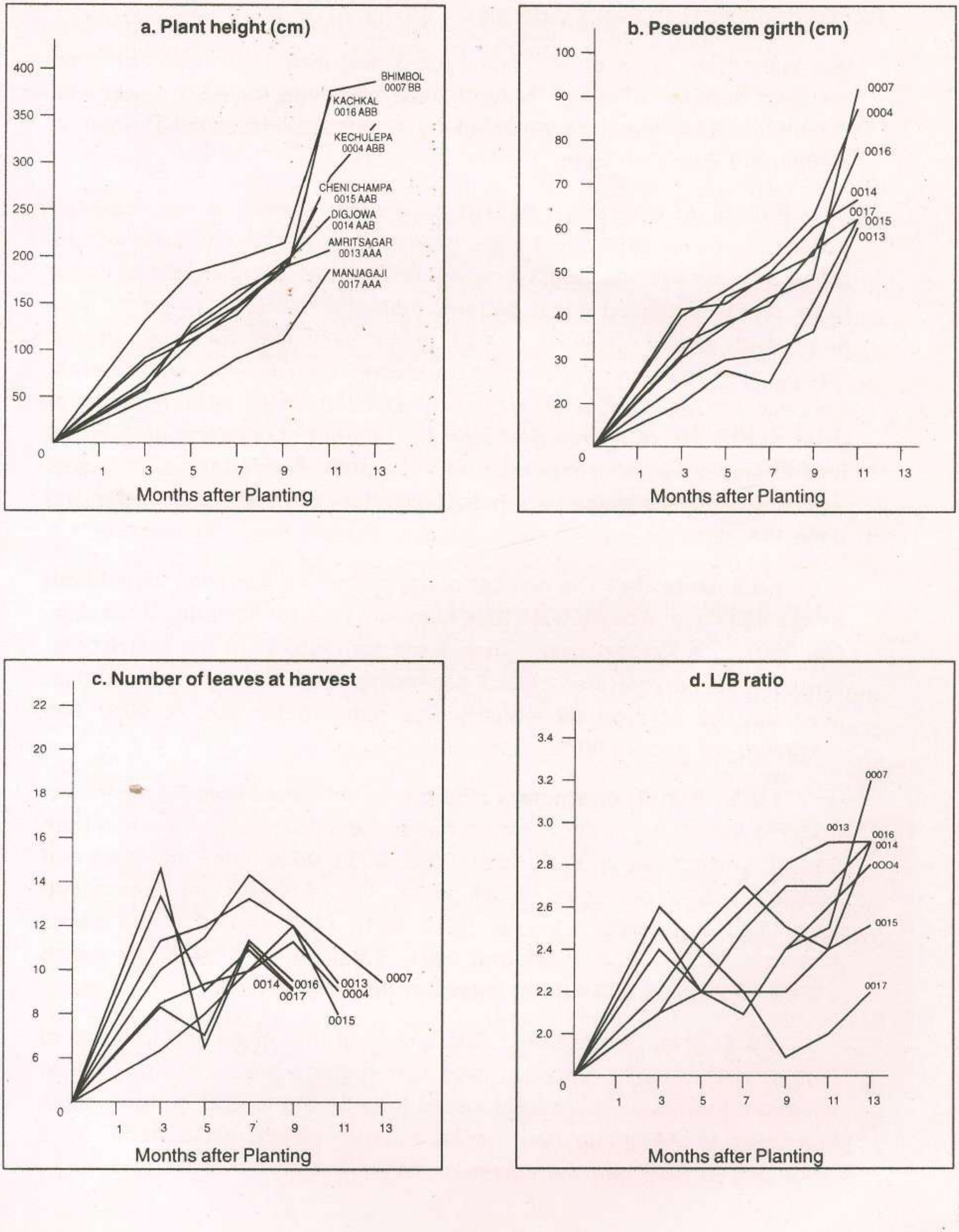


Fig.2 : GROWTH PATTERN OF DIFFERENT GENOMIC GROUPS

Leaf length-breadth ratio : Leaf length breadth ratio variation was due to progress in the growth. However, distinguished ratio was observed for each accession. Length breadth ratio observed for ABB group was maximum. AAA group represented by Dwarf Cavendish and Robusta exhibited a minimum ratio.

Pattern of growth : Pattern of growth studied in few selected accessions have exhibited a linear growth pattern till initial three months for all the accessions (Fig.3-a to d). Increase in plant height at initial three month exhibited linear pattern, thereafter increase in height was slow which picked up at 9th or 11th month exhibiting the linear growth. Pattern of increase in height varied depending upon cultivars with different genomic groups.Pseudostem girth also exhibited similar pattern as that of plant height. No of leaves produced by different accessions at different time intervals was also maximum at 3rd month, thereafter no. of leaves were constantly maintained which declined after 7th or 9th month depending upon the cultivars.

1.3.2 Maturity : The number of days taken for flowering varied from 246 to 483 days. Acc.No.0046 took minimum time for flowering while Acc. No. 0007 took longest time. Time taken for maturity of the bunch from flowering to harvest also varied depending upon the genomic group. Minimum No. of days for maturity was required for acc. no.0060 and maximum for acc.No.0074.

1.3.3 : Bunch Characters : Bunch weight varied from 7.3 kg in acc. no.0074 to 30.8 kg in 0002. No. of hands exhibited a wide variation from 3 to 11. Lowest was in 0006, 0034, 0055, 0063, 0064, 0068 and 0069 and highest in 0070 (belonging to Silk group). No. of fingers per hand varied from 11 to 26, highest in accns. 0012, 0015, 0062 and 0070 and lowest in accns. 0022, 0024, 0036 and 0041. Total no. of fingers per bunch varied from 48 to 153 having lowest in 0036.

1.3.4 Fruit characters : The quality of fruit measured in terms of length, girth, weight, pulp-skin ratio and keeping quality exhibited wide variation. Individual fruit weight varied from 33.3 g to 203 g. Accn. 0031 belonging to AA group had minimum finger weight while Accn. 0016 belonging to ABB had the maximum finger weight.

Fruit length varied from 10.8 cm to 24.7 cm, it was maximum in 0016 and minimum in 0031. Pulp to skin ratio ranged from 1.15 to 5.78 with accn. 0034 (ABB group) the least and 0030 (silk group) the highest. Keeping quality varied from 4 days to 10 days. Minimum of 4 days was exhibited by 0007, 0013, 0024, 0031 and 0064 while 0062 stayed palatable upto 10 days. While comparing the accessions of different groups, it was apparent that the accessions Hatidat and Kanai Bensi had straight and long fruits which may have better accessibility to the export market owing to fruit size and their fruit quality.

1.3.5 Resistance to disease : The accessions were evaluated for the incidence of yellow sigatoka, panama wilt and viral diseases namely, banana bunchy top (BBTV), banana bract mosaic (BBMV) and leaf streak (BSV). Wide range of variation was noted for the severity of sigatoka leaf spot at 6 month, at shooting and at harvesting stage.

No incidence was observed on Accns. 0007-Bhimkol, 0011-Athiakol, 0019-Manohar, 0024-Kechulepa, 0027-Dudhsagar, 0028-Chinali, 0031-Thiruvannan Thaspulam, 0032-Bharat Moni, 0033-Nendra padathi, 0035-Therek Malang and 0036-Kaali. The accessions belonging to Cavendish group (AAA) 0002, 0009, 0012, 0017, 0021, 0029, 0064 and 0070 had high incidence of sigatoka varying from 42 to 57%. These accessions are being tested using susceptible plants by creation of high disease pressure.

Incidence of Panama wilt to the extent of 30% was found on Malbhog. Presence of infectious chlorosis was found only in accessions belonging to Poovan group. Bract mosaic was observed only in one of the accessions belonging to Monthan group.

Salt injury on leaves in banana accessions

1.3.6 Tolerance to Salt : Since the soil of the farm has pH ranging from 8.0 to 9.5, necrotic symptoms of salt injury was exhibited by some of the accessions. Therefore, the accessions were evaluated for the injury due to salt accumulation on 0 to 7 scale. The varieties were grouped as susceptible, highly susceptible, tolerant and highly tolerant. Interestingly, the accessions belonging to Monthan and Bluggoe groups exhibited more of the salt injuries. However, these observations require further confirmation for the selection of cultivars resistant to salt injuries.

1.4 TAXANOMIC EVALUATION : In order to confirm the genomic status of different accessions, 64 aaccessions collected from North Eastern regions were evaluated using score card with 20 characters. From the scores, genomic status was assigned to different accessions depending upon the score obtained adopting the following score card suggested by Silayol and Chom Chalow (1987). The accessions falling under different score range are given in table-6.

Score	Genomic Group
15-25	AA/AAA
26-46	AAB
46-59	AB
59-63	ABB
67-69	ABBB
> 75	BB/BBB

The data presented in the Table-6 for scoring obtained by different accessions distinguished the accessions in different genomic group. However, to make distinction within the same group (AAA i.e. Cavendish and Chakkerakeli) it had a overlapping influence. Similarly overlapping in the scoring was also observed for the accessions in genomic group AAB, ABB. This clearly indicated that there is a need for evaluation of these accessions, using molocular techniques, viz. Isozyme, RPLF etc. so that results of the same will be expressed optimistically, authentic identity of the accessions can be ascertained. Cytological studies are also necessitated for the confirmation of ploidy level.

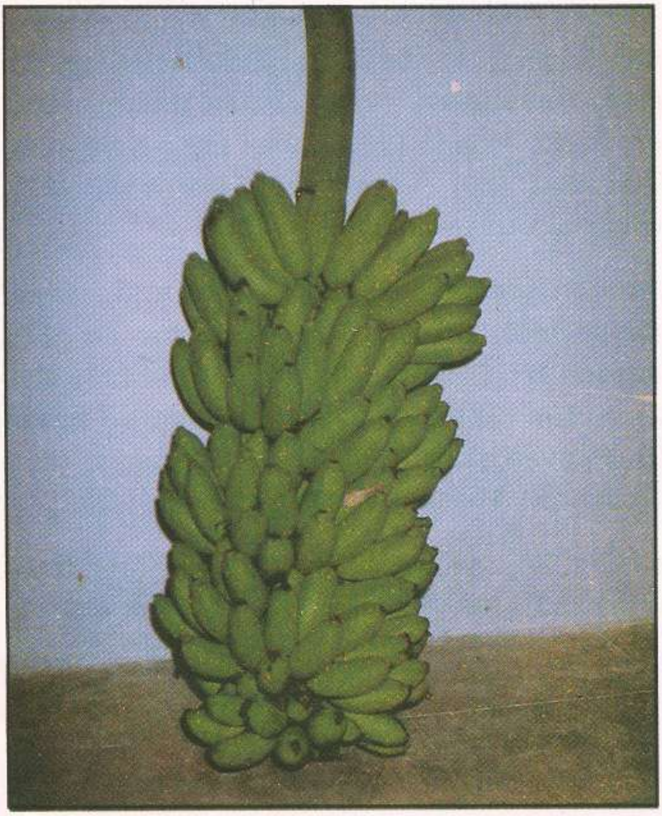
Table-6 : Genomic characterisation of accessions from NE region

Score	Genomic	Germplasms under different genomic groupsgroup
15-25	AA/AAA	Amrit Sagar (21), Borjahaji (24), Borjahaji(25), Dwarf Cavendish (20), Gros Michel (23), Hatidat(22), Honda (22), Jahaji (19), Kere (24), Kanai Besi (20), Leyon (24), Manjahaji (22), Thellachakkarakeli (23)
26-46	AAB	Ayiranka Rasthali(36), Borchampa (30), Chini Champa (43), Chinali (29), Chini champa (27), Dasman (31), Digjowa (27), Dudhsagar (30), Kali (32), Kullan (32), Malbhog (32), Nendra Padathi (29), Poovan (33), Rasthali (29), Saapkal (26), Thiruvannan Thaspulam (29), Vannan (46)
47-58	AB	Aktoman(53), Jatiakal (58), Jawari bale (35), Nalla Bontha (53), Ney Poovan (54)
59-66	ABB	Agni Malbhog (59), Deshi Kadali (66), Karpuravalli (63), Kait Shjeng (64), Kashkal (65), Monthan (67)
67-69	ABBB	Manohar (66) Manohar (67)
70-75	BB/BBB	Athiakol (73), Bhimkol (74), Borkel bahista (72), Kachkel (70), Kechulepa (71).

* *Score obtained by different accessions are given in parenthesis.*

1.5 UTILIZATION OF THE GERMPLASM : Donor parents for several characters viz. resistance to diseases, tolerance to salt, yield potential, maturity etc. identified have to be further confirmed for their use in breeding programme. Two of the accessions collected viz. 0030 and 0016 were found to be superior to local cultivars of the same group, Rasthali and Monthan, respectively.

Accn. 0030 : Taxonomic evaluation of the accession 0030 suggested its grouping under AAB which is akin to Rasthali. It had superiority for bunch characters, fruit quality and had early maturity over Rasthali (Table-7). accession did not record any incidence of panama wilt which is common in Rasthali. Therefore, this accession is being further evaluated along with other accessions from silk group.



Accession-0030 - Promising dessert banana (Silk Group)

The accn. 0030 is medium-tall in height. Pseudostem yellowish green with black blotches on peduncle end. Pigmentation is restricted to pink streaks on pseudostem upto 30 cm above ground level and to the margin of the leaf stalk. Peduncle channel is of open type, lamina elliptical with right side 21/2 inches shorter than the left side. Plant comes to flowering 330-340 days after planting and it takes 400 - 410 days for bunch maturation. Penduncle is glabrous and inflorescence is at an angle of 45° from the pseudostem. Inflorescence has 7 to 9 hands with 16 to 18 compact fruits which do not drop off easily on ripening unlike Rasthali. Fruit skin is paper thin with good pulp-skin ratio of 5.78. Fruit is ivory white in colour. Pulp scored excellent on sensory evaluation and had TSS ranging from 18-20° Brix. Pulp is crisp with low acidity.

Table-7 : Comparative evaluation of Accn. No.0030 with Rasthali

	Parameters	Rasthali	Accn. 0030
1	Crop duration (month)	15-16	13-14
2.	Av.Bunch weight (Kg)	12-15	16-18
3.	Av.No. of hands/bunches	6-7	7-9
4.	Av. No. of fingers/hand	16	16-18
5.	Av. total no. of fingers/ bunch	90-100	100-130
6.	Pulp-skin ratio	2.5 - 3.5	4.5- 5.0
7.	T.S.S.	15-18°Brix	18-20° Brix
8.	Susceptibility to F.wilt	30% incidence	No incidence observed
9.	Salt susceptibility (1-7)	1	1

Accn.0016 : The accession No. 0016 also exhibited superiority over local Monthan for maturity, yield, number of fingers, cooking quality, and pulp skin ratio on ripening. The taxonomic evaluation indicated for the genomic group ABB akin to Monthan. Comparative evaluation of this accession with Monthan presented in table-8 indicated its superiority. The accession was less susceptible to sigatoka and did not record the incidence of panama wilt. This accession has a promise as dual purpose banana.

Table-8 : Comparative evaluation of Acc.No. 0016 with local monthan

	Parameters	Local Monthan	Accn. 0016
1.	Crop duration	14-15 months	13-14 months
2.	Av. bunch weight	18-20 kg.	21-25 kg.
3.	Av. no. of hands/bunch	4-5	6-7
4.	Av. no.of fruits/hand	13-14	15-16
5.	AV.total no of fingers/bunch	70-80	100-120
6.	Fruit skin ratio	1.0-1.10	1.0-1.25
7.	T.S.S	18-20° Brix	18-20° Brix
8.	Susceptibility to salt injury (0-7)	3	1
9.	Susceptibility to sigatoka	54-57%	23-25%

A tall and sturdy plant, pseudostem uniformly dark green in colour lacking pigmentation and blotching. Leaves oblong with a difference of 1" between two halves of laminar base. It takes about 340 days for flowering and 410 days for bunch maturation. Peduncle glabrous and inflorescence is pendulous almost parallel to the pseudostem. Male flowers are deciduous and fertile axis has about 6-7 hands with 15-16 stout, angular, bulky and starchy fruits. Fruit skin is thick with pulp-skin ratio of 1-1.25. Starchy fingers have a TSS of 18-20° Brix with excellent cooking quality

1.6 EVALUATION OF COMMERCIAL CULTIVARS FROM DIFFERENT GENOMIC GROUP : A trial was initiated in April 1994 to evaluate commercial cultivars of the region falling under different genomic groups for growth, yield, tolerance to disease and extended harvest. The trial was planted with Nendran, Poovan, Robusta, Monthan, Pachanadan, and Karpuravalli. Observations on growth pattern, flowering and disease incidence were recorded (Table-9). Nendran and robusta had flowered

Table-9 : Growth characteristics and disease susceptibility of commercial cultivars from different genomic groups.

Cultivars	Plant ht. (9th month)	Girth (9th month)	No. of leaves (at 9th month)	Time taken for flowering (days)	Disease incidence	Salt injury
Rasthali (AAB)	190.6	62.8	15	350	++	-
Nendran (AAB)	223.8	56.3	12	302	+++	-
Robusta (AAA)	183.7	71.2	13	258	+++	-
Poovan (AAB)	218.2	63.8	14	321	++	-
Pachanadan (AAB)	253.4	69.1	16	32.2	+	+
Monthan (ABB)	275.5	78.6	17	334	+	++
Karpura-valli(ABB)	293.8	91.3	20.	yet to flower	0	-

+++ Highly susceptible; ++ Susceptible; + Tolerant; 0 Resistant and other varieties are yet to flower.Yellow sigatoka disease incidence was recorded on robusta and Nendran while this incidence was negligible on Poovan and Monthan. Karpuravalli had no incidence of sigatoka Poovan was found to have high incidence of BSV. Among the cultivars, monthan exhibited highest salt injury while in other cultivars salt injury was negligible. The trial is in progress.

2. IMPROVEMENT

(Development of biotic and abiotic stress resistant cultivars with high yield potential and good quality fruits

Different categories of banana viz. dessert banana, cooking banana, plantain, silk and pome are independent yet inter-related. In holistic approach for development of sustainable banana production, cultivar resistant to biotic and abiotic stressess has to play a significant role. Hence, production of better cultivar with high and stable yields adoption to target areas, resistance or tolerance to biotic and abiotic stresses having acceptable quality is a priority programme.

The commercial cultivars grown in different regions have several undesirable characters and most of them are susceptible to one or other pests and diseases. Transfer of desirable traits from identified source through conventional breeding or biotechnological methods is one of the approaches for improvement. Identification of male and female fertility, study on crossability and synthesis of hybrids for the transfer of desired triats are being attempted. From the studies on pollen fertility 21 accessions under different groups were identified as pollen parents (Table-10).

Table - 10 : Pollen fertility in accessions parents for use in further breeding programmes

AA	AAA	AAAA	AAB	ABBB
Kadali	Dwarf cavendish	Bodles altafort	H-1	Klueteparods
Matti	Erachi vazhai	Gros Michel	H2	
Namarai	Gros michel		Krishna vazhai	
Pisang lilin	Kari vazha		Nendran	
Sannachenkadali	Nakitemb			
Siguzani	Namkanika			
Tongat	Robusta			

2.1 Evaluation of FHIA hybrids : In this trial FHIA 01, 02, 03, Yangambi Km5, Robusta, Rasthali, Karpuravalli and Virupakshi are being tried. The FHIA hybrids obtained from INIBAP are being multiplied. The characteristics of these hybrids are as follows :

FHIA 01 : FHIA-01 (Gold Finger), (Genome AAAB) a cross of Prata Ana x SH 3142 is akin to pome. The hybrid is resistant to sigatoka leaf spot, Fusarium wilt (race 1 and 4) and borrowing nematode. It has sturdy plants which can support large bunches without propping. It has good post harvest green life and shattering free fingers at ripe stage. This hybrid is also resitant to crown rot.

FHIA-02 : FHIA-02 is a genomic group of AAA and similar to the cavendish banana and has different accredited growth. It is derived from a cross of Williams (Cavendish banana) x FH-3393 and is related to cavendish type. Storage quality of this hybrid is relatively poor.

FHIA-03: FHIA-03 is a cross of FH-3386 with FH 3320 and has genomic group of AABB. This is a drought resistant and can survive dry spells. It has fibrous pseudostem which makes the plant resistant to high winds. FHIA-03 is a dual purpose banana with good cooking quality and pleasant odour when ripe.

2.2. Evaluation of FHIA hybrids for resistance to Sigatoka : Yellow Sigatoka is a serious disease of banana especially in humid tropic and requires large number of spray to contain the losses. Therefore this trial is being conducted under IMTP in collaboration with INIBAP. The details of cultivar being tested are given in table-11.

Five tubes each of these varieties obtained from Transit Centre of INIBAP, Leuven are under multiplication. Under each accession 40-60 plantlets have been obtained which are transfered to rooting medium. The trial will be laid out in field after plants are multiplied. The trial will be laid out as per the field plan finalised. Observation will be recorded on disease development time, youngest leaf spotted (YLS), leaf emission rate and disease severity at 6 months after planting and also at shooting and harvesting stages. Observations on growth, sucker production, bunch characteristics and fruit quality will also be recorded. Environmental data during crop growth period, agronomic practices will also be recorded.

Table-11 : Germplasm for evaluation against yellow Sigatoka diseases

FHIA (Honduras)				
1. SH 3444 (AAAA)	FHIA-23		Highgate x SH 3362	ITC 1265
CNPMF/EMBRAPA (Brazil)				
2. PV 03-44 (AAAB)	EMB 402		Pacovan x Calcutta 4	ITC 1262
3. PA 03-22 (AAAB)	EMB 404		Prata Ana x Calcutta 4	ITC 1261
INIVIT/INIFAT (Cuba)				
4. SH 3436-9 (AAAA)			Somaclonal variant of SH 3436 (High gate x SH 3142)	ITC 1283
NATURAL GERMPLASM				
5. Yangambi Km5 (AAA)			Ibota	ITC 1123
6. Saba (ABB/BBB)			Saba	ITC 1138
7. Pisang Ceylan (AAB)			Mysore	ITC 0650
REFERENCE/STANDARD CLONES				
8. Calcutta 4(AAw)	Highly resistant/hyper-sensitive response			ITC 0249
9. Pisang Lilin (AA)	Highly resistant			ITC 0001
10. Pisang Berlin (AA)	Susceptible			ITC 0611
11. Niyarma Yik (AA)	Highly susceptible			ITC 0269
12. Local cultivar				Robusta

2.3. Evaluation of FHIA hybrids for resistance to fusarium wilt.

Fusarium wilt has attained alarming situation in cultivation of banana, especially in silk and pome group. Therefore, the hybrids along with other clones are being evaluated for tolerance to Fusarium wilt. The cultivars being evaluated are given in table-12.

Table-12 : List of clones to be evaluated for reaction to Fusarium Wilt

FHIA (Honduras)			
1. SH 3481(AAAB)	FHIA-01	Prata Ana x SH 3142	ITC 0504
2. SH 3565 (AABB)	FHIA-03	SH 3386 x SH 3320	ITC 0506
3. SH 3649 (AAAA)	FHIA-17	Highgate x SH3362	ITC 1264
4. SH 3444 (AAAA)	FHIA-23	Highgate x SH3362	ITC 1265
CNPMF/EMBRAPA (Brazil)			
5. PV 03-44 (AAAB)	EMB 402	Pacovan x Calcutta4	ITC 1262
6. PA 03-22 (AAAB)	EMB 404	Prata Ana x Calcutta 4	ITC 1261
TBRI (Taiwan)			
7. GCTCV 119 (AAA)		Giant Canvendish variant	ITC 1282
8. GCTCV 215 (AAA)		Giant Cavendish variant	ITC 1261
INIVIT/INIFAT (Cuba)			
9. Burro CEMSA (ABB)		Bluggoe (res. Foc race 2)	ITC 1259
NATURAL GERMPLASM			
10. Pisang Mas (AA)			ITC 0653
11. Saba (BBB/ABB)			ITC 1138
12. Pisang nangka (AAB)			ITC 1062
13. Cultivar Rose (AA)		IRFA 907/IDN 110	ITC 0712
14. Yangambi Km5 (AAA)			ITC 1123
15. Pisang Jari Buaya (AA)			ITC 0312
16. Pisang Lilin (AA)			ITC 0001
17. Calcutta IR 124 (AAA)	_Musa accuminata_ ssp. _burmannicoides_		ITC 0249
REFERENCE/STANDARD CLONES			
18. Gros Michel (AAA)		Race 1 suscept.)	ITC 1122
19. Bluggoe (ABB)		(Race 2 suscept.)	ITC 0643
20. Williams (AAA)	Cavendish	(Race 4 suscept.)	ITC 0570
21. Pisang Cylan (AAB)	Mysore	(adult plant resistance)	ITC 0650
22. Local cultivar			Rasthali

Five *in-vitro* cultures of these accessions obtained from INIBAP are multiplied. In each accession, 35-40 plantlets are available which will be planted in field after hardening.

Field plan and observation will be adopted as outlined in IMTP. Observations on growth and bunch parameters like plant height, days for flowering and bunch emergence, bunch weight, No. of hands etc. will be recorded.Disease severity will be recorded from 3rd month of planting until harvest for parameters viz. yellowing of foliage, splitting of pseudostem base, vascular discoloration in leaf bases, changes in new leaves, shortened internodes, wilting, petiole buckling, internal symptoms of the corm at harvest. Additionally, environmental data at test site from planting to harvest will also be recorded.

3. IMPROVED PRODUCTION TECHNOLOGY

Depending upon resource availability, cultivar preferences, location, tradition and access to marketability, different production systems are adopted. It can be monoculture with intensive cultivation, a subsistence crop in homestead garden, or a mixed crop. The productivity and quality of fruits is largely governed by production technologies for given cultivars. Therefore, crop production having integrated nutrient, water and disease management are important.

3.1 AGRO-TECHNIQUES

3.1.1. Recycling of nutrients in karpuravalli : This trial was laid out to find the effect of mother plant retention on nutrient recycling to daughter suckers in cultivar Karpuravalli. Five treatments consisting of no. retention of mother plants (cutting of mother plant along with bunch), retention of mother plants for 1 month, 2 months, 3 months, 4 months were tried. The trial is in randomised block design replicated 4 times. Observations were recorded on growth, viz. height, girth, number of leaves and disease incidence. No significant influence of treatments was observed. The plants are at flowering stage and the trial is continued.

3.1.2. Banana based cropping systems : The success or failure of banana orchards largely depends upon the previous crop history which not only affects the nutrients and water use but the susceptibility to many soil borne diseases and nematodes. Therefore, the trial aimed at development of banana based cropping system for sustainable soil health and productivity was initiated. Uniform banana crop was grown which will be rotated with different crops to come back to banana.

3.1.3 Evaluation of banana cultivars for high and low input levels and planting density : This trial has been laid out to assess suitable cultivars for different inputs conditions. Nine cultivars viz. Rasthali, Poovan, Pachanadan, Robusta, Ney Poovan, Monthan, Nendran, Sakkai and Karpuravalli are tested under two input levels :(1) 10 kg FYM + 1 kg. cake + 200 N : 40 P_20_5:300 K_20g per plant and (2) 5 kg FYM + 1/2kg cake + 100 CN:20g P_20_5 : 150g K_2O and two spacings (1.8 m x 1.8 m and 2.0m x 2.0 m). Nine varieties were planted under each input and spacing combinations. Observations will be recorded on growth, yield, quality, disease and pest incidence at regular intervals.

3.1.4 **Evaluation of cultivars under organic and inorganic nutrition :** For sustainable soil health and production, organic amendments are considered essential. Organic amendments are detrimental for nematode and amelioration of soil salinity. However, for higher productivity integration of organic and inorganic source of nutrients in different proportion is required. Therefore the trial was laid out with six cultivars, Rasthali, Poovan, Robusta, Monthan, Nendran, and Karpuravalli and six organic treatment viz. 200g N inorganic, 25% FYM+75% inorganic, 25% neem cake+ 75% inorganic, 25% FYM+50% cake+25% inorganic, 25% FYM+50% cake+25% inorganic and 25% FYM+Green manure + 75% inorganic. The trials have been laid out separately for each cultivar having six treatments replicated 4 times in RBD.

3.2. PLANT PROTECTION

For development of crop protection technology, it is of utmost important to understand the incidence of insect pests and diseases, their seasonal distribution etc. Therefore attempts were made to study the diseases on different cultivars in different banana orchards. Roving survey was conducted in 15 orchards in 7 villages on the varieties like Nendran, Karpuravalli, Poovan, Rasthali and Monthan. No. of orchards where the survey was conducted, the varieties grown and the incidence of different diseases on different varieties are given in table 13.

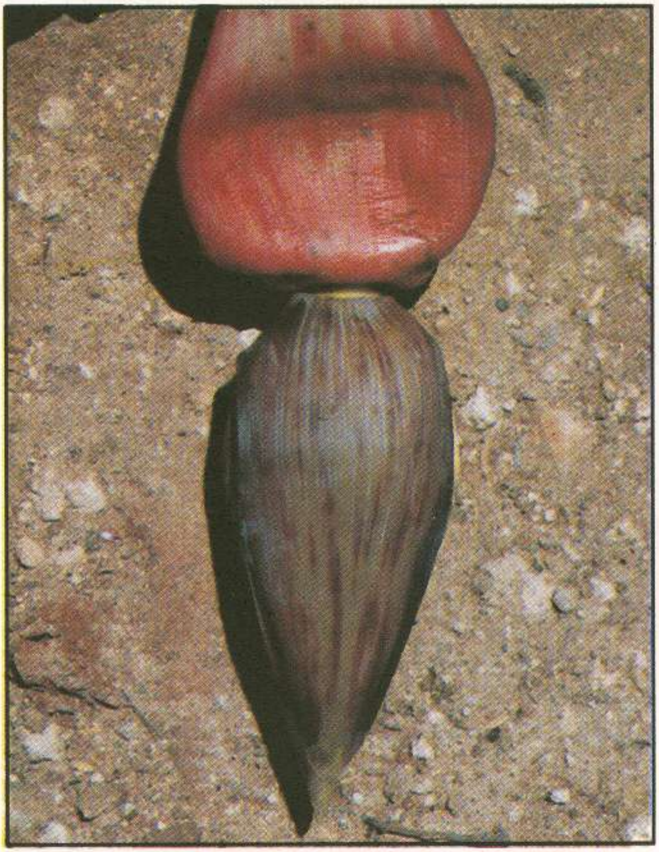
Table-13 : Details of Roving survey conducted around Trichy District.

Orchard No.	Variety grown	No.of plants	Disease	No. of Plants infested	PDI/ % of plants infested
1.	Nendran	1500	SLS	1500	75.51
2.	Karpuravalli	500	FW	60	12.00
3.	Karpuravalli	510	FW	20	3.92
4.	Karpuravalli	1000	SLS	1000	35.96
5.	Nendran	1200	SLS	1200	58.89
6.	Rasthali	900	SLS	900	69.42
		900	FW	27	3.00
7.	Pachanadan	500	SLS	500	59.05
8.	Poovan	950	SLS	950	67.53
9.	Pachanadan	800	SLS	800	50.24
10.	Nendran	1100	SLS	1100	51.23
11.	Poovan	600	BSD	148	24.61
		600	SLS	600	58.28
12.	Nendran	360	Neer Vazhai	10	2.77
		360	SLS	360	49.25
13.	Nendran	800	SLS	800	52.01
14.	Poovan	500	BSD	94	18.75
		500	SLS	500	58.21
15.	Nendran	750	Neer Vazhai	10	1.33
		750	SLS	750	42.10

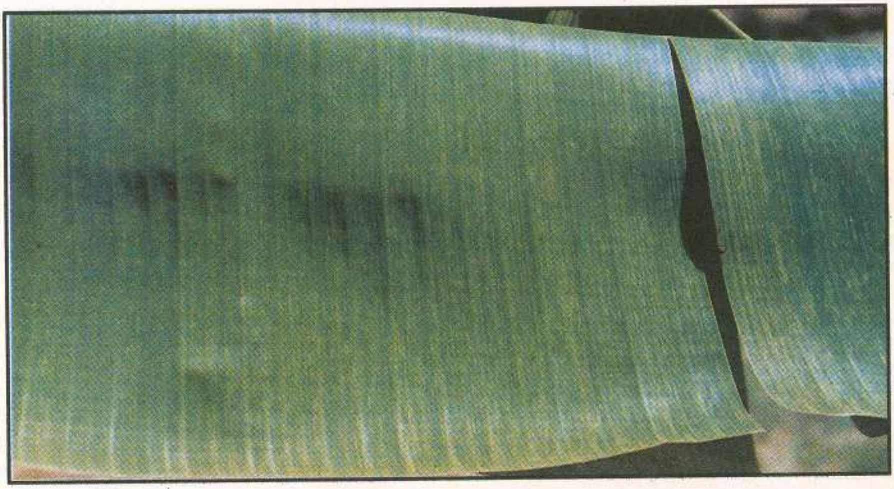
SLS : Sigatoka leaf spot, FW : Fusarium Wilt, BSD : Black streak disease.

Sigatoka leaf spot was more in Rasthali and Nendran with disease intensity of 69.42, 75.51 per cent respectively. However, Karpuravalli was found to be completely free. Very low intensity was observed on Monthan and Poovan. Only, in Rasthali 3 % plants were found to be infested with Fusarium wilt. In Karpuravalli also incidence of fusarium wilt was observed. However, its intensity was very low. No incidence of wilt was observed on Poovan, Monthan and Robusta.

Incidence of BBMV was observed in Monthan type. Incidence of BSV and CMV diseases was found to be more prevalent in Poovan with incidence varying from 18.75 to 73.33 per cent. The severity of the disease was also observed.Since these diseases are observed to be transmitted through suckers, its spread is unnoticed and causing yield losses. The disease was observed to be severe in Poovan group of cultivars plant, which warrants studies on loss assessment. Another diseases caused by poty virus, BBMV was observed in Monthan. This is disease was suspected few years back and was confirmed by a visiting Scientist from INIBAP. The disease is characterised by development of black streak on the petiole, yellow or pinkish coloration on pseudostem and mosaic like symptoms on bract. In infested plant yield losses occurs. This disease also reported to be transmitted by aphids as well as infested planting material. The survey conducted in Kerala as well as in Coimbatore indicated



Symptoms of Banana bract mosaic on Monthan bract the high incidence of bract mosaic in the varietal collections. In the varietal collection at NRCB one accession in Monthan group was observed with characteristic symptoms. The Kokkan disease found in Kerala was also found to be caused by banana bract mosaic. Trials have been initiated to assess the losses caused by this disease.



Leaf rolling in BSV infested plants

Another interesting observation during this survey was that in certain orchards, upto 3 per cent of Nendran plants were found infested with an unknown malady called *Neer Vazhai* which is characterised by under development of fingers, this warrants further intensive research on the cause and remedy to contain this disease.

Cholorotic symptoms on BSV infested leaves

4.POST HARVEST CHARACTERISATION

Characterisation of the gene pool was done with respect to shelf life and quality attributes. Incidence of post harvest diseases on different cultivars was also recorded. Wide range of variability for suitable post harvest qualities, shelf life as well as quality at edible stage was observed. Although two accessions, Hatidat and Kanai Besi from North Eastern region exhibited excellent shape and size of fruit, but had poor shelf life after ripening while accession from AAB (Poovan) and AAB (silk group) exhibited better shelf life after ripening. Sensory evaluation of accessions also indicated wide variability (Table 14). Evaluation of accessions are continued.

Table-14 : Post harvest characters of banana accessions.

ACC.NO.	RATING	ACC.NO.	RATING	ACC.NO.	RATING	ACC.NO.	RATING
OOO1	++++	0023	++++	0045	+++	0064	++++
0002	++++	0024	++	0046	+++	0065	+++
0003	++++	0025	++	0047	++	0066	++++
0008	+++	0026	++	0048	++	0067	++
0009	++++	0028	++	0049	++++	0068	++
0010	+++	0029	++++	0051	++	0069	++++
0012	++++	0030	++++	0052	+++	0070	++++
0013	++++	0031	++	0054	++	0071	++++
0014	++++	0033	++	0055	++	0072	++++
0015	+++	0034	+++	0057	++++	0073	+++
0016	++	0036	++	0059	+++	0074	+++
0017	++++	0040	+++	0060	++	0076	+++
0022	++	0041	+++	0062	++++		
0044	+++	0063	++				

+ = Poor, ++ = Average, +++ = Good, ++++ = V.Good

COORDINATION

The NRCB is identified as nodal centre for IMTP Vr. Sigatoka and IMTP Vr. Fusarium wilt. The trials are proposed to be laid out at Kannara (KAU), Kovvur (APAU) and IIHR, Bangalore which is being coordinated and monitored by NRCB including multiplication and distribution of plants, training for conduct of trials etc.

Details regarding methodology have already been sent to respective centres. The global hybrids received in tubes are under multiplication and will be supplied by NRCB for field planting by the end of 1995.

PUBLICATION :

Singh HP and Uma S., 1995. Banana - A potential fruit for export. in Seminar on Fruit Export and Processing Industry, Anand ; 1-2 pp.

HUMAN RESOURCE DEVELOPMENT

Dr.S.Uma, Scientist underwent a training programme on 'Tissue culture of Banana' at the Tissue Culture Laboratory, I.I.H.R., Bangalore from 06.01.1995 to 14.01.1995.

Dr. H.P. Singh, Officer In-charge, NRCB is welcoming
Mr. R.C. Panda, IAS, Secretary (Agri.), Govt of Tamil Nadu on his visit to NRCB

PARTICIPATION IN SYMPOSIA/SEMINAR/WORKSHOP

Dr.H.P.Singh participated in the seminar on 'Fruits in Export and Processing Industry' held at GAU, Anand on 21 March, 1995 and presented the paper.

HONOURS/RECOGNITION/AWARDS

Dr.H.P.Singh, Officer Incharge, NRC on Banana chaired the Session-II *"Fruits in Processing Industry"* in **National Seminar on Fruits in Export and Processing Industry,** held at GAU, Anand, 12 March, 1995.

LIST OF IMPORTANT VISITORS DURING THE YEAR 1994-95

04.1.1995	Mr.RC.Panda, IAS, Secretary, Agril. Dept., Govt of Tamil Nadu.
28.01.1995	Dr.K.Arulmozhi, IAS, Director of Horticulture, Govt. of Tamil Nadu.
28.01.1995	Mr.S.S. Mehta, Planter and Director, Maxworth orchards, Madras.
25.03.1994	Dr.Ayyam Perumal, Director, Sugarcane Research Station, Sirugamani, Trichy.

WEATHER DATA RECORDED AT TRICHY, 1994-95

MONTH	R.H.(%)	TEMPERATURE (°C)		RAINFALL (mm)
		MAXIMUM	MINIMUM	
MARCH'94	-	33.1	22.4	42.8
APRIL'94	-	35.3	25.1	124.6
MAY'94	-	37.1	25.5	-
JUNE'94	-	36.5	26.0	11.2
JULY'94	-	35.6	25.3	90.8
AUGUST'94	68.0	34.4	25.2	77.0
SEPTEMBER'94	62.0	35.0	25.8	160.6
OCTOBER'94	74.9	33.2	23.7	92.0
NOVEMBER'94	79.7	30.4	21.4	7.4
DECEMBER'94	82.0	30.1	20.5	-
JANUARY'95	83.7	29.4	18.2	-
FEBRUARY'95	80.8	32.1	21.2	7.0
MARCH'95	71.3	35.4	23.1	
				613.4

PMEC

PERSPECTIVE PLAN

Bananas (Musa), the second largest fruit crop in the world produced in tropical and sub-tropical regions of developing economies are recognised to be the 4th important food crop in terms of gross value after paddy, wheat and milk, yet have received the little research efforts. International Network for the Improvement of Banana and Plantain (INIBAP) established with its commitment for improvement in production and productivity of bananas and plantain is playing a vital role in resolving problems through global partnership which has enhanced the capability of National Agricultural Research System (NARS). Concerted effort on banana research and dissemination of information, germplasm conservation and exchange, crop improvement and information system have received greater emphasis. In last few years there has been a fascinating development in the use of biotechnological methods for improvement of banana and the results of the research efforts have attracted world-wide interest for the improvement. Use of the innovative techniques is extended to crop improvement, germ plasm conservation, characterization and utilization of somaclonal variations, somatic embryogenesis etc. These approaches may optimistically bring about the transformation to take the challenges of growing food requirements with shrinking land resources and enhanced aspirations of people in years to come.

At the national level banana is one of the most important fruit crops which contributes about 31.5 per cent to total fruit production. It is interwoven in the national heritage and culture and has socio-economic significance of paramount importance. In South India, a dessert banana is offered as both the actual and symbolic end of a meal and a crop of so fundamental importance to so many people that they have acquired major significance in the society. There are arrays of cultivars grown under varying production systems depending upon agro-ecological regions. The production and productivity vary. Highest productivity is reported from Gujarat, Maharashtra and Madhya Pradesh, where monoculture is practiced and lowest from N.E. regions and Kerala where mixed-cropping system and subsistance cultivation is in practice. Although mono-culture provides high productivity, growing of several varieties is a risk averse strategy, which may require integration.

The per capita consumption of the bananas is to the tune of about 11.4 kg annually which is comparatively low and requires to be elevated to 15 kg. There is an enhanced awareness for its role in nutrition and medicinal value of this fruit which may further increase the demand. With projected requirement of 15 kg of the fruits and growing population added with the commitment for export, 25 million tonnes of bananas shall be required in 2020. Increase in production and productivity of banana noted in the last decades are supportive for the possibilities of achieving the production goal envisaged offing the year 2020 to the tune of 25 million tonnes. The options available for achieving the production level is through enhanced productivity in different regions using improved production technologies. These production technologies have to be environment friendly which can be achieved through improved cultivars, integrated management of insects, pests and diseases, reduction in the post harvest losses and efficient marketing system.

Since the country is endowed with a varying climatic conditions there is a possibility of harvesting the crop round the year. This situation is a strength for exploring the possibilities of export to far east countries provided the quality grade fruits to the standard of export needs are produced. Labour unrest and growing cost of production owing to many abiotic and biotic stresses in exporting countries may enforce the export of banana from India. When the banana is grown in arid sub-tropic i.e., the Central Maharashtra, the diseases problem in Cavendish is minimum, contrary to the problem of diseases in banana exporting countries as well as humid regions in the country. Thus zoning of banana growing region would be an approach for effective planning.

NRCB established in 1993, in an effort to strengthen research capabilities, added with network of coordinating centres in the different growing regions are major strength. At the same time it also provides an opportunity to increase production with manipulation of production constraints. However, manipulation of production constraints have its regional peculiarities which require to be addressed to achieve sustainable growth.

Management of genetic resources and its utilisation, improvement of cultivars, integrated management of pests and diseases, post harvest handling, processing and utilization and use of biotechnological developments are some of the approaches which requires to be addressed to achieve the target results. *In-vitro* conservation enhances genetic unstability. At the same time it also provides an opportunity for the selection of desirable traits. Therefore it is evident that many of the weaknesses can be converted into the opportunities provided efforts cover a full spectrum of research in thrust areas both up-swing and down-swing.

Banana being forth food crop of the world and it's high production in India, there is need to boost the research efforts through development of capability with respect to manpower and infrastructure. Transformation witnessed in economic front and awareness of people for sustainable and environmental friendly growth would be an indicator for the growth of banana as commodity warranting more research efforts. Complexity of crop coupled with varying problems and increased demand would call for better attention in 25 years to come.

Within the research activities the highest priority has to be given for the conservation of the genetic diversity and utilization. The second priority of the research has to be the improvement of banana for abiotic and biotic stresses using conventional and biotechnological measures. Integrated management of insects, nematode pests and diseases and post harvest technologies have also to receive priorities. The concept of sustainability has to be an integral of NRCB which shall address the optimal resources utilization to satisfy the changing requirement. Genetic engineering is likely to safeguard the environment while boosting the production and productivity. Methodologies have also to be devised for innovating activities with attempts to measure the total input and output in the system. When the programmes thrust are precisely defined the impact that we are likely to achieve on the continuing basis shall be visible within five years of the completion of the programme which may give the direction for further research based on the experience.

STRATEGIES:

To increase the productivity, high yielding cultivars and improved production technology have to be used which would require the integration of efficient production, protection and utilization systems. The cultivars resistant to biotic and abiotic stresses have to find better place which shall reduce the use of pesticides. Similarly, for sustainable increase in production soil health has to be maintained through the integrated management of nutrient, water and other recurring inputs. Since production is associated with return of growers, post harvest handling and processing has also to receive emphasis. This would require continued research efforts in Thrust programmes having a team of inter-disciplinary scientists working together having linkage with national and international organisations.

Accessibility to information will be vital both for scientists and the client to avoid the working in isolation. "Upstream" and "down stream" movement of information is required for efficient use of results and refinement of technologies which shall call for strong support of information system.

India being the largest producer of bananas in the world, has high genetic diversity and is considered to be the major centre of origin for many clones. But the genetic diversity is not fully utilized which lack conservation and characterisation. If desired result in improvement is to be achieved, collection, conservation, characterization require the foremost priority. This task shall have to be accomplished through the use of conventional and biotechnological methods for effective utilization of the diversity in improvement programme.

Biotic and abiotic stresses are major constraints in production of banana. Conventional breeding is time consuming and target breeding has many risk factors owing to the complexity of breeding problem. If source of resistance is available in one accession it may not have male or female fertility. Seed setting is desirable in breeding programmes but the ultimate variety should be seedless and meet quality standard. Considerable progress has been made in NARS programmes of few banana producing countries. However, in India, sporadic attempts have been made with little success. Therefore, improvement programme in banana with emphasis on development of cultivars resistant to biotic and abiotic stress require to be addressed. This programme shall have option for import of promising hybrids found promising in NARS of other countries and its evaluation under our conditions. Use of biotechnological methods for quick *in-vitro* screening, enhancement of variability, transformation etc. shall pave the way for achieving the result in shorter time.

Improvement in production of banana over last decade has been achieved through the manipulation of geometry,density, nutrient and water management and control of insects, pests and diseases (production has increased from 1.5 million tonnes in early fifties to 10.4 million tonnes currently). However, quality grade of fruits are much below the standard. For sustainable increase in the production without any deliterious effect on soil health and environment there is a need for integrated system which can help high quality grade fruits and improve production.

There is a considerable loss in the post harvest handling owing to in-sufficient knowledge on storing, packing, transportation etc. Therefore the task would be to reduce the post harvest losses and exploit the use of value added product. Negligible export of banana is due to monopoly of exporting countries as well as production of low quality fruits which do not meet the international standards. With increase in cost of production in exporting countries added with environmental conciousness there is likely chances for the emergence of the country as major exporter in coming years. This would necessitate the preparedness to meet the changing scenario.

Overviewing the above discussions, it is apparent that there has been steady increase in production of banana yet to meet challenges offing 2020 research capability has to be enhanced to work on priority problem in thrust area. Major strategies and thrust of banana research which has emerged through the discussions in seminar meeting as well as scenario analysis are as follows

1. Germplasm management and enhancement

Long period of domestication of *Musa* under different agro-ecological conditions has provided diversity in many genomic group of *Musa.* Attempts have been made to collect the genepool and describe it, but attempts are not complete as situation is more complicated by synonyms. A total of 535 accessions are available in field genebank and *in-vitro* conservation for medium term has also been attempted successfully. Assemblage has been evaluated for resistance against sigatoka leaf spot, Panama wilt *(F.oxysporum* f.sp. *cubense*) and nematode and large number of diploids have been synthesized having resistance to major pests and diseases which can be utilised for transfer of resistant gene into the commercially acceptable cultivars. Since, conventional breeding method (hybridization and mutation) have not brought about substantial improvement in varietal situation, *in-vitro* breeding needs to be attempted. The following strategies for germplasm management and enhancement is envisaged:

* *Collection through prospection and exotic introduction, conservation in field gene bank and in-vitro, characterization using reference cultivars introduced from INIBAP and development of computerized management system on Musa germplasm.*

* *Development of cultivars resistant to leaf spot disease, banana bunchy top, nematode and salt, through breeding complimented with in-vitro culture.*

* *Use of bio-technology for widening the genetic base for selection of clones resistant to biotic and abiotic stresses.*

* *Identification of natural mutants in population, its evaluation and multiplication using in-vitro propagation for large scale testing.*

* *Establishment of central germplasm information system having accessibility to breeder for the choice of parents in breeding for specific objectives.*

* *Regeneration and replacement of germplams which have been found infested by the virus diseases.*

* *Development of reliable screening techniques using sero-diagnostic methods against diseases.*

* *Bio-chemical evaluation of germplasm using anthocyanin, isozyme and DNA finger printing for clone identification in germplasm management.*

* *Identification of cultivars suitable for different system of cultivation based on tolerance to biotic and abiotic stress.*

2 Propagation and crop management

Propagation : Banana has been propagated conventionally through rhizome or suckers of size advocated for higher production. *In-vitro* propagation has been successfully demonstrated and commercially adopted for mass multiplication. But the use of *in-vitro* plants for commercial plantation has been a point of debate owing to genetic instability and advantages, relative to conventional method. So far the attempts made for popularising the *in-vitro* propagated plants of banana has not received serious attention for selection of high yielding clones and standardisation of production technologies suitable for *in-vitro* plants including time of planting. Issues which need consideration are:

* *Meristem should be selected from high yielding clones and its performance in relation to conventional method of propagation be evaluated.*

* *In vitro plants should be evaluated with suckers in varying agro-climatic regions. Once benefit is demonstrated, production technologies viz. time of planting , nutrition, planting density, pest and disease management, should be developed.*

* *There is need to generate more information on selection of in-vitro plants and hardening. Susceptibility of in-vitro plants to diseases in relation to rhizome or suckers should be studied.*

* *Quick method of detection for different viruses should be employed to safeguard the plants from carriers of virus diseases.*

* *Physiology of in-vitro plant in relation to conventional plants requires to be studied.*

High density planting: Impact of high density planting is well reflected in increased production and productivity of banana especially Dwarf Cavendish, across the country. However, experiments were mostly directed to higher production without taking into the account of quality and marketability of fruits. It is also a common knowledge that success of high density planting largely depends upon soil type, climatic conditions and disease scenario. Therefore, there is need to optimise the planting density taking all the factors into consideration. Further more, high density planting has less acceptability for tall cultivars perhaps owing to lack of information or availability of supporting data. This aspect would need attention.

* *High density planting should be worked out for all the commercial cultivars in different systems of cultivation and optimum density is also to be worked out taking into account the quality aspect.*

* *Density and placement of plants should be worked out under drip irrigation system for economising the cost on drip irrigation.*

* *Planting density should be worked out seperately for domestic market and export of fruit which can only be arrived at once the standards are fixed.*

* *Interaction of planting density with production system, resources and disease and pest scenario to be worked out.*

Nutrition : Banana has wide adaptability to soil conditions but its performance vary with soil type, lime concretion, nutrient status, drainage etc., In vertisol or heavy soil, time taken for cropping is enhanced compared to light soil. Information on the soil factors is vital for banana production needs attention for maximising the productivity with available resources.

Nutritional need of banana especially of macro nutrients in different agro-ecological conditions and its time of application are worked out which has improved the productivity impressingly. But information on micro-nutrients for banana is not worked out although deficiency of Zn and B is exhibited in the field. These nutritional recommendations are mostly based on effect of doses on growth and yield and calls for soil-plant integrated system of nutrient management for efficient utilisation of nutrients.

* *Studies on soil factors, viz. soil type, salt concentration, nutrient status and drainage level on productivity of banana cultivars for yield optimization with given inputs.*

* *Studies on integration of soil and plant for nutrient management to optimise the use of fertilizer having no harmful effect on environment.*

* *Work out the threshold value of micro-nutrient in soil and added advantage by exogenous application.*

* *Studies on integration of organic and inorganic farming system.*

Water management : Water is a major input in banana especially for dwarf cavendish and robusta, many cultivars are grown under rainfed conditions. Drip irrigation is rapidly finding a foothold in banana in area of water scarcity and is likely to spread with passage of time by lowering of costs, and improvement in knowledge and skills. Considering the field adoption,there is need to strengthen the research efforts to cater to future needs, and to stay ahead in important technology for water management. Drip system has not only given the advantage of saving water but also productivity has been increased coupled with advancement in harvesting by 30-45 days. Weed growth is also suppressed and dependence on manual labour is reduced. The aspects which need attention are

* *Quantum of water to be applied, significance of critical stage of growth, flowering and fruiting etc.*

* *Placement of dripper to wet uniformly the rootzone in different types of soil and its impact on root distribution.*

* *Application of fertilizer through or independently of drip system, source and concentration of fertilizer when used through drip system, timing of application etc.,*

* *Crop geometries, installation methods, which improve economics.*

* *Studies on maintenance of drip system economically and efficiently for longer time.*

* *Studies on impact of drip irrigation on soil flora in long run use.*

* *Studies on salt accumulation and micro flora under drip irrigation.*

Practices : Weeds cause 62.7 to 106 per cent reduction in yield of tall and dwarf cultivars of banana and extent of loss depends upon stage of growth. Weed flora vary from region to region and is observed to be suppressed by use of cover crop like cowpea and spray of chemicals. Fertilizer use efficiency is also enhanced by the control of weeds and problems vary with system of cultivation. The aspect which need attention are;

* *Studies on critical stage of weed growth and dynamics of weed flora.*

* *Impact of weed flora on nutrient and water use efficiency.*

* *Weed management under different system of cultivation.*

* *Impact of chemical weed control on soil and water pollution.*

Temperature during the growth and fruit development of banana is critical. Finger filling is adversely affected when mean temperature remain below 20°C, the fruits have less consumer preference. Use of polythene for covering the bunches during the period experiencing low temperature have given encouraging results in terms of increased bunch weight and better size grade of fingers.

Therefore, study is needed to integrate the bunch covering and use of chemicals which can maintain better metabolic activities to obtain good grade bunches.

Other problems of banana that need to be addressed are:

* *Studies on physiological disorder of Nendran banana 'Ney vazhai' observed in Tamil Nadu.*

* *Development of production technology directed towards export of fruits through standardizing bunch size, syncrony in harvest, better transhipment etc.,*

3 Production system

Depending upon resource availability, agro-ecological conditions, tradition, crops, different production system is adopted in banana. In Maharashtra and Gujarat banana is grown in rotation of one plant crop while tall cultivars are maintained for 4-5 years. Wet land banana is common in Tamil Nadu and garden land is practiced in commercial cultivation. It is also grown in homestead as shade or nurse crop, mixed crop with arecanut and coconut. In commercial planting it is always managed with high inputs. Most of research efforts have been directed towards cultivation of banana under high inputs conditions,consequently, very little improvement in productivity of banana under different systems of cultivation have been achieved. Even under high input banana cultivation, informations on system which would be environmental friendly atuned to ecosystem in the region is not impressingly known. Therefore, production system should aim at :

* *Identification of different production systems across the country and development of model keeping in view the resources and need of growers for maximum economic feasibility.*

* *Working out the production technologies in different systems of cultivation.*

* *Development of banana based cropping system and its refinement by interaction with growers, and on farm trials.*

4. Insect pests and nematode management

Insect, pests and nematode in different agro-ecological regions have more of regional significance owing to varying levels of damages caused. Banana weevil is a problem in Kerala, Andhra Pradesh and Assam. Mites and thrips are widespread but are not alarming and have sporadic incidence. Banana aphids *(Pentalonia nigronervosa)* is widepsread and cause the damage through the tranmission of banana bunchy top virus (BBTV). In North Eastern regions, Bihar and West Bengal problem of scarring beetle is serious which causes damage on young flower and fruits. Pseudostem borer is problem in tall group of banana specially in the situation having poor sanitation. Among the nematodes, *Radopholus similis* (burrowing nematode) is widespread and *Helicotylenchuss* sp. is serious in North Eastern regions while cyst nematode (*Heterodera oryzicola*) is a problem in Kerala only. Double paring and treating the suckers with 0.50 per cent monocrotophos, growing of sunhemp as intercrop and applications of neem cakes invariably reduce the population of nematode. Thus thrust areas of research would be:

* *Intensified survey and surveillance on the insect pest and nematode in different banana growing areas to be intensified with change in production system.*
* *Studies on population dynamics of aphids and scarring beetle for developing forecasting model.*
* *Concerted efforts are required to study the biology and time of appearance of scarring beetle and its management.*
* *Studies on nematode population in relation to different agro-techniques for its use in integrated management.*
* *Studies on interaction of nematode with wilt disease.*

5. Disease management

Among fungal diseases, sigatoka leaf spot (*Mycosphaerella musicola*) in humid tropics or coastal region is a cause of concern but is absent in Central India. Fusarium wilt is serious throughout the country on Rasthali (AAB) group of banana and is a major threat. Fortunately, Cavendish group of banana is not infected by this disease although sporadic incidence has been recorded. BBTV is serious problem in many regions and has been contained impressingly by sanitation,rogueing and control of vector. Detection using tetrazolium salt has been debatable. Infectious chlorosis mosaic is another serious disease. Incidence of banana streak virus and banana bract mosaic is also noticed in germplasm. In addition, a strain of TMV has also been reported from India. Thus research on banana diseases has to be addressed to :

- *Study the pathogenic variability of sigatoka, Panama wilt and BBTV.*
- *Development of strategic spray programme for management of sigatoka leaf spot based on monitoring and forecasting system.*
- *Use of molecular approaches namely, RFLP and RAPD-PCR analyses for the Characterization of strains of Mycosphacrella and Fusarium.*
- *Monitoring of sigatoka leaf spot disease through forecasting, cultural practices and use of chemicals, and genetical manipulation need better understanding under the situation as disease behaviour is influenced by production system and prevailing weather conditions.*
- *Quick detection of viral diseases using immunological and molecular sero diagnostic techniques.*
- *Biotechnological techniques, such as the insertion of genetic code for the coat proteins of a DNA virus associated with BBTV into the banana genome offer hope for future managemendt of BBTV*
- *Studies on host range of aphids, management using bio-agent needs attention.*
- *Possibilities of mild stain protection against severe strain of BBTV need to be worked out.*
- *A better understanding of the epidemiology of BBTV and other viral diseases and to ascertain the exact cause of BBTV more investigations are needed.*
- *Detailed investigation of BSV and BBMV require to be done to check the losses caused by these diseases.*

6. Post harvest management and marketing

Although there has been commendable improvement in adoption of technologies but improvement on fruit quality front including harvesting, handling and marketing techniques are not impressive. Harvesting is done based on the experience of growers and virtually there is no definite yardstick for grading fruits which can benefit the growers producing the fruits of better quality. Although packing and handling techniques are available but bunch transport by truck or rail continue. Therefore, there is a need to develop post harvest technologies compatible for domestic market and export,to ensures better return which can inspire for adoption of better techniques in handling and packing of fruits.

* *Standardisation of pre-harvest conditions such as disease and pest control, irrigation and manurial schedule for getting optimum quality fruits for both internal and export trade.*

* *Development of grading standards of different cultivars to suite to domestic market and export.*

* *Systematic studies on covering the bunches in field after last hand formation with polythyne bag and its effect on growth and development of fingers, fruit quality and post harvest behavior.*

* *Development of packing station concept as a model for exporting of banana and existing system of handling banana should be phased out by adopting the technique presently available.*

* *Emphasis is required to be given on bulk aseptic /quick frozen packing of puree/pulp for export.*

* *Development of a banana product like fruit spread and other processed products which can be utilized daily by the consumers.*

* *Emphasis on utilization of pseudostem, leaves, flower both for edible and value added products of commerce.*

* *Management of post harvest diseases during transport and storage.*
* *Studies on extended post harvest life of banana using chemicals and appropriate storage conditions.*
* *Studies on shattering of fruits.*

3. PROGRAMMES

The following programmes are identified in major thrust areas :

1. Collection, conservation, characterisation and utilization of genetic resources

Conservation of genetic diversity has received the attention world wide with the inception of INIBAP. Collection maintained at some of the centres are often balancing, collection and maintenance of genetic resources with production priority resultantly many of the unique accessions have been extinct. Therefore, collection, conservation and utilisation of genetic resource has to be addressed systematically, using conventional as well as innovative molecular measures. In these directions, capabilities developed through network at NRCB for maintenance and utilization of genetic resource, and information system will be effectively used. Main objectives in this thrust areas will be :

* *Collection of germ plasm of banana for widening the genetic diversity*
* *Characterization of the germplasm collection for identification of duplicate accessions, selection of accessions with desirable attributes and to provide data in various forms in improvement programme*
* *Retrieval of accessions infested with the diseases and develop the strategies for gene pool enhancement,*
* *Develop genetic linkage map for germplasm and*
* *To serve as a national repository for germplasm and information through the establishment of computerised germplasm information system.*

Collections, expeditions have been made with collaboration of NBPGR and IBPGR for the collection of banana clones and species. These collection will be characterised using reference cultivars for developing computerised data base for the accessibility to the breeder.

Germplasm shall be conserved *in vivo* as well as *in-vitro*, and efficient method for germplasm maintenance will be worked out. Germplasm will be used in varying programmes for enhancement of the diversity. The programme will effectively collaborate with INIBAP and use new biological tools that will add characterisation and genomic identification. Since many of commercial cultivars are the result of natural selection, exploration for the identification of improved genotype will also be given emphasis.

2. Improvement of banana for the resistance to biotic and abiotic stresses using conventional and biotechnological methods

Major objectives of the programme will be :

* *Testing of the hybrids resistant to insects, nematode and diseases,*
* *Breed the varieties suitable for dessert having resistance to biotic and abiotic stresses,*

* *Explore the possibilities for selection using somaclonal variations,*
* *Development of in-vitro screening techniques against diseases and*
* *Exploitation of In-vitro mutegenesis.*

As a first step, hybrid developed at international level will be introduced through the cooperation of INIBAP and tested for its performance under the Indian conditions,and the promising hybrids will be identified and released for adoption.

In the country, banana grown falls under four major categories namely, dessert banana, cooking banana, plantain, silk and pome which requires improvement in few or many characters. Therefore, breeding for target banana types will be given imphasis by conventional and unconventional research.

3. Integrated management of nutrients and water :

Nutrients and water are the major inputs in banana production which require to be used efficiently, therefore, the research programmes will be addressed to develop a system using fertigation and leaf nutrient analysis system for efficient management. Drip and micro irrigation will also receive imphasis.

4. Banana based cropping system

The success or failure of banana orchards largely depends on a previous history of cropping which affects the nutrients and water use as well as susceptibility to many soil borne diseases. Research evidences are available to show that banana grown after graminaceous crop is less prone to infestation with nematodes. At the same time, plantations become more susceptible to infectious chlorosis virus if cucurbitaceous crops are grown in vicinity of the plantation. Banana grown along with tapioca requires more potassium application to achieve the yield level. These informations suggests that there would be a differential response of banana under different cropping systems. Therefore cropping system research requires to be given priority so that system developed shall be dynamic, efficient in use of resources atuned to sustainable production and environment.

5. Integrated management of insects, pests, nematodes and diseases

Many insect pests, nematodes and diseases cause a considerable loss to banana production in different regions. A chemical control is harmful to the environment and causes health hazards at the same time it is expensive. Therefore, there is an urgent need for the development of high level of resistance in the cultivars used by subsistence farmers to improve the production level and make the production system more sustainable by reducing dependence on chemical control. Use of biological agents epidemology, host-parasite relationship etc. shall be the strategies for efficient management. The early detection of disease especially viral and accurate diagnosis are continuing challenges which require to be addressed to achieve an effective management and reduce the losses.

6. Post harvest handling and Technology

Returns to the farmers depends upon the marketing of the produce which is determined by a post harvest losses ultimately becoming factor for the use of inputs. The data are not sufficient on post harvest characterization of different accessions which will be used to improve the programme. Use of waxol, ethylene absorbents and proper handling enhance the self life but these findings are not fully exploited. Glut in the market in a particular season also reduces the returns therefore the research on the banana require to be addressed for exploitation of value added product.

The NRCB has opted for Thrust research through identification of priority programme where the scientists from different discipline will work on programme encompassing the barrier of departments. The broad based programme designed are flexible. Inter-disciplinary team spirit with close linkages with National and International organisations will be developed for achievement of the goal.

Network research will be organised on priority aspects to deal with production technology under different system and agro-ecological regions. It is also envisaged to encourage Banana Association which can play a role of catalyst for transfer of technology among farmers in the different regions and provide an opportunity for researchers, extensionists, educationists to meet periodically and exchange research results informations. Once NRCB develops it capability, it will organize training progarmmes for the benefit of banana farmers and extension workers to meet the requirement of information on banana and also for the rapid dissemination. NRCB will also address the need for bringing all the agencies at National and International level together. Therefore, it will be imperative to continue and develop effective information systems systematically.

ANNEXURE-I

DETAILS OF STAFF POSITION

	Category of Post & designation	No. of sanctioned posts	Name of the incumbent
SCIENTIFIC			
1.	Director	1	Dr.HP.Singh (OIC)
2.	Scientist (Hort)	1	Dr.S.Uma
3.	Scientist (Pl.Path)	1	Shri R.Thangavelu
	(Other positions are yet to be created)		
TECHNICAL			
1.	Asstt.Garden Suptd.(T5) (Incharge)	1	Sh.Ragu Raman
2.	Civil Oversear (T-II-3)	1	Vacant
3.	Tech. T-II-3	3	Vacant
4.	Programmer	1	Vacant
5.	Technician : T-1 (Field)	3	Vacant
6.	Technician ; T-1 (Lab./Lib.)	3	Vacant
ADMINISTRATIVE			
1.	Asst.Admn.Officer	1	Vacant
2.	Asst.Fin.& Accts. Officer	1	Vacant
3.	Assistant	1	Shri M.Balu
4.	Stenographer	1	Vacant
5.	Jr.Stenographer	2	1. Sh.M.Krishnamurthy 1. Vacant
5.	Sr.Clerk	1	Vacant
6.	Jr.Clerk	2	Sh.R.Krishnamurthy Smt.S.Durgavathy
AUXILLIARY			
1.	Driver	1	Sh. A.Subramaniam
2.	Tractor Driver	1	Vacant
SUPPORTING			
1.	Messenger	2	1. Sh.Thangaraj 2. Vacant
2.	SSG-II	5	1. Sh. P.Mohan 2-5 Vacant