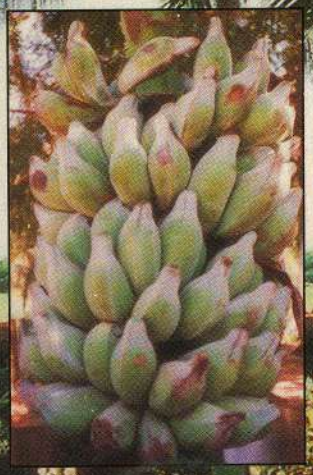
ANNUAL REPORT

1995-96



भाकृअनुप
ICAR

NATIONAL RESEARCH CENTRE ON BANANA
(Indian Council of Agricultural Research)
TRICHY - 620 017.

RMCU

ANNUAL REPORT
1995-96

भाकृअनुप
ICAR

राष्ट्रीय केला अनुसंधान केन्द्र
(भारतीय कृषि अनुसंधान परिषद)
पोदावूर, त्रिची – 639 103. तामिलनाडू

National Research Centre on Banana
(Indian Council of Agricultural Research)
Podavur, Trichy - 639 103. Tamil Nadu.

Published by :

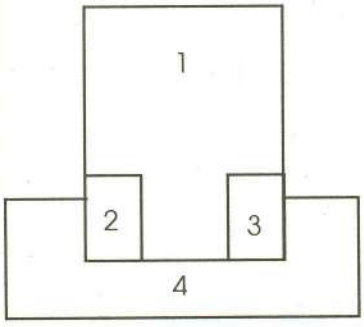
Dr. H.P. Singh
Director
National Research Centre on Banana,
No. 44, Ramalinga Nagar South Extension
Vayalur Road, Trichy - 620 017.
Phone : 0091 - 0431 - 770372
Fax : 0091-0431-770564
Gram : KADALI
e.mail : nrcbanana@x400.nicgw.nic.in

Compiled and edited by :

Dr. H. P. Singh
With the assistance of
Dr. S. Shivashankar
Dr. P Sundararaju
Dr. S. Uma
Dr. R. Selvarajan

Citation :

Annual Report 1995 - '96
NRC on Banana
Trichy - 17



Cover Page

1. Bhimkol - a balbiciana clone from N.E. India and a cure for many ailments
2. A normal Bhimkol bunch with seeds
3. Rasthali - a commercial clone
4. A view of Banana plantation

Cover Design : **Mr. Padmanabhan**

Typesetting & Layout by **Alfa Lazrites** ; Printed at **Print-O-Graph**, Bangalore. Ph : 2877398

CONTENTS

निदेशक प्रतिवेदन

प्रस्तावना :

केले की बढती हुई महत्ता, जीवीय और अजीवीय प्रतिबंधों तथा अनुसंधान की जटिलता को ध्यान में रखते हुए भारतीय कृषि अनुसंधान परिषद द्वारा टास्क फोर्स की अनुसंसा से राष्ट्रीय केला अनुसंधान केन्द्र की नींव 21 अगस्त 1993 को डाली गयी, जो एक अप्रैल 1994 से कार्यरत है। इस केन्द्र का मुख्य उद्धेश्य मूलभूत तथा योजनाबद्ध अनुसंधानों द्वारा केले की उपज एवं उत्पादकता में वृद्धि लाना हैं। अनुवंशिक संसाधनों का उपयोग, नई किस्मों का विकास एवं उत्कृष्ट उत्पादन तकनीकों द्वारा केले की उपज तथा उत्पादकता को बढाना ही राष्ट्रीय केला अनुसंधान केन्द्र का मुख्य लक्ष्य है। राष्ट्रीय केला अनुसंधान केन्द्र का मुख्यालय त्रिची में स्थित है और इसका 36 हेक्टर प्रक्षेत्र त्रिची के दक्षिण पश्चिम में 14 किलो मीटर दूर पोडावूर गाँव में है। कार्यालय एवं प्रयोगशालायें 44, रामलिंगम नगर, वायालूर रोड, त्रिची में स्थित हैं। पिछले दो वर्षों में केन्द्र के आधारभूत ढांचे और अनुसंधान कार्यों में सराहनीय प्रगति हुई है।

आधारभूत सुविधाएँ :

विकास कार्य के एक कारक के रूप में प्रक्षेत्र की तैयारी पर जोर दिया गया। नक्सों की रूप रेखा तैयार करने के उपरान्त रास्ते और नालियाँ बनाई गई हैं। 200 मीटर X 100 मीटर के प्ररवण्ड और 50 मीटर X 50 मीटर के छोटे छोटे प्लाटस बनाये गये हैं। सभी 200 मीटर के बाद 10 मीटर और 100 मीटर के बाद 5 मीटर के रास्ते बनाये गये हैं। 1000 मीटर की पक्की सड़क भी बनायी है। सिंचाई की सुविधाओं की व्यवस्था की जा रही है। प्रक्षेत्र में तीन खुले कुऐ और दो बोरवैल है, जो 60% प्रक्षेत्र की सिंचाई के लिए प्रर्याप्त हैं। सरकार से निवेदन करके 100 मीटर X 30 मीटर भूमि अर्जित की गयी है जिसके द्वारा प्रक्षेत्र को मुख्य रास्ते से जोड़ा गया है। प्रक्षेत्र में कार्य करने के लिए छोटे भवन निर्मित किये गए है एव्म प्रयोगशालाओं में पानी उपलब्ध कराया गया है। पैकिंग हाऊस का निर्माण कार्य प्रारम्भ हो गया है। संपर्क कार्यालय के लिए शहर में ही एक एकड भूमि तथा प्रयोगशाला एव्म कार्यालय भवन के लिए प्रक्षेत्र के पास में आठ एकड़ भूमि अर्जित की गई है। प्रक्षेत्र मृदाकी का पी. एच. मान 8.4 से 10.0 तक है। प्रक्षेत्र उत्थान का कार्य प्रगति पर है।

अनुसंधान योजनाओं के आधार पर प्रयोगशालाओं को अनुवंशिकी एवं जैव प्रौयोगिकी, केला उत्पादन एवं सुरक्षा और सस्योत्तर प्रौयोगिकी वर्गी में विभाजित किया गया है। जैव प्रौधोगिकी प्रयोगशाला के लिए प्रमुख उपकरण

उपलब्ध कराये गये है और अन्य प्रयोगशालाओं के लिए उपकरण की सुविधाओं को जुटाने का प्रयास किया जा रहा हैं। निवेशन तथा संवर्धन सुविधाएँ स्थापित की गई हैं। ऊतक संवर्धन एवम प्रमुख पौधों के यौगिक विश्लेषण के लिए उपकरण उपलब्ध किए गए हैं। पुस्तकालय में 100 से भी अधिक पुस्तके हैं और केले पर उपलब्ध अन्य साहित्य को भी एकत्रित करने के प्रयास किये गये हैं। संबंधित भारतीय पत्रिकाएँ मंगाई जा रही हैं और पुस्तकालय के प्रबंध हेतु कम्पयुटर प्रोग्राम बनाया गया है। केन्द्र पर ई–मेल की सुविधा उपलब्ध है और शीघ्र ही क्षेत्रीय केला इन्फार्मेशन सिस्टम से सहयोजित होने की संम्भावना है। चालू वर्ष में एक जीप और एक मारूति वाहन को केन्द्र के लिए अर्जित किया गया है।

कार्मिक तथा बजट :

इस केन्द्र के लिए कुल 15 वैज्ञानिक पदों का अनुमोदन प्राप्त है परन्तु अभीतक केवल तीन पदों पर ही वैज्ञानिक कार्यरत हैं। अन्य पदों को भरने हेतु प्रयत्न किये जा रहे हैं। प्रशासनिक, तकनीकी, एवं सहायक वर्गों के पदों को भी भरा जा रही है।

वर्ष 1995–96 के लिए 70 लाख रूपयों का अनुमोदित बजट है। वर्ष 1994–95 के लिए 62 लाख रूपयों की राशि अनुमोदित हुई थी जिसका विभिन्न शीर्षों के अंतरगत ययोचित उपयोग किया गया। इस वर्ष प्रक्षेत्र की कुल आमदनी 1.62 लाख रूपयें हुई।

अनुसंधान उपलब्धियाँ :

इस केन्द्र पर मुख्यतः चार लक्ष्यों को ध्यान मे रखकर कार्य प्रारम्भ किया गया–अनुवंशिक संसाधन प्रबंध, प्रजाति विकास, उन्नत उत्पादन प्रौयोगिकी, कृषि प्रविधि एवं सुरक्षा के लिए एक सेस फण्ड परियोजना भी इस केन्द्र में कार्यरत है। अर्न्तराष्ट्रीय मूसा परिक्षण कार्यक्रम (इन्टरनेशनल मुसा टेस्टिंग प्रोग्राम–आई.एम.टी.पी. के) अंतर्गत कुछ परीषण किए जा रहे है।

अनुवंशिक संसाधन प्रबंध :

भारत केला की विविधताओं का केन्द्र है जिसमें अनुवंशिक सम्पदा का विशेष स्थान है। इस केन्द्र में केला के 597 नमूने एकत्रित किये गए हैं। भारतीय केला जननद्रव्य पर अन्वेषण कार्य प्रारम्भ किया गया है। प्रक्षेत्र जीन बैंक में जननद्रव्य का संरक्षण किया गया। रोग रहित केला का पात्र संरक्षण कार्य में भी प्रगति हो रही है। इस वर्ष 24 प्राप्तियों पर संवर्धन कार्य प्रारम्भ किया गया है, जिसमें सफलता मिली है। केन्द्र के प्रक्षेत्र जीन बैंक में 349 प्रात्तियों का विकास, उपज और गुणवत्ता, रोग तथा लवण की प्रतिक्रिया और सस्योत्तर अभिलक्षण के संबंध में प्रारम्भिक मूल्यांकन किया गया है। प्रारम्भिक मूल्यांकन के उपरान्त उन्हें वर्गीकृत करके मूल्यांकन हेतु लगाया गया है।

अनुवंशिक संसाधन का उपयोग :

0079 प्राप्ति, जो पिसांग अवाक समूह का हैं, बौने पन के लिए उत्तम पाया गया । इन बौने चयन को बाह्य सहारा की आवश्यकता नहीं होती । 0052 प्राप्ति सिल्बर मोनथन समूह का लवण रोधी चयन है । अधिक लवण परिस्थिति में भी यह चयन संतोषजनक उपज देती है, जो क्षारीयभूमि में भी एक उत्कृष्ट किस्म हो सकती है । वर्ष 1994–95 के दौरान पहचानें गए 0030 एवं 0016 प्राप्तियों में रेशम एवं मोनथन समूह इस वर्ष भी उत्तम पाया गया । इन चयनों का वृह्द रूप से मूल्यांकन किया जा रहा है ।

प्रजाति विकास :

केला में प्रजाति विकास हेतु नर एवं मादा की निषेचकता का ज्ञान आवश्यक है। अतः उत्कृष्ट जननों को पहचाने का प्रयास किया गया । विभिन्न पराग निषेचकता वाले नर निषेचक प्राप्ति को विलग किया गया । विभिन्न जननसमूहों के 35 प्राप्तियों के मादा निषेचत स्तर को स्थापित किया गया । रोचक विषय यह है कि ये प्राप्तियाँ करपूरावल्ली की तरह पराग निषेचक जनक के पास उगाने पर ही बीज उत्पन्न करती हैं । केले के बीज को अंकुरित करने में सफलता तो मिली किन्तु अंकुरण की प्रतिशतता बहुत कम रही । विदेशी संकरों को अन्तपात्र में गुणन करके प्रक्षेत्र में लगाया गया ।

उत्पादन प्रौघोगिकी :

छः व्यापारिक कृषि योग्य प्रजातियों की विभिन्न विकास अवस्था में मृदीय कारको को पहचाने के लिए परीक्षण किए गए । जैव और अजैव पोषण श्रोतों का प्रयोग करके छः कृषि योग्य प्रजातियों में लवणता की समस्या को सुल्झनें और मिट्टी के स्वास्थ्य को बनाए रखने का प्रयास किया गया । जहाँ पोषण के जैवीय स्त्रोत का उपयोग किया गया, वहाँ लवण क्षति नही देखी गई । गोबर खाद, नीम की खल्ली तथा अजैवीकी पोषण के मिश्रण को डालने से पौधे में महत्वपूर्ण वृद्धि हुई । खरपतवारों से हो रही हानि का पता करने स्वस समन्वित खरपतवार प्रबंध हेतु परीक्षण कार्य किया जा रहा है ।

फसल सुरक्षा :

केले का ब्रैक्ट मोजेक विषायु (बनाना ब्रैक्ट मोजेक वायरस–बी.बी.एम.वी.) और स्ट्रीक विषाणु (बनाना स्ट्रीक वायरस–पी.एस.बी.) रोगों का पता लगाने के उपरान्त उनके फैलाव के कारणें को खोजने के लिए कठिन प्रयास किया गया । देश के प्रत्येक केला उगाने वाले क्षेत्र में पी.एस.वी. का प्रकोप पूवन प्रजाति में प्रभावकारी पाया गया । दक्षिण भारत में नेन्द्रन और मोन्थन प्रजातियों पर बी.बी.एम.वी. का प्रभाव चिंताजनक है । पूवन प्रजाति में बी.बी.एम.वी. और बी.एस.बी. का मिधित संक्रमण देखा गया, जिससे उत्पादकता की सर्वाधिक हानि देखी गई है। रोबस्टा प्रजाति पर भी बी.एस.वी. का प्रकोप देखा गया । नेन्द्रन, पूवन और रोबस्टा में बी.बी.एम.वी. का प्रकोप देखा गया । एक रोग रहित और रोग ग्रसीत पौधों के मूल्यांकन से स्पष्ट हो गया कि बी.बी.एम.वी. से नेन्द्रन की

बढ़ाव एवं उपज में विशेष हानि होती है । स्ट्रीक विषाणु और बी.बी.एम.वी. को इलेक्ट्रोन माइक्रोस्कोपी द्वारा देखा गया बी.बी.एम.वी. का पता लगाने हेतु फिलीपाइन्स से लाए गए प्रतिजीव एन्टीवाडी का मूल्यांकन किया गया, जिसमें ग्रसित नमूनों को सकारात्मक प्रतिक्रिया दिखाई दी । स्ट्रीक विषाणु रहित पौद्य पिसांग सेलान पूवन समकक्ष मूल्यांकन के लिए लगाये गये हैं ।

सामान्य :

केन्द्र द्वारा की गई प्रगति को मान्यता प्राप्त हुई है । राष्ट्रीय केला अनुसंधान केन्द्र ने अखिल भारतीय केला प्रदर्शनी में भाग लिया, जिसके लिए उसे सम्मानित किया गया । केन्द्र की प्रगति में राष्ट्रीय एवं अर्न्तराष्ट्रीय वैज्ञानिकों को आकर्षित किया हैं उप महानिदेशक (बागवानी) डा. के. एल. चड्ढ़ा तथा कई उच्चाधिकारियों सहीत तीन अन्तरराष्ट्रीय वैज्ञानिको ने इस केन्द्र का अवलोकन किया । इस केन्द्र में केले के सुधार का अंतरराष्ट्रीय नेटवर्क (इ.नी.वा.प.) और एशिया तथा पैसेफिक क्षेत्र नेटवर्क (एप्सनेट) की क्षेत्रीय सलाहकार बैठकें इस वर्ष होगी ।

आभार :

डा. किशन लाल चड्ढ़ा, उप महानिदेशक (बागवानी), भारतीय कृषि अनुसंधान परिषद के दिशा निर्देशों एवं प्रोत्साहन के लिए हम विशेष आभारी हैं । डा. इन्द्रजीत सिंह यादव, निदेशक, भारतीय बागवानी अनुसंधान संस्थान, हेसरघट्टा झील डाकघर, बेंगलोर, तथा उन सभी के प्रति हम आभार प्रकट करते हैं, जिन्होने राष्ट्रीय केला अनुसंधान केन्द्र की प्रगति में योगदान दिया है । मुझे आशा ही नही अपितु पूर्ण विश्वास है कि यह वार्षिक प्रतिवेदन केला कार्यकर्ताओं के लिए विशेष लाभकारी सिद्ध होगा ।

(हरिश्चन्द्र प्रसाद सिंह)
निदेशक

दिनांक : 10 अगस्त, 1996

DIRECTORS REPORT

INTRODUCTION

The National Research Centre on Banana (NRCB) was established in August, 1993 based upon the recommendations of the task force appointed by the Indian Council of Agricultural Research. The mandate of the Centre is to enhance production and productivity through basic and strategic research. The vision of NRCB is to improve production and productivity through utilization of genetic resources, development of improved cultivars and improved production technologies. In the last two years, the centre has made appreciable progress in the infrastructural development as well as in research. The headquarters of NRCB is located in Trichy and has 36 hectares of research farm in Podavur village, 14 km South-West of Trichy town.

INFRASTRUCTURAL FACILITIES

As a part of developmental activities, the layout of the farm received major emphasis. After contour mapping, roads and drains were formed. Blocks of 200m x 100m and micro plots of 50m x 50m have been made. Work on 1000m concrete road was completed. Irrigation facilities were developed. The farm has three open wells and two borewells which can irrigate 60% of farm area. By persuading the Government of Tamil Nadu a stretch of 100m x 30m land was acquired for formation of approach road. Fencing of a major part of farm area has been completed. Two farm structures were completed and water connection to farm laboratory was provided. Work order for construction of packing house has been awarded. One acre of land within the city for construction of Liaison Office and eight acres adjoining the farm have been acquired for laboratory-cum-office building.

As per the research thrust, laboratories were organised into (i) Breeding and Biotechnology lab, (ii) Crop production and protection lab. and (iii) Post harvest technology lab. Major equipments required for the biotechnology lab have been procured and efforts are underway to modernise the laboratory facilities for tissue culture work. Inoculation and culture facilities have been created. Equipments for tissue culture work and for analysis of major plant compounds have been acquired. Library has more than 100 books and literature on banana is being collected regularly. Most of Indian journals relevant to the crop are subscribed. Computer programme for management of library was developed and put into use. The Centre has E-mail connectivity and may get connectivity of Regional Banana Information System. The centre procured one Jeep and a Maruti Van during the year.

STAFF AND BUDGET

The centre has a cadre strength of 15 scientists of which three are in position.

Arrangements for filling up other positions have been made. Position of B,C and D categories are being filled up.

The sanctioned budget for the financial year 1995-96 was Rs.70 lakhs. The allocated funding of Rs.60 lakhs for the year 1994-95 was effectively utilized under different heads.

RESEARCH ACHIEVEMENTS

The programmes at the centre have been initiated under four major missions. Genetic resources management, Crop improvement, Improved production technology (Agrotechniques and Crop protection) and Post harvest characterization. A cess fund project for characterization and documentation of banana gene pool is also operational at the centre. International Musa Testing Programme (IMTP) trials were also initiated.

Genetic Resource Management : Musa germplasm collection was enriched to 597 accessions and attempts for exploration of indigenous Musa germplasm were initiated. Germplasm is conserved in field genebank and *in vitro* conservation is in progress. *In vitro* culture for 24 accessions have been initiated. In the field genebank, preliminary evaluation of cultivars with respect to growth, yield, quality, reaction to diseases, salinity and post harvest characterization have been completed for 349 accessions. Description of accessions using INIBAP's descriptor (120 characters) was done. After preliminary evaluation, accessions were classified and planted separately as working collection for further evaluation.

Utilization of Genetic Resources : Accession 0079 belonging to Pisang Awak group (ABB) was found to be promising with respect to dwarf plant stature. This selection does not require propping. Accession 0052 belonging to Silver Monthan group was found to produce acceptable bunch mass even under high salt conditions. It is also promising as a culinary variety under alkaline soils. Two promising accessions identified during 1994-95, viz. 0030(Silk) and 0016(Monthan) were found to exhibit consistency in plant growth and yield characters.

Crop Improvement : Efforts were made to identify promising fertile male and female parents. Male fertile accessions with different pollen fertility status were identified. Female fertility status in 35 accessions belonging to different genomic groups was evaluated. Many accessions including Karpuravalli produced seeds when grown near pollen fertile parents. Successful germination of banana seed was achieved although percentage of germination was low. Exotic hybrids multiplied *in vitro* were planted in the field for evaluation trials.

Production Technology Trials to study the effect of edaphic factors on growth of six commercial cultivars were initiated. To sustain soil fertility and to overcome the problem of salinity, a trial with six cultivars was initiated using organic and inorganic

source of nutrients. Application of a mixture of FYM, Neem cake and Inorganic nutrients to soil significantly increased plant growth parameters. A Trial to find out the effect of weeds on different stages of crop growth and yield of banana was initiated. An experiment on integrated weed management was also taken up.

Crop Protection : After identification of banana bract mosaic virus (BBMV) and banana streak virus (BSV), intensive efforts were made to study their spread. Presence of BSV on cv. Poovan was found in all the banana growing regions of the country, while BBMV was found to occur on cv. Nendran in a severe form in southern states and on cv. Monthan in major secondary collections. Presence of both BBMV and BSV was recorded on cv. Poovan which caused severe loss in growth and yield. Banana streak virus (BSV) was also observed on cv. Robusta in a survey conducted in Trichy district. The presence of BBMV was observed on cvs. Nendran, Poovan, Ney Poovan and Robusta. In field evaluation of diseased and healthy plants, severe losses in growth and yield of Nendran due to BBMV infection was recorded. Electron microscopy of diseased tissues have shown the presence of BSV and BBMV particles. Diseased samples gave positive reaction to BBMV antiserum obtained by the courtesy of Dr.Espino from Philippines. BSV-free plants of Pisang Ceylan (akin to Poovan) was introduced for testing.

General : The progress made by the centre has been well recognised. NRCB participated in the All India Banana Show and was honoured by presentation of memento. Progress made at the centre has attracted many scientists from abroad for collaborative projects. Dr.K.L.Chadha, Dy. Director General (Hort.) and many other dignitaries including three scientists from overseas visited the centre. The centre will be holding Regional Advisory Committee meeting of Asia and Pacific Region Network (ASPNET) under the auspices of International Network for the Improvement of Banana and Plantain (INIBAP).

Acknowledgment

I wish to express my sincere gratitude to Dr.K.L.Chadha, Dy. Director General (Hort.), ICAR for his inspiring encouragement, untiring guidance and support. I also wish to thank Dr.I.S.Yadav, Director, IIHR, Bangalore for his kind cooperation and help in facilitating smooth functioning of NRCB. Thanks are also due to those who have directly or indirectly contributed to the speedy progress of the NRCB. Assistance provided in the preparation of annual report is thankfully acknowledged.

(H.P.Singh)
Director, NRCB

10, August 1996.

INTRODUCTION

Banana referred to in ancient Indian literature as Kalpatharu (Plant of Virtues), is widely grown in India under various agro-climatic conditions having different production systems and cultivars. Banana is not only known for its antiquity, but also is interwoven in the traditional heritage with its multifaceted uses and great socio-economic significance. The total estimated production of banana is 10.4 million tonnes per annum from an area of 3,92,000 ha. accounting for 31 per cent of the total fruit production in the country. In recent years, there has been an appreciable increase in production and productivity, but many of the production constraints still continue to cause yield losses. In the next two decades, 25 million tonnes have to be produced through efficient utilization of land and natural resources in order to meet the increasing consumption needs of the growing population. Growing appreciation for banana among the masses, adverse impact of biotic and abiotic stresses on yield and the complexity of research incited the task force appointed by Indian Council of Agricultural Research to recommend the establishment of National Research Centre on Banana with a mandate to enhance production and productivity through basic and strategic research. On the recommendations of the task force, the land offered by the Govt. of Tamil Nadu was taken over on 21st August, 1993. After sorting out the teething problems, the NRCB has addressed its research efforts in thrust areas and priority programmes with its team of inter-disciplinary scientists working together and having linkages with National and International organisations.

LOCATION

National Research Centre on Banana is situated in Trichy (Tiruchirapalli) in the state of Tamil Nadu at 11.50° N latitude, 74.50° E longitude and 90 m above mean sea level. This region receives precipitation of 800-900 mm annually from both North-East and South-West monsoons. Climate is tropical with higher mean temperature during the months of Apr-June. At present the office and laboratories are functioning in a rented building at 44, Ramalinga Nagar South Extension, Vayalur Road, Trichy - 620 017. The research farm is located in Podavur village, 14 km away from Trichy town on Thogamalai road. The state government has provided eight acres of land on Thogamalai main road adjacent to farm site for the construction of office and laboratory buildings. One acre land has also been provided by the government of Tamil Nadu in the city for construction of liaision office / visiting scientists' hostel and residential buildings.

MANDATE

* To undertake basic and strategic research for the development of technologies with a view to enhancing 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 information related to banana and plantain and also to disseminate the knowledge to improve the production and productivity.
* To provide leadership and coordinatethe network for generating location-specific varieties and technology for solving specific constraints in banana and plantain production.
* To collaborate with National and International agencies in achieving the above objectives.

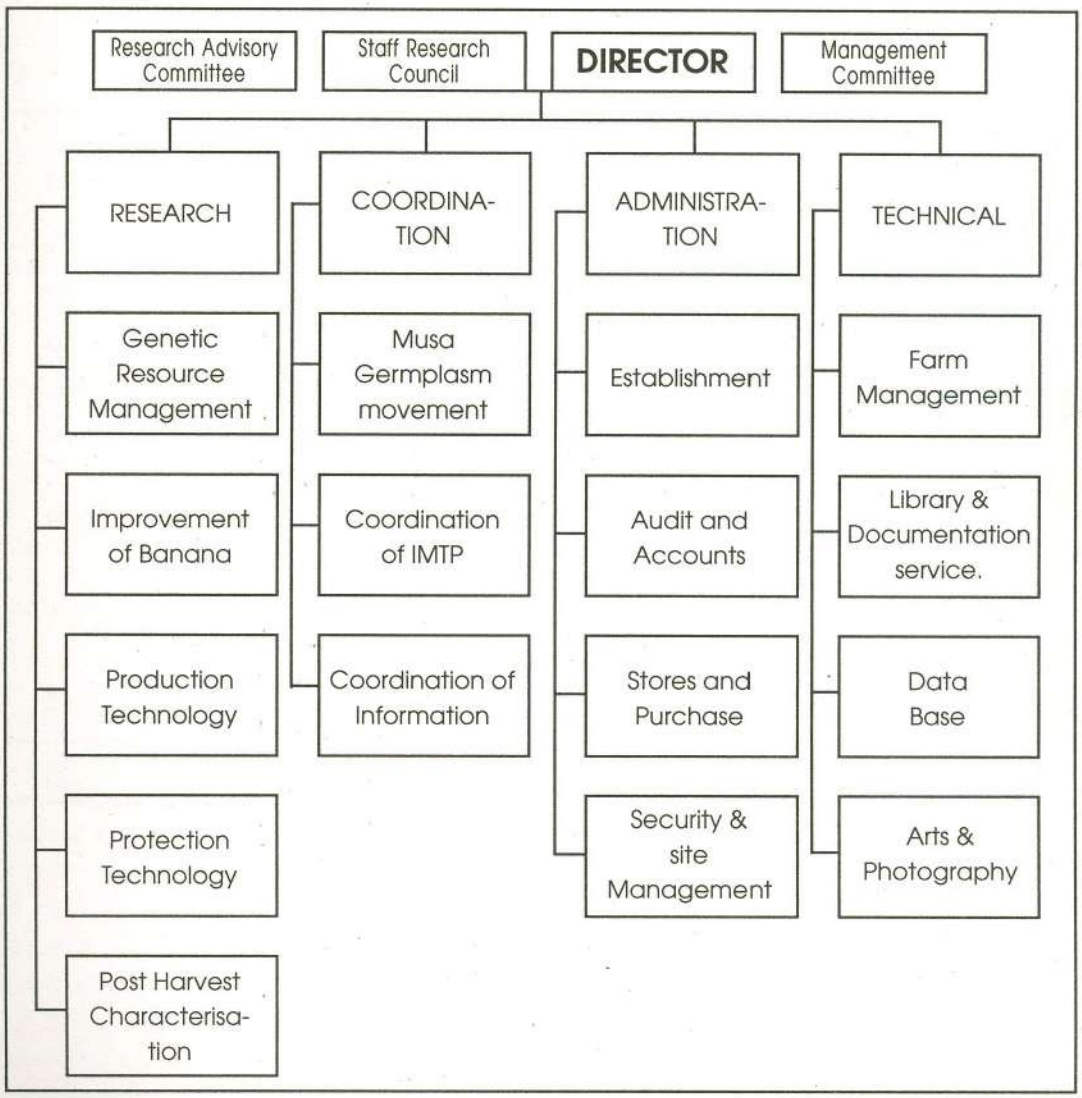


Fig. 1 : Organisational Structure of NRCB, Trichy

ORGANISATION

The NRCB is headed by the Director. The organisational structure of the centre is given in Fig.1. The centre has an approved cadre strength of 15 scientists, one Assistant Administrative Officer, Assistant Finance & Accounts Officer, Assistant Garden Superintendent. The present position of scientific, technical, administrative and supporting staff is presented in Annexure I.

BUDGET

Total outlay for NRCB during the VIII Plan was Rs.230 lakhs. Statement of sanctions and expenditure are given in Table 1. During the financial year allocated budget was fully utilized. Receipts from the sale of farm produce was Rs.1.62 lakhs.

Table 1 : Budgetary allocation and expenditure

(Rs. in Lakhs)

Heads of Account	Allocation during 8th plan	Actual Expenditure			B.E. 96-97
		93-94	94-95	95-96	
Establishment	22.84	-	1.25	4.92	5.50
Travel Allowance	4.70	0.30	0.96	1.50	1.50
Recurring Charges/ Other charges	29.00	0.28	4.91	12.32	30.00
Non-recurring Charges					
Works	120.00	-	7.60	22.04	32.50
Tools, Plants, Equipments, Furniture/Fixture	47.76	3.60	24.21	11.43	-
Vehicle	3.70	0.09	0.05	4.70	-
Any others	-	-	-	-	0.50
Total	230.00	4.27	38.98	61.91	70.00

Receipt : Farm Produce Rs. 1,62,150

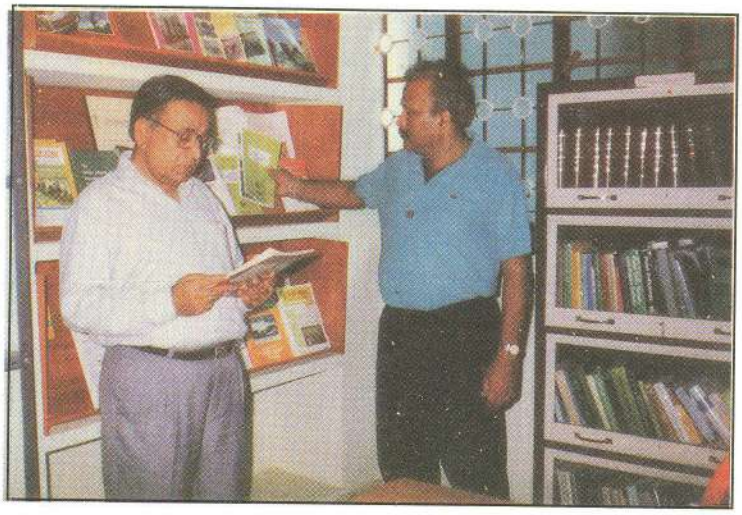
LOGISTIC FACILITIES

Farm Development : Farm of NRCB is located in Podavur village, 14 km away from Trichy town in south-west direction. An area of 0.68 acre has been acquired to provide an approach road connecting the farm to the village road and the Thogamalai main road. The total area of farm is 36 ha. The farm is surrounded by a canal on the southern side and a big village drain on the western side. Most of the farm land is wet except a few patches having gravely soil. About half an hectare of land is marshy. Water table rises when water flows in the canal warranting effective drainage system. Soil pH ranges from 8.0 to 9.5 and hence reclamation process through flooding, gypsum application and effective drainage have been initiated. Three open wells, two bore wells and the canal are the sources of irrigation. After contour mapping, farm layout was completed by making 200 x 300m plots and 50 x 50 micro plots intervened by 10 m and 5 m roads and provided with drainage channels all along. Laying of 1 km length of concrete road on the farm has been completed. Soil survey of the farm was completed during the year. The entire land area in the farm is effectively utilized by planting rotational crops.

Infrastructure : Office-cum-laboratory is functioning in a rented building and necessary facilities are being created. Breeding and biotechnology labs are equipped with many sophisticated equipments. Inoculation and culture facilities were created. Crop production and protection labs are being equipped. The centre has acquired a pH meter, conductivity bridge, BOD incubator, microscope, distillation units, electronic balance, leaf chamber analyzer, a deep freezer (-20°C), a spectrophotometer and a personal computer along with softwares. Meteorological equipments have been procured. Government of Tamil Nadu has provided eight acres land on Thogamalai main road adjacent to farm for office and laboratory buildings. The building plan of NRCB is being prepared. Construction of packing house at farm is sanctioned and the work will be initiated soon.

In vitro of Banana Shoot Tip

Library : The library of NRCB is on the mailing list of concerned national and international institutes. It has a holding of 100 books, fourteen technical reports and many research articles. Technical documents on banana and plantain totaling 27 have been obtained from INIBAP. The centre subscribes to 20 periodicals. Database on banana literature is being developed.



Dr. I.S. Yadav, Director, IIHR on his visit to NRCB Library.

RESEARCH ACHIEVEMENTS

1. GENETIC RESOURCE MANAGMENT (Collection, Conservation, Evaluation and Utilization)

A wealth of genetic diversity in Musa is present in the country owing to its evolution and long periods of domestication. Although Dwarf cavendish forms the basis of commercial cultivation followed by Poovan, Rasthali etc., large number of indigenous and location-specific Musa clones are maintained either in backyard farms or home gardens adding to the Musa wealth of the country. This diversity has the potential to be a major donor source of resistance to pests, diseases and other stresses. The genetic resource management is a priority programme at the centre.

1.1 COLLECTION : In the previous years, collections were made from secondary centres like commercial plantations, research institutes and experiment stations. During the year attempts were made to collect indigenous Musa cultivars through exploration. Coorg district of Karnataka, and Jorhat and Tinsukia districts of Assam were explored and germplasm were collected. Pisang Ceylan was introduced from INIBAP. Clones were also collected from Jalagaon taking the total collection to 597 accessions.

Table 2 : Details of banana accessions at NRCB

Musa sp./clones	No. of accessions	Sources of collection
Musa sp.	005	Indigenous
AA	021	Andhra pradesh, Assam,
AB	030	Bihar, Gujarat, Karnataka
AAA	037	Kerala, Maharashtra,
AAB	106	Tamil Nadu, Tripura,
ABB	262	and West Bengal
BB/BBB	008	
Tetraploids	008	Exotic
Unidentified	120	INIBAP, Belgium

1.2 CONSERVATION :

Musa germplasm is being maintained in field genebank and successful efforts are made to conserve them under *in vitro* conditions. Till now 60 accessions have been successfully conserved and cultures of another 24 accessions have been initiated.

1.2.1 Field gene-bank : Each accession is maintained in triplicate under wetland system of cultivation with a spacing of 2.0m x 2.0m. Trench of 45 cm depth are maintained around two accessions with three plants each for the conveyance of water in summer and drainage during rainy season.

1.2.2 *In vitro* management of banana accessions : Culturing the proliferating shoots on modified Murashige and Skoog medium (MS major and minor nutrients with 400 mg/l KH2PO4 + MS vitamins + glycine + ascorbic acid (20 mg/l) + sucrose (3%) + BAP (10 µM) + IAA (1 µM) + gelrite (0.2%)) enabled to obtain better multiplication. Further culturing of these multiple shoots with reduced BAP concentration (1 µM) helped in better rooting. The well grown plantlets were transplanted to GP pots filled with sand:Soil:FYM:Soilrite at equal proportion and were subjected to various steps of hardening.

For hardening, the plants were exposed to 65-70% RH and light intensity of 40-45 µmol/m^2/S for a period of 10-12 days. Then they were exposed to higher light intensity (200 µmol/m^2/S) and 50-60% RH for a period of 10-15 days. Light intensity less than 600 µmol/m^2/S was provided subsequently for a month. Then the hardened plants were transplanted to polybags filled with sand:soil:FYM at equal proportion. They were allowed to grow in glasshouse for 6-8 weeks at light intensity of 600-700 µmol/m^2/S having good aeration.

Growth and survival of accessions during hardening varied depending on the clone (Table 3). In the present study, survival of hardened plants in nursery varied from 40 to 95 per cent. Test clones of AA genomic constitution exhibited poor survival. A similar trend of high mortality under field conditions was also observed with all diploid, accuminata clones except Pisang Jari Buaya which showed 64 and 96.76 per cent survival in the nursery and field respectively. The clones, viz., GCTCV.199, Pisang Mas and Pisang Lilin, did not survive in the field. The overall performance of different genomic test accessions indicate the need for further improvement of hardening techniques for better field establishment.

Table 3 : Plant height, Per cent survival of *in vitro* grown plants in the nursery and field

S.No.	Clone	Plant height (cm)	Per cent survival in nursery	Percent survival in field
1.	FHIA 01 (AAAB)	13.31	70	24.33
2.	FHIA 03 (AABB	16.88	78	15.16
3.	FHIA 23 (AAAA)	22.10	86	57.70
4.	FHIA 17 (AAAA)	18.94	90	26.57
5.	PV 03 44 (AAAB)	20.10	82	27.38
6.	PA 03 22 (AAAB)	16.13	65	15.33
7.	GCTCV. 199 (AAA)	14.44	52	00.00
8.	GCTCV. 215 (AAA)	15.00	84	39.91
9.	Burro Cemsa (ABB)	12.38	44	92.33
10.	Pisang Mas (AA)	17.63	62	00.00
11.	Saba (BBB/ABB)	19.06	81	39.86
12.	Pisang Nangka (AAB)	23.63	66	26.67
13.	Cultivar Rose (AA)	18.75	56	11.20
14.	Yangambi km5 (AAA)	27.10	95	53.20
15.	Pisang Jari Buaya (AA)	13.44	62	96.76
16.	Pisang Lilin (AA)	11.44	40	00.00
17.	Gros Michel (AAA)	16.19	60	19.14
18.	Bluggoe (ABB)	25.00	76	51.12
19.	Williams (AAA)	13.44	74	38.55
20.	Pisang Ceylan (AAB)	29.19	90	4.82
21.	SH 3436 - 9 (AAAA)	20.44	60	39.48
22.	Pisang Berlin (AA)	16.44	98	39.18
23.	Niyarma Yik (AA)	14.38	56	43.34

1.2.3 *In vitro* conservation : To save the germplasm from natural calamities and to serve as national repository of germplasm, an attempt was made for *in vitro* conservation of all the accessions of different genomic groups maintained in field gene bank. An experiment was conducted to study the response of commercial cultivars belonging to different genomic groups to initiate aseptic culture for *in vitro* conservation. Results indicated that AAA genome was the earliest to putforth side shoots followed by ABB genome. AB genome expressed strong apical dominance even after two sub cultures. Frequent subculturing was required for genomes with Balbiciana blood due to blackening of medium arising from excessive phenol exudation.

1.3 EVALUATION

During 1995-96 preliminary evaluation of 304 accessions for agronomic traits was done. Taxonomic scoring of accessions using 15 characters was done in order to tentatively identify and classify the collections into different genomic groups following the score card method suggested by Silaloy and Chom Chalow (1987).

1.3.1 Growth characters : Growth characters exhibited a wide range of variability among Musa accessions (Table 4).

Plant height : Observations taken on plant height revealed that the increase in plant height was linear and uniform in initial 3 months. Sudden surge in pseudostem height commenced from 4th month upto 11 months beyond which it stagnated. It varied from 36.7 to 44.9 cm in 3rd month, 44.5 to 193.2 cm in 5th month, 85.6 to 210.8 cm in 7th month, 132.1 to 304.4 cm in 9th month and 152.9 to 398.8 cm in 11th month.

Pseudostem girth : There was a proportionate increase in pseudostem girth and plant height recorded at regular intervals. Pseudostem girth varied from 13.2 to 28.6 in 3rd month, 22.8 to 49.7 cm in 5th month, 31.3 to 72.8 in 7th month, 48.5 to 91.7 in 9th month and 55.6 to 122.3 cm in 11th month.

Photosynthetically active leaves : Number of photosynthetically active leaves at any given time showed a great variation among accessions belonging to different genomic groups. Accuminata diploids and triploids in general had the lowest number of functional leaves ranging from 4.3 to 5.8 while in accessions with AAB genomes, it varied from 5.1 to 7.2 and from 7.8 to 9.5 in ABB accessions. Highest range of 12.1 to 14.4 was recorded in Balbiciana clones.

Days taken to bunch harvest : A wide variability was observed among the accessions ranging from 309.21 to 683.17 days. Dwarf Cavendish was the earliest while Bhimkol took longest time to come to harvest.

Maximum variability was exhibited with respect to bunch weight. It varied from 5.87 kg in Borchampa to 34.83 Kg in Pacha Bontha Batheesa. Similarly, number of hands, number of fruits per hand and total number of fruits per bunch varied from 3 to 18, 9 to 26 and 46 to 243, respectively.

Table 4 : Growth and yield parameters of representative accessions of different genomes

	Pl.ht. at harvest (cm)	Pseudo-stem girth at harvest (cm)	No.of photo sythetic leaves at harvest	Days taken for shooting	Days taken for bunch maturation	Bunch weight (kg)	No.of fingers	TSS (o Brix)
AA								
Pisang Lilin	270.65	69.34	5.6	385.4	164.5	9.78	174.8	19.34
Anai Komban	293.12	75.08	5.9	308.2	128.4	10.55	93.4	19.44
AB								
Ney Poovan	299.34	80.35	5.0	353.1	111.3	12.63	223.5	22.18
Kunnan	283.05	75.14	8.4	389.4	90.1	15.63	175.6	19.14
AAA								
Dwarf Cavendish	155.62	59.34	5.2	309.2	84.3	18.52	141.82	20.98
Borjahaji	343.12	68.35	7.6	342.3	98.5	16.38	137.83	21.72
Red banana	398.65	89.98	5.3	498.2	110.7	14.18	68.94	20.63
Thellachak-karakeli	288.34	71.34	5.1	362.3	86.6	9.33	78.72	22.01
AAB								
Poovan	288.12	84.38	5.1	412.3	102.6	16.75	183.1	20.12
Rasthali	316.42	89.45	6.0	422.8	121.8	15.75	140.4	18.04
Kali	285.72	74.02	4.8	382.1	94.6	10.42	89.0	20.18
Nendran	290.18	85.72	4.6	310.2	72.4	11.08	83.2	22.73
ABB								
Monthan	366.12	98.42	8.3	360.2	89.8	16.83	42.4	21.22
Sakkai	340.08	88.68	7.7	348.3	111.4	14.22	68.0	21.63
Pacha Botha	342.72	89.35	8.9	368.1	120.0	34.83	152.3	20.18
Batheesa Karpuravalli	412.73	108.72	9.4	438.7	128.6	23.09	209.3	28.72
BB/BBB								
Bhimkol	493.85	132.62	14.0	683.1	154.8	19.85	121.4	29.1

1.3.3 Fruit characters : Most of the accessions with long fruits belonged to Cavendish and Plantain groups (AAA and AAB). The accession Zanzibar exhibited maximum fruit length of 32.85 cm and shortest in Kadali and Ayiranka Rasthali with 6.97 cm. Individual fruit weight varied from 28.52 g in Kadali to 342.62 g in Zanzibar. Pulp/peel ratio ranged from 1.23 (most of Monthan groups) to 4.68 in Silk group. Keeping quality varied from 5 days among Cavendish groups to 15 days among Balbiciana clones. Bhimkol tooK 15.7 days to turn to bright yellow and softening of pulp.

1.3.4 Disease Resistance : To identify the possible donors to be used in breeding programmes, genepool was evaluated for their reaction to diseases under field conditions.

The highest leaf spot incidence of 52.71% was noted in the variety Singapur. There was no incidence of disease in varieties such as Thiruvananthapuram, Nute Pong, Manohar, Athiakol, Desikadali, Chinali, Nendra Padathi, Kaali, Borchampa, Manguthamg, Kanthali, Kachkela, Shalilkela and Kaitklong.

Youngest leaf spotted (YLS) is the first fully unfurled leaf with 10 or more discrete, mature necrotic lesions and is counted downwards from the topmost leaf. YLS is directly correlated with resistance to disease. The highest YLS of 17 was recorded in Borkal Baista(ABB) indicating the fact that it is the most resistant to leaf spot and the lowest of 2 was recorded in Singapur, Kaitklong and Nepali vannan which indicate the susceptible nature of the varieties.

Rust incidence was also recorded based on 0-6 scale in a manner similar to that of leaf spot (YLS) incidence. The incidence was high in the accessions such as Bhimkol, Kachkel, Nute Pong, Battisa local, Bersian, Pidimonthan, Kapur, Neyvannan sawai and Gauria and low in varieties such as Ney Poovan, Jatikal, Kanthali, Kanchi, Kallu Monthan, Mas, Jillegudem collection, Jammulapalem collection, Bagner and Malai Monthan.

Other diseases such as wilt in Malbhog(100%), viral diseases such as BBMV in Kapur, Pachabontha Batheesa and Monthan and BSV in Alpan, Champa and Chenichampa were noted during the evaluation.

1.3.5 Salt Tolerance : Per cent yield reduction due to salt induced leaf injury forms a major criterion to assess reaction of an accession to salt. Soil pH of the germplasm block varied from 8.0 to 9.0. Response of the germplasm to pH also varied. Most of the AB diploids exhibited symptoms by 6-8th leaf stage while expression was delayed upto 17-20th leaf stage in AAB genomic groups. Among AAB groups, Mysore group was most tolerant to salt injury followed by Silk group. Pome group was severely affected and yield reduction was as high as 40-80%. Among Pome members,

Sirumalai and Lady's finger were the most sensitive compared to Pachanadan and Vannan. Some members of ABB group expressed severe symptoms of leaf injury during flowering and bunch formation but the yield reduction was not significant.

1.4 TAXONOMIC EVALUATION : Preliminary evaluation of all Musa introductions from different agro-climatic conditions was carried out using Taxonomic Scoring developed by Simmonds and Shepherd. The collection was tentatively identified and classified into main genomic groups and sub-groups (Table 6). A total of 472 indigenous accessions were evaluated using 'Taxonomic scoring'. Genomic status was assigned to different accessions depending upon the score obtained adopting the score card method developed by Silaloy and Chom Chalow.

Table 6 : Taxonomic evaluation of germplasm

Score	Genomic Group	No. of accessions
15-25	AA	21
	AAA	37
26-46	AAB	106
47-59	AB	30
60-63	ABB	262
64-69	ABBB	8
> 75	BB/BBB	8
		472

After assigning the genomic groups, accessions were also classified using INIBAP's classification of Musa genomes into sub-groups. Spread of indigenous accessions under different categories are given in table 7.

Table 7 : Classification of NRCB genomes to INIBAP MUSA Classification

No.	Genome	Sub-group	No. of accns. available at NRCB
1.	AA	Sucrier	21
2.	AB	Ney Poovan	6
		Kunnan	24
3.	AS	Kala Kala	-
4.	AAA	Gros Michel	4
		Cavendish	16
		Red	8
		Orotava	-
		ibota	-
		Mutika/Lugugira	-
		Rajavazhai	9
5.	AAB	Plantain	4
		Pisang Kelat	-
		Pisang Raja	3
		Popouluou	-
		Maia Mooli	-
		Nendra Padathi	11
		Mysore	18
		Silk	22
		Nadan	-
		Pome	48
		Laknau	-
		Itholena	-
6.	ABB	Bluggoe	167
		Monthan	53
		Ney mannan	4
		Peyan	10
		Kalapua	-
		Pelipita	1
		Saba	1
		Pisang Awak	26
7.	BB/BBB	Bhimkol	2
		Athiakol	3
		Athia-mutant	1
		Elavazha	1
		Kallar	1
8.	AAS	Ambogwa	-
9.	Tetraploiods	Bodles Altafort	2
		Klue Teparod	2
		Neyvannan Sawai	4

1.5 UTILIZATION : Musa genepool was evaluated for a number of characters like growth and yield parameters, tolerance to biotic and abiotic stresses, breeding behaviour etc. to explore the possibility of utilization in improvement programmes, either in direct selection or in conventional breeding programme. Two accessions viz., 0079 and 0052 belonging to Pisang Awak and Ash Monthan groups respectively were found to be superior.

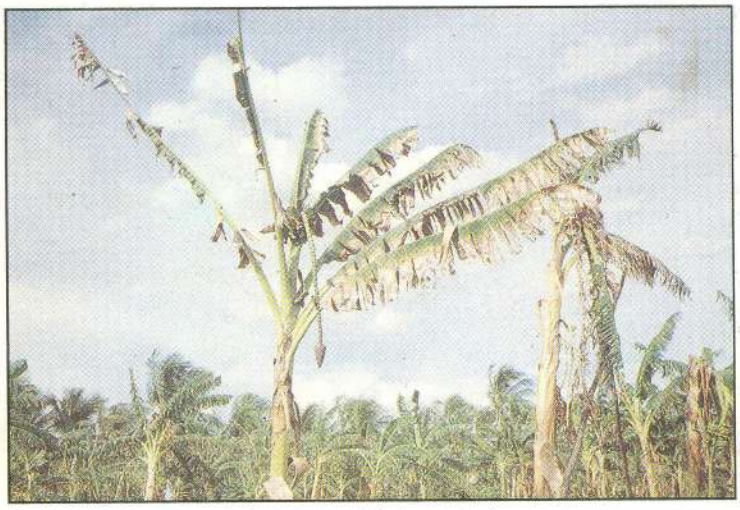
Accn 0079, a dwarf selection from Pisang Awak

Accn.0079 : This accession belongs to Pisang Awak group with ABB genome. Pisang Awak is a very tall growing plant reaching a height of 380-420 cm requiring propping at fruiting whereas 0079 is a dwarf selection of Pisang Awak growing only to a height of 275-310 cm with no requirement for propping thus reducing cost of production. This is also an early crop by 25-30 days. This accession has promise as dual purpose banana (Table 8).

Table 8 : Comparative Evaluation of Acc. 0079 with Local Karpuravalli

Sl. No.	Parameters	Local Karpuravalli	Accn. 0079
1.	Plant height(cm)	400-415	340-360
2.	Crop duration(months)	15-16	15
3.	Average bunch weight(Kg)	20	23
4.	Average no. of hands/bunch	11-12	13-14
5.	Average no. of fruits/hand	16-20	16-20
6.	Total no. of fruits/bunch	200-210	225-235
7.	Fruit-skin ratio	2.12	2.12
8.	T.S.S.	26-28	26-28
9.	Susceptibility to salt	1	1
10.	Susceptibility to Fusariam wilt	Yes	No

Accn.0052 : This accession belongs to Silver Monthan group with long, bold fruits with a prominent knob and it differs from Pacha Bontha or normal green Monthan by its ash coated skin hence the name Ash Monthan or Sambrani Monthan. This



Symptoms of severe salt injury on pome banana

Salt tolerant accn. 0052 (silver monthan) with normal bunch.

accession shows superiority over local Ash Monthan in its excellent capacity to yield a normal bunch even under high incidence of salt injury. At harvest, this accession had retained only 4-6 leaves exhibiting severe necrotic symptoms. This has promise as culinary variety under alkaline soils (Table 9).

Table 9: Comparative evaluation of local Silver Monthan with 0052

No.	Parameters	Silver Monthan	Accession 0052
1.	Crop duration(months)	12-13	12-13
2.	Plant height(cm)	360-380	370-380
3.	Average bunch weight(Kg)	14-16	14-15
4.	No. of fingers/bunch	55-60	55-60
5.	Individual fruit weight(g)	240-260	220-240
6.	No. of photosynthetically active leaves at harvest	10-12	6-8
7.	Salt injury (injury scale 0-7)	3	6

1.5.1 Performance of the ratoon crop of promising selections (Table 10)

Accn.0016 : First ratoon of monthan selection was found to be consistent with respect to plant and yield characters. Days to flowering was 392.4 days and bunch weight was 24.86 Kg. Salt injury was very mild and sigatoka incidence was only 20.4 percent. Reduced incidence of leaf spot diseases in ratoon crop was owing to the prevailing edaphic factors.

Accn. 0030 : First ratoon crops of Silk group selection and local Rasthali were compared. A reduction in yield by 2.8 Kg was observed as compared to plant crop in selection 0030, but when compared with local Rasthali ratoon, reduction in yield was not found significant. Till date no incidence of Fusarium wilt has been noticed in field conditions.

Table - 10 : Performance of ratoon crop of promising selections

Parameters	Local Ratoon Crop	Accn. 0030	Local Ratoon Crop	Accn. 0016
Crop duration (months)	14	12	12	11-12
Av.Bunch weight (kg)	13-14	15-16	18-19	21-24
No. of hands	6-7	6-7	5-6	6-7
Av. no. of fingers/hand	16-18	16-18	15-16	15-16
Av. no.of fingers/bunch	80-100	100-115	80-92	100-120
T.S.S. (o Brix)	18-20	18-20	18-20	18-20
Susceptibility to Fusarium wilt	No.	No	No	No
Salt susceptibility	3	1	2	2
Susceptibility to Sigatoka (PDI)	-	-	15-20	10-20.4

1.6 EVALUATION OF COMMERCIAL CULTIVARS

Performance of different cultivars under marginal input conditions were statistically significant with respect to days taken for flowering and yield parameters. Karpuravalli took maximum time to flower (426.72 days) followed by Rasthali, Poovan and Pachanadan. The bunch yield and quality were significantly affected in cvs. Nendran, Rasthali and Robusta. Other cultivas like, Poovan, Monthan, Pachanadan and Karpuravalli performed well without much reduction in bunch weight compared to average field conditions (Table 11).

Biotic stress, like diseases, is a major hurdle in banana cultivation especially under marginal input conditions. In this study, maximum infection index of 32.3 for sigatoka leaf spot was observed on Robusta followed by 28.4 on Nendran and 3.4 on Karpuravalli. 10.2 per cent of Rasthali and 2.8 per cent of Karpuravalli plants were

afflicted by Fusarium wilt. As regards viral diseases, 94.4 per cent of Poovan plants exhibited BSV symptoms, 4.2% of Nendran plants were affected by Neer Vazhai, an unknown malady and 2.5% of Poovan exhibited Kottavazhai symptoms.

Among abiotic stresses, soil salinity poses a major problem. Hence in this study commercial cultivars were evaluated for salt tolerance. (scale 0 to 7). In Monthan and Pachanadan, leaf injury was noticed upto a score of 2 while it was as high as 4 in Rasthali exhibiting symptoms of injury even before the shooting stage.

Table 11 : Evaluation of local commercial cultivars for marginal input conditions

A. Plant Growth Parameters

	Cultivar	Plant height (cm)	No. of leaves	Days to flowering (g)	Days taken for bunch maturation	Per day yield (g)
1.	Rasthali	236.91	5.08	392.53	118.4	36.37
2.	Nendran	232.05	3.65	293.18	70.2	35.97
3.	Robusta	214.04	3.75	306.92	79.4	57.88
4.	Poovan	225.54	6.82	389.14	110.0	39.72
5.	Monthan	330.28	7.30	343.33	98.5	55.68
6.	Pachanadan	308.28	5.83	340.00	86.8	40.90
7.	Karpuravalli	419.45	8.33	426.72	124.7	53.54
	LSD (0.05 P)	**	1.78	66.32	5.36	

B. Yield and Quality parameters

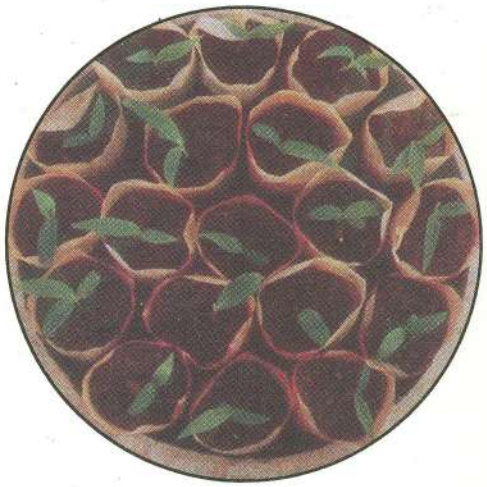
	Cultivar	Bunch height (Kg.)	No. of hands	Total no. of finger	Weight of each finger (g)	TSS (°Brix)
1.	Rasthali	14.26	5.85	78.34	152.33	18.01
2.	Nendran	10.01	4.03	48.61	238.53	20.72
3.	Robusta	18.08	10.63	152.12	170.09	23.47
4.	Poovan	15.46	8.03	131.05	138.11	20.18
5.	Monthan	16.12	5.08	50.01	246.58	19.73
6.	Pachanadan	13.91	5.66	72.39	139.80	20.14
7.	Karpuravalli	20.99	13.42	176.33	150.03	28.03
	LSD (0.05 P)	3.15	3.72	22.52	49.3	3.83

PMEC

2. CROP IMPROVEMENT

Development of resistant cultivars to biotic and abiotic stresses with high yield potential and fruit quality

From pollen fertility studies conducted on 240 accessions, possible pollen parents belonging to different genomic groups could be identified. Among AA diploids, accn. 0195 was found to have very high pollen fertility followed by accns.0562, 0541, 0533, 0379, 0380 and 0381. Triploid Accns. 0022 and 0213 were pollen fertile. High to medium pollen fertility was observed in 127 accessions belonging to ABB genome. Accns. 0007, 0011, 0024, 0018 and 0166 were the richest pollen parents among Balbiciana clones.



Banana seedlings in polybags

Female fertility was found in 35 accessions belonging to following genomic groups, Kunnan (AB) and Karpuravalli / Pisang Awak (ABB). They were found to be effective female parents under both open and cross pollinated conditions with a seed yield of 20-38/fruit depending on the male parent. Balbiciana clones recorded a seed yield of 60-210 per fruit with maximum in Accn. 0007.

Evaluation of the genepool for resistance to sigatoka and fusarium wilt resulted in the identification of suitable donor sources viz., accn. 0007, 0011, 0024, 0018 and 0166 showing dual resistance. 3632 crosses were made using 42 female and 12 male parents. Seed set was obtained in 16 cases with a seed yield ranging from 3-22 per bunch. Variability was observed with respect to seed yield and position of hand. Seasonal variability was significant with respect to seed yield with highest seed set during Sept - Dec. Accns. belonging to Mysore group recorded a seed yield of 23 seeds/bunch during Sept - Oct. There was no seed set in the rest of the months.

2.1 EVALUATION OF GLOBAL HYBRIDS AND PROMISING CULTIVARS :

As a part of improvement programme, hybrids and promising cultivars developed at other international centres were introduced and multiplied by tissue culture. NRCB is one of the test sites to conduct IMTP trials on screening for fusarium wilt, Sigatoka leaf spot and evaluation of FHIA hybrids.

2.1.1 Evaluation of global hybrids and promising cultivars against Fusarium wilt

As part of IMTP trials, twenty one test accessions belonging to various genomic groups and local variety Rasthali were raised from tissue culture and planted in the

field. Results of field establishment of test materials varied significantly. AA diploids, Pisang Lilin, Pisang Mas and wilt resistant selection, GCTCV 119 exhibited high mortality within one month after planting followed by FHIA 03 (90 per cent). Pisang jari Buaya established well in the field with 96.8% survival (Table 12).

Table 12 : Field performance of test accessions

Test Accessions	Genome	Field mortality
Hybrids from Honduras		
FHIA - 01	AAAB	75.67
FHIA - 03	AABB	90.83
FHIA - 17	AAAA	42.30
FHIA - 23	AAAA	62.87
Hyrbids from CNPMF/EMBRAPA		
PV-03-44	AAAB	76.38
PA-03-22	AAAB	86.66
Hybrids from TBRI, Tawian		
GCTCV - 119	AAA	100.00
GCTCV - 215	AAA	65.09
Natural Germplasm		
Pisang Mas	AA	100.00
Saba	ABB	64.34
Natural Germplasm		
Pisang Nangka	AAB	73.33
Cv.Rose	AA	88.88
Yangambu KM5	AAA	46.80
Pisang jari Buaya	AA	3.22
Pisang Lilin	AAA	100.00
Calcutta IR 124	AA	-
NCE Clones		
Gros Michel	AAA	80.86
Bluggoe	ABB	48.88
Williams	AAA	61.42
Pisang Ceylan	AAB	96.64
Local Cultivar (Rasthali)	AAB	10.00

2.1.2 Evaluation of global hybrids and promising cultivars against Sigatoka leaf spot

Eleven test cultivars and a local cultivar Robusta were multiplied *in vitro* and kept under shade for acclimatization. Experiment is in progress.

2.1.3 Evaluation of FHIA hybrids

In this trial, FHIA hybrids are being evaluated alongwith commercial local cultivars like, Robusta, Rasthali, Karpuravalli and Virupakshi for their performance and economics of cultivation.

3. IMPROVED PRODUCTION TECHNOLOGY

3.1 AGROTECHNIQUES :

3.1.1 Effect of edaphic factors on growth, yield, fruit quality and incidence of leaf spot disease in different banana cultivars.

Plant growth and development are dependent on prevailing edaphic factors like temperature, RH, rainfall, sunshine hours etc. This experiment was undertaken to study the effect of edaphic factors on plant growth, yield and leaf spot incidence. Test plants were exposed to different weather parameters by exploiting the time of planting. Planting was carried out bimonthly, starting from June. The growth, yield parameters and leaf spot incidence were correlated with the prevailing weather/ edaphic factors. (Table 13)

Table 13 : Effect of edaphic factors on the growth parameters and leaf spot incidence of different banana cultivars five months after planting.

	JUNE PLANTING				OCTOBER PLANTING			
Varieties/ Treatments	Plant Height (cm)	Pseudo-stem Circum. (cm)	No. of Leaves/ plant	Leaf spot inci-dence	Plant Height (cm)	Pseudo-stem Circum. (cm)	No. of Leaves plant	Leaf spot inci-dence
1.Pachanadan	105.00	36.25	14.39	7.3 (15.66)	105.45	32.37	13.23	3.56 (10.37)
2.Nendran	77.88	25.03	10.53	6.18 (14.38)	66.63	17.78	8.98	4.27 (11.94)
3.Robusta	41.16	15.89	8.26	8.93 (17.37)	65.43	22.48	12.25	5.93 (14.08)
4.Rasthali	50.60	19.91	10.08	6.42 (14.66)	77.23	25.03	12.73	5.34 (13.38)
5.Poovan	69.53	23.70	9.67	-	65.06	19.83	11.03	-
6.Karpuravalli	53.03	22.52	9.96	5.04 (12.98)	55.95	22.90	10.85	0.0
	Max Temp 33-39°C : RF = 92-253 mm Min Temp 24-28°C : RH = 84 - 91%				Max Temp 29-33°C : RF = 0-105 mm Min Temp 23-25°C : RH = 88-93%			

The leaf spot incidence was higher in June planted cultivars than those planted in October. It appears from this that the leaf spot incidence is directly related to the rainfall received during the subsequent 4 months after planting.

Edaphic factors had no influence on the growth parameters of Pachanadan, Poovan and Karpuravalli, whereas in Rasthali and Robusta, plant height, number of leaves and pseudostem girth were higher in those planted in October as compared to those planted in June. The observed increase in growth characters in these cultivars could be due to the high incident solar radiation coupled with near-optimum temperatures prevailing during the months of Oct-Mar.

3.1.2 Evaluation of different cultivars under Organic and Inorganic Nutrition.

An experiment was laid out during June 1995 to evaluate the effect of organic and inorganic nutrition with six varieties grown under six different treatments. Significant differences were recorded for all the growth parameters of Rasthali and Robusta. A treatment combination of 25% N FYM + 50% N Neem cake + 25% N inorganic fertilizers enhanced the crop growth. In Poovan, no. of suckers and mean leaf area increased significantly with a mixture of 25% N FYM + 50% N Neemcake + 25% N inorganics and 25% N FYM + 75% N inorganics respectively. In Karpuravalli, application of 200g N (100% N) by way of inorganics recorded the taller plants and higher no. of leaves than other treatments. (Table 14).

Organic and Inorganic nutrition had no significant influence on leaf spot disease incidence except in cv. Poovan. Youngest Leaf Spotted (YLS) was also found non-significant in all the treatments/cultivars.

In cultivar Robusta, time taken for disease development was uniformly same in all the treatments ranging from 54-64 days.

Inorganic fertilization delayed the disease development time by 18 days in cv. Nendran. But inorganic fertilization with FYM delayed the time taken for flowering. As against the 9th leaf, 14th leaf showed leaf spot incidence with inorganic nutrition in cultivar Monthan.

Combination of FYM with inorganic fertilizer delayed disease development time by 30 days. Same treatment delayed YLS upto 15th leaf stage in cultivar Karpuravalli.

The experiment is in progress for the study of yield and quality characters.

3.1.3 Effect of weeds on growth and yield parameters of the cv. Karpuravalli.

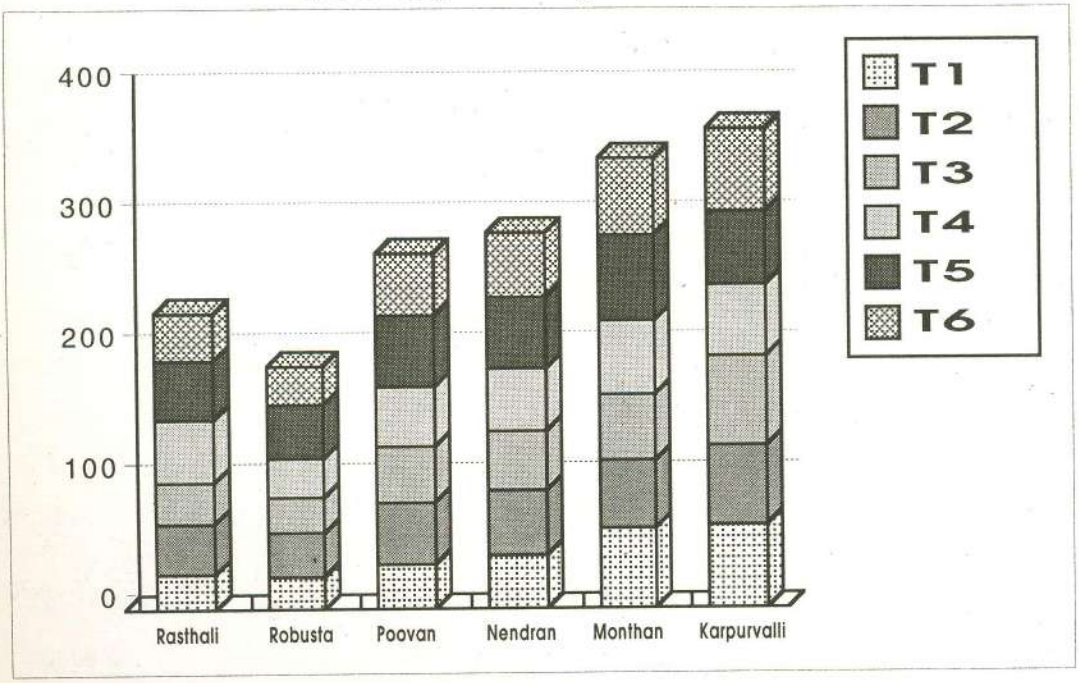
An experiment was laid out to find the effect of weeds on different stages of crop growth and yield of banana to identify critical stage of banana affected by weed growth. The treatments are :

Table 14 : Effect of organic and inorganic nutrition on morphological characters of six banana cultivars (Av. of 12 Plants)

Treatments	Plant Height (cm)	Pseudostem Circum.(cm)	No.of Suckers/Plant	No.of Leaves/Plant	Mean Leaf Area
1	2	3	4	5	6
RASTHALI					
T1	97.78c	31.53b	2.20b	11.13b	28.28c
T2	106.35bc	33.98b	2.39b	12.00b	36.83b
T3	109.35bc	34.28b	2.45b	11.81b	33.40bc
T4	126.33a	42.60a	3.19a	13.55a	45.90a
T5	126.33a	42.60a	3.19a	13.55a	45.90a
T6	113.15b	35.18b	2.91ab	13.21ab	37.44b
CD(P=0.05)	12.5957	5.1114	0.5675	1.3594	7.4952
ROBUSTA					
T1	168.78b	25.63c	1.90c	11.83c	25.47
T2	87.58ab	31.08ab	2.33abc	12.60b	24.11ab
T3	70.98b	26.23bc	2.03c	12.10c	26.65b
T4	75.98b	30.15b	2.20c	11.93c	29.82b
T5	91.68a	35.73a	2.73a	13.43a	39.74a
T6	77.50b	26.70bc	2.23c	11.85c	29.93b
CD(P=0.05)	10.0949	4.0652	0.4201	0.4471	6.3209
POOVAN					
T1	109.23	33.05	1.85b	10.93	35.03b
T2	121.55	39.53	2.63a	11.63	46.51ab
T3	123.98	35.13	2.35ab	11.18	43.64b
T4	125.43	38.20	2.05b	11.70	45.66ab
T5	140.68	42.18	2.42ab	12.68	54.53a
T6	126.70	40.05	2.20ab	11.35	46.73ab
CD(P=0.05)	-	-	0.4472	-	9.6954
NENDRAN					
T1	124.53b	35.08b	1.98b	11.03	41.22b
T2	139.18ab	38.05b	2.50b	11.50	49.29ab
T3	128.55b	36.83b	2.10b	11.13	45.81b
T4	137.20ab	38.45b	2.73ab	11.50	48.42ab
T5	149.90a	42.75a	3.20a	11.53	54.42a
T6	141.40a	39.78ab	2.43b	11.50	50.15ab
CD(P=0.05)	12.4010	3.6046	0.6061	-	6.8336

1	2	3	4	5	6
MONTHAN					
T1	171.40ab	50.88b	2.75	12.38	60.31ab
T2	156.15b	48.88b	2.88	12.00	54.00bc
T3	159.48b	48.85b	2.78	12.10	50.06c
T4	172.30ab	51.33b	2.60	12.48	56.88b
T5	184.55a	57.90a	2.50	13.23	64.78a
T6	171.38ab	50.80b	2.90	12.40	59.84ab
CD(P=0.05)	14.2052	5.7971	-	-	6.1441
KARPURAVALLI					
T1	186.65a	59.60	2.85bc	14.70	63.51ab
T2	166.60	55.85	2.33c	14.40	61.78ab
T3	166.93b	57.05	3.43b	14.53	68.54a
T4	160.10b	54.53	1.78c	13.80	52.65b
T5	165.73b	62.35	2.43	13.85	57.00b
T6	158.94b	54.93	4.33a	14.20	64.60ab
CD(P=0.05)	11.1014	-	0.6454	-	6.9793

Graph Showing the Mean Leaf Area of Six Cultivars under different Organic & Inorganic Treatments



T1 -> No weeding

T2 -> Weed free condition maintained by scrapping the weeds at monthly interval.

T3 -> Traditional weeding practices i.e. removal of weeds by digging along with the first application of fertilizers and subsequently during the second, third & fourth split application of fertilizers & also while making irrigation channels.

T4 -> No weeding till 3rd month and weed free condition till 12th month.

T5 -> No weeding till 6th month and weed free condition till 12th month.

T6 -> Weeding till 3rd month, no weeding from 3rd to 6th month and weed free till harvest.

T7 -> Weed free till 6th month, no weeding between 6th and 9th months after planting and weed free condition till harvest.

T8 -> Weed free till 9th month, no weeding afterwards.

The suckers were planted at a spacing of 2.4 x 2.4 m and fertilizer dose of 200 : 40 : 300 g NPK/plant/crop was given to all the plants in four equal doses. Growth observations, weed intensity and nutrient levels are being recorded.

3.1.4 Weed management in banana

An experiment was initiated on integrated weed management in banana cv. Karpuravalli. Four different weed management practices were taken as treatments.

(a) Hand weeding alone.

(b) Growing of cowpea (double cropping) and incorporation in the soil.

(c) Spraying of weedicide glyphosate @ 2.0 Kg ai/ha followed by another spray of 1.0 Kg ai/ha.

(d) Integrated weed control by growing cowpea and incorporation into the soil, hand weeding and also spraying of herbicides.

Observations on weed intensity, growth and yield are being recorded. Cost/Benefit ratio will be calculated to find out the economics of each treatment. Nutrient analysis of the soil is being done.

3.2 PLANT PROTECTION :

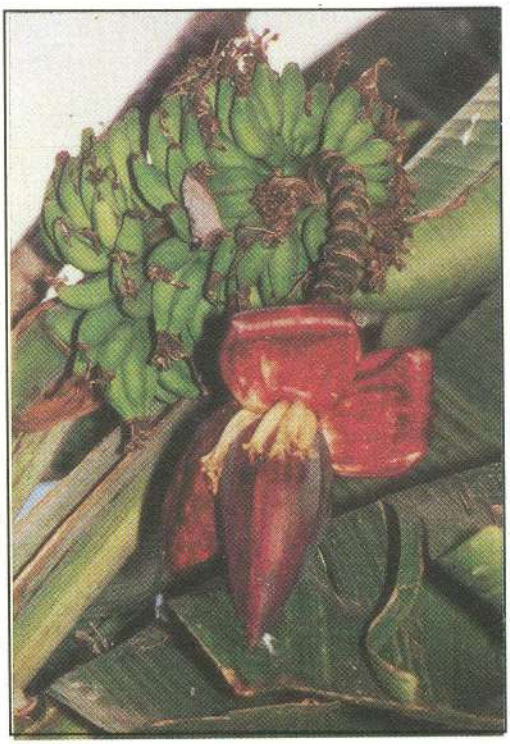
A total of 34 orchards were surveyed during Dec. 1995 to Feb. 1996 and observations on varieties grown, disease occurrence and their intensity were recorded (Table 15). The results of the survey revealed that the major varieties grown were

Nendran, Rasthali, Poovan, Karpuravalli, Pachanadan, Neypoovan and Robusta. Diseases recorded were leaf spot (in all the varieties except cv. Poovan), Fusarium wilt (in Karpuravalli, Rasthali, Pachanadan and Neypoovan), BSV (in Poovan and Robusta), BSV + BBMV (in Poovan) and a malady of unknown etiology called "Neer Vazhai" (in Nendran).

Fungal Diseases :

Leaf spot disease : The percentage incidence of leaf spot ranged from 14.68 to 78.14 with a maximum in Neypoovan and minimum in Karpuravalli .

Wilt : The wilt disease caused by *Fusarium oxysporum,* f. sp. *cubense* was present in cvs. Karpuravalli, Pachanadan, Rasthali and Ney Poovan. In Karpuravalli 26.89 per cent incidence of wilt was recorded which was higher than that recorded in other varieties. Cultivar Pachanadan also showed 13.1 per cent incidence of wilt.



Poovan cultivar showing symptoms of BSV and BBMV infection.

Viral Diseases :

Banana Streak virus (BSV) : The devastating streak virus symptoms were observed in 80.28 per cent of Poovan plants.

Banana Bract Mosaic Virus (BBMV): Banana bract mosaic viral symptoms were observed in cvs. Robusta, Poovan, Ney poovan and Nendran. The per cent incidence of the virus were 4.07, 3.69,1.39 and 2.22 in crs. Robusta, Poovan, Ney Poovan and Nendran respectively. The survey data revealed that some plants of cv. Poovan showed symptoms of both BSV and BBMV.

Neer Vazhai : Two orchards were found to have "Neer Vazhai" disease of unknown etiology, in Nendran. A maximum of 1.67 per cent incidence was recorded.

Table 15 : Survey of diseases of banana conducted in Vayalur area of Trichy district

Name of variety	No.of plants observed	Per cent incidence				Infection index
		BSV	BBMV	Wilt	Leafspot	
Karpuravalli	3700(5)	-	-	26.89	40.5	15.96
Robusta	2750(3)	-	4.07	-	100.00	66.6
Pachanadan	2000(2)	-	-	0.45	100.00	60.7
Rasthali	1950(3)	-	-	3.85	100.00	65.3
Poovan	2140(6)	80.28	3.69	-	-	-
Neypoovan	1443(3)	-	1.39	13.1	100.00	56.24
Nendran	6992(12)	-	2.22	-	100.00	67.13

* Figures in parenthesis are number of orchards observed for disease incidence

Survey and Estimation of yield losses due to BBMV on different banana cultivars

A survey was carried out in the month of January-March, 1996 in and around vayalur and Kulumani areas of Trichy Dist.,Tamil Nadu to find out the presence of BBMV in different varieties. The effect on growth parameters such as height, girth, leaf area and yield parameters (such as number of hands, number of fingers, and weight of bunch) were also recorded during the survey (Table 16)

Table 16 : Effect of BBMV on the growth and yield parameters of three banana cultivars *

Variety		Height (cm)	Girth (cm)	Leaf area (cm2)	Finger wt. (g)	Bunch wt. (Kg)
Nendran	H	301.2±15.4	56.9±4.81	117.9±12.4	223.3±36.7	13.9±1.85
	D	249.5±29.9 S	49.9±3.2 S	88.2±11.7 S	99.4±3.2 S	4.4±1.1 S
Robusta	H	253.7±9.4	62.6±3.99	148.46±14.5	200.2±14.0	20.2±2.6
	D	249.3±17.6 NS	61.55±4.7 S	143.3±10.2 NS	131.0±53.0 S	10.8±1.87 S
Neypoovan	H	335.9±33.1	67.5±3.67	129.34±21.2	112±11.5	19.55±1.25
	D	292.2±21.5 S	60.2±2.82 S	101.6±14.4 S	52.1±29.0 S	9.2±2.5 S

* Twenty randomly selected plants of healthy and diseased from each cultivars were used for observation

H = Healthy; D = Diseased
S = Significant; NS = Non Significant

To find out the damage caused by BBMV, a preliminary trial was conducted in farmers field. Twenty plants of both healthy and BBMV infected plants were randomly selected. Growth and yield parameters were recorded at regular intervals. Significant reduction of both growth and yield parameters like, height, stem girth, leaf area, bunch weight and finger weight were noticed in diseased plants compared to healthy plants. The per cent reduction of height and girth of infected plants ranged from 1.73 to 17.16 in Nendran and 1.67 to 12.30 in Ney Poovan respectively. The per cent reduction of leaf area ranged from 3.47 to 25.19.

There was a significant reduction in yield of all the infected varieties ranging from 46.53 to 68.34 per cent. In all the varieties the finger weight was reduced significantly. The per cent reduction of finger weight ranged from 34.56 to 55.48. The bunch maturity was delayed by more than a month in BBMV infected plants of all the three cultivars.

Survey and estimation of yield losses due to BSV in cv.Poovan

In the same survey, the effect of Banana streak virus (BSV) on growth and yield characters of cv. Poovan was studied. Significant reduction was noticed with respect to growth and yield characters such as height, girth of the pseudostem, leaf area, bunch weight and finger weight (Table 17). The per cent reduction in plant girth and yield were 16.53 and 48.48 respectively. In the severely infected plants, maturity of bunch was delayed by more than a month and the bunch size was smaller with seeded fruits.

Table 17 : Effect of BSV on the growth and yield parameters of cv. Poovan **

Variety	Height (cm)	Girth (cm)	Leaf area (cm2)	Finger wt. (g)	Bunch wt. (Kg)
Healthy	270.6±17.4	64.7±3.5	118.1±9.9	134.4±12.4	19.4±2.3
Diseased	253.7±32.7	34±4.4	107.2±11.4	86.9±31.4	9.8±3.59
	NS	S	NS	S	S

** Twenty randomly selected plants of healthy and diseased were used for observation

S = Significant; NS = Non Significant

DETECTION OF BANANA VIRUSES (In collaboration with IIHR, Bangalore) :

1. Immunodiagnosis :

Enzyme Linked Immunosorbent Assay(ELISA)

A total of 45 samples of banana were tested using indirect ELISA. The antiserum of CMV-banana, BSV, PVY, BYMV, EgPMV and SoMV were used for detection. Out of 45 samples assessed 13 gave positive reaction to one or the other antiserum used. Among them four samples were positive to BSV and three samples were positive to CMV. Three samples gave positive reaction to both BSV and CMV antisera. Three were positive to PVY antiserum.

Immunosorbent Electron Microscopy(ISEM)

Five samples were tested under Transmission Electron Microscope Jeol 100S (TEM) using ISEM decoration technique. PVY, BSV and CMV antiserum were used for decoration. One sample from cv. Poovan with typical streak symptoms had very few bacilliform particles of BSV and isometric particles of CMV.

Molecular diagnosis of banana viruses :

The banana leaves infected with streak symptoms were collected and the virus was isolated by extraction and differential centrifugation. From the partially purified virus preparation, double stranded DNA (ds DNA), the genome of banana streak virus was isolated. The viral genomic DNA was cut with restriction enzymes ECo RI and Kpn I and ligated to pUC 18. Stable clones consisting of part of the viral genome of approximately 2 to 3 kb were obtained. A non-radioactive, DIG labeled probe was made from the cloned fragments. A total of 27 samples were tested by dot blot assay. Using this probe, 22 were found to be infected with banana streak virus.

A probe was made from the coat protein gene of a potato virus Y (PVY). Using this probe, banana samples showing bract mosaic symptoms and few samples with no symptoms were tested by dot blot assay, Out of the 24 samples tested, six samples were weakly positive to the potyvirus specific probe. The apparently healthy banana leaf samples did not react to the probe. Six of the total 11 samples which were positive to PVY were also positive to BSV.

Nematological studies

A preliminary survey carried out in banana plantation in Trichy District during January 1996, revealed the wide spread occurrence of root lesion nematode, *Pratylenchus coffeae*, root-knot nematode, *Meloidogyne incognita* and cyst nematode *Heterodera oryzicola*. Soil samples revealed the presence of ten genera of plant parasitic nematodes viz. *Helicotylenchus, Heterodera, Hoplolaimus, Hemicriconemoides, Meloidogyne, Pratylenchus, Rotylenchulus reniformis, Rotylenchus, Tylenchorhynchus* and *Tylenchus*. An indepth study is being undertaken on this aspect at this centre.

POST HARVEST CHARACTERIZATION

Varietal Evaluation for Chips making

Nendran has been the preferred cultivar for commercial chips making. But due to low yield per unit area production cost of chips is high. Therefore to findout alternative cultivar a trial was conducted using 12 varieties viz. Nendran, Monthan, Boodida Bontha Batheesa, Nattuvazhai, Chinia, Gauria, Beula, Sakkai, Boothi Bale, Kuri Bontha, Kanchkela and Bibutia. Bunch weight, fruit weight and per cent pulp recovery, and all quality attributes except the colour differed significantly. None of the varieties could replace Nendran with respect to quality attributes. A panel of eight judges using Hedonic scale recommended two accessions as alternatives for chips making of which Kuribontha was superior to Kanchkela.

Table 18 : Varietal evaluation for chips making

		Yield attributes				Quality attributes				
		Bunch wt. (kg)	Fruit wt. (gm)	Pulp recovery	Chips recovery	Crispness	Taste	Color	Sweet sour blend	Durability (days)
1.	Monthan	20.33	219.96	77.68	26.55	10.00	11.33	10.00	7.66	7.66
2.	Boodida Bontha Bathes	34.58	175.76	75.64	31.01	11.33	10.00	10.66	12.33	10.33
3.	Nattu Vazha	16.18	107.01	65.86	33.26	9.33	9.33	7.33	9.33	9.00
4.	Chinia	17.35	98.24	72.72	34.74	6.00	12.00	7.00	10.33	11.33
5.	Gauria	15.40	116.83	74.48	42.36	10.33	12.33	7.33	8.00	11.33
6.	Beula	24.80	99.28	73.50	43.03	12.00	13.00	12.33	7.66	11.66
7.	Sakkai	20.33	168.70	77.17	35.23	14.33	8.33	13.00	7.00	8.00
8.	Kuri Bontha	19.25	141.72	74.78	42.66	12.00	13.00	13.40	10.88	11.00
9.	Boodi bale	15.33	125.62	80.32	34.96	15.00	13.00	14.33	15.66	16.33
10.	Bibutia	14.92	141.88	76.47	30.75	9.33	9.00	15.33	12.33	13.33
11.	Kach kel	20.05	189.33	75.18	24.39	9.66	7.33	12.33	16.00	15.33
12.	Nendran	13.58	234.38	75.86	39.06	18.00	19.33	18.33	19.66	19.33
CD (P=0.05)		*.*	11.33	NS	4.68	2.71	2.01	NS	1.63	1.75

Evaluation of varieties for Cooking

Of the eight varieties tried for their cooking qualities, Kanchkel, Monthan, Jillegudem collection were found superior with respect to taste, time taken for cooking and consistency of cooked fruit. Varieties Cuba and Borkal Baista took more time for cooking. They remained hard even after cooking with a sour-sweet blend. Due to the firm consistency after cooking with a good sweet-sour blend they can be successfully exploited for preparation of sweet-coat bananas.

COORDINATION

NRCB has been recognised as the nodal centre for International Musa Testing Programme for Sigatoka and Fusarium wilt. The centre is coordinating IMTP trials at other three centres viz. BRS, Kovvur, BRS, Kannara and IIHR,Bangalore. A trial for IMTP on Fusarium wilt has been laid out and is in progress. The trial on sigatoka will commence soon. Plants required for the trials were multiplied which will be supplied to other test sites.

PUBLICATIONS

1. Singh,H.P and Uma,S. 1995. Current Approaches and Future Opportunities for improvement of major Musa types present in Asia and Pacific regions - Silk/ Pome (AAB - dessert types). Paper presented at the International Banana Breeders and Nematologists Meeting at Kualalampur, Malaysia, 2-5 Oct. 1995.
2. Uma,S. and Singh,H.P. 1995. Collection, conservation, evaluation and utilization of banana germplasm. Paper presented at VIII Annual Workshop of AICRP on Tropical Fruits held at Ludhiana, 27-30 Nov. 1995
3. Singh, H.P and Uma,S. 1996. Banana - A fruit of Millions. *In*: 'INDIAN AGRICULTURE - 2001'. Vol.II Horticulture and Forestry. Ed. V.K.Patil, MAU (In Press).
4. Singh, H.P and Uma,S. 1996. 'Banana' - *In*: `Wealth of India' (In press).

HUMAN RESOURCE DEVELOPMENT

a. Training Programme

i. Mr. M. Krishna Moorthy, Jr.Stenographer underwent a Computer Training Programme on 'PC Trouble Shooting' at New Delhi from 15-17 Dec. 1995.

b. Promotions

i. Dr.S.Uma has been promoted from Scientist to Scientist (Sr.Scale) with effect from 01.09.1995.

ii. Mr.Raghuraman has been promoted from T-4 to T-5 Technical Officer (Field) w.e.f. 1.1.1995

c. Participation in Symposia

i. Dr.H.P.Singh, Director attended the International Symposium on 'New Frontiers in Resistance Breeding for Nematodes, Fusarium and Sigatoka' held at Kualalampur, from 2-5 Oct. 1995.

ii. Dr.S.Uma, Scientist (Sr.Scale) attended the VIII Annual Workshop on All India Coordinated Research Project on Tropical Fruits held at Ludhiana from 27-30 Nov. 1995.

IMPORTANT VISITORS DURING THE YEAR 1995-96

Mr.Rajeev Ranjan, IAS, Distt. Collector, Trichy (10.08.1995)

Dr.David R. Jones, Scientific Coordinator,INIBAP, France (09.10.1995)

Mr.Surendra Kumar Singh, Dy. Collector, Bihar Administrative Service, Bihar (14.10.1995)

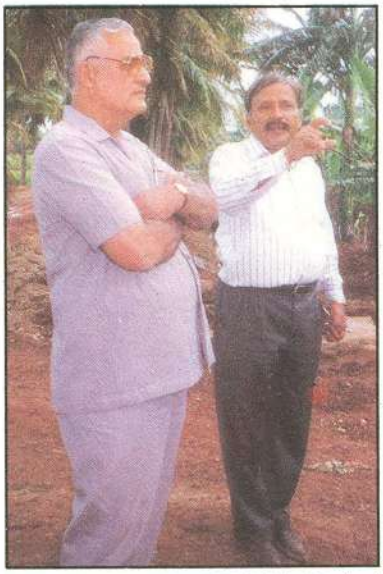
Dr.I.S.Yadav, Director, IIHR, Bangalore (10.11.1995)

Dr.K.L.Chadha, Dy.Director General (Hort.), ICAR New Delhi (11.12.1995)

Dr.H.P.Singh, Chief General Manager, NABARD, Bombay (11.12.1995)

Dr.(Mrs.) Rajani S.Nadagauda, Scientist-E., Tissue Culture Division, National Chemical Laboratory, Pune (11.12.1995)

Dr.Simon S.Gowen, Nematologist, U.K. (18.01.1996)



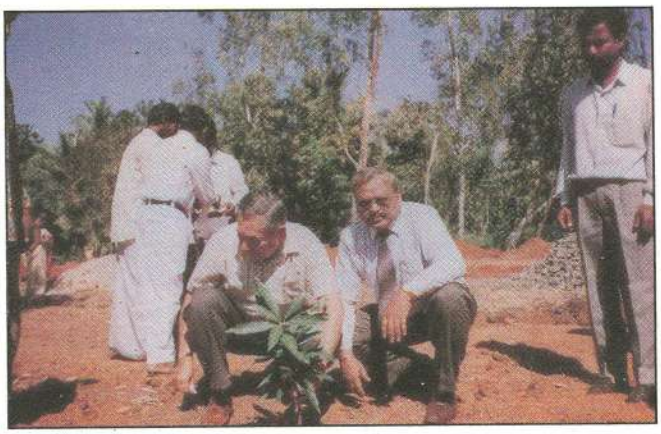
Dr. K.L. Chadha, DDG (Hort) is being explained the activities of NRCB by Dr. H.P. Singh

Dr.Lawrence Kenyon, Plant Pathologist, U.K. (18.01.1996)

Mr.A.N.Rai, Directorate of Extension, Ministry of Agriculture, Govt. of India, New Delhi (19.01.1996)

Dr. S.Sambandamurthy, Dean, Horticultural College and Research Institute, TNAU, Periyakulam (19.01.1996)

Dr. Ramon V.Valmayor, Regional Coordinator ASPNET/INIBAP, Philippines (27.01.1996) on his vist to NRCB Farm



Mr. Rajeev Ranjan, IAS, Collector, Trichy (Dist.) on his visit to NRCB Research Farm

Dr. David Jones, INIBAP on his visit to India; a view of banana plantation

Visit of Simon Gowan, (Nematologist) UK & Lawrance Kenyon (Pathologist) UK to NRCB

HONOURS AND RECOGNITION

i. Dr. H.P.Singh, Director chaired the Technical Session - II Resistance Breeding for Nematodes' in the International Symposium on New Frontiers in ResistanceBreeding for Nematodes, Fusarium and Sigatoka" held at Kualalampur, 2-5 Oct. 1995.

ii. Dr.H.P.Singh, Director was conferred 'SEVROY FOUNDATION AWARD 1995' for his outstanding contribution in the field of Tropical Fruits.

iii. Dr.H.P.Singh, Director, NRCB inaugurated the All India Banana Show organised at Trichy on 18th Jan. 1996.

iv . In the "All India Banana Show' conducted at Trichy from 18-19 Jan. 1996 NRCB was presented a momento in appreciation of an excellent display of banana varieties.

Details of Staff Position : **ANNEXURE-I**

Scientific :

Director	:	Dr.H.P.Singh
Principal Scientist (Hort.)	:	Vacant
Sr.Scientist (Hort.)	:	Vacant
Sr.Scientist (Hort.PHT)	:	Vacant
Sr.Scientist (Nemt.)	:	Vacant
Sr.Scientist (Virology)	:	Vacant
Scientist SS.(Hort.)	:	Dr.S.Uma
Scientist(Hort.)	:	Mr.V.Kumar (w.e.f. 14.2.1996)
Scientist(Pl.Path.)	:	Mr.R.Thangavelu
Scientist (Biochem)	:	Vacant
Scientist (Biotech)	:	Vacant
Scientist (Ent.)	:	Vacant
Scientist (Pl.Breeding)	:	Vacant
Scientist (Food Tech.)	:	Vacant
Scientist (Pl.Physiol.)	:	Vacant
Scientist (Soil Sci.)	:	Vacant

Technical :

Asstt.Garden Supdt. T-5	:	Mr. Raghuraman
Technician T-II-3	:	Four vacant
Computer Programmer T-2	:	Vacant
Lab. Tech. T-1	:	Three vacant
Field Tech. T-1	:	Three vacant

Administration :

Asst.Admn.Officer	:	Vacant
Asst.Accts.& Fin.Officer	:	Vacant
Assistant	:	Mr. M. Balu
Stenographer	:	Vacant
Jr. Stenographer	:	Mr.M.Krishna Moorthy One Vacant
Sr.Clerk	:	Mr. R.Krishnamurthy
Jr.Clerk	:	Mrs. S.Durgawathi one Vacant

Auxilliary :

Car Driver	:	Mr.A.Subramaniam
Tractor Driver	:	Vacant
Jeep Driver	:	Vacant

Supporting :

Messenger	:	Mr. C.Thangaraj Two Vacant
Mali	:	Mr.P.Mohan Three vacant
Safaiwala	:	Vacant

PMEC

WEATHER DATA

		Rainfall (mm)	Temperature (°C) Maximum	Minimum	Rainfall (mm)
1995	April	90	35.5	28.4	39.5
	May	89	38.0	28.5	142.4
	June	89	39.8	28.1	104.1
	July	91	36.6	27.4	89.3
	August	90	36.8	27.0	253.2
	September	84	33.7	26.4	92.5
	October	90	33.6	24.0	105.6
	November	93	30.8	25.5	132.9
	December	90	28.7	24.9	1.1
1996	January	91	29.6	23.0	-
	February	90	30.0	25.0	-
	March	88	30.4	26.3	-
					969.9

Printed at PRINT-O-GRAPH,B'lore. Ph:2877398/2259891