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Significant Research Achievements of CHES (1979-2009)

Central Horticultural Experiment Station
(Central Institute for Arid Horticulture), ICAR
Vejalpur, Panchmahals, (Godhra) 389340, Gujarat

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Front Cover Page : 1. Laboratory-cum-Office Building of the Station, **2.** Goma Kirti ber plant in bearing . **3.** NA-7 of aonla in bearing. **4.** Sathgudi sweet orange. **5.** Ganesh Pomegranate. **6.** Goma Manjari var. of cluster bean. **7.** *Gola* ber plant in bearing.
Back Cover Page : Close-up view of NA-7 Aonla plant in bearing

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Dr. T. A. More
Director

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FOREWORD

It is a matter of great pleasure and pride to place before you a Technical Bulletin encompassing 30 years of Research and Development done at Central Horticultural Experiment Station, Vejalpur, (Godhra). The Station was established by the Indian Council of Agricultural Research in 1979, which functioned under the administrative control of Indian Institute of Horticultural Research, Bangalore up to 30th September, 2000. The Station was established with the objective of generating horticultural technology for the tribal population of western India. The region is known for its diversity in respect of major horticultural crops like ber, pomegranate, aonla, mango, sapota, acid lime, okra cluster bean, chilli, brinjal, tomato and cucurbits like bitter gourd, bottle gourd, pumpkin and muskmelon to mention a few. However, despite its richness in fruits and vegetable varieties, the tribal area has, so far, remained agriculturally and economically backward. The tribals are still deprived of major fruits and vegetables ingredients in their daily diet. The reasons for this gap between tremendous production potential and very poor utilization are numerous but the socio-economic status of the tribals and agro-ecological conditions of the region share the major blame.

In order to bridge the above gaps and to improve the economic conditions of the farmers, it was decided to develop horticultural technology specially tailored for this region and for this type of agro climate where the tribal farmers have limitations to adopt only dry land farming in the degraded and marginal lands. Consequently, a high power Special Committee was constituted by the I.C.A.R. to reorient the functioning of the various institutes working for arid regions under the chairmanship of Dr. K. L. Chadha, former Deputy Director General (Hort.) of I.C.A.R. and with four eminent Scientists as its members. The Special Committee recommended the creation of a new institute, the Central Institute for Arid Horticulture with its Headquarter at Bikaner, and merger of this Station with the newly created Institute. Consequently, the Station was merged with C.I.A.H., Bikaner on 1.10.2000 as first of the five perspective Regional Stations of the Institute.

It may be mentioned with proud that the Station had already made spectacular progress in the last three decade in terms of farm development, germplasm collection, determination of suitable varieties for this region, release of new varieties, development of horti-silvi-pastoral system, evolving effective and feasible control measures against major pests and diseases, mass production of genuine planting material and dissemination of the technology generated at the Station. In the course of time it has become a well-known Station as far as dry land and semi-arid horticultural technology is concerned.

Ever since the last bulletin of the Station was brought out in 2000, the Station has added a few more feathers in its cap, its cultivation technology in aonla and nursery activities have earned a wide acclaim. It has started giving more emphasis on drip-irrigation, post-harvest technology, utilization of native but hitherto under-exploited fruits and vegetables with special mention of jamun, tamarind, bael, wood apple and drumstick, and development of IPM technologies for major pests and diseases. Simultaneously, the Station has also created infrastructure for itself in form of construction of a modern laboratory-cum-administrative building and Hi -tech glass house which facilitated its functioning in better way. Hence, it was thought to update the bulletin and compile the research achievements made so far, which will be of immense use for the farmers, researchers, students and policy planners of semi-arid region of India.

With the advancement in all fronts, it is expected that in near future the Station will further strengthen and contribute to the development of semi-arid horticulture for the Western Indian tribal belt.

Lastly, I express my sincere thanks and appreciation to the authors who contributed their reach and invaluable research findings to strengthen the bulletin for the benefit of researchers extension workers students and ultimately to the farmers.

(Dr. T. A. More)
Director

ACKNOWLEDGMENT

I take this opportunity to express my deep sense of gratitude to Late Dr. G. S. Randhawa, Director, Indian Institute of Horticultural Research, Bangalore who player a key role in establishing this Station for the benefit of tribal farmers of western Indian covering Gujarat, Maharashtra, Madhya Pradesh and Rajasthan.

Subsequently, the guidance and cilities which was provided by Dr. K. L. Chadha, Dr. R. M. Pandey, Dr. T. R. Subramaniam, Dr. I. S. Yadav and Dr. P. P. Reddy, Ex- Directors, Indian Institute of Horticultural Research, Bangalore for the development and cause of this Station are sincerely acknowledged.

Dr. G. B. Raturi, Ex-Head, Central Horticultural Experiment Station, Godhra and Ex-Director, Central Institute for Arid Horticulture, Bikaner who has been instrumental in overall development of the Station and served as Head for 18 years and his immense contributions in the field of research and development is duly acknowledged.

My sincere thanks are due to Dr. D. G. Dhandar, Ex-Director, Central Institute for Arid Horticulture, Bikaner who has been the guiding force in further development of the Station.

Finally, the concerted efforts made by my all colleagues viz. Dr. Sanjay Singh, Principal Scientist (Hort.), Dr. S. S. Hiwale, Principal Scientist (Hort.), Dr. H. K. Joshi, Scientist (S. G.) (Plant Pathology). Dr. V. V. Appa Rao, Scientist (SS) (Soil Sci.), Dr. A. K. Singh, Scientist (SS), Dr. V. Lenin, Scientist (Agril. Extension) and Sh. S. Raja, Scientist (SG) in compilation of this bulletin is deeply acknowledged.

Nevertheless, I am deeply grateful to Dr. T. A. More, Director, Central Institute for Arid Horticulture, Bikaner and Dr. R. S. Singh, Principal Scientist (Hort.) who have critically examined and edited the bulletin and gave appropriate suggestions wherever needed because of this it was possible to bring out this valuable publication.

My sincere thanks are due to all officials of CHES, Godhra and CIAH, Bikaner who have directly or indirectly contributed in bringing out this bulletin.

(B. G. Bagle)
Head

BACKGROUND INFORMATION

INTRODUCTION

Central Horticultural Experiment Station, Godhra, Gujarat was established on April 1, 1979 under the auspices of Indian Institute of Horticultural Research, Bangalore on the recommendations of task force on tribal development appointed by Indian Council of Agricultural Research, New Delhi to promote suitable horticultural technology in western India particularly for the welfare of adivasi (tribal) population covering the states of Gujarat, Rajasthan, Maharashtra and Madhya Pradesh.

Hon'ble Prime Minister Mr. Morarji Desai inaugurating CHES, Vejalpur on 29/3/1979

The Station was inaugurated on the 30th March 1979 by the Hon'ble Prime Minister of India, Shri Morarji Desai. The Government of Gujarat provided nearly 372 ha. of forest land at Vejalpur near Godhra for the establishment of this Experiment Station. The initial progress of the Station remained slow and retarded due to a number of technical and administrative reasons. The State Government could not implement quickly its assurance to supply for water irrigation to the Station. However, the Station started developing and expanding its activities from May, 1983 giving special emphasis on the development of dry land horticultural technology. During the year 2000 on the recommendations of a special high power committee constituted by the I.C.A.R. under the chairmanship of Dr. K. L. Chadha, Ex-Deputy Director General (Hort.) of ICAR and comprising four other eminent Scientists of the Horticultural discipline as its members viz. Dr. R. S. Rathore, Asstt. Director General, I.C.A.R., Dr. I. S. Yadav, Ex-Director, I.I.H.R., Bangalore, Dr. B. S. Chundawat, Ex-Vice Chancellor of Gujarat Agriculture University, S. K. Nagar and Dr. M. S. Manohar, the Ex-Director of Research, Rajasthan Agriculture University, Bikaner, the Station was transferred on 1st October-2000 from the administrative control of I.I.H.R., Bangalore to the new Institute C.I.A.H., Bikaner created by the up-gradation of National Research Center on Arid Horticulture (NRCAH).

MANDATE

The mandate of CHES is to promote suitable horticultural technology in Western India particularly for the welfare of tribal population of covering the states of Gujarat, Rajasthan, Maharashtra and Madhya Pradesh. The activities which are essential to fulfil such aim are given under

major aspect of horticultural research viz. crop improvement, crop production, crop protection and crop utilization.

A. Crop improvement

I. Fruit crops

1. Enrichment of germplasm from indigenous and exotic sources for semi-arid fruit crops.
2. Breeding varieties for desirable traits like high yield, dwarfness, high nutritive value, processing and export qualities through conventional breeding techniques.

II. Vegetable crops

1. Breeding vegetable varieties for desirable traits like high yield and resistance to pest and disease with special reference to cucurbits (Gourds and pumpkin).

B. Crop production

I. Fruit crops

1. High density planting in crops like ber, pomegranate, aonla, etc.
2. Efficient nutrient management through orchard efficiency, leaf nutrient standards, fertigation and integrated nutrient management.
3. Standardization of organic farming and vermiculture.
4. Developing fruit based cropping system for ber, aonla, etc.

II. Vegetable crops

1. Evolving production technology for vegetable hybrids.
2. Technology for different vegetables under organic farming.
3. Production technology to improve quality of vegetables for fresh market, export and processing.

C. Crop protection

1. Survey, collection, identification of major pest and disease of this region and estimation of yield losses of fruit and vegetable crops.
2. Development of IPM and IDM technologies for major pests and disease of fruits and vegetable crops of this region by utilizing bioagents, biopesticides, microbial, botanicals, etc.
3. On farm trials of IPM and IDM technology already developed.

D. Crop utilization

1. Screening of new varieties of fruit and vegetable for their suitability for processing product development from promising new varieties, scale up studies with industries.

OBJECTIVES

Following objectives were set for the Station:

Crop Improvement		Through introduction, selection and hybridization
Crop Production	:	Standardization of agro-techniques, development of leaf nutrient guides, weed control methods and use of plant growth regulators.
Crop Protection	:	Control of insects pests, nematodes, fungal, viral and bacterial diseases, development of integrated pest management methods.
Crop Utilization	:	Post harvest physiology of horticultural crops including maturity standards, handling, storage and processing.
Transfer of Technology		Transfer of scientific knowledge generated on the above aspects to tribal farmers of the region for effective horticultural development of the area and upliftment of farmers.

LOCATION

The Experiment Station is located near village Vejalpur at a distance of 15 km from Godhra on Godhra-Vadodara National Highway (22° 41'38" North and 73° 33'22" East.). It lies between 110 and 115 m above mean sea level. The farm is in four different duly formed segments and stretches east to west across National Highway No. 50. East, North and West sides of farm are bounded by agricultural lands of villages Vejalpur, Kharsalia and Bhadroli, respectively. The farm is divided in four segments or Blocks. Block-I has 16 ha (40 acres) land and is fully fenced and covered with mango, sapota, ber and aonla plants. Block-II (40 ha or 100 acres) is earmarked for buildings and structures. It is also protected with a compound wall on two sides, facing the roads and barbed wire fencing on the other two sides. Block-III and IV (336 ha or 840 acres) are also fully fenced with barbed wire fencing. On 116 ha (290 acres) area mango, sapota, aonla, ber, pomegranate, other fruits and forest species' and vegetable crops are planted in these two blocks. The experimental area and nurseries are located in these two blocks.

A topographic view of the land area allotted to the Station by the Govt. of Gujarat in 1979.

SOIL

The farm is characterized by the presence of hilly and undulating terrains. Occurrence of pebbles and boulders is a common phenomenon. The farm area is extensively drained by a network of gullies and revines. Of the total 372 ha. farm area, 29.50 ha and 5.43 ha fall under ravines and rocks out-crops, respectively. In 84.80 ha. (22.7%) the choice is limited to grasses and shallow rooted plants.

Farm soil is considerably eroded. Apart from prevalence of sheet erosion in major parts of farm, an area of 92.27 ha (24.8%) is affected by severe erosion.

The soil is generally derived from basic rocks, which are calcareous in nature. It is shallow to very deep, clay loam to clay, having a calcium carbonate layer at different depths depending upon the topography, thus necessitating careful irrigation scheduling and adequate drainage measures. The soil is generally saline-sodic which needs amelioration by addition of calcium bearing amendments. The land capability classification of the farm area is given in Table 1.

Table 1. Land capability classification

Class	Area (ha)	Description
I	77.16	Very good cultivable land suitable for intensive farming.
II	198.27	Slow permeability, poor workability, and moderate soil erosion-limits choice of crops. Needs moderate soil and water conservation practices.
III	47.46	Moderately severe limitations of erosion and permeability reduce choice of crops. Requires special conservation practices for both.
IV	49.11	Very severe limitations restrict choice of crops or require very careful management or both.

CLIMATE

The area is characterized by semi-arid hot climate. The annual water need or potential evapo-transpiration of the area ranges between 1500 and 1600 mm whereas, actual mean annual precipitation is about 750 mm, thus causing an annual water deficit of nearly 850 mm.

The rainfall is mainly confined to three months (July-September). The number of total rainy days averages about 35. The mean summer temperature is 31.9°C while the mean winter temperature 22.3°C, indicating that the area falls under hyperthermic soils regime. The mean annual maximum and minimum temperature vary from 42-43° C in May and 6-7° C in January, respectively.

INFRASTRUCTURE FACILITIES

SET UP

The Experiment Station is headed by a Principal Scientist. It has eight sections viz. Fruit crops, Vegetable crops, Plant Pathology, Entomology, Soil Science and Soil and Water Conservation Engineering, Plant Physiology, Statistics and Extension. The Station has sanctioned staff strength of 91 personnel. Till 1999, it was functioning from a hired office building at Godhra town, though a few farm structures were constructed at Vejalpur. However, Laboratory-cum-Administrative Building was constructed at a cost of Rs. 66 lakhs in Block II near Vejalpur and the Station started functioning from this new building since January 2000. The station also has a Krishi Vigyan Kendra functioning since 1st October, 2005.

ADMINISTRATIVE WING

The administrative wing is supervised by an Assistant Administrative Officer who is assisted by 1 Assistant, 2 Personal Assistants, 1 senior clerk and 4 L.D.Cs. The Hindi Wing of the Station has 1 Hindi translator and 2 Hindi typists.

LIBRARY: A total 712 books and 306 back volumes of Journal are available in the library. The Station is subscribing to 23 Indian Journals, annually. Besides, the library has collection of reprints, pamphlets, reports and photocopies of research papers for the use of scientists and students. It is duly supervised by a Librarian (T-5).

ARTIST'S CELL: The Station has an Artist's Cell wherein adequate facilities have been created for preparation of charts, graphs and models, etc. for presentation of results. The cell also helps in organizing exhibitions on various occasions.

PHOTOGRAPHY-CELL: The Station has a Photography Cell both for outdoor and indoor photography. Facilities for Scientists to take photomicrographs have also been created. The working of photography cell has been streamlined and all the slides /prints have been catalogued and placed in separate albums for different sections. So far, 2286 slides and 5454 prints have been prepared and classified. Both the Artist's Cell and Photography Cells are looked after by an artist cum photographer.

ESTATE CELL: Plans and estimates for various farm structures, check dams, roads, culverts and other miscellaneous works including electrification are prepared by this section. It is also responsible for electrification and maintenance of the building. This cell is looked after by Civil Overseer of T-5 grade.

LAND DEVELOPMENT

A Master Plan of the campus has been developed. A Modern Laboratory Building has been constructed at a cost of Rs. 66 lakhs, which houses various laboratories and Administrative Wing. It was occupied in January 2000. Provision for glasshouse, greenhouse, growth chamber, mist chamber, vegetable seeds-processing hall and workshop, etc. has been made on campus planning. A field-laboratory at a cost of Rs. 12.00 lakhs is constructed in Block III. One plant propagation unit constructed by the CPWD at a cost of Rs. 1.45 lakhs is already functioning for raising seedlings and multiplication of plants. One Hi-Tech Glasshouse has been commissioned for large scale propagations of plants. Two poly houses and two greenhouses have been constructed to facilitate plant propagation under different schemes and National Agricultural Technology Project (Jay Vigyan Programme). A Net house has also been constructed under RFS. Drip irrigation and sprinkler irrigation system has also been installed under NATP (Jay Vigyan Programme).

Dr. R. S. Paroda, Hon'ble DG, ICAR, New Delhi Inaugurating Laboratory-cum-Administrative Building of CHES, Vejalpur (Godhra) on 16-01-1999.

In two Blocks, I and III, fencing with barbed-wire has been done on 292 ha area costing of Rs.12 lakhs. A compound wall for Block-II (earmarked for laboratory building and residential quarters) has recently been constructed at a cost of Rs. 35 lakhs. Three km internal roads are macadamized in different blocks.

Dr. I. S. Yadav, Director, IIHR, Bangalore (Right) with Dr. G. B. Raturi, Head, CHES, Vejalpur (Left) Inaugurating Field Laboratory Building on 16/09/1994

IRRIGATION FACILITY

At the personal initiative of the Hon'ble Chief Minister of Gujarat, Shri Madhavsinhji Solanki, the State Government executed a lift irrigation scheme from Panam canal in February 1984 at a cost of Rs.35 lakhs. Water from the canal was filled in to a reservoir of 18 lakhs liter capacity on the farm through 2 km long pipeline. However, the scheme stopped functioning since 1989 due to some administrative bottlenecks.

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Five check-dams have been constructed in different years for water harvesting. Six open wells have also been constructed. In May 1985, the State Government provided one open well in Block-1. However, the water of the well is unsuitable for irrigation because of high salt content (3250 micro mhos.). Jet pump in Open wells in Block-I and in Block-III each and in two bore wells in Block-III have been commissioned. However, these resources meet only partial requirement of total irrigation needs of the Station, specially in view of functioning of the laboratory building, construction of residential quarters and also operation of more number of research projects. In Block-III, three small water reservoirs have recently been constructed for irrigating the juvenile plants and for facilitating spraying.

A view of check-dam in quarry area (RFS nursery) in Block-IV.

FARM MANAGEMENT SECTION

The Station has a T-8 (Garden Superintendent) for overall farm supervision and is supported by a T-6 (Technical Officer) who looks after the largest Block of the Research Farm and Farm management work of the Station. It is further supported by 11 T-II-3 (field technicians), 4 laboratory technicians, 2 mechanics, 1 electrician, 1 pump-house operator, 1 carpenter, 1 tractor driver, 1 staff car driver and a bus driver. The Station has supporting staff strength of 30, which included gardeners, messengers, watchmen and sweepers.

RESEARCH ACHIEVEMENTS

BENCHMARK SURVEY

The benchmark study in the form of a socio-economic survey of tribal families was conducted to understand the socio-economic status of the tribal farmers. The objective was to collect the basic information so that appropriate programmes for the development of horticulture in the area could be formulated. The survey was conducted during 1983-1985 in five tribal talukas of Panchmahals district viz. Dahod, Zalod, Limkheda, Santrampur and Devgadh Baria. According to 1981 census, nearly 60 per cent of the total population of these talukas belonged to Scheduled Tribes, which represents about 18 per cent of the Scheduled Tribes population of the State. The other important tribes are Patelia, Nayak, Rathva and Dhakiya.

The level of economic and social development of the tribal people is very low. They are orthodox in approach and do not assimilate easily into any alien culture. Agriculture is their main vocation. More than 90 per cent of the population depends on agriculture and allied activities viz. livestock, poultry, fishing, honey-extraction, collection of minor forest produce, etc. for their livelihood. Average per-capita cultivated area is about 0.25 ha. Agriculture is basically rainfed and average yield is very low. The per capita income from agriculture works out to be around Rs. 200/- per year. Thus, farming alone cannot sustain the family for the whole year and therefore, the families migrate to nearby cities for employment. The migration usually starts from November and they return in last week of May to prepare their lands for *kharif* season.

Tribal families generally suffer from malnutrition. Intake of fruits and vegetables in their daily diet is negligible. Orchards are conspicuously absent in the area. However, stray plants of mango, guava, pomegranate, papaya, lemon and custard apple are grown as courtyard trees or along the field bunds. Mahua and Chironji are found wild in forest. Majority of fruit trees are of seedling origin. The farmers grow hardy vegetable like cucurbits, cluster bean, brinjal and chillies during the rainy season. Thus, there is enormous scope for introduction of suitable varieties of fruits and vegetable in this area and for promoting rainfed horticulture.

The station initiated the research projects in four disciplines viz. Fruit crops, Vegetables crops, Plant Pathology and Entomology. There were nine projects viz. three in fruit crops and two projects each in vegetables crops, pathology and entomology.

The Station is presently working on 15 research projects of immediate practical applicability. They include 5 in Fruit crops, 2 each in Vegetables, Plant Pathology and Entomology, and one each in Soil Science and Agril. Extension. Besides, two NATP research projects on fruit crops are also in operation. One revolving fund scheme for plant propagation is also functioning in the Station.

Keeping in view the semi-arid climate of the region, different fruit crops like mango, sapota, guava, ber, pomegranate, custard apple, aonla, phalsa, fig and jamun were tried. Various crops responded differently to local and soil climatic conditions. Evaluation trials under dry land conditions conclusively established excellent adaptability of ber, aonla and pomegranate to this area.

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The level of economic and social development of the tribal people is very low. They are orthodox in approach and do not assimilate easily into any alien culture. Agriculture is their main vocation. More than 90 per cent of the population depends on agriculture and allied activities viz. livestock, poultry, fishing, honey-extraction, collection of minor forest produce, etc. for their livelihood. Average per-capita cultivated area is about 0.25 ha. Agriculture is basically rainfed and average yield is very low. The per capita income from agriculture works out to be around Rs. 200/- per year. Thus, farming alone cannot sustain the family for the whole year and therefore, the families migrate to nearby cities for employment. The migration usually starts from November and they return in last week of May to prepare their lands for *kharif* season.

Tribal families generally suffer from malnutrition. Intake of fruits and vegetables in their daily diet is negligible. Orchards are conspicuously absent in the area. However, stray plants of mango, guava, pomegranate, papaya, lemon and custard apple are grown as courtyard trees or along the field bunds. Mahua and Chironji are found wild in forest. Majority of fruit trees are of seedling origin. The farmers grow hardy vegetable like cucurbits, cluster bean, brinjal and chillies during the rainy season. Thus, there is enormous scope for introduction of suitable varieties of fruits and vegetable in this area and for promoting rainfed horticulture.

The station initiated the research projects in four disciplines viz. Fruit crops, Vegetables crops, Plant Pathology and Entomology. There were nine projects viz. three in fruit crops and two projects each in vegetables crops, pathology and entomology.

The Station is presently working on 15 research projects of immediate practical applicability. They include 5 in Fruit crops, 2 each in Vegetables, Plant Pathology and Entomology, and one each in Soil Science and Agril. Extension. Besides, two NATP research projects on fruit crops are also in operation. One revolving fund scheme for plant propagation is also functioning in the Station.

Keeping in view the semi-arid climate of the region, different fruit crops like mango, sapota, guava, ber, pomegranate, custard apple, aonla, phalsa, fig and jamun were tried. Various crops responded differently to local and soil climatic conditions. Evaluation trials under dry land conditions conclusively established excellent adaptability of ber, aonla and pomegranate to this area.

IMPROVEMENT

GERMPLASM COLLECTION AND EVALUATION

Germplasm collection in various fruit and vegetable crops available to date at CHES, Godhra is given in Table 2.

Table 2. Germplasm collections at CHES

Crops	No. of collections	Name of crops	No. of collections
Ber	55	Mango	34
Pomegranate	49	Wood apple	10
Custard apple	15	Karonda	40
Aonla	12	Drum stick	11
Sapota	7	Drum stick	30
Bael	15	Bitter gourd	37
Fig	1	Ridge gourd	25
Phalsa	1	Pumpkin	17
Jamun	66	Cluster bean	2
Tamarind	25	Okra	2
Mahua	50	Khirni	30

FRUIT CROPS

Ber *(Ziziphus mauritiana L.)*

Ber cv. Gola

Ber was found to be most drought hardy and salinity tolerant crop. Germplasm evaluation studies revealed that Gola, Dandan and Rashmi are early bearing varieties while Umran, Seb and Aliganj are late in maturity. These varieties have been recommended for commercial cultivation. In ber, the budded plants bear fruits in the first year itself. The cost of cultivation is realized in the second year with an average yield of 6.0 kg fruits per plant (if sold @Rs. 5/- per kg) giving total revenue of Rs.11,400/- per ha. There was progressive increase in the yield and in the seventh year, an average yield of 35 - 40 kg fruits per plant was harvested giving an income of Rs. 66,500 - 76,000/ha.

Aonla *(Emblica officinalis Gaertn.)*

A branch of NA-7 variety of aonla plant showing profuse bearing.

Aonla has been identified as very important fruit crop for this semi-arid region because it is highly drought hardy and salinity tolerant. Aonla is a rich source of vitamin-C containing 500-1500 mg ascorbic acid per 100 g of pulp, which is nearly 20 times as much vitamin-C as in orange. The fruit contains high amount of galletannic acid, which on hydrolysis yields gallic acid, a compound well known for its antioxidant properties. Aonla is found to be very suitable fruit for processing and post-harvest use. Aonla has high medicinal properties and it is an important ingredient of triphala, chyvanprash and other Ayurvedic medicines. For adivasi population of this region, this rich source of vitamin-C has come as a boon and its cultivation is found highly profitable.

The varietal evaluation of 10 varieties has clearly indicated the supremacy of variety NA-7 in respect of yield and quality. The plants are propagated through patch budding, which is done in the first week of June. The budded plants are precocious and yield fruits in 3-4 years and come to commercial bearing in 6-7 years. On an average, a 7-year old aonla tree is a prolific bearer and yields about 50-60 kg fruits/plant. The fruits of NA-7 aonla are medium large size with conical apex, less in fiber contents and much preferred for processing. The plants produce flowers in February-March and after the fruit set, they undergo dormancy during hot summers, and as soon as the rainy season starts, the fruits start developing in size and attain maturity in October.

An income of Rs. 50,000-60,000 per ha can be generated through an 8 years old aonla orchard. Because of its drought hardiness, the crop has become very popular in this region and the Station has sold several thousands of aonla budlings to the farmers.

Evaluation on growth parameter in 10 varieties revealed that var. Krishna had maximum plant height; diameter and spread and NA-7 had the least vigour. Maximum pulp: stone ratio was recorded in Kanchan (14.68). Per cent fruit set / shoot was more in Banarasi. Number of female flowers per cluster was more in NA - 7 Maximum fruit weight, length and diameter was recorded in Krishna. T.S.S. was highest in Chakaiya. Maximum yield per plant was recorded in NA-7. The var. NA-7 performed better than all other cultivars treated and hence it was recommended for cultivation in the semi-arid rain fed areas.

Custard apple *(Annona squamosa L.)*

Custard apple is a common fruit tree growing in sub-tropical regions of Western India. The ripe fruits of this tree are delicious to eat and have nutritional and medicinal properties. Its seeds contain insecticidal properties. Because of bitter chemicals in its foliage, the cattle do not find it palatable for foraging, hence, it is found very commonly growing even in degraded marginal, undulated terrains with

well-drained sandy or gravelly soils. A large number of Annona germplasm/varieties have been collected at the Station and evaluated for their genetic amelioration. Variety Pink Mammoth was found superior and has been wider adaptability for the semi-arid conditions of this region. Its production technologies have been well standardized. It was found to be propagated most successfully by budding. A large number of planting material or improved cultivars have been generated at the Station and the budlings are distributed to farmers. Some superior strains of local sitaphal or annona (custard apple) were also identified.

Germplasm evaluation revealed that cv. Atemoya x Balanagar was the most vigorous of all. Per cent fruit set was highest in Atemoya x Balanagar (52.26). However, fruit retention was highest in Balanager (59.88). Analysis of physico-chemical characters various germplasm lines revealed maximum fruit weight in Atemoya x Balanagar (216.69 g) and least in Red Sitaphal. Highest yield in var. Balanagar, maximum number of seeds per fruit in local sitaphal and least in Island Gem was recorded highest TSS in variety Island-Gem. Based on the performance of the variety Balanagar is recommended for cultivation in the semi-arid rain fed areas.

Pomegranate *(Punica granatum L.)*

Pomegranate was also be found to be comparatively drought hardy and tolerant to salinity. Varietal evaluation revealed that var. Ganesh was the most promising variety. It is generally propagated by air layer or cuttings. Under rain fed conditions, its cropping can be tailored from July to December making maximum use of available moisture. Comparative studies between different *bahar* treatments revealed that highest fruit yield and best quality fruits were produced in *Hasta bahar*. In the sixth year of cropping, an average yield of 45 q/ha with net profit of Rs. 45,000/ha was obtained under semi-arid / dry land conditions.

"Ganesh" variety of Pomogranate in bearing.

The lines obtained from IIHR, Bangalore for evaluation indicated that vegetative growth parameters, maximum plant height was recorded in Line-A (3.32 m) and it was minimum in Line–H (1.87 m). Maximum fruit weight and fruit diameter were recorded in Line- H (137.33 g and 75.16 mm, respectively). Fruit length and fruit skin weight were recorded maximum in Line - A (68.33 mm and 53.33 g, respectively). Maximum per cent acidity (8.37 %) was noted in Line-H. T.S.S. was, however, maximum in Line–E (18.53Brix). The weight of 100 aril was maximum in Line–H (96.66 g) and it was minimum in Line-B (42.33 g). Juice percentage was recorded maximum in Line-K (134.14 %) and minimum in Line-A (48.93%).

Mango *(Mangifera indica L.)*

Mango is native to this region and a large number of mango trees of seedling origin are found growing in forests, farmers' field and homestead cultivation. However, organized orchards of improved cvs. Kesar, Alphonso, Rajapuri, Dashehari, etc. are prominently absent in this region.

Studies on varietal adaptability of mango revealed that vars. Kesar, Alphonso, Rajapuri, Dashehari, Mallika, Amrapali, Arka Arun, etc. can be grown in this region. Cultivars Kesar and Rajapuri which are native to Gujarat have done exceedingly well in dryland conditions of Panchmahals. At seven years of age, Rajapuri plants yielded about 40.0 q/ha while Kesar plants produced about 35.0 q/hq. However, high summer temperature (39–41°C) coupled with high sunlight intensity during fruit development caused considerable sunscalds of the fruits in vars. Kesar (10.5%) and Alphonso (24.0%).

Guava *(Psidium guajava L.)*

Varietal evaluation in guava revealed that Allahabad Safeda was the highest yielder (17.7 kg/plant) followed by IIHR Selection-8 and Sardar. IIHR Selection-8 was found to be soft seeded.

Varietal evaluation of six guava varieties viz. Allahabad Safeda, Sardar, Selection-8, Chittidar, Apple colour and Red Fleshed during six years revealed that var. Sardar was most vigorous and Chittidar the least. Allahabad Safeda gave highest yield which was closely followed by the Selection-8. However, fruits of cv. Sardar were bigger in size. The seeds of Selection-8 were softest of all followed by Allahabad Safeda.

Sapota *(Manilkara achras (Mill.) Fosberg)*

Sapota plants were observed to be drought hardy and salinity tolerant. Variety Kalipatti was found most suitable for commercial cultivation under local condition, plants yielded 25.0 q/ha at seven years of age.

Seven cultivars of sapota viz., Kalipatti, Pilipatti, Cricket Ball, Singapore, Jumakhia, CO-1 and CO-2 were evaluated for growth, yield and physico-chemical characteristics during the year. Cricket Ball was found to be most vigorous of all in respect of all the vegetative characters and cv. CO-2 was found to be least vigorous. Maximum number of flower clusters per shoot and fruit set per shoot were recorded in cv. Jumakhia (79.78 and 169.00 respectively). Fruit retention per shoot was, however, maximum in Pilipatti (79.66). Maximum yield per plant was recorded in Kalipatti (97.77 kg) and was least in CO-2 (25.62 kg). Physico-chemical analysis of the cultivars revealed that fruit weight (116.67 kg), fruit length (62.03 mm), fruit diameter (59.53 mm) and fruit skin weight (11.33 g) were maximum in cultivar CO-2. Whereas physiological loss in weight was highest in cv. Jumakhia. Pulp stone ratio and T.S.S. was maximum in Kalipatti 42.16 and 31.67°Brix, respectively. Variety Kalipatti outperformed all the varieties under rainfed conditions and hence recommended for cultivation in Semi-arid areas of the country.

Wood apple *(Feronia limonia L.)*

Close up view of Wood Apple

Ten different types on the basis of weight and fruit shape have been collected from the various parts of the country and are being evaluated.

One of the collections was found to be bunch bearing with 4-5 fruits in a bunch. Average weight of the fruit was 550-650 g, in the collections. Fruit length ranged from 53 mm to 102 mm and fruit diameter from 97 to 58 mm. Pulp: stone ratio varied from 0.71 to 1.61. T.S.S. ranged from 7.0 to 14.33°Brix. Seed number per fruit ranged from 134 to 590 and seed weight from 3.4 to 18.2 g. Collection No. 10 had maximum fruit weight and pulp: shell ratio (480 g, 1.61 respectively). Collection No. 9 possessed less seed (3.4 g/fruit). Highest TSS (14.33°Brix) was recorded in Collection Nos. 3 and 5.

Phalsa *(Grewia asiatica L.)*

Studies on time and intensity of pruning in phalsa revealed that pruning phalsa plants at 1.0 meter height from the ground level during the first week of December was found to be best to obtain the high yield and good quality fruits.

Sweet orange *(Citrus sinensis L.)*

Close up view of Sweet orange

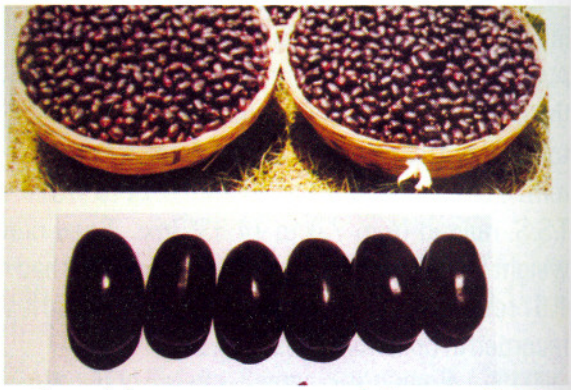
Adaptability trials for the past three years under NATP on sweet orange var. Sathgudi had clearly indicated that sweet orange can be conveniently grown at a spacing of 5 m x 5 m and gives about average yield of 60-70 kg/plant provided irrigations are given at critical phases. The juice of this variety has a flavour that is liked by everyone and hence, it has become most popular in this region. The crop can be grown with minimum incidence of pests and diseases. The adaptability of another sweet orange var. Mosambi was also higher and was found suitable to grow under this climate. All visitors including eminent horticulturists of this country have appreciated the performance of both of these citrus varieties.

Acid lime *(Citrus aurantifolia Swingle)*

The cultivation of acid line at 5 m x 5 m spacing proved to be a profitable proposition under this climatic conditions, provided irrigation at crucial time are given properly. Severity of pests and disease is minimum under these conditions, except occasional incidence of citrus canker during rainy season.

Jamun *(Syzygium cumini L.)*

Total 66 genotypes of jamun have been established in the field. Two promising genotypes i.e. GJ- 2 and GJ -8 were found be promising.



Promising genotypes of Jamun GJ-2

Jamun GJ- : Flowering takes place in the month of March. It ripens in the first week of June. It has recorded 19.50 g average fruit weight, 84.62% pulp, 15.10 % TSS, 0.38 % acidity, 11.40 % total sugar and 42.67 mg/100 g vitamin C.

Jamun GJ-8: Flowering takes place in the month of March. It ripens in the second week of June. It has recorded 17.00 g average fruit weight, 81.82 % pulp, 14.20 % TSS, 0.39 % acidity, 11.35 % total sugar and 45.10 mg/100g vitamin C.

Tamarind *(Tamarindus indica L.)*

Twenty four promising genotypes of tamarind have been established in the field. Tamarind -13 recorded maximum panicle length and fruit set per panicle, maximum fruit weight, pulp weight and TSS content.

A promising genotype of tamarind T-13

Mahua *(Bassia latifolia* Roxb.*)*

On the basis of over all performance, MH-2, MH-4, MH-8, MH-10, MH-14, MH-16, MH-18 and MH 35 were found to be promising among the genotypes studied.

Chironji *(Buchanania lanzan* Spreng.*)*

With respect to all horticultural traits studied the genotypes, CPT-1, CPT-2, CPT-5, CPT-6, CPT-7, CPT-8, CPT-12 and CPT-30 were found to be promising.

Bael *(Aegle marmelos L.)*

Total 31 genotypes have been established in the field of which 11 verieties viz., CISH B-1, CISH B-2, NB-5, NB-7, NB-9, Pant Aparna, Pant Sujata, Pant Urvashi, Pant Shivani, and CHES Bael selection-1 were evaluated for their growth, yeild and quality parametere. On the basis of over all performance NB-5, NB-9 and PB-6 were found to be promising.

BREEDING AND IMPROVEMENT

FRUIT CROPS

Development and Release of Varieties

1. Goma Kirti (Ber): A clonal selection in Ber has been identified for earliness and high yield. The selection has been released for cultivation. Plants are semi-tall with semi-spreading habit, flowers three weeks earlier than Umran. This results in early fruit set, higher fruit retention and consequently higher yield, which varies from 25.8- 38.2 per cent over the years. The keeping quality of the selection was also higher compared to early varieties. The selection was found to be drought tolerant and being early escapes heavy incidence of borer and powdery mildew.

Ber cv. Goma Kirti

2. Goma Aishwarya (Aonla): The clonal selection of Aonla identified was evaluated and then multiplied by in situ budding and tested under field condition for last 5 years The selection was multiplied and 5 plants each to five farmers. The selection out performed the check in earliness and yield. The selection started bearing in the 3rd year. It consistently flowered and fruited since 5 years and data recorded on flowering, fruit set, under semi arid rain fed conditions. The selection was superior to the check. The yield increase was to the tune of 22.9

Plant of Aonla cv. Goma Aishwarya

to 34.15 per cent over control under rain fed conditions of Gujarat. Vegetative growth was less and hence more number of plants can be accommodated / ha. The selection has been released.

The concerted efforts made through survey collection identification and evaluation of under utilized fruits under semi arid ecosystem clearly indicated their suitability and adaptability in this region. New elite lines viz. GJ-2 and GJ-8 in jamun, T-13 in tamarind for fruit weight and pulp weight, CPT-7 in chironji were also found promising based on performance trial. In bael NB-5, NB-9 and PB-6 were quite promising. Collection-9 in wood apple also found promising for less seed.

VEGETABLE CROPS

Development and Release of Varieties

Goma Manjari (Cluster bean): A pure-line developed by individual plant selection and progeny testing from an original line 'Rajasthan Local'. Plants are erect, single stemmed, non-branching, bearing from the base of plant in cluster up to 35 with 8 - 10 pods per cluster at short internodes. Pod are long, thin, smooth, green non-fibrous, stringless, yielding 88 - 103 q/ha, photo-insensitive, crop period 75 - 80 days, tolerant to drought, best suited for inter and mixed cropping and nutrition garden at closer spacing of 45 cm x 45 cm. The variety has become very popular in this region.

Goma Manjari (Cluster bean)

Vegetables amenable to dry land cultivation, were given priority attention. Special emphasis is laid on growing and popularizing hardy vegetables, which require less input. Accordingly, many improved varieties of tomato, brinjal, chillies, capsicum, beans, cucurbits, radish, cauliflower, cabbage, green leafy vegetables and drumstick, commonly grown and consumed by the tribal farmers were tried. Many of the vegetable varieties developed at the IIHR, Bangalore have performed very well at this Station. These include varieties Arka Manik of watermelon; Arka Shirish, Arka Nidhi and Arka Navneet of brinjal; Arka Mohini of capsicum; Arka Harit of bitter gourd; Arka Bahar of bottle gourd; Arka Chandan and Arka Suryamukhi of pumpkin and Arka Nishan of radish. A few other varieties developed at other Institutes have also been found suitable for cultivation at CHES. These include Pusa Deepali and Snowball-16 of cauliflower; Pusa Jwala; Pant-C-1, S-49 and G-4 of chillies and Golden Acre of cabbage. Dwarf, bushy, vegetable-podded, protein-rich, Dolichos bean Arka Jay and Arka Vijay have also shown greater adaptability. They are early and high yielding (150-160 q/ha). In cluster bean, the breeding work done resulted into development of one variety, Goma Manjari.

In muskmelons three promising selections namely Sel. CHES-1, Sel. CHES 238-and Sel. CHES 268-1 were made. Sel. CHES-1 is a selection from the variable line R.M. 69 from Agricultural Research

Station, Durgapura Rajasthan. Plants are dwarf, bearing from base with short internodes, more on secondary branches. Fruits are round with nettled yellow green lined ring, weighing 700 g. Flesh thick, deep salmon and sweet (15 - 18% TSS). Yield 224 q/ha in 90 days. Sel. CHES 238-1 is an improved selection from local collection from Banas river bed, Tonk, Rajasthan. Plants are spreading branched, bear more fruits on secondary branches. Fruits are round with nettled yellow rind, weighing 800 grams. Flesh thick deep salmon and sweet (14-17% TSS). Yield is 240 q/ha in 95 days. Sel. CHES 268-1 is a selection from a variable population of M-6 (3) collected from Agricultural Research Station, Durgapura, and Rajasthan. Plants are dwarf, bearing from base. Fruits are round with nettled creamy white rind, weighing 700 grams. Flesh thick deep salmon and sweet (11 - 13% TSS). Yielding 230 q/ha in 90 days. All these superior selections have been deposited in gene bank of IIHR, Bangalore.

In garlic, the variety' Agri-Found White (G-41) from AADF has been found as best adapted and high yielding (150 to 160 q/ha) in the region and recommended for cultivation.

Forty-six genotypes of pumpkin collected from diversified areas of the country were assessed under rain fed condition genotype CM-16 recorded the highest fruit yield per plant, maximum number of fruits per plant, lower sex ratio followed by CM-20 are higher yielder with small sized fruits.

In bottle gourd, 20 genotypes of bottle gourd collected from diversified areas of the country assessed under rain fed condition. The genotype LS-6 recorded the highest fruit yield per plant, highest number of fruits per plant lowest sex ratio and highest fruit set per cent. Forty-six genotypes of bitter gourd collected from diversified areas of the country assessed under zero irrigation condition.

The genotype MCC-23 recorded the maximum number of primary branches per plant, fruit yield per plot and fruit weight.

Moringa plant in bearing

Studies on genetic variability in annual moringa were carried out. The extent of genetic variability, heritability and genetic advance in respect of 17 quantitative characters in 14 germplasm lines of annual moringa was studied. The highest pulp weight was observed in PKM-2 (169.7 g) compared to MO-9 (35.1 g). The highest number of fruits per plant was observed in PKM -1 (314.76) than MO-8 (78.47). PKM-2 had recorded the highest yield of 44.257 kg than the lowest yielder MO-8 (16.893 kg).

Among the F1s of pumpkin tested season, CM-16 x CM-19 was found better for more number of fruits per plant (9.21) weighing 1.826 kg. In case of bottle gourd, 31 F1s progenies of bottle gourd was tested and categorized based on fruit size index, one is small, 20 are medium sized and 10 are long sized fruits. The shortest time taken for female flowering was observed in (LS14-2 x LS14-1), (LS27-1 x LS30-1), (LS32-2 x LS42-2) and (LS32-2 x LS28-1). Maximum time (69 days) taken was recorded in (LS2-1 x LS12) and (LS12 x LS11-5).

PRODUCTION TECHNOLOGY

FRUIT CROPS

Propagation Technique

Wood apple

Modified method for soft wood grafting in wood apple was devised, wherein the rootstock seedlings (one year old) were defoliated 10 days prior to grafting. The invigourated scion stock was then grafted by usual method and 53.33 per cent success in grafting was recorded in the month of February. Thus it can be concluded that modified Soft wood grafting method was successful in propagation of wood apple. *In situ* soft wood grafting was successful in raising the wood apple orchard, more vigorous growth of the plants was obtained as compared to nursery grafting.

Jamun

Patch budding and soft wood grafting were carried out at monthly interval commencing from September 2002 to August 2004. Patch budded plants sprouted earliest in July (16 days). Higher percentage of graft success was noted in March (40 %) in patch budded plants, where as it was recorded to be highest in soft wood grafted plants in August ((36 %). Soft wood grafted plants had also higher number of leaves than patch budded plants. Patch budding in March and soft wood grafting in July- August may be followed for multiplication of elite jamun plants. The plants propagated by *in situ* patch budding in the month of March and April recorded good success i.e. 80.25 % and 77.50 %, respectively. Patch budding in the month of March and April may be practiced for multiplication of elite jamun genotypes as well as for establishment of orchards in semi-arid environment of western India.

Tamarind

Patch budding in the month of July-August and soft wood grafting in the month of April-May may be adopted in the region for multiplication of elite tamarind genotypes.

Chironji

The plants propagated by in situ soft wood grafting on 15th of July recorded highest success (18.0 %) and number of leaves per plant (33.0). It may be concluded that soft wood grafting in the month of July may be followed for multiplication of elite chironji genotypes under semi arid environment of Western India.

Cropping System

CHES initiated a project on horti-silvi-pastoral system with a view to evolve the methods for optimum utilization of production potential of marginal/degraded lands under semi-arid, dry land conditions adopting a composite farming system with components of horticulture, silviculture and pasture grasses along with soil and water management techniques. Studies on comparative performance of different fruit crops revealed that ber performed better as compared to mango and guava. Growing silviculture species viz., Bamboo, *Eucalyptus* spp., *Leucaena leucocephala* and pasture grasses like *Cenchrus ciliaris* and *Stylosanthes hamata* met the fuel and fodder requirements of farming families. Inter-cropping in ber orchards with *kharif* vegetables was found highly profitable to generate additional income. Comparative performance of various inter-crops indicated that seed sown crops like cluster bean, cowpea, and okra exhibited appreciable drought tolerance as compared to transplanted crops like brinjal which had completely failed during 1987. Cluster bean was found to be most drought-hardy and the ber + cluster bean combination, gave the highest net return of Rs. 14,630/- per ha during the severe drought year of 1987. During 1986, ber + cowpea combination gave the highest net return while in 1988, the highest net return (Rs. 24,627/ha) was obtained in ber + okra combination. The traditional farming system of growing maize + pigeon pea was severely affected by drought conditions and gave very poor returns during all these years. It is felt that this system could serve as module for the development of marginal and degraded lands in the region.

Inter cropping in Aonla block

Aonla based cropping system under rain fed condition of semi-arid ecosystem:

Aonla + bottle gourd combination performed better in the terms of yield ha. So far as the economics of experiment is concerned, maximum income was obtained from plot of bottle gourd than rest of the intercrops. The same treatment proved to be the highest economic return Rs. 67470/ ha and cost benefit ratio 1:1.66. To get maximum profit, aonla + bottle gourd combination may be adopted by the growers under rain fed condition of semi-arid ecosystem.

Harvesting of Bottle Gourd in Aonla block

Nutrient Management

Sapota

Dris Norms in Sapota: A leaf sampling survey was conducted in existing orchards of sapota in Valsad, Navsari, Junagarh and Bhavnagar districts of Gujarat during the year 1999 and 2000 to develop DRIS norms. The optimum nitrogen concentration in the index leaf ranged from 1.25-2.38%, whereas for phosphorus, potassium, calcium, magnesium sulphur, iron, manganese, zinc and copper the optimum values are 0.05-0.17%, 0.36-0.77 %, 1.01-2.04%, 0.48-0.92% and 0.38-0.82%, 18.9-147.43 ppm, 18.12-36.97 ppm, 7.89-16.57 ppm and 3.92-5.66 ppm, respectively. Soil properties of various orchards were analysed during the course of the study. Electrical conductivity, pH organic carbon, phosphorus, potassium, calcium, magnesium and sulphur ranged from 0.05 to 4.3 dSm-1, 7.45 to 8.62, 2.5 to 20.6 g kg-1, 4.41 to 188 kg ha-1, 24.75 to 1620 kg ha-1, 1876.5 to 19518 kg ha-1, 390.6 to 7011 kg ha-1 and 24.75 to 445.95 kg ha-1 respectively

Nutrient trials in sapota: An experiment was conducted with different doses of nitrogen, phosporus and potassium (50 g/tree to 700 g/tree). In this experiment, tree height, spread and fruit number were observed. Based on observations it was concluded that a dose of 400g N/tree. a dose of 600 g P_2O_5 / tree and a dose of 600 g K_2O/tree (kg/tree) are sufficient for getting higher yields in semi arid conditions under rain fed conditions in vertisols soils of CHES, Vejalpur Farm.

INM in sapota cv. Kalipatti: Fruit retention and yield/ plant was significantly influenced by application of mixed fertilizer dose in comparison to recommended fertilizer dose. Maximum number of fruits / shoot were retained (60 /shoot) and yield /plant (92 kg /plant) in combined application of ½ FYM (50 kg) + ½ through chemical fertilizer (N 500 g P 200 g K 200 g/plant). Maximum nitrogen content of leaf was observed in application of nitrogen ½ castor cake + ½ fertilizer (2.67% N) closely followed by ½ groundnut cake + ½ fertilizers dose (2.62%). Potash content of leaf was also significantly influenced and was maximum in fertilizers applied through FYM (0.83%). P content of leaf was not significantly influenced. Data on soil moisture retention indicated that maximum soil moisture (12.22%) on oven dry weight basis recorded in application of N through FYM. It was closely followed by ½ N through FYM and ½ through fertilizer. Highest organic matter content (0.75%) was also recorded in the same treatment. Thus the results indicated that replacement of chemical fertilizers with organic fertilizer is certainly helpful in improvement of soil and plant health and also resulted in 6.97% increase in yield over control (full fertilizer dose).

Ber

High density orcharding in ber with four varieties and three spacing revealed that economics of high-density orcharding worked out indicated that B:C ratio was maximum in closer spacing of 5 m x 5 m; owing to accommodation of more number of plants / ha. It was 1: 4.54.

Studies carried out on intensity of pruning revealed that plant pruned to 90 cm length

produced highest yield and pulp/stone ratio. The pruned material is used as fuel wood. In the first year of pruning, ber plantation yielded about 1.60 q/ha of pruned wood on dry weight basis. The fuel wood production increases progressively and in the seventh year 58.90 q/ha fuel wood was obtained from the annual pruning.

Aonla

High-density orchard in aonla with six spacing had significant influence on the growth parameters of cv. NA-7. At 6 years of age, there was no adverse effect on the growth of closely spaced plants. However, closer spacing had significant influence on plant growth and yield potential of Aonla. Higher the spacing more the yield /plant, whereas, it was just reverse in case of yield / ha. The net profit was 2.93 times higher as compared to 10 m x 10 m spacing. Highest B:C ratio (28.94) was observed at a closer spacing of 5 m x 5 m, owing to accommodation of more number of plants / ha. Hence, to maximize the production potential / unit area and to increase the income of the farmers planting cv. NA-7 at 5 m x 5 m spacing is recommended.

Dris norms in aonla: Leaf sampling survey was done in 2003 in Uttar Pradesh State. Leaf samples were collected from 100 different aonla trees and soil samples were collected from 41 different orchards and analysed for nutrient composition and DRIS norms were developed in aonla. The optimum nitrogen content in index leaf ranged from 1.03 to 3.03 %, phosphorus content ranged from 0.11 to 0.16 %, potassium ranged from 0.31 to 0.6 %, calcium content ranged from 0.44 to 0.88 %, magnesium ranged from 0.17 to 0.48 % and sulphur ranged from 0.07 to 0.12 %. The optimum iron concentration in the index leaf ranged from 62.89-186.3 ppm, whereas manganese, zinc and copper, ranged from 19.97-46.57 ppm, 7.76-13.9 ppm and 5-11.63 ppm respectively. The optimum electrical conductivity of the collected soil samples ranged from 0.022 to 0.115 dSm-1, pH ranged from 6.33 to 8.13, organic carbon ranged from 0.24 to 0.63 %, exchangeable potassium ranged from 29.52 to 136.63 ppm, exchangeable calcium ranged from 621.13 to 1753.03 ppm, exchangeable magnesium ranged from 206.0 to 682.9 ppm, Calcium chloride (0.15%) extractable sulphur ranged from 23.06 to 53.25 ppm.

Mulching: Organic (paddy straw, maize straw, and grasses, subabul lopping and rice husk) and synthetic (black polythene) mulches encouraged plant growth and reduced soil moisture evaporation than control. Soil moisture content was recorded highest in black polythene mulch which was closely followed by paddy straw and it was recorded lowest under control (under no mulched condition). The maximum fruit yield was recorded with paddy straw (41.50 kg/plant) followed by maize straw (40.00 kg/plant) and while lowest was recorded in control (37.50 kg/plant). Highest fruit weight (43.16 g), fruit diameter (4.25 cm) and length (4.00 cm), TSS (8.25°Brix), total phenols (173.450 mg/100 g), vitamin c (498.00 mg/100 g) were observed with paddy straw which was closely followed by maize straw.

Planting systems: Yield per ha of aonla cv. NA-7 was recorded highest from double hedgerow planting system (83.98 q/ha) followed by hedgerow planting system (66.82 q/ha), cluster planting systems (57.71 q/ha) and paired planting system (47.03 q/ha) whereas the yield per ha was

recorded lowest in the traditional square system of planting (39.50 q/ha).

Aonla+ bottle gourd combination performed better in the terms of yield ha. So far as the economics of experiment is concerned, maximum income was obtained from plot of bottle gourd than rest of the intercrops. The same treatment showed the highest economic return Rs. 67470/ and cost: benefit ratio 1:1.66. To get maximum profit, aonla + bottle gourd combination may be adopted by the growers under rainfed condition of semi-arid ecosystem.

Phalsa

Highest yield per plant (1.53kg) was obtained in maximum spacing of 3.0 m x 2.4 m, yield / ha. which was highest in closer spacing of 3 m x 2.4 m owing to a maximum plant population (72.49 q/ha). The net return was also highest in the same treatment (Rs 46,490/-) and B:C ratio of 2.78.

Pomegranate

Biofertilizers: Application of phosphate solubilizing bacteria + Azospirillum (50 g+50 g/ plant) resulted in significant effect on the physico-chemical like fruit weight, Aril weight, juice percent, T.S.S. and yield attributes like number fruits retained, per cent retention and yield per plant in pomegranate cv. Ganesh were recorded. Therefore application of 50 g PSB and 50 g Azospirillum is recommended under rain fed condition in *Hasta bahar* to maximize production in pomegranate in Ganesh and at the same time improving the nutritional status of the plant.

Allelopathy influence of tree species: Germination was suppressed in moth bean, green gram and sesamum. Maximum suppression was observed in neem except in soybean, pigeon pea and Dolichos bean. Custard apple leaf leachate, however, enhanced germination in soybean, maize, pigeon pea, and fodder jowar. Germination was suppressed by all the leaf leachate particularly in green gram, moth bean and sesamum.

Leaf litter fall: Tree species add large amount of leaf litter to the soil due to their deciduous nature. The leaf litter fall recycles large amount of nutrients to the soil improving soil health. Maximum leaf litter fall (9.375 kg) was recorded in aonla. However, on per hectare basis, maximum leaf litter was produced by subabool (9515.33 kg) due to closer planting. Maximum nutrient (N, P, K) on per plant basis were recycled in aonla (74.668 g N/tree, 10.326 g P/tree and 33.806 g K/tree, respectively). Whereas, on per hectare basis, maximum nutrients were recycled by subabool leaf litter (171.482 kg N /ha, 10.472 kg P/ha and 31.437 kg K/ha, respectively). Per cent leaf litter decomposition after the period of two months, was maximum in subabool (44.15%) and minimum in neem (25.27 %). Subabool decomposed leaf litter had the highest N content, whereas maximum P and K content was recorded in decomposed custard apple leaf litter.

Leaf litter of four tree species viz. Subabool, Neem, Sun hemp and Dhaincha @ 10 kg / plant to the pomegranate cv. Ganesh on the onset of monsoon helped to improve the soil health and moisture retention capacity. Fruit retention and yield per ha were also improved to the tune of 29.28 per cent over control and additional income of Rs. 5400/ ha was obtained by application of organic fertilizers compared to control.

Soil productivity and sustainability through agro forestry systems: Soil analysis of the agro-forestry system for the past three years in respect of pH, EC, organic carbon (%) and NPK content showed that there was improvement in respect of all the parameters recorded. pH of the soil decreased marginally. Electrical conductivity of the soil was also decreased. Organic carbon content of the soil improved over the years probably due to addition of leaf litter by tree species and residue by intercrops. Similarly NPK content of the soil increased in all the intercrops over control. Mean nitrogen and phosphorus content was maximum in green gram. (186.60 kg N /ha and 8.250 kg P2O5/ha) being a leguminous crop,

Root distribution in horti-silvi tree species : Maximum root biomass (22.75 kg/ tree) and above ground biomass (267.07 kg/tree) recorded in subabool. Maximum root length (130.20 cm) in neem and maximum horizontal root spread (3.40 m) was exhibited by aonla. Maximum root to crown spread ratio (1.444) was recorded in Subabool. All the tree species have deep root system, which is with in the canopy of the tree and hence did not interfere with the intercrops thus the competition between the species

Soil moisture depletion and its utilization: Maximum run-off and soil loss was recorded in the cultivated uncropped soil. It was minimum in no tillage. Staggered contour trench planting was found to be the best for reducing run-off and soil loss effectively. Run-off and soil loss was higher in custard apple and neem due to higher slope of the land and its soil type. Adopting staggered contour trench planting method, run-off of water and soil erosion losses were reduced almost 3 times, saving the valuable soil and water resources thereby maintaining the sustainability of the soil.

VEGETABLES

Organic Farming in vegetable

An experiment was conducted in vegetables with different forms of organic matter like FYM, vermi-compost, poultry manure and sheep manure with biofertilizer combinations like *Azotobacter* and *Azospirillum* and PSB taking bhendi, brinjal, bottle gourd and sponge gourd as test crops with four replications in rainy seasons of 2004, 2005, 2006 and 2007.

The results indicated that the crop receiving poultry manure gave significantly higher yields compared to other three forms like FYM, vermi-compost, sheep manure and control. Among the two sources of bio fertilizers, *Azotobacter* proved better compared to *Azospirillum* in all the four crops.

Production Technology in Moringa

Spacing: Effect of spacing on growth and yield of annual Moringa PKM-2under semi arid condition was studied. The higher number of pods per tree (183.88) was observed in 5.0 m x 5.0 m spacing and total yield per tree (52.56 kg) which is almost 2½ fold increase over the control. The

highest yield per ha was recorded in treatment 5.0 m x 2.5 m (34.28 tonnes/ha)

Pruning: The maximum plants spread (11.83 m2), minimum days for flowering (108 days), number of panicles per tree (49), number of pods per panicle (2.36) and the highest number of pods per tree (173) was observed in the moringa var. PKM-2 tree pruned in the month of December.

Moringa based vegetable cropping system: Research on Moringa based vegetable cropping system through in situ water harvesting technique under rain fed condition indicated that pitting at 1.5 x 1.0 x 1.0 m applied with 6 per cent FYM proved to best for higher yield per pit 17.205 kg and 6.375 t/ha in ridge gourd, 33.345 kg and 13.325 t/ha in pumpkin with moringa (14.28 t/ha) with net income of Rs. 72557.5 as compared to the control.

Different intercrop combinations comprising ground cover crops (pumpkin-Arka Chandan and bottle gourd -Arka Bahar), medium stature crops (Okra -Arka Anamika and cluster bean-Goma Manjari) and low stature crop (Cowpea-Pusa Phalguni) with drumstick var. + PKM-2, during 2003-2005. The Drumstick + pumpkin+ cluster bean+ cowpea combination out performed over check (maize + pigeon pea) in terms of yield per ha, crop intensity (%), land equivalent ratio, income equivalent ratio and net return.

Interaction of component crops did not significantly reduce the growth parameters of base crop (drumstick) over sole crop. Higher the cropping index (200%), drumstick equivalent yield (28.65 kg/ha) and land equivalent ratio (2.39) has been observed in the treatment combining drumstick and ridge gourd.

Drum stick genotypes for its root as a vegetable: Three genotypes of drumstick, PKM-1, PKM-2 and Pink types were tested to assess their root growth performance in three different medium clay, red and sandy soil. PKM-2 was found to be better for root growth and appearance sown in the sand medium than the other genotypes.

PLANT PROTECTION

MANAGEMENT OF INSECT PESTS

FRUIT CROPS

Ber

About 25 insect pests were recorded infesting ber. Amongst them, hairy caterpillar, *Thiacidas postica* W, ber blue butter fly *Tarucus theophrastus*, leaf hispid and fruit fly *Carpomyia vesuviana* Costa and fruit borer *Meridarchis scyrodes* Meyr. proved to be economically important pests causing the damage to the extent of 15- 17 per cent. Based on seasonality studies, an effective schedule of control involving application of either Monocrotophos (0.05%), Fenvalerate (0.005%), Decamethrin (0.0015%) or Endosulfan (0.07%) commencing from first week of October offered effective protection against fruit fly and fruit borer. Another schedule of control involving two applications of Monocrotophos (0.05%), Fenvalerate (0.005%) or Endosulfan (0.07%) followed by two sprays of either NSKE (5%) or Multineem (0.5%) was also suggested. A commercial formulation of neem at 10 days interval was also equally effective against these pests.

Pomegranate

Over half a dozen of insect pests were recorded in pomegranate through seasonal incidence studies. Out these, the thrips *Scirtothrips dorsalis* Hood, aphids *Aphis punicae*, fruit borer *Virachola isocrates* F. and fruit sucking moth *Othreis* spp. appeared to be serious pests causing potential loss to the growers. As much as over 20 per cent fruits were damaged by anar butter fly while the damage to the extent of over 80 per cent was reported in case of fruit sucking moths during rainy season. Population of thrips was abundant during September and caused serious damage to the vigour of the plant. Based on the recommendation of *Hasta bahar* crop of pomegranate in this regard, a schedule of control involving applications of Monocrotophos or Dimethoate (both at 0.05%) followed by an application of either Fenvalerate (0.005%) or Endosulfan (0.07%) at fortnightly interval commencing from second fortnight of September has been found effective against thrips and anar butterfly. Another strategy of control involving two applications of either NSKE (5%) or Multineem (0.5%) at weekly interval proved equally effective against these pests. Besides, bagging of fruits also gave encouraging results in minimizing incidence of fruit sucking moths in early set of *Hasta bahar* crops.

Sapota

Based on seasonal studies, sapota moth *Nephopteryx eugraphella* R. and bud borer *Anarsia*

achrasella emerged out economically important pests of this region. The damage to the extent of over 30 per cent was reported during the month of August. However, bud borer appeared to be predominant pest attacking buds of sapota during the month of August. In addition, population of bud borer was monitored by using *Krishna Tulsi* (*Ocimum sanctum*) extract @ 500 g per litre of water and the result indicated that maximum adults were trapped during the same period.

Aonla

Amongst the various pests recorded in aonla, aphids *Cerciaphis emblica*, and leaf twister *Caloptilia* sp. shoot gall maker *Betousa stylophora* Swinh, hairy caterpillar (and fruit borer) *Virachola isocrates* and *Meridarchis* spp. were found to cause substantial damage to aonla crop of this region. Studies on varietal reaction to borer complex indicated the susceptibility of all varieties viz. NA-7, Kanchan, Krishna, Banarasi, Chakaiya, etc. to borer attack. The incidence varied between 80 and 94 per cent in the month of August, which further declined to 40 to 50 per cent in the month of September. Neem based pesticides were found to be quite promising in killing the larvae of hairy caterpillar in laboratory.

VEGETABLE CROPS

Chilli

Studies on the effect of varying dates of planting on the incidence of leaf curl caused by thrips, *Scirtothrips dorsalis* Hood, under natural conditions revealed significantly less incidence of leaf curl in a crop planted up to 15th July. Late transplanted crop was found to be severely affected by leaf curl. Consequently, the yield of chilli was adversely affected. Hence, planting of chilli from 30th June was found to be an appropriate time for getting a good yield of chilli by preventing it from the severity of attack of thrips during critical crop growth stages. Seven applications of Monocrotophos (0.05%) at fortnightly interval commencing from 15 days after transplanting could avoid a significant loss in terms of yield of chilli in vars. Pusa Jwala and G-4. Experiments on crop and number of applications of Monocrotophos at 0.5 kg a. i./ha commencing from 35 days after transplanting not only reduced the incidence of leaf curl but also helped to increase the yield of chilli. Simultaneous studies on seasonal incidence of leaf curl caused by thrips showed significant positive correlation with maximum temperature ($r=0.7$), while a negative correlation was observed between minimum temperature, rainfall and relative humidity and the incidence of leaf curl with a correlation coefficient value being $r=-0.75$, -0.78 and -0.32, respectively.

While evaluating a schedule of control against major pests of chilli, it was inferred that five sprays of Monocrotophos alone or a soil application of Carbofuron followed by four sprays of Monocrotophos commencing from 35 days after transplanting gave consistent results in reducing the incidence of leaf curl caused by thrips and consequently a significantly higher yield of chilli was

obtained. Application of two sprays of NSKE (0.5%) at weekly interval was also found equally effective. The other treatments comprising of two sprays of Multineem (0.5%), (commercial formulation of neem) at weekly interval followed by two sprays of Monocrotophos, Phosphamidon and Dimethoate at fortnightly interval were also equally effective in reducing the incidence of leaf curl caused by thrips in chilli var. Pusa Jwala.

Brinjal

Studies on the effect of varying date of planting on the incidence of jassid, *Amrasca biguttulla biguttulla* Ishida under natural conditions revealed that the crop planted up to 15th July give significantly higher yield of marketable brinjal than the crop planted at later dates. Six applications of either Fenvalerate (0.005%) or Endosulfan (0.07%) at fortnightly interval commencing from 21 days after transplanting could avoid a significant loss in the marketable yield of brinjal var. Pusa Kranti. A significant positive correlation was found between the maximum temperature and the population of jassid ($r=0.56$). Schedule of control against the major pests of brinjal were evaluated. Results of the experiments revealed that six foliar sprays of Endosulfan (0.05%) alone or Phosphamidon (0.05%) or Dimethoate (0.05%), or Monocrotophos (0.05%) alone commencing from 21 days after transplanting offered effective protection from the attack of jassid.

Similarly a schedule or control involving application of two sprays of Monocrotophos or Dimethoate (both at fortnightly interval followed by two sprays of either NSKE (5%) at weekly interval was found effective against jassid. However, effective control of shoot and fruit borer, *Leucinodes orbanalis* Guen. was achieved by application of ½ dose of Fenvalerate + ½ dose of Multineem (0.05%).

Bitter gourd

Seasonality incidence extent of damage and assessment of losses caused by fruit fly infesting bitter gourd have been worked out. Schedule involving application of either Dimethoate (0.05%) or Endosulfan (0.07%) in combination with Mancozeb (0.2%) significantly reduced the incidence of fruit fly and downy mildew. The crop raised on pandal recorded an overall incidence of 13- 17 per cent of fruit fly while it was 17- 22 per cent in a crops raised on the ground. An overall disease reduction of 23.59 per cent was observed in a plot treated with Mancozeb (0.2%).

Ready to use pheromone, cue-lure was used in a trap for monitoring population fluctuations of fruit fly during the *kharif* season. The data on weekly catch/trap clearly revealed peak period of activity during second and third week of September which coincided with peak harvest of the crop. The average catch/trap ranged between 30 and 55 adults /trap.

MANAGEMENT OF DISEASES

FRUIT CROPS

BER

Powdery mildew

Powdery mildew (*Oidium ziziphi*) is the major disease of ber. Other diseases which attack this crop are rust (*Phakopsora zizyphi*), brown leaf spots (*Alternaria* sp.), fruit-rots (*Pestalotia cruenta* and *Alternaria alternata*). The pathogenic fungus commonly infects not only the cultivated species *Ziziphus mauritiana*, but also wild species like *Z. nummularia, Z. rotundifolia* and *Z. glabra*. However, *Z. oenoplia* and *Z. xylopyra are* rarely attacked by the powdery mildew.

Epidemiological studies revealed that the disease generally appears soon after the cessation of rainy season during September and becomes severe during October-November. The disease thrives in a wide range of temperature (between 11 and 37°C). However, 13- 24°C temperature range is highly favourable for disease development. The disease is favoured by high humidity (75-95% R.H.) and the disease incidence increases significantly if occasional rainfall occurs during post-monsoon period and in winter season (September to January). Similarly, during drought years, it is observed that disease incidence is not very severe and hence manageable with limited (2-3) number of sprays.

The disease causes white floury patches on leaves, flowers and fruits. Severely infected young leaves turn pale and are distorted in shape. Worst damage, however, occurs on fruits, the pea size stage being the most susceptible. The disease brings about 40-55 per cent fruit drop during pea size and marble size stages of fruit development, which contributes to yield reduction. During the years receiving good rainfall, more than 75 per cent fruits are infected with the disease, resulting in malformed, rough and discoloured fruits showing cracked surface. Their weight is reduced and the TSS is also altered.

Varietal reaction: The varietal screening revealed that all the commercial cultivars are susceptible to the disease in varying degree. Umran, Mundia and Gola are highly susceptible whereas Seb and Banarasi Kadaka are moderately susceptible. Varieties Jogia, Meharwali, Darakhi-1, Darakhi-2, Guli, Sannaur-5, ZG-2, Illaichi and Tikdi were rated as moderately resistant.

Management : Since the disease is air-borne, the fungicidal control offers the best disease management strategy. Several chemicals have been found effective against this disease. The control trial revealed their efficacy in the order of Bayleton (Tridemefon) 0.1% (Per cent disease control, PDC=92.5), Topas (Penconazole) 0.05% (PDC=90.2), Karathane 48 EC (Dinocap) 0.1% (PDC=89.5), Benofit (Benomyl) 0.1% (PDC=88.50), Topsin-M (Thiophanate methyl), 0.1%, (PDC=87.2), Score (Difeneconazole) 0.1% (PDC = 82.3), Calixin (Tridemorph) 0.08% (PDC = 82.0), Bavistin (Carbendazim) 0.1% (PDC=78.1) and Sulfex (Wettable sulphur) 0.25% (PDC=75.5). In the above

stated tria,l spraying was commenced from second week of September and sprays were given three times after every fortnightly interval.

To reduce the cost of spraying without affecting its efficacy, it was suggested that first spray should be with Karathane, Topsin-M or Bavistin and remaining one or two sprays with the cheaper fungicide Sulfex. The efficacy of wettable sulphur can be improved further by addition of some spreader and sticker like Sandovit, soap solution or flour or by combining fungicidal sprays with liquid formulations of insecticides.

Rust

The disease appears in November and brings about considerable defoliation in ber. Though sprays with Dithane M-45 (Mancozeb) 0.2% (PDC=89.7) and Bavistin (0.1%) (PDC=81.2) provided effective disease management strategy, the conventional sprays with Sulfex (0.2%) mainly intended to control powdery mildew also reduce the disease intensity of rust (PDC = 65.6).

POMEGRANATE

Major diseases: Cercospora (*Pseudocercospora punicae*) leaf and fruit spots and anthracnose (*Colletotrichum gloeosporioides*). Other diseases which cause damage to pomegranate include leaf spots and fruit spots (*Alternaria* sp., *Sphaceloma punicae*, *Pestalotia* sp. *Phomopsis punicae*), bacterial leaf spots (*Xanthomonas punicae*), fruit-rot (*Aspergillus* spp; *Phomopsis* sp., *Phytophthora parasitica*, etc.).

Cercospora leaf spots

The disease causes circular to irregular spots with dark grey center and blackish brown margin on both surfaces of leaves, flowers and also fruit rind. In case of severe infection, heavy defoliation is resulted, which imparts a sick and blighted look to the plant. On fruits, circular to irregular dark grey spots with light grey specks in the center are seen during and a few days after the rains i.e. during August and September. Varieties Jyoti, Ramnagram, P-16, P-23 and P-26 were found moderately resistant. Results of fungicidal control trials revealed that one or two fortnightly sprays commencing from the first fortnight of August with Topsin-M, 0.1% (PDC =83.2), Captaf (Captan) 0.2%, (80.2), Dithane M-45, 0.2% (PDC= 77.1), Difeneconazole (Score) 0.05% (PDC=82.5), Kavach (Chlorthalonil), 0.2% (PDC=91.7), Bavistin, 0.1%, (PDC= 77.6), Blitox, 0.3% (75.1), and Benlate (Benomyl) 0.1%, (73.2) provided effective management of the *P. punicae* leaf spots.

Colletotrichum leaf spots

The disease is manifested by minute, circular to irregular, dull, violet-black to black leaf pots on leaves during rainy season. On fruits, circular to irregular, dark-brown to black depressed spots develop

which enlarge and cover the entire fruit. Results of fungicidal control trials revealed that 2-3 fortnightly sprays during August-September with Bavistin 0.1% (PDC=80.3), Blitox 0.3% (PDC=78.5), Kavach (Chlorthalonil) 0.2% (PDC=79.4), Mancozeb (Dithane M-45), 0.2% (PDC=75.3), Captaf, 0.2%(PDC=74.6) and Score 0.05% (PDC=80.12) provided good management strategy against the disease.

It was also observed that avoidance of *mrig bahar* crop, removal of crop debris near the infected plants, spray with Captaf (0.2%) or Mancozeb (0.2%) and incorporation of *Trichoderma viridae* spores in soil @ 2 x 105 cfu /g. of soil and also its spray on plant surface brings about the reduction in disease incidence to nearly negligible level.

AONLA

Diseases: Fruit rot (*Colletotrichum* state of *Glomerella cingulata*), rust (*Ravenalia emblicae*), fruit rot (*Penicillium islandicum*, *Aspergillus niger* and *Rhizopus* sp.). The results of the control trials against major diseases viz. Glomerella fruit-rot (anthracnose) and rust revealed that prophylactic sprays with Mancozeb (Dithane-M-45, 0.2%) and Chlorthalonil (Kavach 0.2%), provided very effective management of both the diseases.

PHALSA

Rust

Rust (*Dasturella grewiae)*, Cercospora leaf spots (*C. grewiae*), and powdery mildew (*Oidium* sp.) are the major diseases of phalsa.

The rust of phalsa occurs in October and was found to be effectively managed by two fortnightly spray with Mancozeb 0.2% (Dithane M-45) (PDC=75.48, Chlorthalonil (Kavach) 0.2% (PDC=64.66), Blitox (0.3%) (PDC=65.1) and wettable sulpher (Sulfex 0.2%) (PDC=63.3) during October.

Cercospora leaf spots also occur during September – October and were found to be controlled by sprays with Mancozeb (0.2%) and Blitox (0.3%). However, often the sprays are often not required in Godhra condition, since the phalsa bushes are pruned during December.

Powdery mildew

The disease causes the coating of white coloured mildew colony on fruits. One or two fortnightly sprays with Sulfex, 0.2% and Bavistin 0.1% (PDC=94.1 and 96.3, respectively) during December-January provided excellent disease management.

MANGO

Major diseases of mango are powdery mildew (*Oidium mangiferae*), die-back (*Botryodiplodia theobromae*), anthracnose (*Colletotrichum gloeosporiodes*) and leaf blight (*Pestalotiopsis mangiferae*). Other diseases: *Aspergillus* fruit rot and malformation are the other diseases of this crop.

Powdery mildew

The disease is characterized by white powdery growth on young leaves, tender stem, and inflorescence and young fruits. The disease is favoured by cloudy warm humid days and cool nights during December to March. Heavy fruits and flowers drop occurs after infection which results in severe losses. Sprays with Sulfex (0.2%) or Bavistin (0.1%) or Benlate (0.1%) or Calixin (0.1%) or Topsin-M (0.1%) or Topas (0.05%) twice at fortnightly interval efficiently managed the disease, and offered a disease control to the extent at 77.1, 86.2, 82.8, 89.1, 88.5 and 90 per cent, respectively.

Anthracnose

The disease is characterized by appearance of brown spots on leaves and inflorescence. Twigs show dieback symptom, flowers shed and black spots appear on fruits. High humidity, frequent rains and a temperature range between 24 and 300 C. at flowering and fruit set stage favour the disease development. Sprays with Blitox (0.3%), Bavistin (0.1%), Benlate (0.1%), Topsin-M (0.1%), Cuman-L (0.35%) or Captaf (0.2%) were found very effective to reduce the disease incidence and provided 72-80 per cent disease control.

Gum oozing and dieback

The disease is characterized by drying up of affected branches, oozing of ambar coloured gum from stem and branches and ultimately death of plants. For its management removal of the affected portion of bark by knife and application of copper fungicide (painting on stem with copper fungicide up to 2-3 feet height) on bark was found effective. Sprays with Captaf (0.25%), Bavistin, Benlate or Topsin-M (all 3 at 0.1%), were also found very effective and offered 68-75 per cent disease control. These strategies coupled with balanced nutrition provided complete control of the very important malady of mango.

Grey leaf blight

The causal fungus brings about brown coloured irregular spots generally on leaf margins and tips, later black colour pin head shaped mass is seen in the centre. For management of the disease, prophylactic spray with Mancozeb (0.2%), Topsin-M (0.1%), Bavistin (0.1%) and Blitox (0.3%) in rainy season were found effective and provided 60-75 per cent disease control.

PAPAYA

Major diseases of papaya are foot and root rot (*Pythium aphanidermatum*), papaya ring spot virus.

Other diseases: Powdery mildew (*Acrosporium* sp.), cercospora leaf spots (*C. papayae*), anthracnose (*Colletotrichum gloeosporioides*), leaf curl virus are other diseases of papaya.

Foot and root rot

The disease causes dark coloured, water soaked patches on stem of the seedlings near collar region and decay of the roots. The disease was found to be managed by drenching in soil with Blitox (0.3%)(PDC=61.2), Ridomil-Mz (0.25%) (PDC=85.6), Aliette (0.2%) (PDC=82.2), Chlorthalonil (0.2%) (PDC=75.1) and Captaf (o.25%) (PDC=73.8). Application of *Trichoderma harzianum* spores @ $2x10^6$cfu/g of soil also helped in management of the disease and provided about 78.2 per cent disease control.

VEGETABLE CROPS

Nursery Diseases

The nurseries of transplanted crops viz. chillies, brinjal, tomato, capsicum, cauliflower and onion, etc. often suffer with high incidence of pre and post-emergence damping-off which is most commonly incited by *Pythium debaryanum*, *P. aphanidermatum* and other pythiaceous fungi, although occasionally other fungi like *Rhizoctonia solani* and *Sclerotium rolfsii* also bring about mortality and poor seedling stand. The disease caused by *Pythium* spp. is characterized by poor emergence and mortality of seedlings due to toppling over. The infection starts at or below ground level on juvenile, soft and non-thickened tissue in form of soft and water-soaked lesions near root tips and advance upwards through root system to the stem and the base of stem becomes constricted. On the other hand *R. solani* attacks seedlings at ground level (at hypocotyls region) and grows downwards, from there into roots. Under favourable conditions like excessive crowding, high moisture and relatively low light intensity, the mortality was found to be as high as 48-60 per cent.

Management of Nursery Diseases

(A) Chemical control: Seed treatment with broad spectrum fungicides like Ridomil-Mz @ 2.5 g/kg seed (0.25%), or Captaf @ 2.5 g/kg seeds or Emisan @ 2.5 g/kg seed, Thiride @ 2.5 g/kg seed or Blitox @ 3 g/kg of seeds provided very effective control of post-emergence damping-off (caused due to *Pythium* spp.) of all the transplanted crops.

Soil-drenching with Blitox (0.3%), Ridomil-Mz (0.25%), or Aliette (Focetyl-Al) (0.2%) provided 69.13 - 87.0 per cent disease control in solanaceous crops like tomato and chillies.

A combination of seed-treatment and soil drenching almost eliminated the chances of disease occurrence and also provided more vigorous seedlings as compared to control.

(B) Non-chemical management strategies: Amongst non-chemical methods of disease management, incorporation of *Trichoderma viridae* spores in soil @ 2 x 10^6 cfu/g soil in seed-bed added with neem cake resulted in 84.12 per cent disease reduction as compared to control and also gave higher number of more vigorous seedlings as compared to control. Similarly, soil fumigation with 2% formalin also reduced the disease incidence by 80 per cent.

Covering the nursery-beds with transparent polythene sheet for two weeks during April and May months also provided about 74.12 per cent disease control. Deep ploughing in summers followed by direct exposure of soil to the hot sun also showed 47.1 per cent reduction in disease incidence. Integration of various strategies recorded almost complete control of the diseases.

Growing the nursery on 2" thick band of *Glomus mosseae*- infested soil showed good disease control, provided the VAM fungus colonies the roots. Burning of 9" thick stack of trash also offered good disease management. Incorporation of neem cake saw dust and vermicompost also helped in containing the disease.

The seedling mortality in chilli due to infection by *R. solani* and root rot due to *Sclerotium rolfsii* in chilli, brinjal and tomato was found to be completely controlled by soil-drenching and seed treatment with Captaf (0.25%), Bavistin(0.1%), Benomyl (0.05%), Blitox (0.1%), Topsin-M (0.1%) and Emisan (0.2%).

The healthy nursery practices were also recommended to control several seed-borne infections like alternaria blight of foliage of solanaceous and bulb crops, ripe fruit rot and dieback due to *Colletotrichum capsici* of chillies, *Phomopsis* fruit rot of brinjal, etc.

To control leaf curl of tomato, covering of nurseries with nylon-net was not considered necessary in rainfed cultivation since the disease occurs in this region generally in the month of September.

CHILLIES

Major diseases: Powdery mildew (*Leveillula taurica*), anthracnose (die-back and ripe fruit rot) (*Colletotrichum capsici*), tomato spotted wilt virus (TSWV) and leaf curl virus (TLCV) are the major diseases of chilli. Other diseases affect this crop are *Alternaria* leaf spots (*A. solani*), *Alternaria* fruit spots (*A. alternata*), *Cercospora* leaf spots (*C. capsici*) and tobacco mosaic virus.

Powdery mildew

The disease was characterized by whitish spots on dorsal side of leaf showing fluffy growth, the corresponding upper surface shows pale spots. On older leaves symptoms on both the surfaces were noticeable, heavy defoliation was observed and significant reduction in yield was recorded. In var. Reshampatti recorded 30 per cent avoidable loses in yield whereas Pusa Jwala and G-4 showed

losses ranging between 32.0-54.8 per cent, depending on the growth stage at which the disease attack the crop. Epidemiological studies showed that the disease starts in November and becomes severe during December and January. Therefore, the rain fed chilli crop is found free of its attack. A temperature regime of 15-25°C and relative humidity between 85 to 100 per cent was found favourable for disease development. The results of epidemiological experiments clearly revealed that early transplanting (up to 15th July) results in disease escape and provides higher yield due availability of favourable crop growth period.

The disease was found to be managed by 2 fortnightly sprays soon after the disease appearance with Sulfex (0.2%) (Per cent Disease Control PDC=66.1), Penconazole, Topas 0.05%) (PDC = 79%), Karathane (0.1%) (PDC=76.5) and Calixin (0.1%) (PDC=80.8). Alternative of Sulfex sprays with foliar sprays of KH_2PO_4 (0.1 M solution), provided significant reduction in disease severity. Foliar sprays of K_2HPO_4, $NaHCO_3$, $MgSO_4$ and $KHCO_3$ were also found superior over the control. Sprays with diluted dairy milk (50%) also displayed significant reduction in yield.

Anthracnose (ripe fruit rot and die back)

Both the diseases are common on chilli crop during and after rainy season- i.e. during August-September. Moderately warm temperature 28-30°C and high humidity (92–100% R.H.) favour the disease development. Under favourable conditions 25 - 35 per cent plants showed dieback symptoms. The ripe-fruit rot also causes 9.2 - 32.0% spoilage of fruits. Variety G-4 was found to be moderately resistant to fruit anthracnose (PDI=3.1) whereas Pusa Jwala (PDI=19.2) was highly susceptible. Dieback symptoms start with dark brown water soaked spots on twigs turning them dark and developing black dots on them. The ripe fruit rot was found to develop straw coloured, oblong spots with black dots in the inner lining of fruit. The disease was found to be seed borne since seeds extracted from anthracnose affected fruits showed about 15-20% disease incidence. The fungus also subsists on debris of infected plants. Hence, for its effective management, seed treatments as well as fungicidal sprays were tried. Results of nursery experiments with seven fungicides revealed that seed treatment with Captaf (3 g/kg seed or 0.3%), (PDC= 95.38), Thiride (Thiram) (0.3%) (PDC=91.5), Blitox (0.3%) (PDC=87.53), and Bavistin (0.1%) (PDC=89.2) were highly effective in providing disease-free seedlings. During field trials, two fortnightly sprays in August and September with Cuman-L (Ziram) (0.35%), (PDC=78.12), Mancozeb (Dithane M-45, 85.8, (Chlorthalonil (Kavach 0.2%) (PDC=90.52), Thiophanate methyl (Topsin-M, 0.1%) (PDC=89.43), Captaf (Foltaf,0.2%) (PDC=88.24), Copper oxychloride (Blitox, 0.3%) (PDC=67.09) and Carbendazim (Bavistin 0.1%) (PDC=86.58) were found very effective in controlling die-back and fruit rot. When both these strategies were integrated the disease incidence was reduced to almost negligible level.

Alternaria leaf spots

It is caused by *A. solani* and fruit spots *A. alternata*. Seed treatment with Blitox (0.3%), Rovral (Iprodione)(0.25%), Thiride (0.25%) or Mancozeb (0.2%) followed by spray with Mancozeb (0.2%) within one month of transplanting provided effective management of the disease and offered over 90

per cent disease control.

Cercospora leaf spots: Prophylactic spray with Bavistin (0.1%), Blitox (0.3%) or Thiophanate methyl (Topsin-M, 0.1%) during August provided almost complete freedom from the disease.

Tomato spotted wilt virus (TSWV)

The disease is characterized by bronze coloured marking on leaves, their mosaic pattern and upward curling followed by necrosis of growing point of the twig which further advances downwards leading to yellowing, browning and finally wilting. The disease is transmitted by thrips and is very serious in this region. Conventional insecticidal sprays (Monocrotophos, 0.05% or Phosphamidon (0.05%), originally intended to control leaf curl caused by the thrips, *Scirtothrips dorsalis*, also take care of this disease and provide 60-80 per cent disease control.

Leaf curl

Upward curling of leaves, reduction in leaf size, shortening of internodes, bushy look generally dwarf with pale colour foliage, production of small and deformed fruits, etc. are characteristic symptoms. The disease is transmitted by white fly (*Bemisia tabaci*). One or two tri-weekly sprays of insecticides (Monocrotophos, 0.05%) during August-September (as in case of TSWV) were found very helpful and provided 60-70 per cent disease control.

BRINJAL

Phomopsis blight (*Phomopsis vexan*) and little leaf (*Phytoplasma* or Mycoplasma-like organisms) are the important diseases of brinjal. Other important diseases like leaf spots caused by *Cercospora melongenae* and *Alternaria melongenae* also attack this crop.

Phomopsis blight

The disease starts at nursery stage and from there, it is carried to field. Often lower leaves are found badly infected. It is characterized by small, circular spot which become cinnamon-buff later and are surrounded by irregular blackish margin. It is a seed borne disease but the fungus also subsists on infected debris in field. Warm and wet weather with temperature ranging between 21 and 32°C favour the disease development. The disease was found to be managed by use of disease free seeds. The seeds extracted from the diseased fruits provided 7-15% seedlings infected with the blight, whereas the nursery grown from the seeds extracted from healthy fruits recorded less than 0.5% disease incidence. Seed treatment with Mancozeb (0.2%), Captaf (0.3%), Foltaf (Captafol 0.2%), Blitox (0.3%) and Bavistin (0.1%) provided almost 80-90% disease free seedlings. Spray with these fungicides, and selection of disease free seedlings provided almost complete freedom from disease on new foliage.

Cultural control like deep ploughing in summer and crop rotation with chilli for three years also showed very low (<5%) disease incidence.

Alteraria leaf spots/fruit spots

Seed treatment with Iprodione (Rovral, 0.2%) or Mancozeb (Indofil-M 45 0.2%) and sprays with Mancozeb provided 68-82 per cent disease control.

Little leaf disease (LLD)

The disease was found to be caused by phytoplasma like organism. Studies pertaining to estimation of losses, reaction of various cultivars against little leaf disease, seasonal incidence, transmission to different hosts and control were made.

Losses (26-40%) were high during winter crop than in rainy season (2.23-5.85%). On the basis of epidemiological studies, it was concluded that transplanting up to 15th July resulted in reduced incidence of this disease and consequently provided higher yield. Vars. Pusa Purple Cluster, Arka Sheel and Manjari Gota were relatively resistant to the disease whereas vars. Pusa Kranti, Pusa Purple Long, Pusa Purple Round, Arka Nidhi, Arka Navneet, etc. were highly susceptible.

The disease was graft transmitted to about one dozen hosts. Two angiospermic parasites (*Orobanche* sp. and *Cuscuta campestris*) infecting little leaf diseased brinjal plants also developed symptoms. These parasites showed the presence of MLO when observed under Electron Microscope.

Incorporation of Phorate 10 G or Carbofuran @ 1.0 kg/ha, in soil at nursery stage and 1-2 sprays with Monocrotophos (0.05%) or Phosphamidon (0.05%) to ward-off the leaf hopper vectors provided good (63-71%) disease control. Removal of infected plants was found very helpful in reducing the disease severity.

TOMATO

Major diseases of tomato in this region are early blight (*Alternaria solani*), Fusarium wilt (*Fusarium oxysporum*), and leaf curl (TLCV). Besides, Buck-eye rot (*Phytophthora parasitica* var. *nicotianae*), powdery mildew (*Oidiopsis taurica*), *Cercospora fuliginea* and *Septoria* leaf spots, spotted wilt virus, fruit rots caused by *Sclerotium*, *Rhizoctonia*, *Phoma* and *Alternaria solani*, anthracnose (*Colletotrichum phomoides*), etc.

Buckeye rot

Staking the plants, earthing-up operation and two fortnightly sprays with Blitox (0.3%), Mancozeb (0.2%) or Ridomil-Mz (0.2%) provided good management of the disease, offering about 62-68 per cent reduction in disease incidence.

Early blight

Seed treatment with Iprodione (Rovral 0.2%) and 2 sprays at fortnightly interval during September and October with Mancozeb (0.2%) or Kavach (0.2%) provided effective management of the disease by reducing the disease severity from 45.5 per cent in untreated control to 8-12%.

Cercospora leaf spot *(Cercospora fuliginea):* Two fortnightly sprays with Topsin-M (0.1%), Blitox (0.3%) or Kavach (0.2%) during September provided effective management of the disease.

Leaf curl virus (TLCV)

Incorporation of soil-pesticides (Carbofuran @ 1.0 kg/ha.) in nursery and two fortnightly sprays with Monocrotophos (0.05%) during September-October provided good (about 70%) disease management. Keeping yellow sticky traps in the field for attracting white flies also helped in management of the disease. Early transplanting (up to 15th July) was found reducing the severity of not only TLCV but other-viral diseases also. Removal of infected plant was also recommended to reduce the inoculum from the field. By taking all these measures, the disease incidence can be reduced by 75-80 per cent.

Tomato spotted wilt virus (TSWV)

Sprays with Monocrotophos (0.05%) and removal of TSWV infected chilli plants in the vicinity of the tomato crop was found effective in control of the diseases. The disease incidence was found to be reduced by 65-70%, when prophylactic sprays were given.

Rhizoctonia-Fruit Rot: *(Rhizoctonia solani):* Incorporation of *Trichoderma harzianum* in the soil was found helpful to manage this disease.

GARLIC AND ONION

Major diseases: Purple blotch (*Atlernaria porri*), Stemphylium blight (*Stemphylium vesicatorium*) and powdery mildew (*Oidiopsis taurica*) are the major diseases of these crops. Bacterial bulb rot also causes damage.

Powdery mildew: Two accessions from NBPGR viz. IC 47373 and IC 47383 were found resistant to the diseases but some promising cultivars namely G-1, G-41, G-50 and G-242 were found to be more susceptible. Sprays with Bayleton (0.1%) or Topas (0.05%) helped in managing the disease effectively.

Purple blotch: Sprays with Mancozeb (0.2%) twice during November-December helped in managing the disease.

CABBAGE AND CAULIFLOWER

Major diseases: Downy mildew (*Peronospora parasitica*) and blight (*Alternaria brassicae*) are the major diseases of these crops. Besides, Bacterial black rot (*Xanthomonas vasicatoria*), and yellows (*Fusarium oxysporum*) also cause considerable damage to these crops.

Downy mildew: Two fortnightly sprays during November and December with Blitox (0.3%) or Ridomil-Mz (0.2%) or Aliette (0.2%) or Mancozeb (0.2%) provided effective management of the disease.

Blight: Mancozeb (0.2%) sprays applied fortnightly twice during December and January provided effective management (PDC=70-80%) of disease. Sowing of Rovral (Iprodione) treated seeds @ 2 g/kg. for growing nursery also reduced the disease intensity by 10-15 per cent.

CUCURBITS

Downy mildew (*Pseudoperonospora cubensis*), powdery mildew (*Sphaerotheca fuliginea*) leaf spots (*Cercospora lagenariae*), viruses, anthracnose (*Colletotrichum lagenarium*) are the major threats to the cucurbitaceous crops.

Sponge gourd and bitter gourd: Downy mildew was found to be managed by two fortnightly sprays with Blitox (0.3%) and Mancozeb (0.2%) in August.

Bottle gourd: The cercospora leaf spots were effectively managed by two fortnightly sprays during August month with Roko (Thiophanate methyl) (0.1%) and Blitox (0.3%). The anthracnose was found to be managed with two sprays of Blitox (0.3%), Bavistin (0.1%) and Cuman-L (0.35%) during August and September.

OKRA

Major diseases of okra are yellow vein mosaic virus (YVMV), powdery mildew and black sooty leaf spots (*Cercospora abelmoschi*). Other diseases viz. anthracnose (*Colletotrichum* sp.) and enation leaf-curl virus also attack okra.

Two sprays with Sulfex (0.2%) or Bavistin (0.1%) managed the powdery mildew disease effectively when applied at fortnightly interval during August end and September. Variety Parbhani Kranti and Arka Anamika were found resistant to YVMV.

CLUSTER BEAN

Major diseases of cluster bean are powdery mildew (*Leveillula taurica*) and blight (*Alternaria cyamopsidis*). Other diseases attacking cluster bean are Leaf anthracnose (*Colletotrichum cyamopsidis*), bacterial blight (*Xanthomonas cyamopsidis*) and viral disorders.

Powdery mildew was found to be managed by sprays with Sulfex (0.2%) during August month.

POST HARVEST TECHNOLOGY

Fruits of NA-7, Banarasi and Agra Bold matured by the last week of October while Francis and Krishna matured by first week of November. The fruits of Anand-1 and Anand-2 matured by middle of November. Kanchan matured by last week of November and that of Chakaiya by first week of December under semi- arid ecosystem of Gujarat.

Aonla NA-7 fruits treated with GA3 100 ppm or calcium nitrate 1.5 % and kept in perforated polyethylene bag were found most efficient to retain the fruit quality attributes till the last day of storage under ambient conditions

The fruits were harvested from experimental orchard and graded on the weight basis (A grade=50 ± 5 g, B grade=40 ± 5 g and C grade =30 ± 5 g). Physiological loss in weight was lower in A grade than B and C grade fruits during storage. The spoilage loss in NA-7 amounted to 14.00, 17.00 and 21.00 per cent in A, B and C grade fruits respectively on 7th day of storage, however, it was recorded 7.20, 13.00 and 14.00 per cent in Chakaiya.

Effect of Zero Energy Cool chamber and other post harvest treatments on shelf life of aonla and ber was studied. Fruits of aonla cv. NA-7 and ber cv. Gola treated with calcium chloride 1.5% and kept in Zero Energy Cool Chamber recorded the least physiological loss in weight and spoilage loss during storage under ambient conditions

Results of the study on the tree storage revealed that the fruits of aonla NA-7 could be retained on the tree itself up to 30 days from the date of maturity without any reduction in fruit quality attributes under semi-arid environment of western India. This practice may be adopted by the aonla growers to fetch more economic return by expanding harvesting span.

Packaging in aonla and ber: CFB with NPL was found to be most suitable and economically viable packing container during transportation of aonla and ber fruits under ambient conditions and may be followed for the benefits of both consumers and processors.

TRANSFER OF TECHNOLOGY

CENTRAL HORTICULTURAL EXPERIMENT STATION [CHES]

Since inception in 1979, this Station has been generated several technologies and disseminated to the farmers by organizing field day, training programmes, radio talks, etc. The various activities are given below.

FIELD DAY

Celebration of field days is an important extension activity, which is aimed at highlighting the new technology generated at this Station. The function is generally marked by the presence of some important dignitaries as chief guests. Generally, the field days are coupled with some important events of the Station. Field days are often celebrated in best crop conditions and are accompanied by related extension activities like release of extension folder and bulletins, arrangement of exhibitions, distribution of planting material, etc. The field days are attended by large number of farmers, State Government officers, Extension Personnel and students, in addition to the local political leaders. List of highly successful field days of the CHES is given in table 3.

Hon'ble Union Minister of state for Agriculture Shri Yogendra Makwana, Dr. K. L. Chadha (DDG-ICAR, New Delhi) and Dr. R. M. Pandey (IIHR, Bangalore) on the occasion of field day on 13-01-1988.

Table 3. List of field days

Dates	Functions	Chief Guests
28.09.1985	Udhyan Diwas	**Shri T. D. Soyantar IAS** Commissioner & Secretary Tribal Development Deptt. . Govt. of Gujarat, Gandhi Nagar
11.01.1986	Ber Day	**Shri P. R. Gokul Krishnan** Chief Justice, Gujarat High Court Ahmedabad
13.01.1988	Horticulture Day	**Shri Yogendra Makwana** Minister of State for Agriculture, Government of India, New Delhi

Dates	Functions	Chief Guests
06.01.1990	Bagayat Divas	**Shri Abdul Rahim Khalpa** Ex-M. L. A., Godhra.
13.01.1992	Horticulture Day	**Shri Shankar ji Thakor** Minister of Agriculture, Govt. of Gujarat, Gandhi Nagar
13.11.1996	Field Day	**Dr. K. L. Chadha,** D.D.G. (Hort.), ICAR New Delhi.
13.11.1996	Field Day	**Shri Shanti Bhai Patel,** Ex-Union Deputy Commerce Minister, New Delhi.
16.01.1999	Field Day	**Dr. R. S. Paroda** Secretary, DARE & DG, ICAR, New Delhi

EXHIBITIONS

Occasions pertaining to the developmental activities of the Station are invariably arranged in combination with the field days. Besides this, the Station also participated in exhibitions arranged at off-campus.

Shri Shantilal Patel, Ex. Union Deputy Minister of Comm., Govt. of India, inaugurating the exhibition on the occasion of field day on 13-11-1996; with him are Dr. K. L. Chadha (DDG-ICAR, New Delhi) and Dr. I. S. Yadav (Director-IIHR, Bangalore).

Dr. R. S. Paroda (DG-ICAR and Secy. DARE Govt. of India, New Delhi) being explained about vegetable cultivation by Head, Dr. G. B. Raturi on 16-1-1999

Exhibitions are arranged regularly in the States of Gujarat, Maharashtra, and Madhya Pradesh by putting up stalls. Exhibits in the form of live specimens of fruits and vegetables, photographs, charts, posters and models of diseases and pests are displayed. Finally, supplementary literature is provided to visitors. List of exhibitions in which the Station has participated is given in table 4.

Table 4. List of exhibition

Year	Exhibition	Organizer/Place
8.2.1987	Krishi Mela	G.A.U., Tarapur
17.10.1987	World Food Day	C.H.E.S., Vejalpur
2.1.1989	Krishi Mela	G.A.U., Navsari
24-29.2.1999	Agro-99	Aurangabad
23.12.2002	Kisan Divas	C.I.A.H., Bikaner

TRAINING PROGRAMMES

Demand driven training programmes on different aspects of advanced production of technology in horticultural crops are organized based on the needs of the agencies like State Department of Agriculture, NGO's, etc. Farmers, farm women, extension personnel, foreign delegates and students are trained by the Scientists. On-campus training includes hands on experience at

Training programme on Nursery management and production technology in horticultural crops under semi-arid condition

Practical Demonstration of grafting of mango seedlings to women trainees on 19/01/2009

Demonstration of how to make the budded plants to RAWE-students from AAU, Anand on 06/01/2009

Agricultural students from Gujarat being explained about horticultural crops on 18-09-2003.

propagation unit about various techniques like grafting, budding, laying, etc. course notes are distributed to the trainees. Off-campus training is also imparted in collaboration with State Line Departments GLDC, GAU and NGO's. Scientists of the Station are identified as resource persons in the training organized by other organizations.

Table 5. List of training programmes

Sl. No.	Title	Dates		No. of participants
		From	To	
1	Cultivation of semi-arid fruits	05.04.1999	06.04.1999	20
2	Composite farming system under dryland conditions	07.10.1999	--	17
3	Recent Development in Horticulture in semi-arid regions.	09.12.1999	11.12.1999	13
4	Krishi – 2000 at Ratlam (M.P.)	06.2.2000	08.2.2000	200
	Total			250

VILLAGE ADOPTION PROGRAMME

During 1999, tribal dominated Dageria village in Jhalod taluka of Dahod district in Gujarat is adopted by the Station. Three tribal farmers are selected and motivated to adopt ber cultivation. Consequently, a demonstration trial is laid out in one-hectare area by planting two varieties of ber viz. Goma Kirti and Gola. In-situ budding is done in desi ber plants. Regular follow up is done.

RADIO TALKS

Godhra and Vadodara stations of All India Radio, regularly broadcast the horticultural technologies in the agricultural programme slots.

Dr. G. B. Raturi Ex-Head, CHES delivered his first radio talk on horticultural development of the Station, **CHES, Godhra A Gem in Panchmahals crown**. Dr. B. G. Bagle gave a radio talk on Progressive development of the Station and technology generated at this station. Dr. Hiwale gave a speech on importance of fruit crops and its suitability and profitability under semi-arid ecosystem. Dr. H. K. Joshi highlighted the importance of plant protection in increasing the yield of horticultural crops. Besides Shri. D. K. Saraswat delivers over 10 talks on popularity of semi arid fruit crops.

TELEVISION PROGRAMMES

Doordarshan Kendra, Ahmedabad covered the visit of the Director General Dr. R. S .Paroda to the Station and also the Station's important activities in 'Gram Jagat' Programme on 28th January 1999.

FARM VISITS

Farm woman visiting the Aonla block on 24/09/2009

Farmers from Madhya Pradesh visiting the mango nursery on 19/03/2008

Large numbers of farmers from various States visit this Station time to time. The visiting farmers, extension workers, scientists, etc. are taken to a guided ' farm tour' by a team comprising a scientist, and two technical staff and are briefed about various activities of the Station including technologies generated, researches in pipe line, etc.

EXTENSION PUBLICATIONS

The Station has brought out publication in the form of bulletin and folders for providing detailed information on the cultivation technologies of ber, pomegranate, aonla, mango and some vegetables. Details are depicted in table 5.

Table 5. List of Publication

S. No.	Title	Language	Form
1	Central Horticultural Experiment Station, Godhra	English	Bulletin
2	In service of tribal belts of western India	English	Folder
3	Kendriya Bagayat Sanshodhan Kendra	Gujarati	Folder
4	Goma Manjari, Cluster bean	English	Folder
5	Promising Ber CHES-1	English	Folder
6	Suka Vistar Ma Bor Ni Sudhareli Kheti	Gujarati	Folder
7	Suka Vistar Ma Dadam Ni Sudhareli Kheti	Gujarati	Folder
8	Suka Vistar Ma Amla Ni Sudhareli Kheti	Gujarati	Folder
9	Suka Vistar Ma Amba Ni Sudhareli Kheti	Gujarati	Folder

KRISHI MELAS

Dr. B. G. Bagle, Sr. Scientist, explaining the research activities of the station to the chief guest Shri. S. S. Bhandari, during inauguration of "Agro-99 Farm Fair" at Aurangabad on 24-02-1999.

Shri Kantilalji Bhuriya, Hon'ble Union MoS for Agriculture alongwith VC of JNKVV visiting the exhibition stall of CHES, Vejalpur at Jhabua (M.P.) on 15-10-2004.

The Station participated in various Krishi melas. Recently it participated in 'Krishi-2000' organized by Madhya Pradesh State Department of Agriculture and District Administration, Ratlam, at Ratlam during 2000. Scientists participated in 'Kishan gosthi' and suggested suitable measures for farmer's problems and also assisted the organizers in various activities of the Mela, like evaluating the stalls and acting as Quiz Master. Earlier, the Station also participated in Krishi Mela at Tarapur (Anand) in 1987 and begged first prize for various live exhibits.

Shri Balramji Jakhad H.E. Governer of Madhya Pradesh, and Shri. Kantilalji Bhuriya Hon'ble Union MoS for Agriculture visiting the exhibition stall of CHES, Vejalpur at Jhabua (M.P.) on 29-01-06.

FRONT LINE DEMONSTRATIONS

Under NATP project on 'Household food and Nutritional security for tribal, backward and hilly areas' Demonstration Trials on Ber and Pomegranate are planted in Panchmahals district of Gujarat.

SEED PRODUCTION AND PLANTING MATERIAL

In addition to the generation of new horticultural technology, the Station is prominently known in this region as a source of genuine planting material for major fruit crops. While recommending improved cultivars of mango, aonla, ber, pomegranate, custard apple and sapota, the expectation of farmers are also kept in view that the genuine planting material should be made available from the

Station. Our nursery plays vital role in providing quality plant materials at affordable price to the farmers. While approaching us, farmers not only lift the critical input i.e. plant material, but also the 'technology basket' of the fruit crops.

The Station's recent recommendation to grow ber var. Goma Kirti and NA-7 have further aroused the feeling that nursery activities should be accelerated. Although, the Station was generating good number of clonally propagated plants of Rajapuri and Kesar varieties of mango; Gola and Umran varieties of ber; Kalipatti variety of Sapota, and Ganesh variety of pomegranate, but this number was too meager to meet the heavy demands of the farmers. Since, the station faced a shortage of irrigation facility, infrastructure and funds, the nursery activities had to be restrained. However, with the intervention of the Director General and the Deputy Director General (Hort.) of the ICAR, New Delhi, a Revolving Fund Scheme (RFS) was sanctioned for Station on 1.4.1999. Seed-money of Rs. 8.00 lakhs was provided. The RFS started functioning with effect from 1st April, 1999 in the leadership of Dr. G. B. Raturi, the then Head of the Station. Consequently, the nursery activities got a fillip and some infrastructural facilities were created to facilitate fast clonal multiplication of the fruit plants. Since then, the RFS has bee able to produce several thousand clonally propagated plants and generated income exceeding Rs. 10 lakhs (Annexure III).

KRISHI VIGYAN KENDRA

The activities on transfer of technology done by CHES has been further strengthened through Krishi Vigyan Kendra which was established on 1st October, 2005 at Central Horticultural Experiment Station, Vejalpur (Godhra) and is functioning under the auspices of Central Institute for Arid Horticulture, Bikaner. Various training programmes viz. cultivation of major and minor fruits in semi-arid region, propagation of fruits in semi-arid region, cultivation of vegetables in semi-arid region. Growing disease free nurseries of vegetables, plant protection measures in major horticultural crops and agro-forestry with the help of horticultural are being regularly conducted for the farmers and farm women.

Dr. L. R. Verma, VC H.P. Uni. along with other committee members and the Director Dr. D. G. Dhandar visiting the farm area for deciding KVK site on 04-09-2004

Hon'ble DDG (Hort.) Dr. H.P. Singh laying the foundation Stone of KVK admin. building on 13/10/2009

Field visit of Hon'ble DDG (Hort.) Dr. H.P. Singh and Director in Block 3rd in CHES Farm, Vejalpur on 13/10/2009

Head CHES, Vejalpur explaining to Hon'ble DDG (Hort.) Dr. H. P. Singh and Director the overall development of the KVK and the CHES farm on 13/10/2009

The Station has laid special emphasis on sustainable empowerment of farm families of western Indian tribal through sharing information of cutting edge technology ultimately leading to better standard of living. Various time-tested extension methods are used to disseminate the integrated horticultural technologies.

The Krishi Vigyan Kendra (KVK) functioning under the auspices of CHES, Vejalpur conducted 15 on-campus training programmes and imparted training to 232 males and 162 female participants. 190 males and 123 female participants belonging to SC/ST/OBC were also included amongst the participants. The KVK also conducted one off-campus training programme for 56 participants (farmers belonging to Panchmahals region) in collaboration with EEI, AAU, Anand on scaling up to water productivity in agriculture through teaching-cum-demonstration from 3rd to 7th June, 2008. The programme was sponsored by Govt. of India. The scientists from CHES, Vejalpur viz. Dr. S. S. Hiwale and Dr. H. K. Joshi acted as Resource Persons in the above training programmes. The CHES, Vejalpur and its KVK entertained 39 batches of visitors including 884 male farmers, 294 female farmers and 243 students.

The KVK also laid out 73 Front Line Demonstrations (FLDs) on two varieties of maize, five of paddy, one each of wheat, castor, pigeon-pea, mango, aonla, lime and chillies.

The Station also participated in "Krishi Mahotsava–2008" at Godhra on 08.05.2008 and put its exhibition stall which drew huge crowd. Prominent varieties of mango and bael were displayed in the exhibition. A meeting with farmers of the district was also held under the chairmanship of Dr. S. N. Pandey, the then ADG (Hort.), ICAR, New Delhi at CHES, Vejalpur and was attended by Dr. B. G. Bagle, PS & Head, Sh. Shrikant Mehta, a progressive farmer from Salem, T. N. & Member, RAC of CIAH, Bikaner. The KVK also participated in several district level meetings at Godhra including NFSM, ATMA, Kisan-Vani programme of AIR, Godhra & Vadodara, SACs of KVK, Vadodara, etc. It also participated in several training programmes arranged by different organizations. The scientists of the Station also delivered Radio-talks on the relevant subjects from the Kisan-Vani programme of the All India Radio. Seven FLD participant farmers of KVK, Vejalpur were interviewed by All India Radio, Godhra on the

performance of the various demonstrations.

The KVK also produced 1.2 q seeds of bengal gram, 1.3 q seeds of pigeon-pea and maize for the benefit of farmers. Popular articles (in Gujarati) were prepared and distributed to the visitors. The KVK presented its Annual Report and Technical Programme in the Regional Workshop at MPUAT, Udaipur and AAU, Anand.

The KVK also organized the Scientific Advisory Committee Meeting on 29.05.2008 at CHES, Vejalpur under the chairmanship of the Director, CIAH, Bikaner. The meeting was attended by Sh. Shrikant Mehta, RAC Member, CIAH, Bikaner; Dr. P. P. Patel, Director (Extension), AAU, Anand; Dr. R. H. Patel, Asstt. Director (Research), AAU, Anand; Scientists of CIAH, Bikaner & CHES, Vejalpur, progressive farmers and women participants.

Three batches of 28 students each were imparted RAWE training during the year. Two batches belonged to AAU, Anand and one to NAU, Navsari.

DISTINGUISHED VISITORS

Dr. H. P. Singh, Deputy Director General (Hort.), Indian Council of Agricultural Research, New Delhi visited the Central Horticultural Experiment Station, Vejalpur (Godhra) on 26th December, 2007. He was apprised of Research Activities being carried out at the Station. He visited the farm area in various blocks and suggested ways and means to improve the look of farm areas. Other important visitors are as mentioned below.

1. Dr. M. H. Mehta, V.C. GAU, Anand (26/08/2000)
2. Shri. Gopalsingh Solanki, MP Rajyasabha (21/04/2001)
3. Shri. Natvarsingh Thakor, MLA, Mahuda (10/09/2001)
4. Dr. G. Kalloo, DDG (Hort.) ICAR, New Delhi (11/11/2001)
5. Dr. Satyabrato Maiti, Director, NRCMAP (11/11/2001)
6. Dr. C. R. Ramesh, PS and Head IGFRI, Dharwad (05/03/2003)
7. Dr. G. Kalloo, DDG (Hort.) ICAR, New Delhi (24/11/2002)
8. Shri. R. P. Patel, Dy. Director of Agriculture, NIP, Vadodara (31/05/2003)
9. Dr. G. B. Raturi, Ex. Director, CIAH, Bikaner (06/10/2003)
10. Dr. P. M. Nimje, PS and I/c KVK, CIAE, Bhopal, (08/10/2003)
11. Shri. T. G. K. Menon, Advisor, NWDPRA, Govt. of M.P., Indore, (14/06/2004)
12. Shri. B. M. Modi, Joint Director of Agricultural Extension (04/09/2004)
13. Dr. K. F. Patel, Director of Extension, AAU, Anand, (04/09/2004)
14. Dr. R. N. Prasad, I/C Z.C. Unit VI, Cazri, Jodhpur, (04/09/2004)
15. Prof. L. R. Verma, VC, HP University, Simla, (04/09/2004)

16. Dr. D. G. Dhandar, Director, CIAH, Bikaner (04/09/2004)
17. Dr. S. N. Rao, Chairman, QRT, (16/08/2004)
18. Dr. O. P. Pareek, Members, QRT
19. Dr. S. J. Singh, Members, QRT
20. Dr. G. C. Srivastav, Members, QRT
21. Dr. A. S. Dhatt, Members, QRT
22. Dr. T. A. More, Members, QRT.
23. Dr. R. S. Raval, I/C Dy. Director, Govt. of India, Mumbai (24/12/2005)
24. Sh. R. J. Patel, IAS, D.D.O.,District Panchayat, Godhra (05.10.2006)
25. Sh. Ashwinbhai Parmar Dy. Director, GFS, PRDA, Panchmahals (05.10.2006)
26. Dr. S. H. Patel and Sh. M.G. Patel,District Agriculture Officers, Panchmahals (10.10.2006)
27. Sh. R. J. Patel, IAS, D.D.O.,District Panchayat, Godhra (10.10.2006)
28. Sh. M.G. Patel,District Agriculture Officer, Panchmahals (28.10.2006)
29. Dr. Brahma Singh, Ex-Director Agril.& Life Science, DRDO, New Delhi (24.08.2008)
30. Dr, P. P. Patel, Director of Extension, Anand Agriculture University, Anand (27.12.07)
31. Dr. T. A. More, Director. CIAH, Bikaner (07.02.2008)
32. Dr. R. S. Singh, Principal Scientist (Hort.), CIAH, Bikaner (12.09.2007)
33. Smt. Geetaben Barot, Principal, Govt. Girls School, Vejalpur (13.09.2007)
34. Dr. A. Vergheese, Principal Scientist (Ento.), IIHR, Bangalore (12.09.2007)
35. Dr. A. K. Mishra, Principal Scientist (Plant Pathology),CISH, Lucknow (12.09.2007)
36. Smt. Nishaben Prnami, Project officer, M.P.Rural Livelihood Project, Zila anchayat, Mandla (M.P.) (30.05.2007)
37. Sh. D.B. Gajera, Dy. Director of Agriculture (Training) FTC, Dahod (26.09.2007)
38. Sh. R. M. Naik, Soil Survey Officer, WALMI, Anand (17.10.2007)
39. Sh. Rajendra N. Patel, Journalist, Deshvalia Kukshi, Dist: Dhar (M.P.) (07.02.2007)
40. Dr. M. S. Tomar, Asstt. Director (Horticulture), Dhar, M.P.(27.02.2008)
41. Sh. S. K. Chobey, A.E.O. (Agriculture), Distt : Panna M.P..(27.02.2008)
42. Sh. Milind Torwane, IAS, Collector, Panchmahals, Godhra (03.03.2008)
43. Sh. I. S. Nauke & Dr. P.P. Singh, Associate Professor, College of Horticulture, Mandsaur (M.P.) (06.03.2008)
44. Sh. Suraj Pal Singh, AAO, Dy. Director Agriculture Office, Sirohi,Rajasthan (9.03.2008)
45. Prof. S. A. Patel, KVK, SD Agriculture Uni. Deesa, Gujarat (19.03.2008)
46. Dr. B. S. Chauhan, Asstt. Director (Horticulture), Dharmapuri, Dhar, MP. (20.03.2008)
47. Dr. H.P.Singh, DDG (hort.),ICAR, New Delhi (13.10.2009)

Annexure-I

LIST OF RESEARCH PROJECTS

A. INSTITUTE'S PROJECTS

G-1	:	Collection, introduction and evaluation of germplasm of wood apple and other fruit crops (S. S. Hiwale).
G-2	:	Collection, introduction and evaluation of under exploited fruits (jamun, tamarind, bael, mahua and chironji) (Sanjay Singh and A. K. Singh).
G-3	:	Standardization of of production technology of Aonla (Emblica officinalis Gaertn) (A. K. Singh, Sanjay Singh, S. S. Hiwale and V. V. Appa Rao.).
G-4	:	Standardization of agro-technique on some semi-arid fruits (ber, pomegranate, phalsa) (S. S. Hiwale, Sanjay Singh and A. K. Singh).
G-5	:	Standardization of organic farming in some semi-arid fruits (S. S. Hiwale, V. V. Appa Rao).
G-6	:	Storage studies in aonla and ber (Sanjay Singh, A. K. Singh and H. K.Joshi).
G-7	:	Breeding for yield and resistance to biotic and abiotic stress in cucurbitaceous crops (S. Raja, B. G. Bagle and H. K. Joshi).
G-8	:	Crop regulation in moringa and inter cropping system under semi-arid conditions (S. Raja, B. G. Bagle and V.V. Appa Rao).
G-9	:	Nutrient management in aonla and sapota (V.V. Appa Rao and D. T. Meshram).
G-10	:	Organic farming in vegetable crops in semi-arid system (V.V. Appa Rao and H. K. Joshi).
G-11	:	Integrated orchards management in ber, pomegranate and aonla. (B. G. Bagle, H. K. Joshi, S. S. Hiwale and V.V. Appa Rao).
G-12	:	Integrated pest management in bitter gourd and pumpkin (B.G. Bagle, S. Raja and H. K. Joshi).
G-13		Integrated disease managementin semi-aid horticultural crops (H. K. Joshi, B. G. Bagle).
G-14	:	Biological control of diseases of semi-arid fruit and vegetables (H. K. Joshi and B. G. Bagle).
G-15		Strategies for adoption of integrated horticultural technologies (V. Lenin)

B. SPONSORED PROJECTS

NATIONAL AGRIULTURAL TECHNOLOGY PROJECT

1. "Household Food And Nutritional Security For Tribal, Backward And Hilly Areas.'(B. G. Bagle, CCPI and A. K. Singh, Co. CCPI)

2. "Develop Sustainable Agri-silvi-horti Production System For Marginal Lands Under Arid Conditions.'(S. S. Hiwale, PI. and V. Lenin CO-CCPI)

REVOLVING FUND SCHEME

Commercial nursery propagation of fruit plant. (S. S. Hiwale, PI.)

Annexure-II

STAFF POSITIONS

SCIENTIFIC

1.	Head	: Dr. B. G. Bagle.
2.	Principal Scientist (Hort.)	: Dr. Sanjay Singh.
3.	Principal Scientist (Hort.)	: Dr. S. S. Hiwale.
4.	Scientist Sel. Gr. (PI. Path.)	: Dr. H. K. Joshi.
5.	Scientist (Sr. Scale) (Soil Science)	: Dr. V. V. Appa Rao.
6.	Scientist (Sr. Scale) (Ag. Extn.)	: Sh. V. Lenin.
7.	Scientist (Sr. Scale) (Veg. Crops)	: Sh. S. Raja.
8.	Scientist (Sr. Scale) (Hort.)	: Dr. A. K. Singh

List of past Scientist

Dr. M. P. Alexander, Scientist, S-2 (Cytogenetics and Head)
Dr. G. B. Raturi, Scientist S-3 & Head
Dr. O. P. Vijay, PS, (Vegetable Crops)
Dr. K. Jagdishchandra, Sr. Sci., (Plant Pathology)
Dr. N. K. Krishnakumar, Sr. Sci., (Entomology)

TECHNICAL

1.	T-8 (Tech. Officer) (Farm Management)	: Sh. D. K. Saraswat
2.	T-6 (Tech.Officer) (Farm Management)	: Sh. Nihal Singh
3.	T-5 (Tech.Officer) (Library)	: Sh. G. U. Trivedi
4.	T-5 (Overseer)	: Sh. Ashok Kumar Dhobi
5.	T-I-3 (Artist cum Photographer)	: Sh. B. J. Patel

List of past Technical Officers

Shri. B. C. Mryutunjaya, GS

Shri. C. T. Kushalppa, Jr. GS
Shri. Nafis Ahmed, Jr. GS
Shri. Tejbirsingh, Jr. GS

ADMINISTRATIVE

1.	Asstt.Adm.Officer	: Sh. J. B. Saxena (retired on 30.06.2009)
2.	Asstt.Adm.Officer	: Smt. R. K. Shah (w.e.f. 01.07.2009)
3.	Personal Assistants	: Sh. R. K. Solanki
4.	Assistant	: Sh. K. F. Kharkhariwala
		: Sh. N. A. Patel

Annexure-III

Particulars of plant material sold to the farmers during 1995-96 to 2007-2008

Sl. No	Plant Material	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	Total
1.	Anola budded	149	355	2459	645	6294	2230	4003	2034	861	1353	1106	830	1850	24169
2.	Pomegranate (Air Layered)	42	199	606	5	1347	27	201	95	227	389	387	60	396	3981
3.	Ber (Bud stick)	700	600	50	-	-	-	–	-		80			40	1470
4.	Sapota (grafted)	60	86	878	124	211	273	334	292					260	2518
5.	Ber (Budded) (Gomakirti)	-	8	543	-	1197	55	327	161	201	481			25	2998
6.	Ber budded (Gola/Umran)	50	146	972	-	560	152	506	952			117	03	123	3581
7.	Lime (Seedlings)	41	1	550	100	398	100	257	–			06	709	1220	3382
8.	Lime(Air Layered)	1	2	1470	-	125	-	–	468	239	519	110	995	-	3429
9.	Lime Seedless (Air Layered)	-	18	-	-	-	-	–	11					-	29
10.	Mango (Approach Grafted)	1	56	9420	1284	2400	900	2503	–	219	142	728	272	-	17925
11.	Mango (Soft Wood Grafted)	-	-	-	6	225	4	04	1475					2430	4144
12.	Guava grafts	1	-	-	1250	35	-	25	–				449	-	1311
13.	Guava Seedlings	-	-	2490	-	121	25	265	159	224				942	4675
14.	Phalsa Seedlings	-	32	-	2	-	-	–						-	34
15.	Jamun Seedlings	-	-	-	-	7	-	–						11	18
16.	Custard apple grafts	-	-	-	-	274	-	–						-	214
17.	Custard apple seedlings	-	-	-	-	270	882	956	08	115	56	24	100	20	2431
18.	Papaya seedlings	-	-	1	-	-	-	400				10	41	04	456
19.	Badam seedlings	-	-	300	-	6	-	–						-	306
20.	Cactus plants	6	-	-	-	-	-	–						-	6
21.	Acalypha plants	2	-	-	-	-	-	–						-	2
22.	Other foliage plants	10	1	-	-	-	-	–	24	12	18		09	-	74
23.	Bougainvillea plants	9	8	-	-	9	-	–		63	23	16	12	-	140
24.	Crotons plants	12	27	-	-	3	-	–		01				-	43
25.	Hibiscus plants	8	2	-	-	-	-	–						-	10
26.	Badam										02	36		-	38
27.	Rose plants	-	-	-	-	22	-	–		77				-	99
28.	Jasmine plants	-	-	-	-	5	-	–		01	05			-	11
29.	Dracaena plants	-	1	-	-	-	-	–						-	1
30.	Tomato seedlings	-	1350	3450	1200	2700	150	1200	9337	650		1100		300	21437
31.	Chillies seedlings	-	5625	42800	2000	7050	2500	9600	6325	19700	16930	14900	5600	200	133230
32.	Brinjal seedlings	-	125	9250	4600	13500	8700	7400	7727	2300				400	54002
		1092	8642	75239	11216	36759	15998	27981	29068	2890	19998	18540	9080	8221	**286724**

Annexure-IV

Technical Bulletins, Books, etc.

1. Pandey, R. M. (1988). Programmes and Progress Information Bulletin No. 8, pp. 1-24.
2. Yadav, I. S. (1992). Programmes and Progress Information Bulletin No. 8, pp. 1-28.
3. Dhandar, D. G. (2004). Two Decades of Research and Development 1979-1980 to 1999-2000, pp. 1-41.
4. Bagle, B. G. (2004). Integrated pest management in arid fruits. In: Advances in Arid Horticulture Vol. I (Eds. P. L. Saroj, B. B. Vashistha and D. G. Dhandar), pp. 535-544.
5. Bagle, B. G., Joshi, H. K. Hiwale, S.S. and V. Lenin (2003). Two Decade of Research, Development of CHES, Vejalpur Technical Bulletin No. 8, p. 1-41
6. Bagle, B.G., Joshi H.K. and More, T.A. (2009). Integrated orchard Management in pomegranate in semi-arid region of Western India. Book Chapter (In Press).
7. Raturi, G. B. and Hiwale S.S. (1993). Horti-silvi-pastoral system for increased productivity of marginal and degraded lands under rain fed conditions. In: Forestation of Arid Land (Eds. Trivedi and Gupta G.N.), pp. 364-369.
8. Hiwale, S.S. (2004). Resource management in Horti-silvi-pastoral system. In: Advances in arid Horticulture Vol. I (Eds. P. L. Saroj, B. B. Vashistha and D. G. Dhandar), pp 425-436.
9. Hiwale, S. S., Raturi, G. B., Bagle, B. G. and More, T. A. (2007). Fruit tree based farming system for dry lands. CIAH/TECH/PUB No. 19, CIAH, Bikaner. pp 1-32.
10. Sanjay Singh, Singh, A.K., Joshi H.K., Bagle, B. G. and Dhandar, D.G. (2007). Jamun- A fruit for future. CIAH/TECH/PUB No. 18. CIAH, Bikaner.
11. Sanjay Singh, Nagaraja, A., Singh, A.K., Joshi, H.K., Bagle, B.G. and Dhandar, D.G. (2007). Post Harvest Management in Aonla and Ber. Aliette
12. Sanjay Singh, Singh, A.K., Bagle, B.G. and More, T.A. (2008). Mahua – A multipurpose Tree for Tribal. Aliette