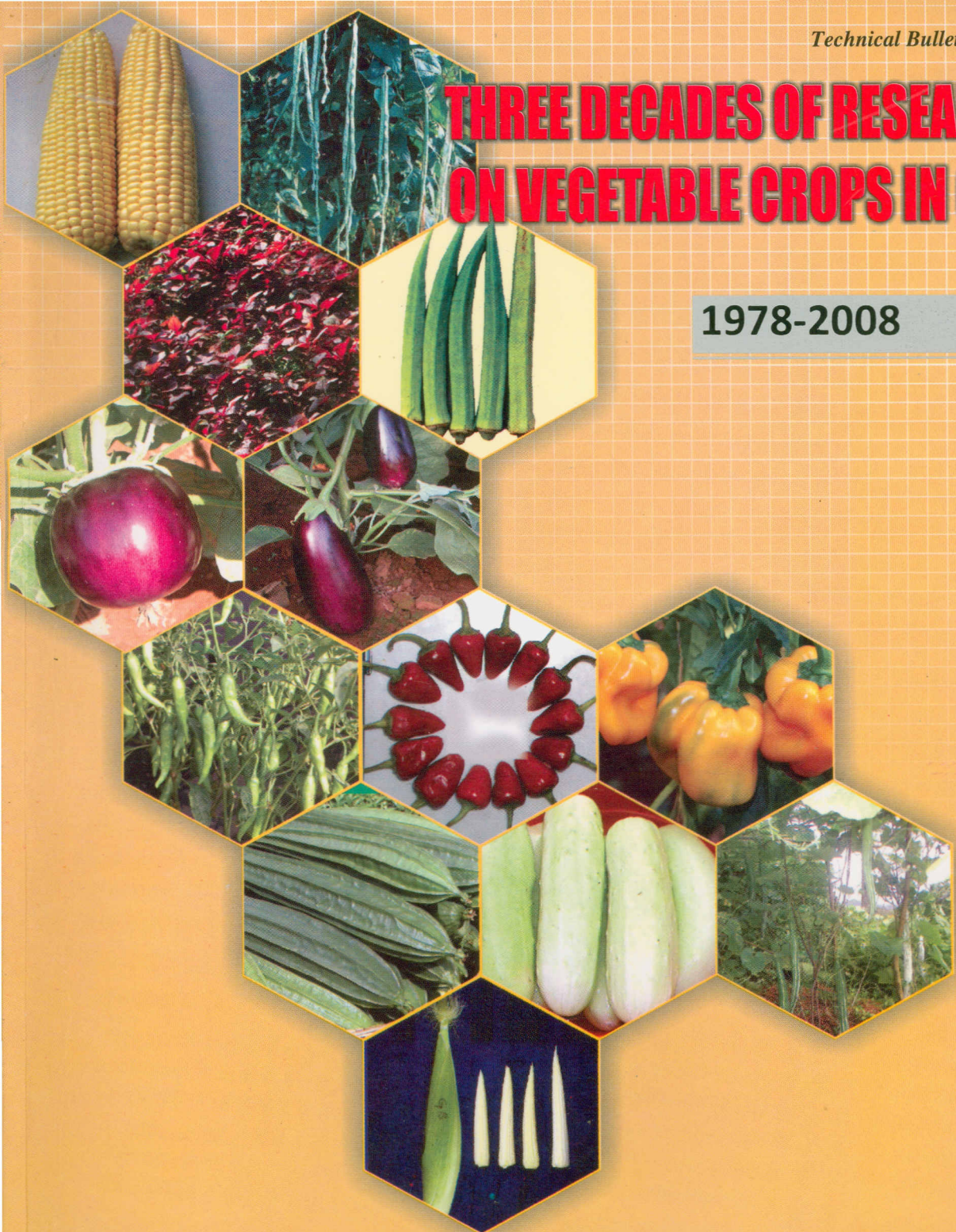


THREE DECADES OF RESEARCH ON VEGETABLE CROPS IN GOA

1978-2008



ICAR RESEARCH COMPLEX FOR GOA

(Indian Council of Agricultural Research)

Ela, Old Goa- 403 402, Goa, INDIA

Technical Bulletin No. 18

THREE DECADES OF RESEARCH ON VEGETABLE CROPS IN GOA



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Dr.V.S.Korikanthimath

Director

ICAR Research Complex for Goa

Ela, Old Goa – 403 402, Goa, India

Fax : 91-832 - 2285649
Phone : 91-832 - 2284678, 2284679
Email : director@icargoa.res.in
Web site : http://www.icargoa.res.in

Research contribution by:

M. Thangam

K. Ramachandrudu

M.S. Ladaniya

P.A. Mathew

R. Ramesh

Text Prepared, Compiled and Edited by:

M. Thangam

Technical Assistance:

Minanath M. Zalmi

Rahul M. Kulkarni

Word processing:

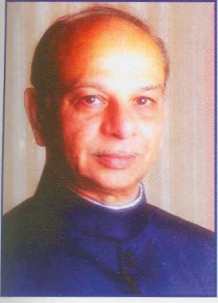
Sidharth K.Marathe

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Pratapsingh Rane

Speaker
Goa Legislative Assembly
Porvorim - Goa

Foreword

Vegetables play important role in providing nutritional security to the people, since they are easily available and cheaper sources of vitamins, minerals, numerous phytochemicals and antioxidants essential for human beings. The recommended intake of vegetables should be 330 grams/day to meet the daily requirement of essential nutrients. Hence it is imperative to increase the availability of safe and clean vegetables to the ever growing demand. India has to produce around 220 million tonnes of vegetables by 2020 to meet the domestic and export market.

As Goa has carved a niche as the most sought after tourist destination in the world, the visit of both international and domestic tourists is on the increase year after year. Hence the demand for different types of horticultural produces in general and vegetable crops in particular is increasing every year. More than 85 per cent of total vegetable requirement of Goa is met from the neighbouring states. However, Goa is well known for the native vegetables viz., brinjal, okra, chillies, cucurbits with distinct qualities and consumer preference. Generally the prices of even common vegetables are high compared to other states and reach peaks during disturbances in transport etc. In order to meet the demand of local population and tourists, it is high time to increase the area and production under vegetable crops. This can be achieved through introduction of high yielding varieties and hybrids in different vegetable crops, adoption of improved production technologies along with increasing the area under vegetable crops. The paddy fallows can also be effectively brought under vegetables with protective irrigation.

In this endeavour, I am happy to know that ICAR Research Complex for Goa is bringing out the Technical Bulletin entitled "**Three Decades of research on Vegetable Crops in Goa**" to disseminate the valuable information generated out of the research programmes conducted on vegetable crops.

I hope that the technologies like cultivation of improved varieties of important vegetable crops, introduction of new high value crops, information on under utilized crops etc. will be useful to farmers, extension workers, stake holders and policy makers. Dissemination of these technologies to the end users i.e farmers will lead to increased production and assured nutritional security to the state of Goa. I appreciate the efforts made by the Scientists in bringing out this technical bulletin. I would further add that the Government should translate this Bulletin in local languages such as Konkani and Marathi, so as to make it available to the people in general.

Pratapsingh Rane

Preface

India ranks second next only to China in area and production of vegetables, producing 101.43 million tonnes from an area of 6.76 million hectares with an average productivity of 15.1 t/ha. Goa is a small state and the area under vegetable crops is 8213 ha with an annual production of 84290 tonnes. The productivity (10 t/ha) in vegetable crops is much lower than the national average thereby unable to meet the ever increasing demand of the local and floating population of the state. The average productivity is found to be stagnant during the last decade. A wide gap exists between the actual yield obtained (realized) and the potential yield (realizable). By adopting improved varieties and technologies the production and productivity can be increased.

In Goa, more than 57 per cent of the total area is under horticultural crops, in which cashew and coconut are the major crops. Therefore, concentrated research efforts were made to improve productivity of perennial crops like cashew, mango etc. Nevertheless, the research work on vegetable crops started way back in 1978. Exclusive work with specific research targets on vegetable crops was initiated from 1998 onwards. Presently, the prime areas of research are collection, conservation, cataloguing and evaluation of germplasm in important local vegetable crops of Goa besides introduction and evaluation of improved varieties of vegetable crops from other states. Standardization of agro techniques and protected cultivation of high value crops under Goa condition are also attempted on priority.

This technical bulletin is a compilation of detailed research work conducted on vegetable crops. The consequent valuable information and technologies generated for the past three decades (1978-2008) along with the salient achievements are presented over here. Future thrust areas of research are also indicated for further planning for increasing the production and productivity of vegetable crops in the state of Goa.

While bringing out this first research bulletin on vegetable crops, I sincerely acknowledge the opportunity and facility extended by the ICAR, New Delhi for carrying out research on vegetable crops.

I take this opportunity to profusely thank Dr.V.S.Korikanthimath, Director, ICAR Research Complex for Goa for his continuous encouragement and help in bringing out this important publication. In addition, he has gone through the manuscript and made valuable suggestions to make the bulletin more informative. I also sincerely thank him for his sustained interest in initiating new research programmes in vegetables.

I sincerely thank and duly acknowledge Dr.D.G.Dhandar, Dr.P.G.Adsule (Former Directors), Mr. P.A.Mathew, Dr.K.Ramachandrudu, Dr.S.C.Rana, Dr.A.R.Desai, Dr.B.L.Manjunath and Dr.M.S.Ladaniya for their research contribution and support.

I am grateful to Shri. Pratapsingh Raoji Rane, Hon'ble Speaker, Goa Legislative Assembly for his foreword and deep concern for the development of agriculture in the state of Goa. I hope that the information compiled in this technical bulletin will be useful to farmers, students and officials of Developmental Departments of the state of Goa and adjoining regions in order to achieve self sufficiency in vegetable production.

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Introduction

India has made substantial growth in production and productivity of vegetable crops with a total annual production of over 88.6 million tonnes next only to China. India's share in world production of vegetables is 11.4 per cent. The average productivity of vegetables is 14.4 tonnes/ha. With the advent of hybrid technology coupled with greater concern for nutritional security among the people, the vegetable production in the country is progressing in the right direction. Although the national productivity is around 15 tonnes/ha, production and productivity of vegetables in some of the states are static around 10 tonnes/ha. In these states, there is an urgent need to reorient the vegetable production strategy so that vegetable production gets impetus.

Goa state being an internationally renowned tourist destination with huge influx of both domestic and international tourists throughout the year, the requirement of fresh fruits and vegetables is always high. In Goa, the area under vegetable crops during 2006-07 was 8213 ha with the annual production of about 84,290 tonnes. The average productivity works out to be around 10 tonnes/ha which is very low compared to national average of 15 tonnes/ha. The present magnitude of vegetable cultivation is very low and disproportional to the Goan and floating population. Hence, bulk of vegetable requirement is met mostly from the neighbouring states like Karnataka and Maharashtra.

ICAR Research Complex for Goa has made efforts since its inception in the year 1975 to demonstrate the feasibility of cultivation by introduction and evaluation

of new vegetable crops under prevailing condition. Apart from this, attempts have been made to collect, conserve and evaluate the available vegetable germplasm of important crops of Goa.

Goa at a glance

Goa has a total geographical area of 3,61,113 hectares which lies between 14°16" North latitude and 73°75" East longitude bound by the Arabian sea on the West, State of Maharashtra on the North and Karnataka on East and South. The climate is hot and humid with the temperature ranging from 18 to 35°C through out the year. The annual rainfall ranging from 2500 to 3500mm is received in about 100-120 days between June and October. The soils are predominantly red lateritic (73.40%) followed by alluvial and marshy soils (11.70%), sandy coastal soils (10.11%) and saline soils (4.79%). Major soil series are coarse to medium textured with good drainage and poor water holding capacity. The pH of soil is 4.5-6.5 with medium available Nitrogen, deficient in available Phosphorous and Potassium.

Area and production of Vegetable crops

It is estimated that around 60% of the total cultivated area in Goa is under horticultural crops. But the area under vegetable crops is less i.e only 5% of the total cultivable area. The data for the past one decade shows that the area under vegetable cultivation hardly increased from 7550 ha in 1997-98 to 8213 in 2006-07. Vegetables are cultivated on hill slopes and in paddy fallows during *kharif* and *rabi* season respectively.

Table.1. Area and production of vegetable crops in Goa.

Year	Area (hectares)	Production (tonnes)	Productivity (t/ha)
1997-1998	7,550	69,460	9.20
1998-1999	7,550	70,000	9.27
1999-2000	7,550	70,000	9.27
2000-2001	7,600	70,467	9.27
2001-2002	7,600	70,467	9.27
2002-2003	7,600	70,467	9.27
2003-2004	7,800	70,467	9.03
2004-2005	7,800	74,725	9.58
2005-2006	8,144	82,580	10.14
2006-2007	8,213	84,290	10.26

(Anon, 2007)

The productivity is also very low when compared to the national average of 15t/ha. Requirement of most of the vegetables in the state is met from the neighbouring states like Karnataka and Maharashtra. Moreover, the climatic limitations (high humidity and temperature) do not favour commercial cultivation of major vegetable crops like potato, cole crops, tomato, onion, garlic *etc.* Thus these vegetables

have to be necessarily imported from neighbouring states.

There are three main seasons of vegetable production in Goa

- (i) Rainy or *Kharif* season: June to September
- (ii) Winter or *Rabi* season : October to February
- (iii) Summer season : March to May

Table.2. Major vegetable crops of Goa.

S.No.	Season of cultivation	Major vegetable crops
1.	<i>Kharif</i> or rainy season (June-September)	Cucurbits (Cucumber, Ridge gourd, Snake gourd, Bitter gourd, Pumpkin, Ivy gourd <i>etc.</i>), Okra, Chilli,
2.	<i>Rabi</i> or Winter season (October-February)	Sweet potato, Brinjal, Amaranthus, Vegetable cowpea, Radish, Knol khol, Okra, Pumpkin, Chilli, Onion, Cluster bean <i>etc.</i>
3.	<i>Rabi</i> extended summer (February-May)	Amaranthus, Okra, Onion, Vegetable cowpea, Chilli

Research and development in Vegetable crops at ICAR Research Complex for Goa

The present institute was started in April, 1975 as a research station for Goa region and later became a part of CPCRI, Kasaragod as one of the Regional stations. Since then it is working on all aspects of agricultural and allied sciences and later to give more importance, it was elevated to an independent national institute in April, 1989.

Though the research work on vegetable crops was started way back in 1978, systematic work with exclusive research project on vegetable crops was initiated from 1998 onwards. Main areas of research are collection, conservation and evaluation of available germplasm in important vegetable crops of Goa, introduction and evaluation of improved varieties in vegetables from other states and protected cultivation of high value crops under Goa condition. The salient findings of the research programmes on vegetables conducted at the institute are as follows.

Brinjal

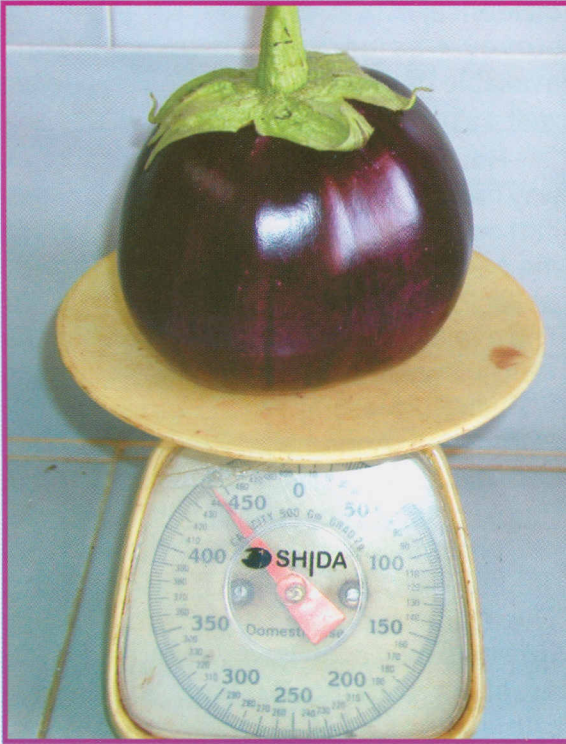
Brinjal is the most important vegetable crop of Goa. It is largely cultivated during *rabi* season and on a smaller scale during *khari* season as well. There are two popular local types of brinjal *viz.*, Agassim and Taleigao. The Agassim type has oblong dark purple fruit with soft flesh, where as Taleigao is round with light purple colour. The flesh of Agassim is soft and puffy while it is hard in Taleigao hence its shelf life is longer. Both the varieties are highly susceptible to bacterial wilt disease. In order to combat high

incidence of wilt problem, an intensive survey was carried out to collect all available germplasm for wilt resistance as well as high yield.

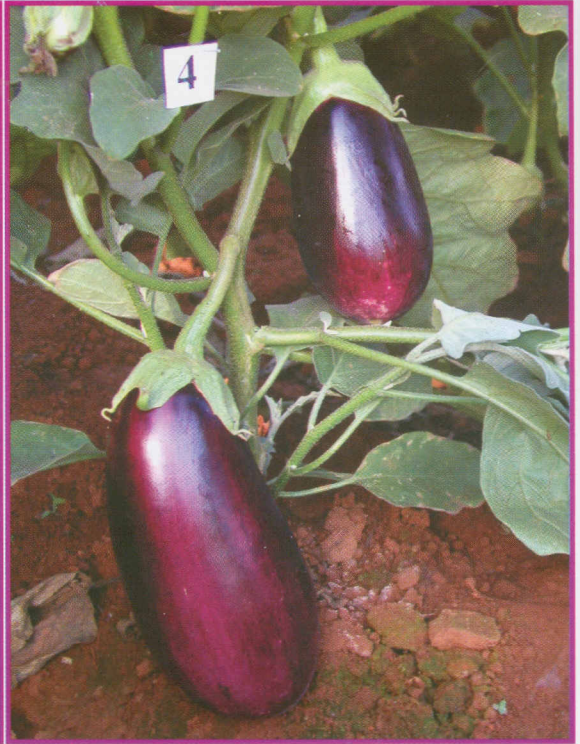
Research work on brinjal was initiated way back in 1978 and the results indicated that out of eight cultivars of brinjal tested, the Arka series was susceptible to jassids while Pusa Purple Round was tolerant. The evaluation trial was again taken up in 1980 with nine released varieties *viz.*, Sel-1, Pusa Purple long, Pusa Purple cluster, PBR-129-5, Annamalai, PH-4, SM-17(4), Local types (Taleigao and Agassim). Pusa Purple cluster recorded the highest yield (35 t/ha), followed by Pusa Purple long (32 t/ha) and Sel-1 (28t/ha) respectively. The fruits produced by the two local varieties were of large size and with excellent cooking quality. Among all brinjal lines, SM-6 was found to be resistant to bacterial wilt.

Later during 1989-90, two lines namely IIHR-21 and IIHR-12 were found resistant to bacterial wilt, conforming to the previous observation. Local types of brinjal *viz.*, Agassim and Taleigao were included for evaluation since the yield potential of these types is high and seed content in both the varieties is low. Both the varieties are highly susceptible to bacterial wilt and little leaf diseases.

The two lines yielded equally well and no appreciable difference was observed in the number of fruits per plant. The fruit girth was similar and the longest fruits were produced by IIHR-21 while the fruit colour was also better in the latter. Considering the yield and fruit characters, IIHR-21 can be the most promising line for Goa with field tolerance to bacterial wilt (Table.3).



Taleigao type



Agassim type



Plate. 1. Glimpses of variability in brinjal accessions.

Table.3. Performance of local types and introduced lines in Goa during 1989-90.

Line	Plant height (m)	No. of fruits/plant	Fruit length (cm)	Fruit breadth (cm)	Yield / plant (kg)	Yield (t/ha)
IIHR-21	0.95	27.4	19.03	2.70	1.02	29.00
IIHR-12	1.04	31.5	17.46	2.72	1.06	28.53
Agassim	1.10	07.0	17.50	6.85	1.97	49.25
Taleigao	1.14	06.9	10.90	9.40	2.34	58.50

Since large variability was found in brinjal, intensive survey was carried out to collect all available germplasm in brinjal with varying colour, shape and morphology and evaluated for their performance.

The preliminary evaluation carried during 2004-05 showed that majority of the local types are early in flowering with better fruit size and yield. For comparison, improved varieties from Kerala Agricultural University, Thrissur, Kerala, Indian Institute of Horticultural Research, Bangalore, Karnataka and Indian Agricultural Research Institute, New Delhi were included in the study. The yield potential of local types ranged from 0.5 to 1.85 kg/plant thus indicating their potential yield ranging from 15-45 tonnes/ha.

The important disease which is more severe in brinjal is bacterial wilt. In order to assess the reaction of local germplasm against this dreaded disease, observation on disease incidence was recorded periodically after transplanting up to final harvest. The per cent incidence of bacterial wilt under natural condition ranged from 2.94 to 28.82 per cent. The results indicated that there was over all

reduction in the per cent incidence of bacterial wilt in the current year. Though most of the local accessions were good yielders, they were susceptible to bacterial wilt. The highest per cent incidence of bacterial wilt (28.82) was observed in acc.5 and the lowest (2.94) in acc.36. Among the varieties, Swetha exhibited field tolerance and recorded no incidence of bacterial wilt. But this needs to be validated by consecutive trials and screening under artificial inoculum pressure. The research work on this line is already initiated to improve the local germplasm with better resistance to biotic stress.

Yet another important trait which needs to be discussed is individual fruit weight. The data on individual fruit weight ranged from 75 to 485 g with varying shape and colour. Other important yield contributing traits *viz.*, number of primary branches, individual fruit weight, fruit length and circumference are also recorded wide variability in the local germplasm.

This wide variability may facilitate the breeder to go for selection of high yielding plants with optimum fruit size (Table 4).



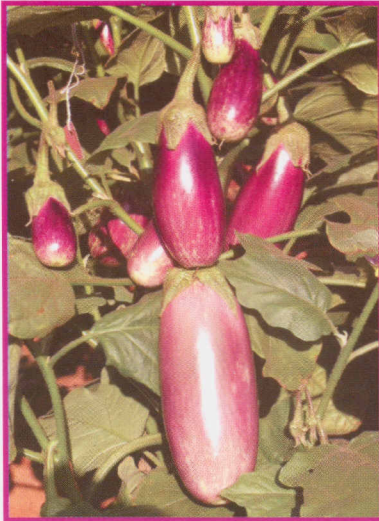
SMG-20



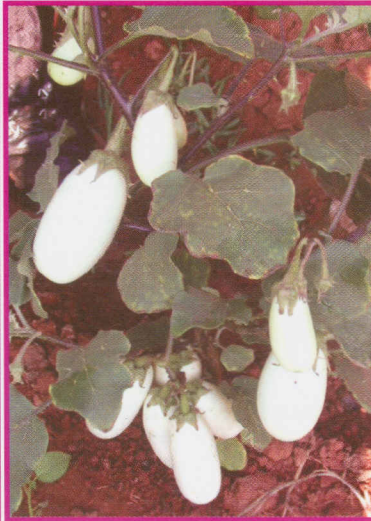
SMG-6



SMG-27



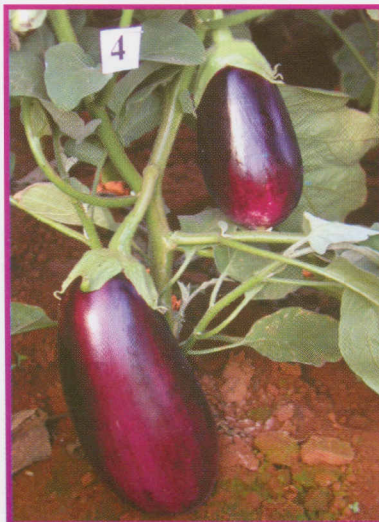
SMG-2



SMG-23



SMG-26



SMG-4



SMG-8



SMG-14

Plate. 2. Promising local types in brinjal germplasm.

Table.4. Variability found in local accessions of brinjal.

Trait	Range
Plant height (cm)	53.00 - 117.25
No. of primary branches	3.00 - 5.50
Days to 1 st flowering	34.50 - 47.00
Moisture content	32.00 - 69.44
Percent incidence of wilt	2.94 - 28.82
Individual fruit weight (g)	75.85 - 484.51
Length (cm)	11.52 - 24.32
Circumference (cm)	12.34 - 39.94
Yield / plant (kg)	0.456 - 1.985
Yield / hectare (t)	13.68 - 58.50

Since the year 2005-06, the institute has become the voluntary centre of AICRP on Vegetable Crops. Under this, three sets of trials in brinjal were allotted to ICAR Research Complex for Goa. Twenty five varieties of brinjal comprising of long and round types along with five improved varieties were evaluated during *rabi* season. The comprehensive results are as follows:

Wide variability was recorded for the traits *viz.*, plant height, percent wilt incidence, individual fruit weight and yield per plant. The plant height ranged from 58.25 (Harita) to 122.25 (PB Sadabahar). The earliest flowering was recorded in PB Sadabahar (53 days) followed by JBR-03-16 (70.55 days). The observation on bacterial wilt incidence was recorded and it ranged from 1.85 to 26.85 per cent. Wide variability was recorded for individual fruit weight among the varieties. JBGL-01-01 recorded the highest fruit weight (202.41 g) and the lowest fruit weight was recorded by Arka Keshav (29.09 g). In general, majority of the varieties yielded better than the local check (Agassim). The yield per plant ranged from 0.267 to 1.505 kg/plant (Table 5).

The highest yield was recorded in PB 66 (45.19 t/ha), which was followed by PB 61 (36.69 t/ha).

Research achievements in brinjal.

- ❖ Initial evaluation study concluded that Pusa Purple Cluster was the highest yielder followed by Pusa Purple Long and Selection-1.
- ❖ SM-6 was found to be resistant to bacterial wilt.
- ❖ With respect to yield and fruit characters, IHR-21 was the most promising line for Goa.
- ❖ Local types *viz.*, Agassim and Taleigao recorded the highest yield among the brinjal types, but both the varieties were highly susceptible to bacterial wilt and little leaf diseases.
- ❖ Intensive survey in Goa resulted in collection, conservation and evaluation of thirty seven accessions of brinjal for yield and other characters.
- ❖ The yield potential of local accessions ranged from 0.5 to 1.85kg/plant.
- ❖ The per cent incidence of bacterial wilt under field condition ranged from 2.94 to 28.82.
- ❖ The institute has become voluntary centre under All India Coordinated Research Project on Vegetable crops, Indian Institute of Vegetable Research, Varanasi during 2005-06.
- ❖ Three years of consecutive evaluation indicated that brinjal lines PB-66, PB-61, KS-331, Punjab Sadabahar and DBL-02 are most promising and consistent in yield under Goa condition.
- ❖ Incidence of bacterial wilt in AICRP lines ranged from 1.85 to 26.85 per cent.

Table .5. Evaluation of AICRP brinjal varieties during 2006-07.

S. No.	Varieties /Traits	Plant height (cm)	No. of primary branches	Days to 1st flowering	Individual fruit wt (g)	Length (cm)	Circum. (cm)	Yield/plant (kg)	Yield/ha. (tonnes)	Moisture content (%)	Percent incidence of bacterial wilt
1	PB-67	111.52	3.55	69.00	119.59	21.31	18.12	0.895	26.84	63.72	3.33
2	JBR-02-11	99.25	3.33	60.50	165.85	19.63	22.92	1.114	33.41	65.24	12.54
3	KS-331	98.21	3.55	63.00	103.11	17.55	21.76	0.770	23.09	60.15	10.25
4	KS-331	75.61	4.25	69.50	110.71	19.50	17.16	1.115	33.45	51.58	9.87
5	SH-SB-101	95.31	5.05	62.50	70.33	18.21	22.98	0.506	15.19	40.55	26.85
6	PB-66	109.86	4.33	58.50	99.48	22.23	14.37	1.505	45.19	61.57	9.55
7	PB adabahar	122.25	4.00	53.00	63.74	19.67	15.11	1.055	31.64	65.48	11.21
8	PB-61	82.16	4.08	55.00	154.56	18.16	28.85	1.223	36.69	65.87	5.58
9	KS-224	84.27	4.55	55.00	159.55	23.18	16.21	1.069	32.07	58.98	7.52
10	PB-60	100.17	3.50	69.50	163.31	17.23	25.62	0.793	23.80	55.87	2.55
11	JBGL-01-01	85.16	4.50	69.00	202.41	20.25	28.63	0.533	15.99	66.87	4.56
12	HLB-25	71.38	5.05	53.50	61.38	19.23	28.71	0.723	21.69	68.74	10.11
13	JBGL-03-04	111.12	6.55	68.00	142.86	15.41	22.98	1.138	34.14	59.98	8.89
14	PB-64	79.23	4.08	55.50	97.14	18.61	24.41	0.567	17.00	55.86	18.54
15	KS-358	96.56	4.33	55.00	94.18	19.72	16.71	0.923	27.69	63.54	3.66
16	KS-356	99.21	4.36	62.00	92.18	17.66	28.61	0.745	22.34	69.33	3.55
17	ABR-02-23	71.68	4.25	67.50	132.63	19.22	26.87	0.959	28.78	59.87	4.56
18	HLB-25	110.89	3.55	70.50	62.64	17.16	25.87	0.973	29.19	68.54	2.99
19	JBR-03-16	92.98	3.00	70.00	162.11	22.61	18.97	0.609	18.28	46.58	3.56
20	SMB-115	95.23	4.05	69.00	62.08	18.62	18.88	0.745	22.35	58.87	5.44
21	BWBH-3	92.21	4.55	69.00	50.37	21.23	25.61	0.590	17.70	46.85	11.25
22	Arka Keshav	85.68	3.55	68.50	29.09	19.99	15.25	0.267	8.00	58.87	9.93
23	White long	62.18	5.00	55.50	39.94	15.36	13.81	0.774	23.21	58.95	1.85
24	Harita	58.25	2.88	62.00	61.67	17.98	15.71	0.709	21.28	61.48	5.22
25	Surya	66.28	4.25	67.50	60.63	13.98	22.81	0.606	18.19	59.64	4.22

Chilli and Capsicum

Chilli is the second important vegetable crops in Solanaceous group. It is largely cultivated during *rabi* season in paddy fallows. There is a wide variability for fruit size, shape, and colour in chilli. Perennial type chilli belonging to the species *C. frutescens* is also present in farms of arecanut and other plantation crops which is highly pungent in nature and mostly used as spice in *papad* making.

A total of 54 types of chilli were collected from all over Goa state. These types include low pungent germplasm suitable for vegetable purpose and highly pungent types for spice purpose. The remaining types were intermediate in their pungency levels. All the types were evaluated during 2005-06. The individual

fruit weight ranged from 4.25 to 19.25g and green chilli yield per plant was from 365.25 to 145.85g/plant. The ascorbic acid in green chilli ranged from 312.11 to 98.57mg/100g of fruit whereas in case of red ripe chilli, the range was from 174.52 to 45.5257mg/100g. All the collected types were preserved for further crop improvement purpose.

Varietal evaluation was taken up in chilli under AICRP on Vegetables during 2005-08. Seventeen entries comprising of advanced lines and improved varieties from different institutes were evaluated during *rabi* season. The earliest to flowering and yield was noticed in Arka Meghana and PC-7 respectively. The red ripe fruits were harvested periodically and per plant yield was highest in LCA-206 (2.67 t/ha), which was closely followed by PC-7 (2.57 t/ha) (Table 6).

Table . 6. Evaluation of chilli varieties during 2005-08.

Varieties	Days to 1 st flowering	Days to 1 st harvest	No of fruits/plant	Ripe fruit weight (g)	Yield /pt (g)	Yield /ha (kg)
HDC-75	67.55	84.50	21.58	3.22	69.85	1968
Jawahar mirchi	66.25	86.50	29.00	3.36	54.75	1414
PC-7	66.88	74.59	22.00	3.76	95.64	2569
Sel-11	55.50	78.00	24.52	2.94	69.58	2392
Arka lohit	65.00	82.00	33.88	3.11	62.10	1389
Arka Meghana	49.85	78.85	24.45	2.74	88.76	2312
Arka Harita	56.00	81.50	20.73	2.89	59.42	1374
Anugraha	62.50	85.50	19.38	2.64	47.54	1819
Ujwala	72.00	105.00	18.44	2.02	21.25	1573
White kanthari	81.00	96.00	29.65	1.82	33.63	1976
CCH-2	53.00	84.50	39.58	4.11	84.23	1920
JCA-9	65.00	91.50	29.85	3.26	54.75	1348
LCA-206	66.50	85.85	38.00	4.89	101.25	2669
KA-2	66.00	89.52	44.17	2.94	89.57	2854
Jopani long	65.75	87.99	29.75	3.83	62.18	1427
Uttkal yellow	59.00	95.50	24.78	3.88	71.78	2184
SH-KC-12	72.00	96.52	22.78	3.89	59.42	1892

Protected cultivation of Capsicum hybrids under naturally ventilated polyhouse

Capsicum (green and coloured types) has good demand to meet the requirements of hotel and tourism industry in Goa. In order to tap this potential, a field experiment was taken up under naturally ventilated polyhouse to evaluate different capsicum hybrids. Four hybrids *viz.*, Bombi (Red), Orobelle (Yellow), Indra (Green) and Swarna (Yellow) were evaluated during 2007-08 (Table 7).

Morphological observations like number of leaves, plant height and stem

girth besides other traits *viz.*, individual fruit weight, flesh thickness, TSS, yield per row, average yield per plant, maximum yield per plant, moisture content, plant fresh and dry weight were also recorded during the crop growth period. Among the traits studied, plant height (at 2 months), individual fruit weight, TSS and potential yield per plant showed significant differences at 5% level. The fruit weight ranged from 54.80g (Indra) to 110.40g (Swarna) with an average weight of 81.10g. The maximum yield per plant was noticed in Orobelle (1.29kg) followed by Swarna (1.27kg).

Table .7. Evaluation of capsicum hybrids for morphological and yield traits.

Hybrids	Plant ht. (cm) at 2 months	Plant ht. (cm) at 8 months	Stem girth at 2 months	Stem girth at 8 months	No of leaves/plant	Flesh thickness (cm)	Fruit weight (g)
Bombi	52.92	143.45	3.25	6.02	50.66	3.96	79.60
Orobelle	49.92	142.20	3.10	5.56	50.64	4.16	91.60
Indra	58.08	149.45	3.30	5.94	55.88	3.98	54.80
Swarna	55.02	155.50	3.12	5.06	50.36	5.05	110.40
CD (5%)	5.86	NS	NS	NS	NS	NS	23.56

Hybrids	TSS °Brix	Moisture content (%)	Biomass (Fresh)	Biomass (Dry)	Yield/plant (kg)	Potential yield/plant (kg)	Incidence of bacterial wilt (%)
Bombi	9.82	91.43	609.00	136.40	0.55	1.01	49.67
Orobelle	8.78	93.32	524.00	89.20	0.65	1.29	51.66
Indra	5.32	93.22	403.20	78.40	0.49	0.92	74.00
Swarna	8.06	91.33	471.60	90.00	0.66	1.27	54.67
CD (5%)	2.10	NS	NS	NS	NS	NS	12.82

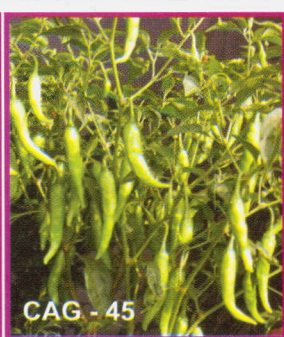
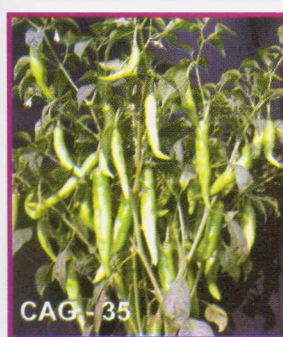
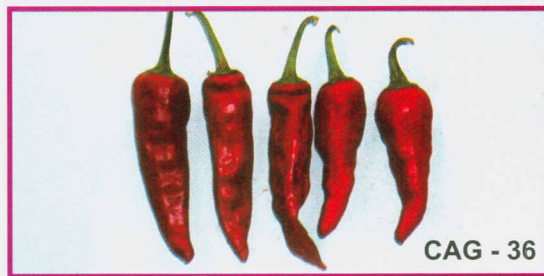
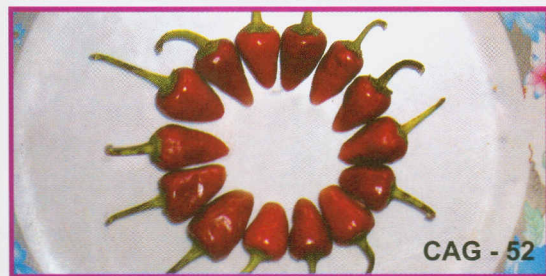
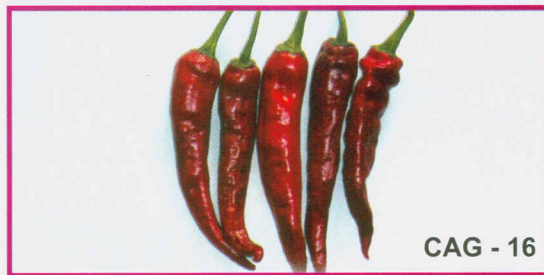
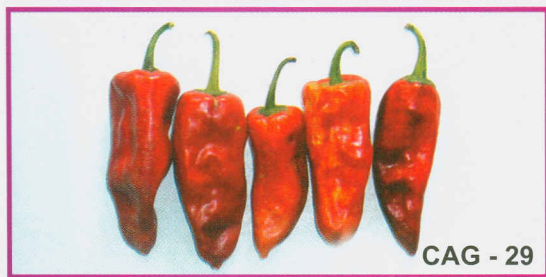
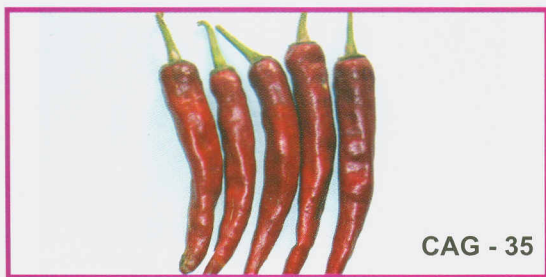


Plate. 3. Glimpses of variability and promising local types in chilli accessions.



Seedlings in plug trays



Seedlings planted on raised beds



Plants staked with plastic thread

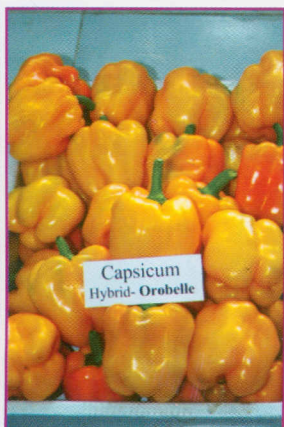
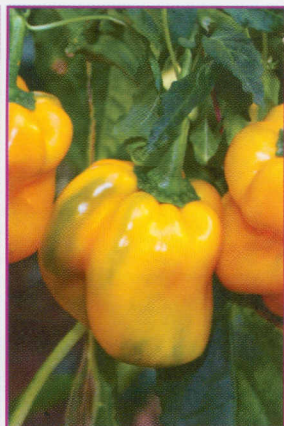


Plate. 4. Capsicum cultivation under naturally ventilated polyhouse in Goa.

Research achievements in Chilli and Capsicum

- ❖ Intensive survey resulted in collection, conservation and evaluation of fifty four chilli accessions in Goa.
- ❖ Average fruit weight ranged from 4.25 to 19.25g with green chilli yield of 145.85-365.25g per plant.
- ❖ Ascorbic acid in green and red ripe chilli was 98.57-312.11 and 45.52-174.52 mg/100g of fruit respectively.
- ❖ The institute has become voluntary centre under All India Coordinated Research Project on Vegetable crops during 2005-06.
- ❖ Three years of consecutive study resulted in identification of three varieties viz., LCA-206, KA-2 and PC-7 for high yield.
- ❖ The highest yield (red ripe fruit) was recorded in LCA-206 (2.67 t/ha) followed by PC-7 (2.57 t/ha.)
- ❖ Evaluation of capsicum hybrids indicated the possibility of growing under naturally ventilated polyhouse.
- ❖ Highest yield per plant in capsicum was recorded in Orobelle (1.29kg) followed by Swarna (1.27kg).
- ❖ Incidence of bacterial wilt in capsicum is a major constraint for commercial cultivation under naturally ventilated polyhouse.
- ❖ The highest incidence of bacterial wilt was recorded in Indra (74%) and the lowest in Bombi (49.67%).

Okra

Okra is an important vegetable crop predominantly cultivated during *kharif* season on hill slopes. It is also cultivated to some extent during rabi season in paddy fallows. Yellow vein mosaic disease is a major problem during *rabi* and summer season crop. Research work on okra was initiated during 1978 itself and continued further on evaluation of local germplasm along with improved varieties to identify suitable variety for Goa state. Pusa Sawani bhendi recorded the highest yield of 8.06t/ha followed by Goa local (6.02t/ha). The local type was apparently resistant to YVM disease under field condition.

Two YVM resistant lines found promising earlier were also found resistant to the disease during 1989. The YVM incidence was almost nil. The yields of both the varieties were good. Sel.10 was more vigorous and recorded more number of fruits per plant. Fruit length and breadth did not vary much between varieties. Both were found highly resistant to YVM disease. Sel.4 was most promising in terms of yield and disease resistance.

Sel.4 (Arka Abhaya) and Sel.10 (Arka Anamika) continued to perform well as regards to YVM resistance in the field, the incidence being 95.6% in local, 2 and 3% in Sel.10 and Sel.4 respectively during summer. During *rabi* season, okra leaves were severely affected by necrotic spots and blight causing heavy mortality of young plants. The fungus has been identified as *Nimbya samphrenal* through the assistance of Common Wealth Mycological Institute, London.

The local types fetch premium price in the market due to consumer preference over other varieties from neighbouring states. The fruits of local types are slightly yellow in colour and are exceptionally long. The result of extensive survey through out the Okra growing areas resulted in collection of 15 types from Goa state. The collected types exhibited wide variability for fruit colour, length and number of ridges. The details of the collected types are presented in the table 8.

Variety DVR-1 recorded the highest germination percentage (95.45) followed by local type-7 (81.21). The highest fruit weight of 31.38g was recorded in local type-4, followed by local type-17 (29.92g). The observation on YVM incidence showed that DVR-1, local types 1,3,10,12 and 13 exhibited mosaic symptoms whereas Arka Anamika, Parbhani Kranti, DVR-2, Sel.10, VO-1, VRO-6, local types 2,4,5,6,7,9 and 11 were free from the YVM incidence.

The Okra germplasm collections showed wide variability for fruit length, weight etc. It was observed that the fruits of local types are exceptionally long when compared to released varieties. It is a fact that when the harvest is delayed by even one day, there is a proportionate increase in fibre content in the fruit which makes it unsuitable for human consumption and reduces its palatability. But the local types though very long, maintained the tenderness. To estimate the fibre content of the local types and other varieties, a study on different stage of harvest was initiated. In this experiment, the flowers were tagged with date immediately after the anthesis and periodically observed on fruit length, weight and fibre content. The crucial days like 6th to 9th day after anthesis was taken for recording observation and the same are presented in table 10.

Table 8: Germplasm collection in Okra and their source, salient characteristics

S.No	Type/Variety	Place of collection in Goa	Salient fruit characters
1	Local type -1	Adnem	Green, pubescent, five ridges
2	Local type -2	Shiroda	Dark green, pubescent, five ridges
3	Local type -3	Ponda	Light green, five ridges, pubescent
4	Local type -4	Chimbel	Light green, pubescent, six ridges
5	Local type -5	Ponda	Green, five ridges, pubescent
6	Local type -6	Margao	Green, five ridges, pubescent
7	Local type -7	Shiroda	Light green, pubescent, nine ridges
8	Local type -8	Margao	Green, five ridges, pubescent
9	Local type -9	Shiroda	Light green, seven ridges
10	Local type -10	Mapusa	Green, seven ridges, pubescent
11	Local type -11	Sanguem	Green, pubescent, five ridges
12	Local type -12	Ponda	Green, pubescent, five ridges
13	Local type -13	Karmali	Light green, five ridges, pubescent
14	Local type -14	Canacona	Light green, eight ridges, pubescent
15	Local type -15	Balli	Light green, pubescent, six ridges



Plate. 5. Glimpses of variability and promising local types in okra accessions.

Table 9. Observations on morphological and yield traits in local Okra accessions.

Varieties/types	Germination (%)	Days to first flowering	Days to first harvest	First fruit bearing height (cm)	First fruit bearing node	Internodal length (cm)	Individual fruit weight (g)	Fruit length (cm)	Fruit circum. (cm)	Yield/plant (g)	YVM incidence
Arka Anamika	51.58	41.00	54.33	19.10	3.33	7.62	21.84	14.65	6.66	129.23	Absent
Parbhani Kranti	75.15	38.66	48.66	24.11	3.11	13.53	24.45	14.96	7.11	181.41	Absent
DVR-1	95.45	39.00	48.00	23.27	3.11	10.49	23.22	16.81	6.31	154.54	Present
DVR-2	68.48	38.66	48.00	17.78	2.89	10.66	20.28	16.56	5.72	140.58	Absent
Sel-10	69.39	40.00	48.66	15.31	2.56	9.46	23.01	15.84	6.61	192.89	Absent
Bo-1	71.82	40.33	49.66	18.74	2.55	7.90	25.81	16.78	6.84	239.22	Absent
VRO-6	78.18	40.66	48.00	22.14	3.56	9.54	19.21	16.69	6.11	173.40	Absent
Local type-1	60.00	40.33	48.66	25.38	3.55	10.36	28.77	19.45	6.24	238.23	Present
Local type-2	14.21	40.33	52.66	21.29	3.22	8.94	19.75	12.88	6.01	164.57	Absent
Local type-3	81.21	38.66	48.00	23.44	3.33	10.22	22.68	18.70	6.08	170.86	Present
Local type-4	45.76	43.33	53.00	30.55	3.78	10.20	31.38	15.46	6.27	120.05	Absent
Local type-5	63.33	37.33	49.66	25.67	3.33	11.38	22.94	15.97	5.84	183.61	Absent
Local type-6	78.79	40.00	49.66	22.19	3.22	8.32	24.08	19.90	6.29	176.68	Absent
Local type-7	41.51	40.00	49.66	26.13	3.22	11.41	29.92	18.29	6.22	159.69	Absent
Local type-8	69.39	40.00	49.66	19.39	3.00	9.01	20.69	16.05	5.95	180.74	Present
Local type-9	25.76	41.33	50.66	17.50	2.78	9.14	27.19	17.14	5.92	131.09	Absent
Local type-10	33.03	43.66	51.00	23.07	3.56	8.33	21.01	15.04	6.03	159.75	Present
Local type-11	32.62	42.33	51.00	24.57	3.78	10.17	19.86	19.82	6.05	182.25	Absent
Local type-12	78.79	40.00	48.66	19.11	3.67	10.75	21.84	16.91	6.69	142.67	Present
Local type-13	50.00	42.33	51.66	38.12	4.48	11.54	25.84	17.92	7.16	197.68	Present
CD (5%)	35.56**	3.29**	3.04**	8.65**	NS	2.76**	NS	2.49**	0.76**	58.12**	

Table .10. Observation on fruit traits during different days of harvest.

Days after Anthesis	Arka Anamika	Local type-1	Local type-3	Local type-6	Local type-11
Fruit weight (g)					
6 th day	18.28	24.21	22.16	25.12	23.89
7 th day	20.67	28.44	23.98	27.26	25.67
8 th day	24.81	32.40	28.29	32.21	29.26
9 th day	26.26	36.24	34.27	35.46	32.28
Fruit length (cm)					
6 th day	17.98	20.82	16.29	18.67	19.16
7 th day	19.08	22.12	17.10	20.53	21.10
8 th day	20.55	22.24	22.50	30.12	22.15
9 th day	22.33	23.93	25.51	32.66	25.78
Fibre content in fruits (%)					
6 th day	7.86	6.27	7.08	6.89	7.01
7 th day	9.36	9.62	9.26	9.32	9.46
8 th day	11.37	11.04	11.25	11.05	11.26
9 th day	12.86	11.89	12.18	12.06	12.38

The above table shows that the rate of increase in fruit weight and length in local types was higher when compared to those of Arka Anamika. Nevertheless the trait fibre content in the fruits was same even after 9 days after anthesis. But the fruits in Arka Anamika became unpalatable after 9 days of anthesis compared to local types which were still palatable and very well suitable for consumption with less fibre content. It clearly indicates that there would be increase in yield when the fruits are retained in the plants itself up to 9 days without much deterioration in quality in case of local types. This specific quality trait can be exploited in crop improvement programme with higher yield.

One of the maturity indices in Okra is its tenderness which is ultimately related to fibre content in the fruit. The fibre content after 6 days of anthesis is almost same in all the treatments and it was proportionately increased after 8 days of anthesis and it is very high in Arka

Anamika (12.86 %) compared to other local types which makes them still suitable for consumption.

An evaluation trial was undertaken to enrich the germplasm collection and to identify the promising ones among the accessions of okra. Forty six accessions of okra which were identified at NBPGR, Regional Station, Thrissur, Kerala were evaluated during *kharif* 2006. Wide variability was recorded for important morphological and yield traits. The earliest flowering was recorded in IC-99757 (36.45 days) whereas, days to first harvest was lowest in IC-90269 (44.25 days). Arka Anamika recorded the highest fruit weight (29.00g) followed by IC-282240 (28.01g) and the lowest was in IC-90251 (13.60 g).

The trait fruit length ranged from 10.26 (EC-133408) to 19.86 cm (IC-52298-B). The yield per plant was arrived by taking the average of five plants and the highest was in Salkeerthi (522.12) and the lowest (122.25) was in EC-169384. The other

Table.11. Clustering of okra accessions for important traits.

Days to first flowering (< 40 days)	Days to harvest (< 45 days)	Fruit length (>17 cm)	Fruit weight (>25 g)	Yield per plant (>300 g)
A.Anamika	IC-90251	IC-52298-A	A. Anamika	A. Anamika
IC-282293	IC-20269	Salkeerthi	IC-282277	Salkeerthi
IC- 99757	IC-99757	IC-128057	IC-90269	IC-282249
IC-218883	IC-26375	IC-45833	IC-99757	IC-282287
IC- 90264			IC-31340-A	IC-282268
IC-31850			IC-31032	IC-282266
			IC-282240	

quality traits like presence of spine on the fruit and colour of fruit on maturity were also recorded. The colour of the fruits in different accessions varies from light green to dark red. Barring few, majority of the accessions did not express any YVM symptoms. Although the evaluation was taken up during *kharif* season, wherein white fly population-potential vector for transmission of Yellow Vein Mosaic (YVM) is almost nil, seven accessions showed the symptoms of vein clearing and yellowing indicating their susceptibility.

Based on the morphological and yield traits, clustering of the accessions was attempted for important traits. Six accessions recorded flowering within 40 days of sowing indicating their earliness. In case of fruit weight, seven accessions recorded a fruit weight of above 25g and the highest was in Arka Anamika. The fruit length of over 17 cm was recorded in four accessions and fruit weight (> 25 g) recorded in six accessions. With respect to yield per plant (> 300g), six accessions were identified as good yielders under Goa condition (Table.11).

Research achievements in Okra

- ❖ Initial studies on okra indicated that Arka Anamika and Arka Abhaya performed consistently better with field resistance to Yellow Vein Mosaic (YVM) disease.
- ❖ Collection and conservation have resulted in evaluation of fifteen accessions in okra.
- ❖ Highest fruit weight of 31.38g (local type-4) and the highest fruit length of 19.90 cm (local type-6) was recorded in local accessions.
- ❖ Seven local types were free from YVM incidence under field condition.
- ❖ Study on the stage of harvest indicated that local types were still tender even on 9th day of anthesis where as it was unpalatable with more fibre in Arka Anamika .
- ❖ Among the NBPGR accessions, the highest fruit length (19.86cm) was recorded in IC-52298-B.
- ❖ Highest yield was recorded in Salkeerthi (522.12g/plant).
- ❖ Five accessions recorded an average yield of above 300g/plant under Goa condition.

Vegetable cowpea

It is one of the important vegetable crops of Goa cultivated extensively during *rabi* season. Apart from pole type of vegetable cowpea, bush types were also introduced and evaluated for their performance. Bush type variety 61-B was suitable for both *rabi* and summer seasons because of early maturity (flowering in 30 days), good yield (5.7 tonnes/ha) and quality having fibreless fleshy pods.

During initial evaluation, three types of cowpea primarily based on seed colour were evaluated during 1994-95. Among three types *viz.*, long fleshy poded, red seeded and black seeded, the most promising line is long fleshy poded with red seed which is also the highest yielder. Variation in pod colour was observed in the other two types and there is scope for selection of pure lines for uniform colour and yield. The black types are useful for selection lines whereas the fleshy grains (seeds) are preferred for specific uses.

The local types available in Goa were collected and evaluated during 2003-2005 for three consecutive seasons. Some of the lines were promising for pod length, number of pods per plant etc. The details of traits studies are furnished in table 12. The high variability for pod yield per plant is apparent as the pod yield ranged from 315.25 to 2070.45 g /plant with an average of 827.48 g per plant. Pod yield depends on number of pods per plant, pod length and pod weight. Number of pods per plant ranged from 36.65 to 147.80. Pod weight depends on pod length, number of seeds

per pod and hundred seeds weight. Wide variation was observed for all these characters in the present study.

In vegetable cowpea, VCG4 recorded the highest pod length of 64.70 cm followed by VCG22 (59.50cm). The highest yield per plant was in VCG4 (2070 kg/ha) mainly due to high pod weight (35.52 g) coupled with length (64.70 cm). Among the accessions, six lines recorded more than 1kg/plant which are promising for further selection. Other important yield contributing traits *viz.*, plant height, number of primary branches, leaf length, leaf width, pod length, pods per plant, number of seeds per pod and 100 seed weight recorded wide variability among the local germplasm and other varieties.

Research achievements in vegetable cowpea

- ❖ Initial evaluation concluded that bush type variety 61-B was suitable for both *rabi* and summer seasons.
- ❖ Among the pole types, the most promising line is long fleshy poded with red seed which is also the highest yielder
- ❖ Intensive survey resulted in collection and evaluation of 26 pole types in vegetable cowpea.
- ❖ Six genotypes *viz.*, VCG-3, 4, 8, 22, 23 and 24 were found promising with respect to yield per plant.
- ❖ The highest yield was recorded in VCG-4 (2070 kg/ha).



Plate. 6. Promising vegetable cowpea types.

Table .12. Mean performance of vegetable cowpea germplasm for various quantitative characters.

S. No	Acc.	Plant height (cm)	No.of branches	Leaf length (cm)	Leaf width (cm)	Days to flowering	Days to harvest	Pod length (cm)	Pod weight (g)	Pods / plant	No. of seeds /pod	100 seeds weight (g)	Pod yield / plant (g)
1	VCG1	4.49	6.60	13.48	9.68	43.00	57.60	35.17	10.58	77.00	14.61	17.32	820.50
2	VCG2	5.29	8.25	11.39	8.25	50.40	71.15	40.77	12.36	77.65	14.70	27.23	950.50
3	VCG3	4.85	5.25	10.63	7.77	51.30	71.00	47.35	13.90	74.40	13.76	25.65	1030.45
4	VCG4	6.29	4.10	12.54	9.56	46.40	60.00	64.70	35.52	58.35	13.19	19.22	2070.45
5	VCG5	3.46	5.60	9.98	6.47	52.20	69.70	40.85	9.26	54.50	17.34	25.25	505.50
6	VCG6	4.37	5.85	11.29	8.67	56.15	69.90	39.42	9.00	50.45	16.97	19.82	455.40
7	VCG7	3.90	5.25	11.13	9.33	48.50	62.90	37.53	8.47	67.15	15.15	14.90	565.65
8	VCG8	4.26	4.60	12.21	9.14	43.50	60.00	37.90	11.58	147.80	15.63	18.47	1710.65
9	VCG9	4.35	4.85	11.94	9.34	45.20	60.90	36.69	9.80	92.45	14.52	22.50	910.40
10	VCG10	4.41	6.65	10.84	7.97	50.60	66.90	40.32	11.13	72.50	14.77	13.45	810.00
11	VCG11	4.99	4.40	11.88	7.40	46.40	64.20	41.24	10.89	78.50	15.88	20.11	850.45
12	VCG12	4.64	4.80	11.08	7.27	51.90	77.10	43.01	9.60	58.40	16.55	15.39	555.40
13	VCG13	3.72	5.05	11.78	8.29	54.50	74.30	40.55	12.84	51.50	17.91	20.31	660.25
14	VCG14	4.31	4.15	13.73	9.93	44.20	61.20	41.19	9.74	65.05	15.51	20.51	635.25
15	VCG15	4.38	5.00	12.78	10.66	43.60	60.00	39.02	10.68	85.35	15.97	19.29	910.45
16	VCG16	4.75	4.85	12.24	9.58	45.30	60.70	27.97	6.22	83.60	15.26	20.93	520.65
17	VCG17	4.08	4.70	13.00	9.80	51.60	62.80	31.54	10.61	59.10	15.99	22.33	625.20
18	VCG18	4.46	4.25	13.60	9.93	55.20	67.00	33.36	8.66	36.65	16.11	20.11	315.25
19	VCG19	3.39	5.05	10.54	10.39	42.10	66.00	46.13	12.08	44.15	15.75	15.04	527.30
20	VCG20	4.64	4.85	11.42	9.05	44.40	71.90	51.95	12.03	52.20	14.97	17.55	606.20
21	VCG21	4.43	5.55	11.89	9.24	44.00	71.60	48.14	11.13	86.45	13.03	20.05	908.45
22	VCG22	4.95	6.25	12.07	10.21	46.10	70.20	59.50	19.13	72.50	16.86	22.29	1374.15
23	VCG23	4.10	6.15	11.74	9.87	44.00	65.60	55.64	10.57	105.50	16.04	20.39	1183.55
24	VCG24	4.72	5.30	11.14	9.61	51.80	78.40	46.87	13.31	91.60	13.06	23.56	1262.45
25	VCG25	4.86	4.95	12.33	9.10	51.00	77.60	48.77	14.09	48.80	13.61	20.61	697.50
26	VCG26	3.95	4.65	13.13	11.20	48.70	62.50	51.01	13.94	64.10	13.61	19.84	783.10
27	Vijayanthi	2.90	6.15	11.13	10.95	50.70	72.00	47.23	10.75	50.70	12.94	23.21	408.60
28	Arka Garima	1.00	5.20	10.00	10.89	42.90	64.60	51.40	10.95	71.30	12.20	21.96	707.80
29	Arka Suman	1.05	5.10	9.39	10.09	45.90	65.00	54.28	12.07	65.20	13.05	19.94	635.45
	CD (0.05)	0.61	0.60	0.82	0.71	3.06	3.98	3.36	1.63	7.36	1.92	1.62	123.72

Baby corn and Sweet corn

The demand for baby corn and sweet corn is on the increase in Goa due to large number of domestic and foreign tourists visiting through out the year. Hence, an evaluation study was undertaken to study the performance of different varieties and hybrids of baby corn and sweet corn in Goa.

Fourteen varieties of baby corn *viz.*, PEHM-5, PERUM-3, DHM-105, DHM-111, DHM-115, PEHM-3, COBC-1, VLBC, Vigro, Mridula, G-5406, VL-42, Nunhems and Pop-135 were evaluated during *kharif* season 2005 under rainfed condition. The highest cob weight of 97g was recorded in Mridula and the same variety recorded the highest plant biomass (481g/plant) as well. In general, 50 per cent of the varieties recorded 3.33 cobs/plant. The weight of dehusked cob weight ranged from 6.82 to 13.03g (Table 13).

Ten varieties of sweet corn *viz.*, Sweet pearl, Priya, Bandit, VL-15, Golden honey, Madhuri, Tokita, Win yellow, Indam and Athimadhur were evaluated for yield and other yield contributing traits during *kharif* season 2005. Among the varieties evaluated, Golden honey performed well for the traits like cob weight, dehusked cob weight, length and girth of cob, number of kernal rows and number of kernels per row. The highest plant bio mass was recorded in variety Bandit (Table 14).

Storage studies in baby corn varieties:

In order to assess the quality changes in terms of total sugar and total starch in baby corn during storage, a laboratory experiment on storage and shelf life study was under taken. In general there was a peak reduction in total sugar content during initial three days of storage under ambient condition. On 6th day after storage, the reduction in total sugar content was more than 50 per cent. But the cobs stored under refrigerated condition stored well up to 10 days with out much deterioration in quality traits including total sugar content. There was slight increase in case of total starch content up to 3 days after storage and there after it declined to original level (Table 15).

Research achievements in baby corn and sweet corn

- ❖ Baby corn and sweet corn were successfully introduced and evaluated during *kharif*, *rabi* and summer seasons
- ❖ In baby corn, good quality cob was obtained in Mridula which recorded the highest biomass/ plant
- ❖ In Sweet corn, the best cobs were produced in Golden Honey followed by Sweet Pearl, but the highest biomass/ plant was recorded in variety Bandit

Table .13. Evaluation of baby corn varieties for morphological and yield traits.

Varieties	Days to harvest	Cob Wt. (g)	Wt. of dehusked cob (g)	Length of dehusked cob (cm)	Width of dehusked cob (cm)	Plant height (cm)	No. of cobs.plant	No. of nodes/plant	Stem girth (cm)	Plant biomass (g)
PEHM-5	47.00	76.55	8.53	8.61	1.52	118.27	3.33	13.40	5.97	329.33
PERUM-3	45.33	61.87	10.60	9.67	1.48	129.67	3.33	14.13	6.16	331.33
DHM-105	51.33	59.61	9.13	9.44	1.47	145.53	2.67	12.40	7.13	502.00
DHM-111	50.00	55.00	8.60	8.57	1.42	137.47	3.33	14.27	6.63	462.00
DHM-115	49.33	51.00	8.10	9.56	1.39	114.93	2.83	13.30	6.27	349.00
PEHM-3	49.67	73.67	9.55	8.22	1.31	138.40	2.83	13.13	6.13	332.33
COBC-1	50.33	59.77	7.55	8.74	1.31	120.53	2.33	12.07	5.99	323.00
VLBC	41.00	56.17	7.40	9.66	1.54	129.73	2.67	12.60	5.53	194.33
GB-Vigro	52.67	64.47	9.67	8.71	1.45	127.33	3.33	13.57	6.23	466.00
Mridula	52.67	97.00	8.99	7.31	1.48	125.87	3.33	13.40	7.67	481.33
G-5406	51.67	84.58	6.82	9.59	1.50	115.93	3.33	13.20	6.37	346.67
VL-42	39.00	70.53	11.47	10.27	1.58	126.13	2.67	11.73	5.93	210.00
GB-Nun	45.67	56.44	12.67	9.97	1.48	98.63	3.33	13.07	6.27	349.67
Pop-135	53.00	75.53	13.03	9.24	1.62	131.23	2.67	12.00	6.37	303.33
CV	1.79	10.47	15.54	7.67	5.65	6.96	18.5	4.99	6.31	14.77
CD (0.05)	1.46	11.84	2.46	1.17	0.14	14.69	NS	1.09	0.67	88.23

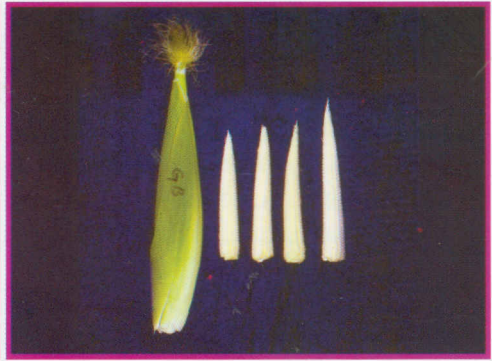
Table .14. Evaluation of sweet corn varieties for morphological and yield traits.

Varieties	Days to harvest	Cob weight (g)	Dehusked cob weight (g)	Length of dehusked cob (cm)	Girth of dehusked cob (cm)	No. of kernel rows / cob	No. of kernels/row	Plant height (cm)	No. of cobs/plant.	No. of nodes/plant	Stem girth (cm)	Biomass weight/pt.
Sweet Pearl	84.67	200.00	143.33	18.92	12.72	12.50	33.33	176.74	1.34	11.62	5.93	247.86
Priya	70.33	254.33	215.33	17.62	15.20	13.80	32.65	160.14	1.20	12.66	6.38	222.42
Bandit	76.33	233.67	168.33	17.79	14.59	12.21	33.40	169.29	1.11	12.93	7.10	392.68
VL-15	80.33	323.67	261.00	21.13	15.89	14.69	39.88	181.11	1.30	12.49	7.72	380.75
G.Honey	72.33	230.67	138.00	18.49	13.31	11.75	36.69	171.54	1.17	12.82	6.41	389.00
Madhuri	69.67	259.33	163.67	17.43	13.99	12.12	35.46	142.00	1.40	11.65	6.35	204.62
Tokita	72.33	214.00	138.33	17.74	13.23	13.11	32.76	164.05	1.41	11.96	6.14	327.02
W.yellow	76.67	202.00	135.33	17.47	13.84	13.22	31.30	164.82	1.31	13.05	6.98	390.34
Indam	83.00	218.33	116.00	17.75	12.48	12.74	26.63	158.17	1.03	9.83	6.30	250.66
Athimadur	84.67	200.00	143.33	18.92	12.72	12.50	33.33	176.74	1.34	11.62	5.93	247.86
CV	1.01	10.97	7.22	4.51	2.75	4.01	4.91	3.88	9.90	4.46	3.47	24.69
CD (0.05)	1.31	45.22	20.51	1.41	0.65	0.89	2.85	11.08	0.21	0.94	0.39	134.27

Sweet corn : Priya



Baby corn : Golden Baby



Dehusked Baby corn and Sweet corn



Plate. 7. Baby corn and Sweet corn: Potential high value crops under open field condition in Goa.

Table .15. Changes in total sugar during storage of baby corn.

Varieties	Fresh	1 st day	2 nd day	3 rd day	4 th day	5 th day	6 th day	7 th day	8 th day	9 th day	10 th day
Un husked Ambient Condition											
Perum-3	7.05	6.85	5.94	5.52	4.71	4.32	3.46	3.44	3.21		
DHM-105	5.76	5.72	4.91	4.69	4.12	3.22	2.91	2.85	2.80		
Vigro	6.53	6.21	6.01	5.82	4.53	4.33	4.04	3.81	3.19		
Nunhems	5.01	4.82	3.93	3.63	3.61	2.50	2.41	2.31	2.01		
Husked Ambient Condition											
Perum-3	7.05	4.95	3.53	3.01	2.70	2.20	1.80				
DHM-105	5.76	4.45	3.20	2.95	2.45	2.10	2.01				
Vigro	6.53	5.76	4.57	3.60	3.20	2.76	2.50				
Nunhems	5.01	4.42	3.81	3.12	2.92	2.56	2.30				

Changes in total sugar during storage of baby corn:

Varieties	Fresh	1 st day	2 nd day	3 rd day	4 th day	5 th day	6 th day	7 th day	8 th day	9 th day	10 th day
Un husked Refrigerated Condition											
Perum-3	7.05	7.03	6.92	6.71	6.52	6.23	5.82	5.62	5.56	5.22	5.10
DHM-105	5.76	5.68	5.57	5.42	5.41	5.38	4.88	4.67	4.62	4.59	4.48
Vigro	6.53	6.48	6.42	6.22	6.18	6.08	5.84	5.51	5.32	5.12	5.01
Nunhems	5.01	5.00	4.98	4.72	4.51	4.01	3.99	3.72	3.50	3.47	3.32
Husked Refrigerated Condition											
Perum-3	7.05	6.88	6.72	6.62	6.59	6.57	5.89	5.68	5.42	5.31	5.20
DHM-105	5.76	5.72	5.51	5.49	5.42	5.32	5.12	4.89	4.61	4.52	4.50
Vigro	6.53	6.51	6.48	6.12	6.10	5.98	5.88	5.71	5.62	5.57	5.46
Nunhems	5.01	4.98	4.82	4.81	4.62	4.41	4.12	4.11	4.00	3.99	3.87

Tomato

Tomato is not a commercial crop of Goa state. Its cultivation is hampered by severe incidence of diseases like tomato leaf curl virus, spotted wilt virus and bacterial wilt during *rabi* season. Solanaceous crops like brinjal and chilli are being cultivated widely in Goa, but tomato, the major vegetable crop of this family is not being taken up for cultivation due to disease and other abiotic problems. The first trial on tomato was laid out during 1989 and 1990. Two summer trials on tomato were carried out with bacterial wilt resistant and heat tolerant types. The incidence of bacterial wilt in all the lines was less than 10% excepting in the clones Arka Saurab and Arka Vikas that are not resistant to wilt. LE.79 and BWR-1 were the best among the clones as regards to yield, fruit size and disease tolerance to bronze wilt and leaf curl virus. Sonali and BWR-5 yielded meaty fruits whereas other varieties produced juicy fruits. All the varieties were susceptible to the bronze wilt and leaf curl viruses except the varieties LE.79 and BWR-1 which were

able to record satisfactory yields in spite of severe incidence of disease. However LE.79 suffered from severe fruit cracking, though it is the most vigorous and adapted clone for Goa. Hence, only the clone BWR-1 can be recommended for Goa during the summer season. Growing tomato during *rabi* is not economical due to severe incidence of bronze wilt virus.

Since bronze wilt and leaf curl virus diseases emerged as major problems in previous trials, intensive studies on the diseases were made for which a pot culture experiment was conducted under protected (insect proof cage) and natural (open field) conditions. Among the pots kept under natural conditions, 39% of the plants were infected by bronze wilt disease where as 22.5% plants acquired the leaf curl disease. Among the pots kept under protected condition, the incidence of bronze wilt disease was found to be quite low (8%). However, the incidence of leaf curl under insect proof cage was more (27%) indicating that the infection might have been acquired through seed or seedling at nursery stage.

Table .16. Performance of tomato varieties during summer.

Clone	Plant height (m)	Good fruits (t/ha)	Low grade fruits (t/ha)	No. of fruits/plot	Fruit weight (g)	Incidence of bronze wilt (%)	Incidence of leaf curl (%)	Total Incidence (%)
LE.79	0.77	4.32	6.39	47.8	48.82	12.40	7.40	19.40
BWR-1	0.74	4.39	3.93	45.0	51.71	18.40	10.50	28.90
BWR-5	0.95	4.34	4.48	55.5	41.85	24.00	12.80	36.80
MST32/1	0.67	3.15	4.06	43.3	39.61	19.10	20.90	40.00
Arka Vikas	0.62	1.44	1.10	14.3	58.98	25.00	22.70	47.70
Arka Saurab	0.67	2.84	0.91	27.3	57.47	22.40	24.50	46.90
CD(5%)	12.773*	NS	NS	5.5661*	NS			

Another set of potted plants was maintained under protected condition to see the effect of inoculating the diseased plant sap on the healthy plants of different age groups at 15, 30, 45 and 60 DAT. It was observed that the incidence of bronze wilt was more in older plants whereas that of leaf curl was higher in younger plants. The average yield per plant in healthy plants was 0.7kg whereas it was 0.4kg in bronze wilt affected plants and nil in leaf curl affected plants.

During summer season of 1991, 22 lines received from AVRDC, Taiwan, were evaluated. Nine indeterminate and 13 determinate types were included in the trial. The results are presented in Table 17.

The results indicated that the lines 310191, 310192, 310193, 310195, 310199, 310201, 310207, 310208, 310209, 310211 and 310212 are promising. Only 310199 showed some degree of tolerance to bronze wilt. The severity of bronze wilt disease resulted in higher percentage of cult fruit in many lines.

Testing of tomato lines for good fruit size, yield, resistance to bacterial and spotted wilt and high temperature tolerance was continued. During the year, sixteen lines were tested. The crop duration was 83 days for line 310206 and 86 days for 310203 and 91 days for all other lines. The most promising lines are 310199, 310193, MST25/7 and 310210. The first two are indeterminate while the last two are determinate types. All the plants exhibited resistance to the bacterial

wilt. But the reaction to spotted wilt virus was variable.

Testing of tomato lines for good fruit size, yield, resistance to bacterial wilt and spotted wilt and high temperature tolerance was continued. During the year, sixteen lines were tested. The crop duration was 83 days in line 310206 and 86 days in 310203 and 91 days in all other lines. The most promising lines are 310199, 310193, MST25/7 and 310210. The first two are indeterminate while the last two are determinate types. All the plants exhibited resistance to the bacterial wilt. But the reaction to spotted wilt virus was variable.

Pot culture studies on spotted wilt virus using LE.79 tomato line were conducted with treatments of full sunlight, partial shade and with moisture stress. It was observed that moisture stress had no effect on disease incidence. However, light intensity played a crucial role in disease development. Plants kept under full sunlight (22.3 to $61.3 \mu\text{mol S}^{-1} \text{M}^{-2}$) did not show any symptoms up to 60 DAT. Only 6.67% of plants developed symptoms at later stages of crop growth. Plants grown under shade appeared healthy, possessed good vigour and yielded normal size fruits.

A trial of eight bacterial wilt resistant lines of tomato was carried out during 1993 summer to test the tolerance to these lines to a new virus disease called bronze wilt or spotted wilt. All the lines were observed to be susceptible to the disease. The disease strikes virulently after fruit set resulting

Table .17. Performance of AVRDC tomato lines.

S. No.	Lines	Avg. yield of good grade fruit/pt (g)	Avg. total yield/pt (g)	Avg. No of good grade fruit/pt	Cull fruit (%)	Avg. wt. of good grade fruit (g)	% incidence of bacterial wilt	% incidence of bronze wilt	% incidence of other viruses	Remarks
	Indeterminate									
1	310191	216.3	260.0	3.4	27.96	64.04	26.67	100.0	8.88	Promising
2	310192	176.2	205.2	2.7	23.66	64.51	30.77	100.0	0.00	Promising
3	310193	199.2	231.9	3.0	24.71	65.39	30.23	100.0	0.00	Promising
4	310194	-	-	-	-	-	-	-	-	No germination
5	310195	401.3	437.4	5.2	17.54	76.85	11.11	100.0	0.00	Highly Promising
6	310196	125.8	150.8	1.8	29.55	69.00	5.88	100.0	0.00	Needs testing
7	310197	66.5	96.9	1.2	46.43	57.67	84.62	100.0	5.80	Not promising
8	310198	50.0	72.0	0.8	51.28	65.79	52.00	100.0	8.00	Not promising
9	310199	175.6	679.3	4.2	81.73	42.05	2.50	77.5	25.00	Promising
	Determinate									
1	310200	0.0	338.4	0.0	93.18	41.09	11.11	100.0	7.41	Not promising
2	310201	184.0	642.7	3.8	83.67	48.60	35.71	100.0	0.00	Promising
3	310202	0.0	134.3	0.0	100.00	15.46	0.00	100.0	0.00	Not promising
4	310203	0.0	307.8	0.0	100.00	18.72	0.00	100.0	3.70	Not promising
5	310204	0.0	0.0	0.0	0.00	0.00	100.00	0.0	0.00	Severe wilt
6	310205	72.6	262.6	1.4	85.96	53.37	0.00	100.0	11.53	Not promising
7	310206	175.3	335.5	3.6	64.68	49.24	0.00	100.0	12.00	Not promising
8	310207	316.0	614.3	6.3	65.35	50.27	14.29	100.0	0.00	Promising
9	310208	251.8	357.4	4.9	45.15	51.25	4.35	100.0	0.00	Promising
10	310209	206.4	412.1	4.1	64.20	49.83	0.00	100.0	7.14	Promising
11	310210	44.1	248.5	1.3	86.03	44.06	0.00	100.0	4.17	Not promising
12	310211	278.6	350.0	5.0	33.73	55.73	0.00	100.0	63.64	Promising
13	310212	129.5	315.6	2.7	77.83	48.23	0.00	100.0	0.00	Promising

Table .18. Performance of tomato varieties and hybrids under Goa condition.

Hybrids	Days to 1 st flowering	Days to 1 st harvest	Wt. of fruit (g)	No. of fruits/pt	Yield/pt (kg)	Incidence of TSWV + TLCV (%)
TLBRH-5	32	45	38.81	22.52	0.650	28.88
TLBRH-6	31	48	44.31	18.52	0.725	39.21
TLBRH-9	29	46	43.20	21.22	0.724	31.65
A. Aabha	35	51	53.00	18.56	0.812	21.08
A. Abhijit	36	50	59.00	23.21	0.712	23.43
A. Aloak	32	49	58.00	17.58	0.521	52.55
A. Shresta	33	49	46.00	16.98	0.612	38.87

in non maturity of fruits and low yields. The line MST25/7 recorded satisfactory yields. It was observed that the varieties with mostly determinate growing habit are able to give satisfactory yields in spite of the incidence of bronze wilt. Only neem pesticides were used to control the probable insect vectors.

In order to identify a suitable variety/hybrid for Goa condition, an evaluation was undertaken during 2006-07 using bacterial wilt and leaf curl virus resistant varieties and hybrids. The results indicated that there was incidence of diseases, but performance was satisfactory. Important diseases of tomato were Tomato Spotted Wilt Virus (TSWV) and Tomato Leaf Curl Virus (TLCV) and the highest incidence of both diseases recorded in Arka Aloak (52.55 per cent). Among the varieties evaluated, Arka Aabha recorded the highest yield per plant (0.812 kg) followed by TLBRH-6 (0.725 kg). The average fruit size was maximum (59.00g) in Arka Abhijit (Table 18).

Research achievements in Tomato:

- ❖ LE-79 and BWR-1 were the best varieties as regards to yield, fruit size and tolerance to bronze wilt and leaf curl virus.
- ❖ Hence BWR-1 can be recommended for the state of Goa.
- ❖ Among the AVRDC lines, 310199, 310193, MST25/7 and 310210 most promising for yield and disease resistance.
- ❖ Study on effect of shade on spotted wilt virus, light intensity played a crucial role in disease incidence whereas plants under shade were healthy with normal size fruits.
- ❖ In a recent study on evaluation, Arka Aabha recorded the highest yield per plant (0.812kg).



Plate. 8. Performance of Tomato varieties and hybrids under Goa condition.



Plate. 9. Consistently performing Potato varieties: HT-99 and Kufri Surya.

Roots and Tubers

An important crop cultivated under this group is Sweet potato during *rabi* season on paddy fallows with residual moisture. Predominantly local type of sweet potato with white skin is preferred by the farmers due to consumer's preference over other types. But studies on evaluation of improved varieties was taken up since the inception of institute.

Twenty two varieties of sweet potato and tapioca from CTCRI, Thiruvananthapuram, Kerala were evaluated during *kharif* season. The variety 76(OP) 219 was found to be promising with tuber size of 187g followed by Cross-4 in Sweet potato.

In tapioca, the highest yield was obtained in accession 2304 (2.75kg/plant) but tuber size and quality were poor. Tuber size was best with short tuber varieties (20/77, 97, 123, 1687). M-4 was the best from the cooking point of view followed by 123,

1687, 22/77, 11, 72, 212 and 347. Quality and yield wise, 168J was the best clone for Goa.

Other tuber crops *viz.*, Elephant foot yam, *Dioscorea*, *Colocasia*, *Xanthosoma* were tried under coconut based cropping system in collaboration with CTCRI, Thiruvananthapuram. The Yields of elephant foot yam (30t/ha) and *Dioscorea esculenta* (8.5t/ha) were satisfactory under Goa condition.

In case of Rice based cropping system, crops like Sweet potato (76(OP219), okra, knolkhol (White Vienna), brinjal (Agassim) and chillies were evaluated. Out of these, sweet potato (Cross 4 and Kanjagad local) and brinjal (Agassim) were found to be most promising with respect to gross returns (Table 19).

During 1990-1994, a comprehensive study was under taken to identify suitable crops under coconut based cropping system. The final result with economic returns is furnished in Table 19.

Table .19. Yield of different intercrops under cropping system in coconut.

Season	Crop	Yield (q/ha)	Gross returns (Rs.)	Expenditure (Rs./ha)	Net profit/loss (Rs./ha)
<i>Kharif</i>	Ginger	62.55	93750	31563	62187
	Turmeric	117.29	73019	30859	42161
	Pine apple	40.57	16229	12656	3573
	Cluster beans	10.57	10570	6333	4237
	Veg.cowpea	1.71	3420	2760	660
<i>Rabi</i>	Chillies	10.17	12204	6146	6058
	Brinjal	27.03	16218	5833	10385
	Amaranthus	5.78	1156	2467	-1311
Summer	Veg.cowpea	2.42	4840	3073	1767
	Tomato	0.78	936	6667	-5731
	Bhendi	7.19	7190	4427	2763
	Coconut	3607 nuts	14600	3000	12759
	Mango	1.45	1159		

Potato

Potato is not a traditional crop of Goa state. But the development of new heat tolerant varieties for tropical regions has prompted for trial under coastal condition. In this regard, an evaluation was undertaken with heat tolerant varieties from CPRI, Shimla. Four varieties viz., Kufri Surya, Kufri Pukhraj, Kufri Laukar and HT-99 were planted during three different dates of planting based on previous year's weather data. The sowing dates were 10th, 20th and 30th November, 2006. In all the dates of sowing, HT-99 performed better than all other varieties. Kufri Surya was second best variety in performance (Table 20). The dry weight which contributes for processing purpose was also estimated and the results indicated that Kufri Laukar had higher dry weight in two dates of sowing.

The trial was repeated during 2007-08 to study the consistency of performance over the years. Plots of 5.4m² were formed for each replication and equal number of tubers was sown on 16.11.2007 after

treating with Bavistin. Sprouting and crop stand was better in Kufri Pukhraj followed by Kufri Surya and Ht-99-722. Poor germination resulted in less crop stand in Kufri Surya (Hill). The highest plot yield of 3.36kg was recorded in HT-99-722 which was followed by Kufri Surya (2.865 kg). The conversion of plot yield to hectare basis indicated that HT-99-722 has the potential to yield up to 62.2q/ha followed by Kufri Surya (53 q/ha).

Research achievements in Roots and tuber crops

- ❖ In sweet potato, 76(OP219) was most promising with good tuber size.
- ❖ In tapioca, M-4 was best for cooking followed by 123, 1687 and 22/77.
- ❖ The yield of elephant foot yam (30t/ha) and Dioscorea (8.5t/ha) was satisfactory under coconut based cropping system.
- ❖ In case of rice based cropping system, sweet potato and brinjal were found to be most promising with respect to gross returns.

Table .20. Evaluation of potato varieties.

Varieties	No of surviving plants/plot	No of tubers/plot	Weight of tubers/plot (kg)	Moisture content (%)	Dry weight (%)
D/S: 10.11.2006					
K.Surya	19.00	58.00	1.242	53.25	46.75
K.Pukhraj	16.60	59.20	0.726	51.25	48.75
K.Laukar	8.00	18.00	0.147	48.31	51.69
HT-99	23.40	49.80	1.014	57.71	42.29
D/S: 20.11.2006					
K.Surya	24.60	48.00	0.883	57.32	42.68
K.Pukhraj	27.00	54.40	0.674	53.88	46.12
K.Laukar	17.40	43.20	0.325	62.69	37.31
HT-99	32.60	72.00	1.264	53.87	46.13
D/S: 30.11.2006					
K.Surya	35.00	54.20	1.109	50.81	49.19
K.Pukhraj	30.80	48.00	0.553	49.62	50.38
K.Laukar	35.20	49.80	0.552	55.71	44.29
HT-99	36.60	89.40	1.606	52.19	47.81

- ❖ Among the vegetable crops, highest net profit was recorded in brinjal (Rs.10385/ha) under coconut based cropping system followed by chillies (Rs.6058/ha).
- ❖ Heat tolerant potato variety HT-99-722 recorded consistently high yield (62.2q/ha) among four varieties evaluated for two years.

Evaluation of exotic vegetables under Goa condition

The tourism industry in the state of Goa demands exotic vegetable supply throughout the year to feed the star hotels. Hence, an evaluation trial was planned by including Cole crops like Chinese cabbage, Swiss chard, beet root, cabbage and broccoli to make use of mild winter weather during November to February. The preliminary trial gave satisfactory results in case of Chinese cabbage, Swiss chard and beet root for leafy purpose. Curd formation in cabbage and broccoli was observed, but the size and quality was not satisfactory.

Radish

The performance of Arka Nishant radish variety was assessed during *rabi* season. It recorded a yield of 28.61t/ha with an average root weight of 0.326kg. The root length averaged 24.0cm and root girth 2.21cm. The root quality was as good as Japanese white which is commonly grown in Goa.

Bottle gourd

Gourd variety namely Arka Bahar was tested during *rabi* season of 1990-91. Its growth and fruiting were satisfactory. After a growth period of 5 months, the variety yielded 12.23t/ha with an average fruit weight of 1.2kg and average of 7.2 fruits per plant.

Problems encountered in the varietal performance of some vegetables in Goa

Improved varieties in cole crops and cucurbits were evaluated and there were some problems in fruiting as well as head formation apart from severe incidences of diseases. The details are given in the following table (Table 21).

Table .21. Problems encountered in the varietal performance of some vegetables in Goa.

Crop	Variety	Remarks
Cauliflower	Unhali No.1(heat tolerant)	Poor head formation
Chinese cabbage	AVRDC hybrid	Severe incidence of bacterial soft rot
Pea	FC-1 (powdery mildew resistant)	Suffered from wilt. Flowering and pod formation unsatisfactory
Pumpkin	Arka Chandran and Arka Suryamukhi	Severe incidence of mosaic disease
Musk melon	Arka Jeet	Severe incidence of downy mildew
Round melon	Arka Tinda	
Long melon	Arka Sheetal	



Chinese cabbage



Swiss chard



Cauliflower



Beet root

Plate. 10. Performance of cole crops under open field condition in Goa.

Collection of Minor / Under utilized vegetables of Goa

Goa is bestowed with relatively rich floristic diversity, as it is ensconced on the slopes of Western ghat, which is described as one of the hot spots of biodiversity in India. With this background, a survey was conducted during 2001-02 to identify important under utilized vegetables, the variation found among them and their utilization and further exploitation for nutritional security of the region. The under

utilized vegetables are mostly collected from forest areas immediately after the onset of monsoon. But most of them fetch premium price in the market because of their limited availability and consumer preference for their taste (Table 22 and 23).

In general, all the minor or under utilized vegetables are rich in starch content which ranged from 18.21 to 32.78 mg/100g of flesh. This will in turn enrich the carbohydrate availability of cereal foods. Apart from this, most of the types are good source of ascorbic acid (Vitamin-C).

Table .22. Details of minor/under utilized vegetables of Goa state.

S. No.	Common name	Vernacular name	Botanical name	Parts used	Season of availability
1	Mangrove fern	<i>Akhur</i>	<i>Acrostichum aureum</i> - Pteridaceae	Young shoots	June-September
2	Taro	<i>Madi</i>	<i>Colocasia esculenta</i> - Araceae	Modified basal stem	July-October
3	Aerial yam	<i>Karane</i>	<i>Dioscorea bulbifera</i> - Dioscoreaceae	Aerial tubers	September-December
4	Bamboo	<i>Maan</i>	<i>Dendrocalamus spp</i> - Bombacaceae	Stem sprouts	August-November
5	Chinese potato	<i>Katte kanuga</i>	<i>Solenostemon rotundifolius</i> -Labiatae	Under ground tubers	August-November
6	Kakrol	<i>Phalga</i>	<i>Momordica dioica</i>	Spiny fruits	August-November
7	Breadfruit	<i>Nirpanos</i>	<i>Artocarpus altilis</i>	Fruits	Year round
8	Mushroom	<i>Allami</i>	<i>Teratomyces spp</i>		July-September

Table .23. Physico-chemical analysis of minor vegetables.

S. No.	Name of vegetable	Moisture content (%)	Acidity (%)	Ascorbic acid (mg/100g)	Starch (mg/100g)
1	Mangrove fern	90.27	0.218	17.95	18.21
2	Bamboo	91.30	0.326	22.26	26.29
3	Kakrol	87.82	0.318	38.89	18.27
4	Dioscorea- brown	77.42	0.125	16.66	29.32
5	Dioscorea-black	73.72	0.235	19.44	31.78
6	Colocasia	88.92	0.267	29.27	32.78
7	Bread fruit	78.25	0.108	19.86	32.18

Table. 24. Suitable varieties of different vegetable crops for Goa region.

Vegetable crops	Variety suitable	Season	Potential Yield (t/ha)	Remarks
Brinjal	a) Arka Neelkanth ,Arka Nidhi, Surya, Swetha	Rabi and Summer	20-35	Resistant to bacterial wilt Susceptible to bacterial wilt As intercrop in coconut
	b) Agassim and Taleigao		30-40	
	c) Agassim and Taleigao		3-6	
Chilli	Pusa Jwala, Arka Meghana, KA-2, PC-7	Rabi	1.5-2	Dry chilli
		Kharif	6-8	Green chilli
	Local types		1-1.5	Dry chilli
Okra	Arka Anamika and Parbhani Kranti	Rabi and Summer	8-10	Resistant to YVM
	Salkeerthi and local types	Kharif	8-10	Susceptible to YVM
Vegetable cowpea	Local types	Rabi	2-3	Local preference
Baby corn	Mridula, G-5406, GB vigo	All seasons	2-3cobs /plant	High demand
Sweet corn	Golden Honey, Sweet Pearl Win yellow	All seasons	1cob/plant	High demand
Potato	HT-99, Kufri Surya	Rabi	5-6	Low yield
Tomato	LE-79, BWR-1, Arka Aabha	Rabi	0.5-0.8kg/plant	Low yield Severe incidences of TLCV and TSWV
Sweet potato	Local types	Rabi	15	Rice fallow
Cluster bean	Pusa Navbahar	Summer	4-5	Rice fallow
Radish	Arka Nishant and Japanese White	Rabi	15-20	
Amaranthus	Red and green type	Rabi	5-6	
Knol khol	Local types	Rabi	12	
Sweet potato	Local types	Rabi	15	

Conclusion and Future thrust

The comprehensive compilation of results of research work carried out since 1978 on vegetable crops indicate the salient outcomes with immense use for the farmers, extension functionaries, scientists as well as policy makers. In addition, the information on the research gaps which can be addressed holistically through all the stake holders in order to bring quantifiable improvement in production and productivity of vegetable crops in the state of Goa in future is highlighted.

There is enough work done with respect to germplasm collection and conservation in major vegetable crops of Goa viz., brinjal, chilli, okra, vegetable cowpea etc. But the improvement of local cultivars and land races becomes priority areas of research since most of the highly preferred local types are lacking for disease resistance and high yield.

Introduction and evaluation of many high value vegetable crops like baby corn, sweet corn, capsicum, potato, tomato, and leafy vegetables indicate the possibility and economical viability of cultivation in Goa. There should be proper mechanism with market support to be established to popularize these high value crops to capitalize the huge demand during tourist season.

There are some interesting researchable areas like interventions in the cultivation of hill cucurbits during *kharif* season. Hill cucurbits namely cucumber, ridge gourd, bitter gourd and snake gourd are cultivated by a specialized group of farmers in Goa called *mollekars* belonging to tribal communities. These cucurbits are cultivated during *kharif* on the hills of Western Ghats in the Goa region. There are no reports on the area under these crops in Goa, however the cultivation of these cucurbits has steadily increased in the State over the years and can be roughly estimated to be around 500 hectares of which cucumber occupies 50 per cent of the area followed by ridge gourd while (30%), bitter gourd (10%) and snake gourd (10%). This group of vegetables forms the important areas of researchable interventions to improve the local production of vegetables.

The production and productivity of vegetable crops over the year is stagnant in comparison to growing demand. The major constraint in agriculture in Goa is high costs and scarcity of labour. In recent years only 17% of the total population is dependent on agriculture as a primary source of income compared to 60% during 1960. The area under cultivable fallow land is also increasing year after year thus

posing serious threat to availability of vegetables. It is an appropriate time to devise a sustainable policy to improve the area and production of vegetables to meet the increasing requirement of local population and tourists. The priority area of improvement would be to introduce large scale cultivation of hybrid vegetables in major crops. The local vegetable types cultivated fetch premium price and they are in high demand. But the productivity levels of these local types of vegetables are low compared to national varieties and

hybrid vegetables. Hence introduction of improved varieties/hybrids in major vegetable crops followed by large scale cultivation of vegetable crops with improved production technologies may increase the production and productivity of these high value vegetable crops. Thus, the immediate concern would be to raise the present productivity level of 10tonnes/hectare in Goa to national average of 15 tonnes/hectare, which will add almost 50 per cent more production of vegetables per year.

Selected References:

Adsule, P. G., A. R. Desai, M. Thangam, S. Priya Devi and K. Ramachandrudu. 2002. Biodiversity of Konkan region with reference to horticultural crops. In Extended summary of National Conference on coastal Agricultural research, 6th-7th April, Goa. Pp-208-210.

Annual reports, 1976-77 to 188-89 of Central Plantation Crops Research Institute, Kasaragod, Kerala, India.

Annual reports, 1989-90 to 2007-08, ICAR Research Complex for Goa, Old Goa, Goa, India.

Anonymous, 2007. Area, production and productivity statistics of crops in Goa. Department of Agriculture, Government of Goa, India.

Anonymous, 2006, Focus to be on vertical expansion. In The Hindu Survey of Indian Agriculture, Chennai, India. Pp-158-163.

Thangam, M., S. Priya Devi, M. S. Ladaniya, A. R. Desai, S. P. Singh, M. M. Zalmi and V. S. Korikanthimath (2008). Farm tourism with non traditional exotic flowers and vegetables crops in Goa. International Seminar on Natural area tourism: Impact, planning and management. St. Xavier College, Mapusa, Goa. 14th and 15th February, 2008.

Thangam, M., S. Priya Devi, K. Ramachandrudu and P. G. Adsule. 2002. Genetic resource of under utilized vegetables in Goa state. In abstracts of International Conference on Vegetables, 11th-14th November, Bangalore. Pp - 381.

Thangam, M., S. Priya Devi, A. R. Desai, K. Ramachandrudu and P. G. Adsule. 2002. Genetic resources of vegetable crops in Goa and their utilization. In Extended summary of National Conference on Coastal Agricultural Research, 6th-7th April, Goa. Pp-230-232.

