Spices Indica

Silver Jubilee Souvenir

INDIAN INSTITUTE OF SPICES RESEARCH

25 YEARS OF SPICES RESEARCH 1976 - 2000 SILVER JUBILEE YEAR 2000 - 2001

Indian Institute of Spices Research
(Indian Council of Agricultural Research)
Calicut - 673012, Kerala, India.

Press

Silver Jubilee Souvenir

Spices Indica

IISRPUB-36

8-9 Oct. 2001

ICAR

Indian Institute of Spices Research
Calicut - 673012

Published by

Director
Indian Institute of Spices Research, Marikunnu P.O,
Calicut – 12

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Sponsored by :

Indian Society for Spices, Calicut - 12
National Academy of Agricultural Sciences, New Delhi - 12

Citation

Sarma Y.R, Sasikumar B and Chempakam B. (Eds.) Spices Indica - Silver Jubilee Souvenir, Indian Institute of Spices Research, Calicut – 12. October 2001.

Printed at

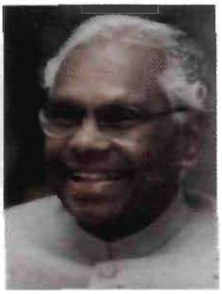
Modern Graphics
Cochin - 17

नासतो विद्यते भावो
नाभावो विद्यते सतः

Messages

25 YEARS OF SPICES RESEARCH
iisr
1975 - 2000
SILVER JUBILEE YEAR
2000 - 2001

राष्ट्रपति
भारत गणतंत्र
PRESIDENT
REPUBLIC OF INDIA



MESSAGE

Spices are very important for the national exchequer, as key foreign exchange earner as also a major employment provider for vast sections of society.

On the occasion of the Silver Jubilee year of the Indian Institute of Spices Research, Kozhikode, under the Indian Council of Agricultural Research, I extend my best wishes to the Institute in its endeavours to promote production and productivity of spices in the Country and wish the Silver Jubilee Celebrations every success.

Narayanan K.R.

K.R.NARAYANAN

New Delhi
July 27, 2001

GOVERNOR OF KERALA

R A J B H A V A N
THIRUVANANTHAPURAM

July 13, 2001

MESSAGE

I am happy to learn that the Indian Institute of Spices Research (Indian Council of Agricultural Research) has completed 25 years of its valuable service to the spices growers of the country, and that a Souvenir is being published to mark the occasion.

The efforts of the Institute in raising various high yielding varieties of black pepper, ginger, turmeric, cardamom and cinnamon are indeed laudable. I hope the Institute would continue its good work in the coming years too, especially in developing high production technologies for various crops, and methods of controlling pests and diseases.

The Silver Jubilee Souvenir, I hope, will highlight the various problems faced by the spices farmers, and the service rendered to them by the I. I. S. R.

I wish the Souvenir as well as the Silver Jubilee Celebrations all success.

(Sd/)

SUKHDEV SINGH KANG

Phone Office : 333812
333682
Fax : 333489

THIRUVANANTHAPURAM

A.K. ANTONY
CHIEF MINISTER KERALA

07.07.2001

MESSAGE

I am happy to learn that Indian Institute of Spices Research, Kozhiode is bringing out an elegant and informative Souvenir to mark the year long Silver Jubilee Celebrations.

It really is a precious moment for the institute which has registered significant achievements in spices research by developing various high yeilding varieties of pepper, ginger cardamom, cinnamon etc.

I send my good wishes for the success of the Silver Jubilee Celebrations and the Souvenir being published to highlight the event.

A.K. ANTONY

K.R. GOURI AMMA
MINISTER FOR AGRICULTURE & COIR

Office : 327759
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THIRUVANANTHAPURAM

Date : 17.9.2001

MESSAGE

I am delighted to know that the Indian Institute of Spices Research, Kozhikode has completed 25 years of existence and is now celebrating it's Silver Jubilee year from 10th November 2000 to 9th November 2001. It is heartening to learn that the Institute has evolved many high yielding varieties of black pepper, ginger, cardamom, turmeric, cinnamon etc. besides perfecting biocontrol of disease of spices. Biocontrol of diseases will go a long way in producing pesticide residue free, 'clean spice'. In this post WTO era, the Institute's role is paramount in maximising productivity from unit area by evolving high yielding varieties having resistance to pests and diseases.

I wish the function all success.

K.R. Gouri Amma

सत्यमेव जयते
J.N.L SRIVASTAVA
SECRETARY
&
DIRECTOR GENERAL

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद्
कृषि मंत्रालय, कृषि भवन, नई दिल्ली 110 001

GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
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24-09-2001

MESSAGE

I am glad to know that the Indian Institute of Spices Research, Kozhikode has completed 25 years of service to spices community and is now celebrating its Silver Jubilee Year from 10th November, 2000 to 9th November, 2001. I understand that the Institute has evolved about 15 high yielding varieties of spices besides perfecting biocontrol strategy for disease control in spices. I also understand that the Institute possesses the world's largest genebank of Piper. I congratulate the Director and the staff of IISR for the achievements relevant to the farming community.

I hope the Institute will be in the forefront of the cause of spices in coming years too. I wish all success for the Silver Jubilee Celebrations. May all the achievements of IISR benefit the farming community.

J.N.L. Srivastava

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INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Krishi Bhavan, Dr. Rajandra Prasad Road, New Delhi - 110 001

Dr. G. Kalloo
Dy.Director General
(Horticulture)

October 1, 2001

MESSAGE

It gives me immense pleasure to know that the Indian Institute of Spices Research, Calicut is celebrating its Silver Jubilee during October 8 - 9, 2001 and a Souvenir is bringing out to comemmorate the Celebrations.

The transformation of erstwhile Regional Station of the Central Plantation Crops Research Institute to Indian Institute of Spices Research through NRC (Spices) with in a span of 25 years is an achievement to be enshrined in golden letters. A dedicated team of scientists and other staff members coupled with effective leadership are singularly responsible for this achievement.

I wish all success for the Silver Jubilee Celebrations and also for the Souvenir.

(Sd/)

G. KALLOO

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Krishi Bhavan, Dr. Rajandra Prasad Road, New Delhi - 110 001

DR. MANGALA RAI
Dy.Director General
(Crop Science)

MESSAGE

From its incipient beginning as Regional Station of Central Plantation Crops Research Institute in 1975, the Calicut Research station was transformed into a full fledged Indian Institute of Spices Research in 1995. While Silver Jubilee Celebrations of the station is a milestone, we cherish the memories of the station more because of its vast contributions in overall development of spices like black pepper, ginger, turmeric, cardamom, tree spices, vanilla etc.

I am sure the Institute will be doing necessary introspections in the two interfaces with exporters and farmers in its Silver Jubilee celebrations so as to successfully meet the challenges arising in the wake of the new global developments. I wish all the success for the Institute and the Silver Jubilee celebrations.

(MANGALA RAI)

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e-mail : pdas@kab.delhi.nic.in

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
(Agril, Extension Division)
Krishi Anusandhan Bhavan, Pusa,
New Delhi - 110012

Dr. P. Das
Dy.Director General (AE)

MESSAGE

I am happy to learn that Indian Institute of Spices Research is now celebrating the Silver Jubilee Year. Spices are very important for the national exchequer, as they are important foreign exchange earners. To sustain and retain India's glory in spices production and trade, the technology emanating form the Institute should reach the farming community. I am sure, the efforts of the Institute for dissemination of technology through Agricultural Technology Information Centre (ATIC) and Krishi Vigyan Kendra (KVK) will go a long way in this direction.

I congratulate the Director and staff of the Institute on the occasion of the Silver Jubilee Celebrations of the Institute.

(Sd/)
P. DAS

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Dr. R.N.PAL
Asst. Director General (PC)

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कृषि भवन, डॉ. राजेन्द्र प्रसाद रोड, नई दिल्ली - 110 001
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Krishi Bhavan, Dr. Rajundra Prasad Road, New Delhi - 110 001

October 1, 2001

MESSAGE

I am very happy to know that the Indian Institute of Spices Research which bagged the Best Institute Award of ICAR in 1999 has completed 25 years service to the farming community. I am fully aware of the contributions of the Institute in developing high yielding varieties of spices, high production technology of spices, biocontrol strategy for pest management of spices and postharvest technology of spices. I understand that these technologies have already made an impact in the country, especially the ginger variety 'Varada'. It should be a matter of pride for all that the world's largest genebank of Piper is at IISR, Calicut. Similarly, the impressive collections of cardamom, ginger, turmeric, clove, nutmeg, cinnamon and vanilla, conserved both under *ex situ* and *in vitro* is also a sort of achievement of world class. The infrastructure facility developed at the Institute over the last 25 year is definitely second to none.

In the field of basic research also IISR has carved a niche of its own as many Universities have accorded recognition to the Institute for doctoral studies.

I hope that Indian Institute of Spices Research will reach new heights in the years to come.

I wish all success for the function and the Souvenir.

भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली - 110012
INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI - 110012 (INDIA)

Prof. K.L. CHADHA
Ph.D., D.Sc., FAAS
ICAR National Professor (Horticulture)
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MESSAGE

I am extremely happy to learn that Indian Institute of Spices Research is celebrating its Silver Jubilee on 8th and 9th October 2001. The institute, which started as CPCRI Regional Station in 1975, became independent during 1986 as NRC far Spices and subsequently got elevated to the present IISR. I had the fortune of guiding the destiny of the Institute and I am extremely happy to see the rapid strides it made in the area of High Production Technology, Biotechnology and Biocontrol technology in pest and disease management. I understand that National Network Project on *Phytophthora* Diseases of Horticultural Crops (PHYTONET) which was initiated by me, has made remarkable success. IISR has done yeoman service to farming community by releasing about 15 high yielding varieties of black pepper, cardamom, ginger, turmeric and cinnamon. The institute should continue to give high priority to solve farmers' problems. In this occasion of the Silver Jubilee, I send my greetings to Director and staff of IISR for the remarkable achievements in spices research and wish a bright future for IISR.

K.L. Chadha

(K.L. Chadha)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Dr. S.P. GHOSH
Sr. Horticulture Programme
Development Expert
Integrated Horticulture &
Nutrition Development Project

Project Office
Room No. 624, Rear Wing
Khamarbari, Farmgate
Dhaka - 1215, Bangladesh

MESSAGE

The Regional Station of Central Plantation Crops Research Institute (CPCRI) of the Indian Council of Agricultural Research established in 1975 in Calicut has travelled a long way to become the Indian Institute of Spices Research of today's repute. The hard work of a dedicated team of scientists and other members of the staff has made it possible to take the Institute to such a height. The public good that had emerged from the R&D activitites of the Institute has already made visible impact in the spice industry of the country.

I am indeed delighted to know that the Institute is now bringing out a Silver Jubilee Souvenir covering major activities and achievements of the Institute in the field of spices crops research. I hope that the publication will be useful and I congratulate the Director of the Institute and his team for the endeavour.

S. P. Ghosh

S.P. GHOSH

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It takes more than
an impressive building
to create an Institution

Annals of Growth

25 YEARS OF SPICES RESEARCH
iisr
1975 - 2000
SILVER JUBILEE YEAR
2000 - 2001

As CPCRI Regional Station in a rented building at Calicut city (1975)

Establishment of farm building at Peruvannamuzhi (1975)

As NRC (Spices) in temporary sheds at Chelavoor, Calicut (1986)

* Merging of Cardamom Research Centre at Appangala (1986)

Present Indian Institute of Spices Research at Chelavoor, Calicut (1995)

* Originally with IIHR, Bangalore has become a Research Station of IISR Calicut in 1986 through CPCRI, Kasaragod

Leaders who serve will
serve as good leaders

Captains
-in Pavilion and in field

25 YEARS OF SPICES RESEARCH
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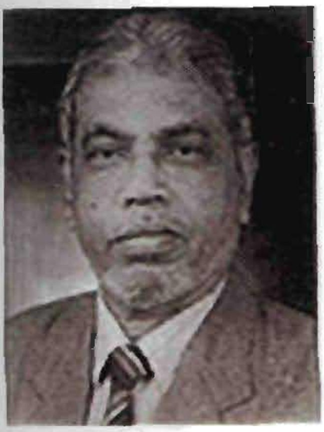
Directors

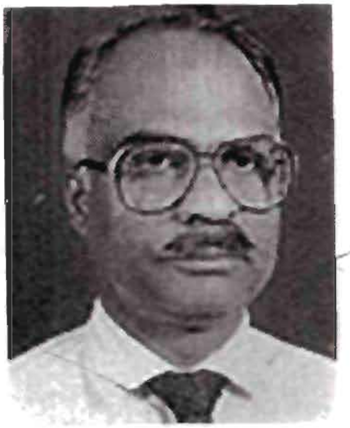


Dr. K.V.A Bavappa
(1975-77 : 1982-86)

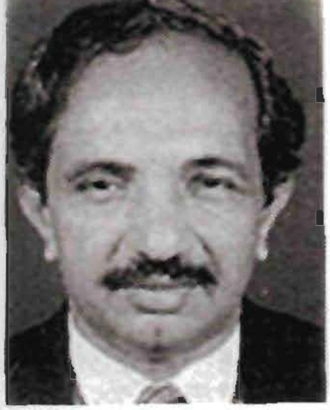
Dr. A. Ramadasan
(1989-91)

Dr. Y.R. Sarma
(2000-till date)

Dr. N.M. Nayar
(1977-82)

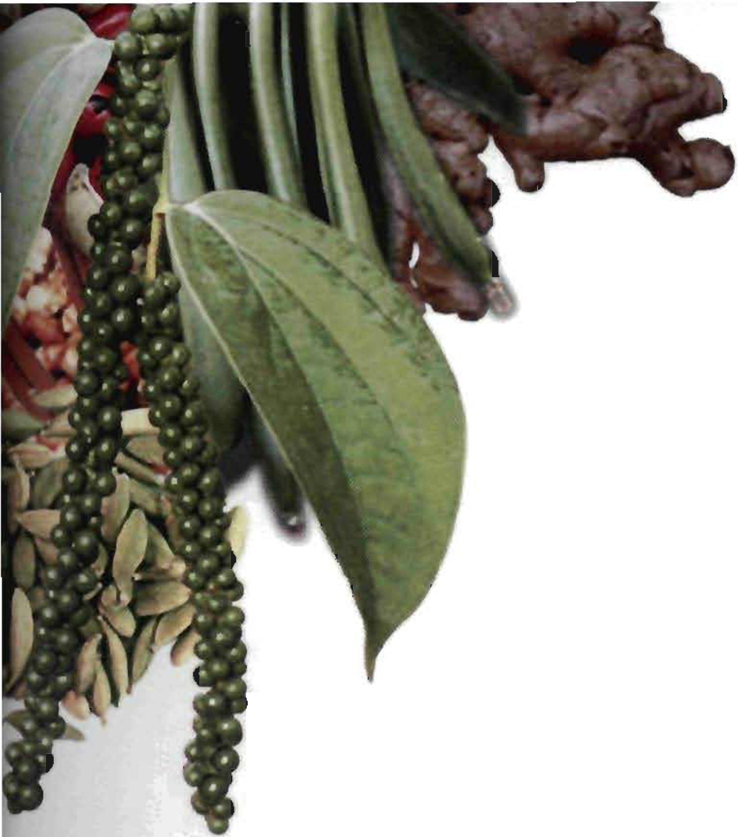


Dr. K.V.Peter
(1991-2000)



Dr. M.K. Nair
(1986-89)

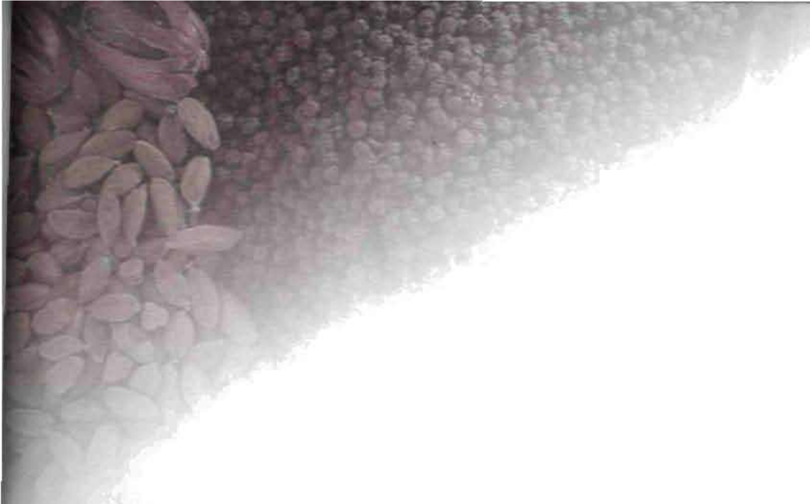
Dr. P.N. Ravindran
(Jan.2000-Aug.2000)

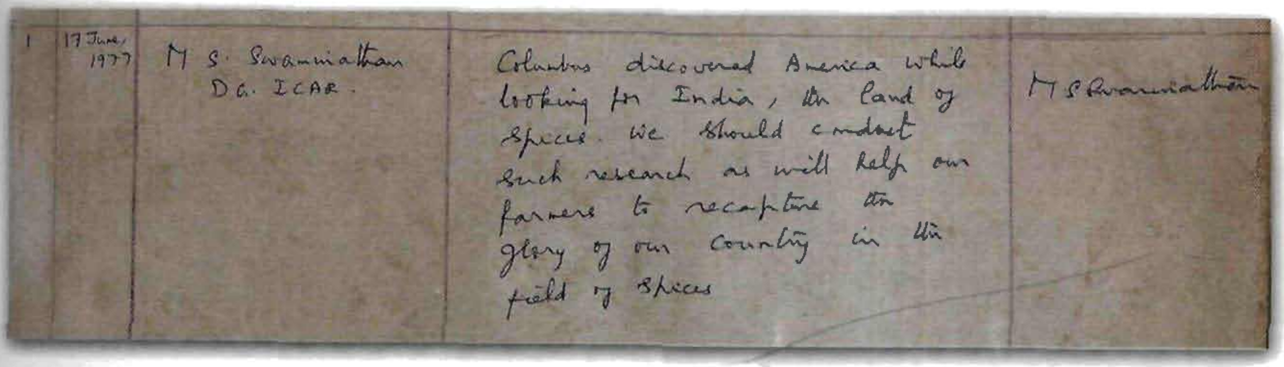


यद्यदाचरति श्रेष्ठ-
स्तत्तथैवेतरो जनः

A Prophetic Vision

25 YEARS OF SPICES RESEARCH
iisr
1975 - 2000
SILVER JUBILEE YEAR
2000 - 2001





1	17 June, 1977	M S Swaminathan DG. ICAR.	Columbus discovered America while looking for India, the land of Spices. We should conduct such research as will help our farmers to recapture the glory of our country in the field of Spices	M S Swaminathan

- Opening remarks of Padmavibhushan Prof.M.S.Swaminathan from the visitor's book of erstwhile CPCRI RS, 17-06-1977

Spices Indica

INDIAN SPICES IN THE 21ST CENTURY

M S Swaminathan
Chairman, M.S. Swaminathan Research Foundation
Chennai - 600113

Although historically India was the Land of Spices, India's leadership position has been coming down gradually both in volume and value terms (Tables 1 & 2). At present, farmers are facing a very difficult position, due to a fall in prices. It is obvious that unless vigorous steps are taken through mutually reinforcing packages of technology, services and public policies, the position of India in the spice world will decline further.

I. Malady – Remedy Analysis

Table 1. World trade in spices and India's share (value)

	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002
World trade (US $ Million)	1282	1333	1387	1442	1500	1560
India's share (US $ Million)	347	394	429	468	352	365
% share	27	30	31	32	23	23
Value (Rs.Cr.)	1231	1467	1796	2025	1612	1700

Table 2. Indian spice exports – stagnant in volume

Volume / value	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Quantity (M.T.)	203398	225295	242071	240863	236142	230000
Value (Rs. Cr.)	804	1230	1466	1796	2025	1612
US $ Million	241.43	346.97	394.45	428.79	468.12	352.13

The major constraints are:

- Low productivity leading to insufficient exportable surplus.
- Increasing stringency of quality standards in the export market. Some of these are:
  - Pesticide residues
  - Mycotoxins and microbial infection
  - Poor quality control

- Increasing competition from South East Asian countries like Vietnam.

The potential remedies are:

  - Increased productivity & production
  - Increased value addition
  - Introduction of new varieties
- Production of organic spices
- Cultivation of non-traditional spices like paprika, vanilla, culinary spices
- Extending traditional spices cultivation to new areas
- Establishing agricultural export zones for spices

II. India's strength

India is endowed with a rich diversity and excellent collection of spices having intrinsic quality. The centre of origin of two major spices viz. black pepper *(Piper nigrum L.)* and cardamom *(Elettaria cardamomum M.)* are in the Western Ghats of India. The country has excellent infrastructure for research and development of spices with Spices Board, Cochin; Indian Institute of Spices Research, Calicut; Directorate of Arecanut & Spices Development, Calicut and State Agricultural Universities of Kerala, Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, West Bengal Rajasthan etc, engaged in spices research and development. Value added industry is well developed in the country with about 20 units and there is an expanding global market for spice oils and oleoresins. The organic spices market is also predicted to have 20 percent annual growth rate and there is an expanding global organic market. Alternative Systems of Medicine are gaining importance in the western world and India has a rich tradition of Ayurveda and many of the spices (about 25 spices) are used in Ayurvedic medicine.

The spices of importance in terms of export are black pepper, chillies, turmeric, ginger, mint oil, curry powder,

Table 3. Market potential of organic spices

Country	Market size of conventional spice(t)	Market size of organic spice(t)
Europe	2,10,000	* 21,000
US	3,00,000	* 30,000
Japan	60,000	* 6,000
TOTAL		57,000

* 10 percent of conventional spice

(Source: ITC imports of spices into selected market, 1996)

value added products such as spice oils and oleoresins are the important spices. However, seed spices, garcinia, vanilla, herbal spices, organic spices and saffron are going to be of importance in the years ahead.

III. Future prospects of spices

1. Spice production

As about 80 percent or more of the spice farmers are small/ marginal farmers, any production technology must be scale neutral or skewed towards this sector. Integrated Plant Nutrient Management (IPNM) techniques suited to different agro-ecological situations in the country is a future area of relevance in boosting spices production. At present, scope for area expansion of spices with limited exception of Arunachal Pradesh (for ginger) and A&N islands (for ginger and pepper) is rather meagre. Non traditional area expansion based on soil suitability studies should be given priority. It is reported that there is good scope for bringing the tea/coffee estates under pepper production as hardly 1/3 of the shade trees in coffee/tea estates are covered with pepper. Area under coffee alone in South India (305902 ha) can accommodate standards upto 38 million. Assuming that half of which is only used for growing pepper, the remaining standards can result in pepper yield upto 20447 t/annum at the rate of 1.07 kg/standard. Tea estates in Wyanad and other similar places in the North East can also accommodate more than 2 million standards for pepper. Ideal varieties for these regions need to be developed, if not already identified.

Financial mechanisms to tide over risk and market fluctuations in spices production can help growers to invest in spices plantations and prevent them from shifting away. The Aggregate Measure of Support to farm sector in India is low and there is scope to increase the support to spice farmers.

The annual growth rate of organic spice market is around 20%. There is an increasing potential for organically produced spices in the global market.

There are now about 12 accredited exporters and traders of organic spices in India. India has a potential to capture the expanding global organic spice market, as majority of our small and marginal farmers hardly use any pesticides/chemical fertilizers. Special organic spices zones may be established.

2. Planting material

The planting material requirement for different spices for the coming few years is given in Table.4. Right now there is a glaring gap between demand and supply of good quality planting material of spices. Planting material derived from elite sources should be multiplied and distributed to farm women, community organisations and other needy sectors.

3. Crop Improvement and Biotechnology

The productivity of many spices (pepper-370 kg ha^{-1}, ginger 2.6 t ha^{-1} etc), is very low as compared to other producing countries. The yield levels of seed spices are also low. Increase in productivity of spices by exploiting hybrid vigour (pepper and cardamom, seed spices) and other improved varieties is very important in the post WTO scenario. Non splitting and high yielding coriander is another important area to focus. Use of biotechnological

Table 4. Estimated planting material requirements during the 10th Plan

Planting material	2002-03	2003-04	2004-05	2005-06	2006-07	10th Plan
Pepper rooted cuttings (@ 1100/ha)	11,795,300	12,267,200	12,757,800	13,268,200	13,799,500	63,888,000
Ginger(@ 1400 kg/ha)	4,888,800	5,084,800	5,287,800	5,499,200	5,719,000	26,479,000
Chillies (@ 2 kg/ha)	80,288	83,500	86,840	90,314	93,926	434,868
Turmeric (@ 2000kg/ha)	14,020,000	14,582,000	15,164,000	15,770,000	16,402,000	75,938,000
Coriander (@ 20 kg/ha)	491,800	511,460	531,920	553,200	575,320	26,637,000
Garlic (@ 500 kg/ha)	2,573,500	2,676,500	2,783,500	2,895,000	3,011,000	13,939,500
Cumin (@ 15 kg/ha)	178,185	185,325	192,735	200,445	208,455	965,145
Fennel (@ 10 kg/ha)	8,240	8,570	8,920	9,270	9,640	44,640
Fenugreek (@ 25 kg/ha)	93,000	96,700	100,575	104,600	108,800	503,675
Celery (@ 5 kg/ha)	1,035	1,075	1,120	1,165	1,210	5605
Clove seedlings (@ 200/ha)	28,600	29,600	30,800	32,000	33,400	154,400
Nutmeg seedlings (@ 150/ha)	43,650	45,450	47,250	49,050	51,150	236,550
Cinnamon seedlings @ 275/ha	9,075	9350	9,900	10,175	10,450	48,750

tools such as marker assisted selection can be pressed into the service for selecting elite genotypes in the juvenile stage. Genome mapping and transgenics with resistance to devastating diseases, are two of the important biotechnological areas of relevance to spices.

4. Value addition and product diversification

Market for value added spices has been growing steadily over the years. If during 1995-96 India exported 1912 MT of spice oils and oleoresin worth Rs. 11501.77 lakh, it is 2,825 tons worth Rs. 28,546.25 lakh in 1999-2000. Value addition is another future area of scope for the spice sector. India has not done enough ground work on product diversification in spices. Various home products derived from spice mixes or single spice have good demand in the domestic and export market. Brand promotion of Indian spices in consumer packets should also be given importance.

Quality of spices with respect to location is very pertinent. Fibre in ginger, curcumin in turmeric etc. vary with respect to location and season. The factors influencing the quality parameters in spices should be studied so as to schedule the harvesting/processing etc. to suit various end products.

5. Biocontrol of pests

Ecofriendly biological control of the diseases and insect pests of spices should be evolved and transferred to farmers so as to ensure the sustainability of 'clean spices' production.

6. Spices in Alternative Systems of Medicine

There is increasing awareness world over about the Alternative Systems of Medicine. About 25 spices are used in Ayurveda. India's heritage Ayurveda can be channelised for the better prospects of spices.

Conclusion

Where there is a will, there is a way. Scientists, farmers and policy makers should work together to enhance India's trade in volume as well as value terms. Let us restore during this century, India's leadership position in the world of spices which it occupied four centuries ago.

VISTAS IN SPICES RESEARCH - AN OVERVIEW OF 25 YEARS OF SPICES RESEARCH ACHIEVEMENTS AT IISR

G. Kalloo[1], R.N. Pal[2], K.V.Ramana[3] AND Y.R. Sarma[4]

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[4] Director, IISR, Calicut - 673 012

"Columbus discovered America while looking for India, the land of spices. We should conduct such research as will help our farmers to recapture the glory of our country in the field of spices" so wrote Prof. M.S. Swaminathan once. Being the centre of origin and diversity and also a major producer of black pepper, cardomoms, ginger and turmeric, India is qualified to be called as 'Land of Spices'. Spices are replete with history and created history ultimately leading to colonial rule in India. Global trade of spices is about 4.5 million tons valued about US $1500 million. India exported about 2,36,142 tons of spices worth US $ 428.77 million amounting to about 7.09% of the total production of 2.8 million tons from 2.5 million hectares.

History of spices research

Serious research efforts for the improvement of spice crops are only about 25 years old. Research activities initiated in black pepper at Panniyur (Kerala) during 1949 and on cardamom at Mudigere (Karnataka) and Pampadumpara (Kerala) during 1951 are the historic events in spices research. Calicut has a proud place in spices industry for starting the first oleoresin factory during 1930.

During 1951, Govt. of India constituted a Spices Enquiry Committee (SEC) to suggest measures to improve the production of cashew and spices besides marketing of cash crops. The SEC submitted the report during October 1953, and the Govt. of India recommended to entrust the work with Indian Council of Agricultural Research (ICAR). This was followed by the formation of the Central Spices and Cashewnut Committee during September 1961 to advise ICAR in planning and implementing the SEC recommendations, which was reviewed during January and September 1963. The spices research pro-gramme under ICAR took solid shape with the establishment of All India Co-ordinated Improvement Projects on Coshewnut and Spices (AICIPCS) at Central Plantation Crops Research Institute, during 1971. The Cardamom Research Centre, Appangala started by the then Mysore Govt., later coming under IIHR, Bangalore, was taken over by CPCRI during 1974. Subsequently CPCRI Regional Station for spices was established at Calicut on 10th November 1975 to intensify spices research. During 1986, this was delinked from CPCRI and was upgraded to National Research Centre for Spices (NRCS) by merging Cardamom Research Centre, Appangala. NRCS was further upgraded as Indian Institute of Spices Research with effect from 1st July 1995. Thus, the spices research with a humble start from CPCRI, Kasaragod blossomed into a full fledged national institute at Calicut. The All India Coordinated Improvement Project on Cashewnut and Spices was bifurcated and an independent All India Coordinated Research Project on Spices (AICRPS) came into existence. The project started with four centres and four mandate crops viz., black pepper, cardamom, ginger and turmeric, is now coordinating the research activities at 20 centres spread out in 15 states of India with 12 mandate crops viz., black pepper, small cardamom, large cardamom, ginger, turmeric, cumin, coriander, fennel, fenugreek, clove, nutmeg and cinnamon.

At present IISR has three campuses, one at Calicut, consisting of research laboratories and administrative offices located at Chelavoor (NH 212), IISR Experimental Farm at Peruvannamuzhi, 51 km north east of Calicut, and IISR Cardamom Research Centre at Appangala, Kodagu district, Karnataka. The research institute started with a meagre staff of about 8 during 1975 is now agog with about 163 staff members.

Research at IISR is conducted through various divisions namely Crop Improvement and Biotechnology (Plant breeding, Genetics, Horticulture, Economic Botany and Biotechnology); Crop Production and Post Harvest Technology (Agronomy, Soil Science, Plant Physiology, Biochemistry and Post Harvest Technology), Crop Protection (Plant Pathology, Nematology and Entomology), besides Social Science section (Agricultural Extension, Statistics and Economics).

Mandates

- The Indian Institute of Spices Research (IISR) will serve as an Institute of excellence for conducting and coordinating research on all aspects of spices improvement, production, protection and post harvest technology.

- To extend services and technologies to conserve spices genetic resources as well as soil, water and air of spices agroecosystems.
- To develop high yielding and high quality spices varieties and sustainable production and protection systems using traditional and nontraditional techniques and novel biotechnological approaches.
- To develop postharvest technologies of spices with emphasis on product development and product diversification for domestic and export purposes.
- To act as centre for training in research methodology and technology upgradation of spices and to coordinate national research projects.
- To monitor the adoption of new and existing technologies to make sure that research is targeted to the needs of the farming community.
- To serve as a national centre for storage, retrieval and dissemination of technological information on spices.

Mandate crops

Black pepper, cardamom, ginger, turmeric, paprika, vanilla and tree spices (clove, nutmeg, cinnamon, allspice and garcinia) are the mandate crops.

Eventhough research emphasis during earlier years was to meet immediate needs of farmers with mission mode approach, specifically on foot rot of black pepper and rhizome rot of ginger, the research programmes are reorganized with a view for the holistic improvement of spice crops through basic and applied research. Apart from the institute's own research projects, externally funded projects from ICAR Cess Fund, Dept. of Science and Technology (Govt. of India), Dept. of Biotechnology (Govt. of India), National Agricultural Technology Projects and Projects from Ministry of Agriculture, Govt. of India and Govt. of Kerala are also undertaken, to fulfill the research targets and in building up the modern infrastructure facilities to meet the demands of cutting edge technologies like biotechnology and molecular biology. An overview of research achievements of IISR during the last 25 years is outlined.

A. Towards attaining increased production through crop improvement

1. Biodiversity conservation

Prevention of genetic erosion and conservation of the existing biodiversity in spices are the high priority programmes of IISR. The institute has played a vital role in collection and conservation of the genetic resources of spices, which include cultivars, wild species, hybrids and several related gene pools. The National Repository of Spices Germplasm maintained in *ex situ* and *in vitro* conservatories are enriched regularly by undertaking collection surveys in primary and secondary centers of origin.

Facilities for *in vitro* long term storage of germplasm have been established and about 400 accessions are maintained at present in this *in vitro* facility.

The valuable collections in the *Piper* genebank include endangered species like *Piper barberi* and *P.hapnium*. *P. silentvalleyensis*, *P. sugandhi* and *P. nigrum* var. *hirtellosum* (*P. pseudonigrum*) are three new taxa identified and reported. A South American species, *P. colubrinum*, a source of multiple resistance to *Phytophthora*, *Radopholus similis*, *Meloidogyne incognita* and pollu beetle is another important species of *Piper* conserved in the genebank. *Vanilla andamanica*, *V.whitiana*, multi-branched types and natural 'katte' resistant lines of cardamom, king clove, dwarf clove, putative wild types of ginger and black turmeric, kasturi turmeric and high curcumin types of turmeric are also collected and conserved in the genebank. At present, the spices germplasm at IISR is the biggest in the world (Table 1). In addition to IISR collections, germplasm collection of spices are also maintained at various coordinating centres of AICRP (Spices).

2. Varietal improvement

Varietal improvement through selection and breeding for high yield, quality and resistance to biotic and abiotic stresses remains as the major aim of IISR. So far IISR has evolved 15 spices varieties besides identifying few lines which are in advanced stages of release. The details of the varieties released are given (Tables 2,3,4,5,6). In addition to these varieties, two black pepper hybrids, HP 105 and HP 813, are found suitable for high altitude areas. Coll:1041, a high yielding clone of 'Thevanmundi', tolerant to foot rot disease,

Table 1. Germplasm of spices conserved at IISR, Calicut

Crop	No. of Accession		
	Wild	Cultivated	*In vitro*
Black pepper	770	2327	26
Small cardamom	-	313	-
Turmeric	129	657	120
Ginger	56	581	69
Nutmeg	34	444	-
Cinnamon	64	235	4
Clove	10	217	-
Allspice	-	180	-
Vanilla	4	36	215
Garcinia	2	27	-
Paprika	-	38	9

HP 1411, another hybrid line and an open pollinated progeny of Karimunda (OPKm) are the other black pepper lines short listed for release.

3. High quality spices

The demand for Indian spices is because of their intrinsic quality. The existing variability for the quality specifically for oils and oleoresins has been studied in detail in the available germplasm, and identified the lines with high quality which can be exploited by the spices industry based on the international demand (Tables 7 & 8).

4. Resistance breeding

Biotic and abiotic stresses are the major production constraints in spices. Foot rot, slow decline, 'pollu' beetle and drought in black pepper; capsule

Table 3. Varietal improvement in black pepper

Variety	Average yield kg ha^{-1} (dry)	Oleoresin (%)	Pipenne (%)	Essential oil (%)
Sreekara	2677	13.0	5.1	4.0
Subhakara	2352	12.4	3.4	4.0
Panchami	2828	12.5	4.7	3.4
Pournami	2333	13.8	4.1	3.4
Palode 2	2475	15.5	3.3	4.8

Table 4. Varietal improvement in small cardamom

Varieties	Ess. oil (%)	1,8-cineole (%)	α– terp. acetate(%)	Yield kg ha^{-1}
CCS-1	8.7	42	37.0	745
RR-1	-	-	-	848

Table 2. Varietal improvement in turmeric

Name	Av. yield t ha^{-1}	Duration (days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%)	Essential oil (%)
Suvarna	17.4	200	20.0	4.30	13.5	7.0
Suguna	29.3	190	12.0	7.30	13.5	6.0
Sudarsana	28.8	190	12.0	5.30	15.0	7.0
Prabha	37.47	220	19.5	6.52	15.0	6.5
Prathibha	39.12	225	18.5	6.20	16.2	6.2

Table 5. Salient traits of Varada

Av. yield t ha^{-1} (fresh)	22.6
Dry recovery (%)	20.7
Crude fibre (%)	3.29
Oleoresin (%)	6.7
Essential oil (%)	1.75
Remarks	Bold rhizomes. Farmers are of the opinion that Varada is tolerant to diseases.

Table 6. Varietal improvement in cinnamon

Variety	Bark yield kg ha^{-1} (dry)	Bark oil (%)	Bark oleoresin (%)	Leaf oil (%)
Navashree	250	2.70	8.0	2.80
Nithyashree	250	2.70	10.0	3.00

rot, 'Katte', 'Kokke kandu' and thrips in cardamom; rhizome rot in ginger and turmeric are some of the major stresses. Concerted efforts to locate resistant gene sources led to the identification of some of lines which are also found field resistant / tolerant, besides being high yielding. (Table. 9) These resistant gene sources are being utilized in conventional and molecular breeding programmes or as new varieties. *Piper colubrinum* with multiple resistance to *P.capsici*, *R.similis*, *M.incognita* and 'pollu' beetle is unique for exploitation through biotechnological approaches and as a good root stock. About 78%. graft success is observed with double graft method of pepper onto *P. colubrinum* and the field performance of the grafts in farmer's plots with reasonably high water table is encouraging.

5. Biotechnological Interventions

The stress problems in spice crops need biotechnological interventions and the powerful tools of biotechnology can be exploited to address biotic and abiotic stresses alleviation, characterization of germplasm and production of disease free planting materials.

Table 7. Black pepper cultivars / varieties with high quality

Variety/cultivar	Essential oil (%)	Oleoresin (%)	Piperine (%)
Subhakara	4.0	13.0	4.0
Sreekara	4.0	13.0	4.0
Kumbhakodi	4.0	14.0	5.0
Panniyur – 1	3.5	11.0	4.0
Kottanadan	4.0	17.0	6.0
Balankotta	5.0	12.0	3.5

Micropropagation protocols have been standardized for about 40 species of spices and aromatic plants and would help for long term storage and safe exchange of germplasm. Besides, synseed technology and production of microtubers in ginger and turmeric have become handy for disease free planting material transport of these crops.

Protoplast technology developed for black pepper, cardamom and ginger, and also somatic embryo culture technique, are ideal systems for genetic engineering and also for planting material production in black pepper. *Agrobacterium* mediated transformation in black pepper has opened up new avenues for future crop improvement programmes. Optimum conditions for direct gene transfer through particle bombardment in cardamom and ginger have been standardized.

B. Towards agrotechnology for increasing production and productivity

1. Production of planting materials

Non availability of adequate quality planting material is one of the major production constraints in spices. Production of healthy planting material is of pivotal importance in all crops to ensure better field establishment, longevity, production and productivity. This is particularly important in vegetatively propagated perennial crops

Table 8. High quality lines of black pepper, cardamom, ginger and turmeric identified at IISR, Calicut

Black pepper			
Accession	Oil (%)	Olearesin (%)	Piperine (%)
41	4.5	14	5.0
43	4.5	12	3.5
49	4.0	13	3.8
164	3.2	14	5.0
Cardamom			
Accession	Oil (%)	α – terpinyl acetate %	1,8 – cineole (%)
APG 106	10	38	40
57	9.8	55	32
221	8.5	55	19
223	7.8	53	22
NKE 3	7.6	33	48
Ginger			
Accession	Oil (%)	Oleoresin (%)	Crude fibre (%)
287	1.8	5 0	3.0
288	1.7	4.8	3.2
22	1.9	5.3	3.2
18	1.8	5.2	3.2
14	2.5	9.0	4.4
118	2.6	6.0	4.0
Turmeric			
Accession	Curcumin (%)	Oleoresin (%)	Essential oil (%)
220	8.0	15.0	6.8
109	6.8	14.0	6.9
126	6.9	14.3	6.3
210	7.0	14.8	6.8
257	7.1	15.0	7.3

In view of the increased demand for planting materials of these crops, agrotechniques have been standardised to ensure a multiplication rate of 1: 40 in black pepper and 1:20 in cardamom. Epicotyl grafting and top working in nutmeg and air layering

Table 9. Stress resistant / tolerant lines and species in spices

Crop	Stress/pathogen	Resistant or tolerant lines/species
Black pepper	Foot rot *P.capsici*	P 24*, P1534, P339, Coll:1041, C1095, C 847, C 1090, HP780 *P.colubrinum, P.arborium*
	Slow decline *M.incognita*	**Pournami, ACC No. 4163, 4175, 1090, 334 (cultivated) ACC 3219, 3286, 3287, 3311 (wild)
	R.similis	ACC No. 3141, 3200, 3283, 3291, 3299 (wild) HP 305 (hybrid)
	'Pollu'	*P.barberi, P.chaba, P.hymenophyllum, P.longum,* ACC No. 2070 (cultivar)
	Drought	Panniyur 5, ACC 4216, 4226, 1343, 1368, 1226
Cardamom	'Katte' (Poty Virus)	*KFR3, KFR 12, KFR 19 (Katte field resistant) Kokke kandu (Virus) Clone 893
	Rhizome rot (*Pythium vexans / Rhizoctonia solani)*	RR 1
	Drought	P3, P6
Turmeric	Rhizome rot (*Pythium graminicolum*)	PCT 13, PCT 14

** Variety being recommended for release*

*** Variety released*

and cuttage in cinnamon, cassia, and allspice are also standardized.

2. Integrated Nutrient Management (INM)

A fertilizer dose of 140:55:270g of NPK vine^{-1}yr^{-1} for laterite soils has been recommended for black pepper. Slow release fertilizer technology with neem coated urea increased the yield of black pepper by 51%. Use of mussori rock phosphate @ 80g P_2O_5 vine^{-1} yr^{-1} is found to be as efficient as superphosphate. Application of lime @ 500g vine^{-1} during alternate years increased yield by 5.7%. Application of neem cake @2t ha^{-1} with Zn and Mo @6.2, and 0.9kg ha^{-1} enhanced the yield by 25% and 14.2%, respectively in Zn and Mo deficient soils. A fertilizer schedule of 120:120:240kg NPK ha^{-1} has been recommended for cardamom.

High Production Technology (HPT) developed through high yielding varieties and effective crop husbandry practices in black pepper and cardamom could achieve, about 200% increase in yield and reduction of diseases to less than 1%. In cardamom through HPT programmes yield of 460 kg ha^{-1} can be produced, compared to 116kg ha^{-1} under average management. Diagnosis and Recommendation Integrated System (DRIS) is developed for black pepper to assess the nutrient balance and yield.

3. Plant density studies

Technology has been developed to accommodate 5000 vines ha^{-1} by adoption of 2 x 1m spacing using dead standards thereby increasing the productivity to 5000kg ha^{-1}.

4. Bush pepper technology

Bush pepper can also be grown in the field at a spacing of 2 x 2 m accommodating 2500 bushes ha^{-1}. Application of 5kg FYM and NPK @ 10:5:20 g pot^{-1} resulted in yield of 1960kg ha^{-1}. Bush pepper can well fit in cropping systems involving coconut and oil palm.

5. Cropping systems approach

Multiple cropping system ensures a cushion form the fluctuating prices by offering remunerative price for one of the commodities crops. Basic studies are in progress on remunerative cropping system involving spice crops. Critical assessment of various parameters in relation to moisture conservation, nutrient efficiency and microbial interaction in coffee-pepper, coconut-pepper and arecanut-pepper systems has been taken up.

6. Organic spices

In view of greater preference for organically grown spices by the importers, a new momentum has started in India especially for black pepper, to adopt organic agriculture. Main components of organic farming such as recycling of organic residues and vermicomposting have been taken up. Besides, biofertilizer programmes using *Azospirillum*, P solubilizing bacteria and fungi and also Vesicular Arbuscular Mycorrhiza (VAM) have been initiated and the indications are encouraging. Combination of *Azospirillum*, phosphobacteria and VAM showed synergistic effect on growth of black pepper.

7. Post harvest technologies

Technology for white pepper production has been standardized. Panniyur-I, Valiakaniakadan and Balankotta are suitable varieties. Technology for preparing salted ginger has also been developed. Dryer has been developed for drying nutmeg, mace and seed which retains its original colour.

C. Towards ecofriendly Integrated Pest and Disease Management (IPM/IDM)

Crop loss due to diseases and pests is the major production constraint in spices. *Phytophthora* foot rot, slow decline in black pepper, capsule rot of cardamom, rhizome rot and bacterial wilt in ginger and turmeric, cumin and coriander wilts still remain as threats to these crops. Viral diseases of cardamom viz., 'Katte' and 'Kokke kandu' caused by poty virus and stunted disease of black pepper caused by cucumber mosaic and 'badna' are debilitating and cause considerable yield loss. 'Pollu' beetle and root mealy bug damage in pepper, thrips in cardamom and stem borer in ginger and turmeric are serious insect pests causing substantial crop loss.

An integrated approach of crop protection involving nursery hygiene cultural, chemical and biocontrol and botanicals coupled with host resistance is the strategy adopted to combat the menaces. Effective botanicals like neem based formulations, microbial pathogens, parasites and predators have been identified for insect pest management. Greater emphasis is for biological control as a component of eco-friendly crop protection that would ensure pesticide free clean spice. Spices, being export oriented, ecofriendly biocontrol is the major thrust as a component of integrated pest and disease management that would ensure pesticide free produce. The crop protection technologies developed at IISR are given below.

1. Solarisation

Soil solorization of the moist nursery beds/nursery soil by transparent polyethylene sheet tarping proved to be highly effective in disease suppression in ginger and cardamom besides suppressing of weeds. Disinfection of seed through rhizome solarisation is found effective for bacterial wilt management.

2. Nursery management

Production of disease free planting materials is an essential prerequisite to ensure optimum field establishment, longevity and productivity. Raising plants in solarised nursery mixture, fortified with *Trichoderma* spp. and VAM, has been found effective in suppressing root rot in pepper and cardamom.

3. Agrochemicals

For management of pests and diseases, major focus had been chemical control with insecticides and pesticides, besides cultural practices. Endosulfan and quinolphos were found effective against 'pollu' beetle. Similarly monocrotophos, phosolone, fenithion applications are effective against cardamom thrips and malathion against stem borer of ginger and turmeric.

Pre and post monsoon sprays with 1% Bordeaux mixture and drenching with copper oxychloride are found effective both for foot rot of black pepper and capsule rot of cardamom. Use of systemic fungicides like metaloxyl and phosphonates are highly effective against foot rot in black pepper and are compatible with the biocontrol agents. IDM for foot rot of black pepper developed at IISR has been implemented in 47000 ha. in five districts of Kerala in collaboration with Kerala Agricultural University and Dept. of Agriculture at a cost of Rs. 28 crore for 3 years, funded by Ministry of Agriculture, Govt. of India and the technology is well received by farmers. Similarly seed treatment of rhizomes and selective soil drenching with mancozeb or metaloxyl mancozeb has been found effective against rhizome rot of ginger.

4. Biocontrol

Plant Growth Promoting Rhizobacteria (PGPR), fluorescent pseudomonads and *Bacillus* Spp. from rhizosphere are found suppressive to root pathogens of black pepper and are being utilized to develop biocontrol consortia. Vesicular Arbuscular Mycorrhizae (VAM) and *Trichoderma harzianum* are effective against *Phytophthora* and plant parasitic nematodes in black pepper. Agro-wastes like coffee pulp /husk, coconut water and coir compost are ideal carrier media for production of inoculum of *Trichoderma*. Efficacy of biocontrol in checking foot rot in black pepper, capsule rot in cardamom and rhizome rot in ginger has been established under field condition. Impact analysis of the technology of black pepper biocontrol programmes in farmers' field indicated that 80% of farmers are benefited. Potassium phosphonate with biocontrol agents is found effective against foot rot and this becomes the major component of IDM. The biocontrol technology of *Trichoderma* is transferred to 10 entrepreneurs, to meet the demand of the farming community.

5. 'Katte' clinic

For viral diseases of cardamom, phased eradication and replanting with disease free nursery stock is the strategy implemented. 'Katte clinics' at Cardamom Research Centre of IISR, Appangala are highly successful in appraising the planters the management of 'Katte' disease of cardamom.

6. Diagnostics

Since viral problems are on the increase and major spices being vegetatively propogated, the diseases are likely to be transmitted vertically through nursery stock. Diagnostic techniques like ELISA and also latest molecular techniques like PCR are being developed for early detection of diseases in nursery stock. *Ralstonia solanaeorum*, a serious pathagen of ginger could be detected in the soil by PCR using *Ralstonia* specific primers.

7. Botanicals

Active neem formulation viz., Neem gold is found effective for 'pollu' beetle management. A cost effective package is developed combining both neem products and insecticides. Aqueous extracts of garlic, mustard, *Strychnos nuxvomica*, *Chromoloena odorata*, *Piper colubrinum* and allspice are found inhibitory to *P.capsici* at various phases of life cycle under *in vitro* conditions. However, the active principles need to be identified to exploit them for practical use.

8. Microbes for insect pest management

Bt (*Bacillus thuringiensis)* formulations are effective against stem borer of ginger and turmeric. *Pasteuria penetrans, Paecilomyces lilacinus* and *Verticillium chlamydosporium* are effective in suppressing root knot and burrowing nematodes and are under field evaluation.

9. Parasites/predators

Potential natural enemies like *Chilocorus nigrito* against scale insects in pepper have been identified. Mass rearing techniques have been developed and field efficacy in scale insect management has been established. A variety of potential parasites and parasite predators for various pests have been documented.

10. Host resistance

Black pepper somaclones tolerant to *Phytophthora* are developed through tissue culture. Black pepper 'Pournami' is tolerant to root knot nematode. 'Pollu' beetle resistance has been located in four accessions of black pepper and are being evaluated for their yield potential. The available host resistance in black pepper is utilized adopting varietal mixture concept superimposed by biocontrol and chemical control along with cultural practices.

D. Basic research towards strong foundation for applied research

i) Breeding behaviour of black pepper is elucidated.

ii) Genetics of shoot tip colour in pepper revealed the involvement of two pairs of complementary genes.

iii) The parameters for draught resistance are investigated in detail, and stomatal resistance, transpiration, leaf water potential and chlorophyll carotenoid ratio are found ideal for draught screening in black pepper.

iv) Ontogeny of rhizome development in ginger and turmeric is studied.

v) Basic embryology of black pepper is elucidated.

vi) Based on morphological studies and variability, *Phytophthora* species has been identified as a re-described species of *Phytophthora capsici*. Leonian 1922 amend A. Alizadeh & Tsao

vii) Studies on host parasite interaction in black pepper – *Phytophthora* pathosystem showed increased activity of polyphenol oxidase, peroxidase and PAL in the roots of black pepper of the tolerant line P 24 as compared to susceptible Karimunda. Enhancement of PR proteins especially of β-1,3 glucanase in tolerant cultivar compared to susceptible Karimunda has been observed .

viii) With regard to the characterization of *Ralstonia solanacearum*, Biovar III and Biovar IV have been detected based on the colony character and carbohydrate utilization. Characterization of membrane proteins of *R.solanaceorum* revealed the presence of 40 Kda protein.

ix) Immunobinding assay (NCM-ELISA) is found ideal for detection of *R.solanacearum*.

x) About 500 *Phytophthora* isolates maintained in the National Repository are being characterized based on morphological, biochemical and molecular parameters. Biochemical characterization of *Phytophthora* isolates maintained at National Repository, IISR, Calicut is initiated using isozyme analysis. A total of 27 *P.capsici* isolates from two hosts namely, black pepper (19), betel vine (8) and 13 isolates of *P.parasitica* from betelvine are characterized for four enzymes namely catalase (CAT), superoxide dismutase (SOD) malic enzyme (ME) and glucose – 6 – phosphate dehydrogenase (G-PDH). Cluster analysis of the isozyme data revealed the presence of is sub populations each in *P.capsici* and *P.parasitica*.

xi) Protocols are standardized for isolation of DNA from *Phytophthora* of black pepper and cardamom. PCR conditions for RAPD studies in *Phytophthora* are also worked out. *Phytop-hthora* isolates from cocoa, coconut, cardamom, vanilla and black pepper were tested with three different primers, OPA 01, OPA 11 and OPA 19. Isolates from cocoa and coconut showed similar banding pattern with all the three primers tested. Black pepper isolates with umbellate sporangial ontogeny showed different banding pattern from the isolates with sympodial ontogeny.

E. Towards Information Technology

1. Bioinformatics Centre – an IT centre to assist researchers

The Distributed Information Sub Centre (DISC) is a part of the Bio technology Information System Network (BTISNet) of the Department of Biotechnology (DBT), Government of India, New Delhi. This Bioinformatics Centre is launched at IISR, Calicut in May 2000. The center concentrates on data collection and development of databases and website for the institute, besides imparting training and education.

2. National Informatics Centre for Spices - A library with offline and online access to world literature

The IISR library functions as a national information storage and retrieval system for spices and related crops besides providing support to research workers of the institute. It aims at acquiring scientific literature related to spice crops and various scientific disciplines of interest to the scientists, organizing and displaying these materials and making them available to users.

The infrastructure facilities of the library have been expanding continuously, the latest being the establishment of National Informatics Centre (NICS) on Spices. This centre serves as a documentation centre for disseminating information on various aspects of spices.

3. Information resources

The major resources of the library include books, journals, theses, reprints, annual reports and technical reports. At present, the library has a total collection of 3577 books, 2621 bound volumes, 2168 reprints, 610 technical reports, 82 theses and is subscribing to 38 foreign journals and 60 Indian journals and also receiving 13 journals and 48 newsletters on gratis.

NICS is building up a rich resource base of books, journals, reprints, bound volumes and CD-ROMs. At present the centre possesses CAB, Biotechnology and AGRIS CDs. Scientists and research workers working in the Institute can have free access to these CDs. The Informatics Centre has automated a majority of its operations using the Library Management Software, LIBSYS.

Attempts are also being made to introduce Internet facilities at the centre to get exhaustive online information.

4. Agricultural Research Information System (ARIS)

The Agricultural Research Information System (ARIS) cell is in operation at the institute to meet the requirements of scientists and researchers with latest computers, Local Area Network (LAN) with Internet and E-mail facilities.

F. Towards technological innovation in extension

1. Agricultural Technology Information Centre (ATIC)

The Agricultural Technology Information Centre under National Agricultural Technology Project is a single window delivery system of technological inputs and information emanating from the institute. It would ensure better interaction of research workers, farmers, spice traders and entrepreneurs.

2. Krishi Vigyan Kendra

A Krishi Vigyan Kendra (KVK) is established at the research Farm, Peruvannamuzhi, during 1992 for effective transfer of technology to the farming community. The KVK organizes training programmes and field demonstrations on proven technologies in farmers' fields, exhibitions and kisan melas on agriculture, animal husbandry, fisheries and home science for the benefit of farmers, unemployed women and youth and development workers. The KVK has a farmers training cum administrative building attached with a farmers hostel. The kendra also has 20 ha of land with spices, coconut, arecanut and cashew plantations and an orchard comprising of miscellaneous fruit plants. A small area is maintained as forest for ecological stability.

Future thrust

1. Productivity

India would remain as a major player in spice trade at global level with the present pace of research and developmental efforts. With the stiff competition from other producing countries the Indian products should become competitive. Major efforts should target increased productivity through development of varieties with resistance to biotic and abiotic stress, specially in the case of black pepper and cardamom. While conventional breeding remains as a basic strategy, invoking appropriate biotechnological approaches like molecular breeding are of high priority.

Characterization of germplasm through conventional and DNA profiling should be a major thrust area in crop improvement programme to guard against biopiracy and to identify useful genes.

Market driven and need based production should be the hall mark of increased productivity. The role of micro-nutrients like Zn, Mo and B in increasing the productivity apart from NPK should be looked into. The nutrient buffer power concept should be given priority to ensure organic spices. Organic spices are in great demand in major spice importing countries. Intensification of research programmes on biofertilizers and biocontrol based pest and disease management is called for in this regord. Development of eco-friendly plant protection measures through IDM and IPM is imperative to ensure clean and '0' pesiticide residue spices.

With opening of world trade in accordance with WTO agreement, it is imperative that Indian farmer should become competitive through reduction of cost of production and increased quality consciousness. Technologies already developed (Tables 10 &11) and recent research achievements at IISR would meet these demands partially.

2. Post harvest technology

The intensification of research efforts on post-harvest technologies especially, value addition has becomes important. The production of mycotoxins on spice produce is a serious concern and research programmes need to be identified to overcome this hazard. Reducing the microbial load in the produce and consequent reduction of mycotoxins through ideal processing and storage methods should receive attention.

Maintenance of quality standards acceptable to the international community is of utmost importance. Unlike in the past, there is a good demand for value added products in the world spice market. India with its strong research infrastructure facilities is in a better position to increase the share of value added products in its export basket than other competing countries. It is important that technologies should address the problem not only for export but also for the advantage of local consumers.

Table 10. Technologies developed at Indian Institute of Spices Research

Sl. No	Major constraints	Technology
1	*Phytophthora* foot rot in black pepper	Phytosanitation, minimum tillage. IDM technology - Two pre-monsoon sprays with Bordeaux mixture (1%), one drenching with copper oxychloride (1%) combined with potassium phosphonate spray and drench, in place of Bordeaux mixture.
2	Viral diseases of cardamom 'Katte' and 'Kokke kandu' and stunted disease of black pepper	Rouging out diseased plants and phased replanting with healthy plants
3	Nursery management in pepper and	Soil solarization with polyethlene tarping for 30-40 days cardamom nurseries to suppress disease as a presowing treatment. Incorporation of VAM and *Tricho dermo* in the nursery.
4	Rhizome rot of ginger	Healthy seed selection, seed dressing with *Trichoderma* and its soil application coupled with organics. Soil solarization.
5	Nematodes, thrips and root grubs in cardamom	Spot application of phorate @ 2.5 g a. i per clump, twice a year during April-May and October – November
6	'Pollu beetle' in black pepper	Spraying endosulfan (0.05%) during July (21-30 days after setting of berries) followed by three sprays of Neemgold (0.6%) during August, September and October or four sprays of Neemgold (0.6%) during July, August, September and October is effective.
7	Shoot borer in ginger and turmeric	Four sprays of Dipel (0.3%) (*Bacillus thuringiensis*) during July- October at 21 days interval commencing from the first symptom of pest infestation.

Table 11. Agrotechnologies in advanced stages of evoluotion

Crop		Technologies
Black pepper	*	High yielding hybrids HP 813,34 and 105 are promising at Valparai (3000 ft MSL) as potential varieties for high ranges; Coll:1041, a germplasm collection from Idukki (Kerala) is tolerant to *Phytophthora* foot rot.
	*	Biofertilizers : Soil application of *Azospirillum*, phosphobacteria and VAM alone and in combination, increased biomass, dry matter production and nutrient uptake of black pepper.
	*	Application of Zn,B and Mo @ 5,2 and 1 kg ha^{-1} along with 150,60, and 270 kg ha^{-1} of N,P and K increased the yield by 134%.
	*	Standardized technology for protected cultivation of bush pepper with high density (350 pots per 140 s.q.m) is well suited to homesteads / house back-yards.
	*	Spraying etherel on the harvested berries hastened the retting period for production of white pepper.
	*	P 24 line of black pepper found field resistant to *Phytophthora* foot rot in field demonstration trials.
	*	Integrated disease management involving potassium phosphonate spraying along with organics like neem cake application @ 1 kg per vine and soil application of biocontrol agents showed the lowest disease incidence.
Cardamom	*	F1 hybrids involving 'Katte' resistant lines NKE 10 x NKE 34, NKE12 x NKE 19 and NKE 12x are promising.
Ginger	*	Accessions 35 and 117 lines proposed for release performed better consistently with about 23% dry recovery and fibre content less than 3.5%; sources of resistance to root knot nematodes identified (Acc. 182, Acc.198)
	*	Based on colour, appearance, flavour and texture, ginger accessions 35,64,71,117 and 179 are found good to prepare salted ginger.
Turmeric	*	The Alleppey finger turmeric, Acc. 585 is identified as high high curcumin line with 7 % curcumin.
	*	Treatment of rhizomes with Ridomil mancozeb and soil application with *Trichoderma harzianum* reduced rhizome rot of ginger and tumeric.
Tree spices	*	Clove lines B-95 and B-59 are promising
	*	Allspice cuttings treated with IBA (2500 ppm) + NAA (2500ppm) in charcoal gave 63% rooting.
	*	Cassia lines with high leaf oil, bark oil and bark oleoresin are identified.

GLOBALIZATION, LIBERALIZATION AND INDIAN SPICE

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The words 'Globalization and Liberalization' have to be put in the correct perspective.

Indian Spice exports always faced global competition from various producing countries and stood its ground relying on certain inherent strengths in terms of volume of production, variety and growing domestic demand. Indian spice exports, highest in terms of volume in the world, remained strong even when the fairly protected markets in the rupee-trading block disappeared some years ago.

India is the largest producer of spices with an annual production of around 28 lakh tons and exports around 2.30 lakh tons per annum. In terms of quantity India's market share in the international trade is 46% and in terms of value it is 23% [2000-2001].

The distinguishing features of the Indian spice scene are too well known. These are, on the positive side, high volume of production, huge domestic demand that consumes about 92% of the production and variety. In that context Indians spice industry is less vulnerable compared to those economies with poor domestic demand and therefore a larger reliance on international trade.

Fairly high cost of production, slow pace of growth of value addition in exports, disproportionate dependence on certain items and markets for export are the negative factors.

The inter play of these factors would impact both production of and trade in Indian spice depending on the variations in the factors that constitute the international scenario. The latter is characterized by the emergence of low cost economies in the South East Asian countries with limited domestic demand, high productivity, increasing production and therefore capable to compete successfully in the international market with limited and foreseeable growth particularly in commodity form.

The melt down of the South East Asian economies, consequent devaluation of the local currencies, relatively low level of prices for necessities and consumer items prevailing in those economies influencing the terms of trade in favour of export production are also key factors strengthening their competitiveness in the short run.

Some of these economies like Vietnam are going through the euphoria of opening up and of nascent free enterprise. The trade channels are not yet fully developed and perhaps some degree of bartering of exportable commodities for daily necessities or imports must be taking place. Consequently the price at which these commodities are offered for export may not have any relation to their intrinsic value, particularly when earning of foreign exchange at any cost is a national mission.

The mute question is whether these factors would continue to operate indefinitely and to what extent, to constitute a significant threat in the coming years to the grower or exporter of Indian spices.

The significance of shipping and related costs, cost of financing and process technology upgradation and absorption in determining international competitiveness is perhaps not fully realized. Though situated farther apart, compared to us, from the main consuming centers, the South East Asian countries would perhaps incur less of transaction costs to move their material to the consuming markets. Thus, even if farm gate prices are same in India and competing South East Asian countries, they will be more competitive because they can offer commodities at lower landed costs as they are situated closer to the transshipment points which offer low freight to most destinations. Another significant element is the cost of financing exports where we are perhaps about three times more expensive compared to our competitors. These were not important factors when we had near monopoly over production but of crucial importance when we have to compete on prices. The implication is all the starker in the case of high volume and low value products. It is reasonable to expect that in the long run there would be positive changes in these areas.

If present levels of productivity are maintained and additional acreage is pressed into spice cultivation, as evidence indicate would be, in the South East Asian countries, competition for the international market would intensify, even if the benevolent influence of the factors related to the slow down of the South East Asian economies were to disappear in the long run.

Since the International market cannot probably absorb all the increased production, these economies are bound to compete for the Indian market as well. Therein lie the real threats of liberalization and the dismantling of quantitative restrictions.

In this context, pepper would make a good case study partly because Indian spice exports are what I would like to call 'Peppercentric' and partly because it is easy to discern the trends in the movement related to the production and trade in the commodity.

India's productivity is one of the lowest in the world as far as pepper is concerned (Table 1).

Table 1. Area, production and productivity of pepper in major producing countries (1999)

Country	Area [ha]	Production [MT]	Productivity kg ha^{-1}
Brazil	23,000	22,000	957
India	1,89,804	70,160	370
Indonesia	1,31,775	44,500	338
Malaysia	11,000	21,500	1,955
Vietnam	20,000	30,000	1,500

Source: International Pepper Community, Jakarta, Indonesia

What is depressing is productivity has stagnated at same levels for many years now. While additional areas can be brought under pepper cultivation through inter cropping in many agro climatic regions across the country, there is tremendous potential to increase productivity without much changes in land use in any significant manner in the traditional pepper growing areas. The increase in the pepper out put within the country in the recent past is the result of extension of acreage in the coffee growing areas of Karnataka. If the potential for productivity increase is fully realized, and export surplus can be created at competitive prices without sacrificing farm income rather with appreciable increase in the same. Meanwhile pepper has been successfully introduced in many non-traditional areas like the North East, Andaman and Nicobar, coastal Maharashtra and such other areas, though in small measure.

As far as area expansion is concerned, the best bet is to expand pepper cultivation in the North Eastern states to create an exportable surplus in competition with the South East Asian countries whereas as far as the traditional pepper growing areas are concerned, there has to be immediate attention to extension services to improve productivity through replanting old plantations with improved varieties, which are already available.

An analysis of the export volumes of the last few years indicates that the export volumes have stagnated at around 2.35 lakh tons and that growth in value, both in rupee and dollar terms is largely the result of the fluctuations in the value of some key items, pepper being the most notable one (Table 2).

Table 2. Spices export-stagnant in volume

Volume/Value	1996-97	1997-98	1998-99	1999-00	2000-01
Qty [MT]	225295	242071	240863	236142	230000
Value [Rs. Cr.]	1230	1466	1796	2025	1612
US $ [Million]	346.97	394.45	428.79	468.12	352.13

As far as pepper is concerned, the volume has reduced considerably due to price sensitivities from 45000 tons in 1996-97 to almost 17500 tons in 2000-01. In such a scenario strategies to increase earning per unit of export assume great importance. Product diversification is one of the easiest to adopt and with direct and positive impact on farm gate prices. Indian pepper commands a certain premium due to its quality. It would not be difficult to add to its strength and increase value through farm level operations. Increasing concerns for food safety has made organic farming a paying proposition. Additional spin-offs in terms of reduced input costs to the farmer and environmental sustainability are other attractions. However strategies based on relatively low technologies cannot give long term competitiveness.

Details of value added spice exports for the last five years are given in Table 3.

It is worthwhile to look at the share of value addition in export of pepper and pepper products over the last few years.

The volume share of whole pepper in the export of pepper and pepper products has not changed significantly

Table 3. Value added spices exports

Year	Quantity [MT]	Value [Rs.Cr]	Value US $ [Millions]
1996-97	42,619	449	126.72
1997-98	46,252	523	140,77
1998-99	47,707	654	156.23
1999-00	49,763	671	155.26
2000-01	50,810	718	156.87

in the last five years. In fact this has hovered above 90% except during the last fiscal when it came down to 89%; simply as a result of drastic reduction of in the export volume, while the share of value added pepper remained constant. In terms of value the share of pepper whole was above 80% during the last five years except in the last fiscal when it came down to 72%, again due to decline in total pepper exports, rather than for reasons of increase in value addition.

In terms of volume, the share of lower end of processed pepper items [white pepper, green pepper in brine, pepper powder] improved gradually form 2.96% [1996-'97] to 5.44% [99-'00]. For reasons explained earlier the percentage share improved to 6.89 during the last fiscal but the absolute volume at 1377 tons was less than the volume of 1434 tons during 1996-97. In terms of value, the increase was more tortuous from 2.92 % in 1996-97 to 4.25 % in 1999-2000.

An interesting observation is that, prima facie, value addition in pepper powder appears to be negative, indicating mixing of supplies from cheaper sources or other practices adopted to remain competitive.

The apparent low value realization in the category of processed pepper below does not show negativity (Table 4.) since the unit prices refer to such items as pepper in brine where the proportion of pepper to weight of the processed item would be much less than one.

The performance of higher end of value added items requiring some degree of sophistication in technology, [piperine and olearesin] was steady but at low levels increasing from 1.155 to 3.75% in volume terms during the same period. In terms of value the share of this category improved from 8.14% [96-97] to 11.07%[99-2000]. The relative figure of 20.72% during the last year has to be explained in terms of factors narrated above.

Table 4. Export of pepper and pepper products from India. (Qty MT; Value Rs. Lakh; Unit value Rs kg^{-1})

	1996-97			1999-2000(P)			2000-01(E)		
Item	Qty	Value	Unit value	Qty	Value	Unit value	Qty	Value	Unit value
Pepper (whole)	46459.08 (95.89)	39923.29 (88.94)	85.93	40430.38 (92.49)	84256.43 (84.67)	208.40	17872.25 (89.36)	29771.63 (72.33)	166.58
Pepper (Dehy. & fr.dried)	301.15 (0.62)	732.54 (1.63)	243.25	335.11 (0.77)	1588.77 (1.60)	474.10	232.85 (1.16)	1255.87 (3.05)	539.35
Pepper (processed)	1132.94 (2.34)	576.00 (1.28)	50.84	2040.70 (4.67)	2642.95 (2.66)	129.51	1144.91 (5.72)	1605.25 (3.90)	140.21
Pepper (oils and olens.)	554.73 (1.15)	3655.92 (8.14)	659.04	905.20 (2.07)	11019.93 (11.07)	1217.40	749.75 (3.75)	8530.25 (20.72)	1137.75
Total	48447.90	44887.75		43711.39	99508.08		19999.76	41163.00	

(Figures in parenthesis indicate percent in total export)

It is true that we have a market share of more than 60% in the global oleoresin market. But prices of pepper oil and pepper oleoresin have started moving in sympathy with pepper price movement, indicating that oleoresin is also nearing commodity status. Further value addition into flavours, seasoning and end products is therefore necessary.

India had the benefit of being the pioneer in the manufacture of oleoresins but in updating the technology, we are far behind. It is absolutely necessary that the industry should adopt new technologies such as super critical fluid extraction technology, which would ensure zero contamination from solvents. Sooner or later, the buying countries will insist upon these parameters and industry should gear up to face the emerging challenges.

Another way of looking at the performance of value added exports is to find the dollar value of all value added spice exports during the last five years. The absolute dollar value increased from US$ 126.72 (1996-97) million to US$ 156.87 million in 2000-01. As a matter of fact the share of all value added spice exports virtually remained constant in dollar terms in the last three years, the apparent increase in rupee terms being simply the function of a depreciating rupee.

The average unit value realization in items other than whole pepper of the year 2000-2001 is telling and stands as a pointer to the directions in which the industry should move. While pepper whole fetched an average value of Rs.170 per kg, the average value per kg of white pepper was Rs 274, dehydrated green pepper fetched Rs 409 and freeze dried green pepper commanded a price of Rs 964 kg^{-1}. It is true that the realization in these products move in sympathy with the realization in the value of the base commodity namely pepper whole. Notwithstanding, the higher value per unit return in these processed items is much more than proportional even after factoring the conversion ratio and the processing cost.

Two things stand out with respect to trade in processed pepper. One is the low volume of processing as explained earlier and the slow pace of growth of the processing sector while the other is the absence of any Indian brand name being used in any of these items. Processed items are exported in bulk and are repacked into consumer packs in the importing countries.

A 63g pack of white pepper retails for the equivalent of US $ 1.91 in Brazil. A 50g pack of white pepper powder under the brand name of 'Gewurze' is supplied to the retailer at a price of US $ 1.41, which is equivalent to a dollar price of 28.2 kg^{-1} at the wholesaler level but in consumer packs. As per the export realization ruling in 2000-2001, Indian pepper powder would not cost more than US $ 8 per kg were it to be shipped in similar packing, all costs including wholesale margin included. The huge difference is the potential for earning even after considering significant brand building and promotion expenses.

Brazil is a substantial producer of pepper and therefore it can be reasonably assumed that the consumer and wholesale prices of similar items will be higher in markets without its own source of supply. The same story would repeat over and over again with respect to other Indian spice exports.

I have therefore no doubt that the way forward to the Indian spice industry is to enter into the brand promotion of their own rather than being bulk supplier to others at low margins. Major attention of the export promotion agencies therefore should be towards capacity building in this area for long-term sustainability of exports.

Widening the export basket is necessary to contain competition. A diversified mix of product portfolio, foraying into non-traditional spices, vanilla, cambodge, mint, organic spices, saffron, herbal spices and other exotic spices, will help us to reduce dependence on few spices.

In this regard, vanilla holds great hope since the present availability of natural vanillin from existing sources all over the world meets only a fraction of the total demand estimated at 30000 tons annually. Current high prices, availability of a package of practices for cultivation and curing, development of protocols for tissue culture and the tremendous enthusiasm among growers can be exploited to make India a significant player in the field. Similar options are available in increasing the production of many other spice varieties like paprika and indigenous varieties of chillies with high colour values and low capsaicin content. The same position holds good with respect to a number of herbal spices.

Bulk of our exports is destined to the American market. Britain, Germany and Japan constitute the other major buyers. There is urgent need to focus attention to non-traditional markets.

Spice products, ground spices, spice oils and extractions find extensive use in tradition as medicines and cosmetic application in the country. While an extensive body of knowledge in this regard is available by way of traditions, it is perhaps not codified and supported by documented, verifiable and rigorous trials required by modern scientific practices, much less sufficient to claim patenting of products. Similarly research could be focused on the nutritional values of spices and derivatives to make formulations, which can be patented.

There is also tremendous scope for promoting spice extractions and products as health foods and alternate medicines, a market segment that is fast expanding. Some degree of research is a prerequisite for providing creditability to such products. Such research could focus on the reported antioxidant properties of curcumin, its capacity to reduce pesticide residues and cholesterol reduction in addition to its use as a food colourant. Garlic and fenugreek are known to have antidiabetic properties as well. Menthol, especially peppermint, is reputed to be capable of fighting irritable bowel syndrome and help cooling and respiration. The possibilities seem to be endless in marrying the known beneficial properties of Indian spices to export potential.

Food safety is going to be a serious issue that will impact upon India's capability to export spices. Establishing oneself as a reliable source of supply of pesticide free spices, will go a long way in improving our export potential. The recent ban introduced by the Government of Andhra Pradesh on the use of Ethion in chillie crop is praiseworthy but long over due. A large number of pesticides, which are in use in food crops and spices, are manufactured under a regime of deemed registration without proper trials to understand the damage they could cause.

Another pressing area is the notion that the quality considerations in production and processing are required only for export purposes. Nothing can be more short sighted than this. For one, the Indian consumer deserves better in terms of quality spices. For another, from a long term perspective, a discerning buyer would refer to buy from a market that has a commitment to quality per se and not from a source where quality is a marketing strategy. The standards in the PFA act and Agmark in so far as they relate of spices should be revised to reflect this thinking and to confirm to internationally accepted standards.

There is considerable misconception about what WTO is all about and how it will impact the growers of spices. A more than cursory look at the agreement on agriculture is required to understand how international competition would impact production, domestic market, prices and farm income in general and issues related to spices in particular. While the commitments of individual countries vary, the broad consensus is in the areas relating to international trade barriers, market access, support to agriculture and export support. More specifically there is agreement to dismantle non tariff barriers [quantitative restrictions], reduction in the tariff levels by certain percentage over a period of time, reduction in the volume of subsidized exports and budgetory therefore to certain levels and reduction in aggregate support measure both general and commodity specific and export subsidies, limited market access, and further negotiations.

Contrary to impressions, India has not committed to guarantee market access to competitors. The aggregate measure of domestic support to farm sector is well below the 10% ceiling and product specific support is considered negative and can continue to be extended. India has the option to introduce safeguards if 'surge of imports' take place as a result of lifting of quantitative restrictions. The agreed percentage reduction in tariff is insignificant and is to be achieved over a ten-year period. India has proposed that food security and livelihood concerns also should be matters of negotiations for the next round and therefore is not likely to agree to any further restrictions unless the food security and livelihood concerns are adequate addressed.

In effect I do not see much risk in the liberalization process in the sense that the Indian market would be flooded with imported spices due to the lifting or quantitative restrictions in the wake of globalization and liberalization. The risk 'if any' would be in the export arena and the main element of the same would be competitiveness, which hinges on productivity, production and availability of an export surplus. The second most important element would be food safety issues, which would become more stringent as time passes. On both these counts, we cannot afford to be complacent. Importing countries have the discretion of introducing sanitary and phytosanitary conditions regarding imports. I do not think that this would cause serious problems in the long term. However, I can see a real threat. Many countries with developed consumer markets, operate a differential tariff regime, a lower one for bulk commodity imports and a higher rate for processed items. Obviously these are introduced to protect domestic industry and domestic value additions, and to compel developing countries to continue to be exporters of bulk commodities rather than exporters of value added items. Such a scenario would hamper the efforts at promotion of Indian brands in the sophisticated markets and should find a place in the agendas for the next round of WTO discussions.

In conclusion, only one thing need to be said. There is no need to shy away from competition and the way forward is improving productivity, post harvest practices and high value addition.

AUGMENTING INDIAN SPICE TRADE WITH GEOGRAPHICAL INDICATION

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Spices have a special place in India's international trade. Since historic times, spices had earned a place for India in the global trade map. Indian spices, which are largely produced in the Western Ghat, were the principal merchandise for the trade with several countries in Europe and Middle East. It was this trade connectivity that not only created history but also diversified Indian agriculture. The Arabs, Greeks, Portuguese, Dutch and British traders slowly established their base in India, which eventually led to their colonization of the country. The journey of Columbus to the coast of India and his accidental landing on the coast of the New World and introduction of several crop plants to India from Africa, Middle East and South America and the reverse flow of Indian crop plants are the historic consequences of this ancient spice trade with India. Thus, a flourishing Indian spice trade in the historic past not only served as a gateway for colonization but also promoted enrichment of Indian crop diversity.

Since independence, Indian trade on spices has substantially expanded in volume and value. A comparison of the export earning from spices during the recent past and its share in the earning from total agricultural commodities and allied products is provided in Fig 1. Since 1991-92, the total value of spices exported, increased four to five-folds. The share of spices to the total export earning from agricultural commodity also increased from 4.7% during 1991-92 to 6.4% during 1998-99. This rise in export had an impact on the annual average growth rate in the production, which exceeded 7% during the last six years in all important spice crops, except chillies. The production increase, however, has come from increase in area rather than improvement in productivity.

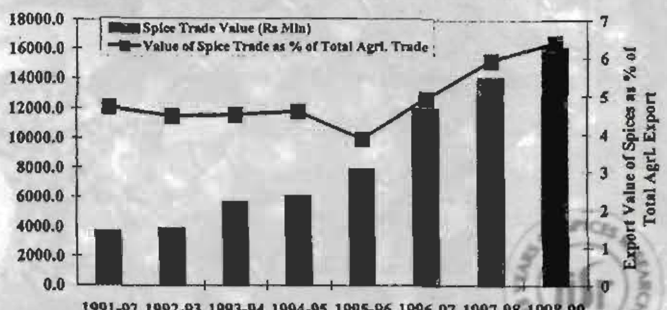

Fig 1. Comparative performance of India's export of spices.

The export scene is also notable for a qualitative change, in the recent past, through value addition. Export of spice oils, oleoresin and curry powder is increasing. This shift in trade has also been influencing the research back up with development of new varieties having higher quality in terms of essential oil and other essential ingredients such as piperine, oleoresin, curcumin, etc.

Indian spice trade deals with produces and products from more than a dozen crops. Nearly 70% of the total export value is, however, earned by four or five producers and products. These produces and products and their mean export value share during the quinquinneum since 1995-96 are as follows: pepper (30.3%), spice oils and oleoresin (15.4 %), chillies (14.5%), turmeric (6.0%) and ginger (3.3%).

It is known that spices are, in general, high value crops. An examination of area under spices and their export earnings shows that this earning, on an average, during last five years is about Rs.7700 per ha. In the case of high value products like pepper this export earning is Rs. 35700/ha while the same for low value spices like garlic is Rs.1100/ha. The general difference between prices of the unit quantity of these high and low value spices is about 30-fold. It is natural that for products of such high value, quality becomes the most important requirement. Qualities of many agricultural commodities are known to be influenced not only by the genetic make up of the variety, but also the environment where they are grown or even by the traditional skill of the people cultivating or processing the product. Many of these qualities do earn recognition and reputation in the local and international markets. Such reputation invariably attracts higher market preference and prices. For augmenting these advantages, it is important to understand whether a given Indian spice commands a higher market preference or price in international market vis-à-vis the same product exported by other major exporting countries. Annual average international prices of five major spice crops from major exporting countries during the past five years presented in Tables 1 to 5, show that the Indian turmeric, ginger and cardamom consistently commands higher prices, while such price advantages is absent in black pepper and Indian chillies. Indian chillies fetch lower price than Chinese chillies. Despite lacking price advantage, Indian pepper is known for

Table 1. International market prices* of black pepper exported by major exporters

Year	Malabar Grade 1	Lampong	Brazil	Sarawak
1991-92	0.64	0.65	0.61	0.61
1992-93	0.55	0.55	0.55	0.55
1993-94	0.74	0.68	0.70	0.97
1994-95	1.04	1.04	0.86	1.04
1995-96	1.15	1.15	1.17	1.15

** US \$ pound[1] in New York market*

Table 2. International market prices* of chilli exported by major exporters

Year	China	Pakistan	India
1991-92	1.21	0.77	1.31
1992-93	1.56	0.92	0.97
1993-94	0.91	0.95	0.56
1994-95	0.77	-	0.68
1995-96	1.07	-	1.00

** In US $ pound^{-1} in New York market*

Table 3. International market prices* of turmeric exported by major exporters

Year	India (Alpy 5.5)	India (Alpy 5.0)	China
1991-92	1.03	0.93	0.39
1992-93	0.94	0.83	0.39
1993-94	0.62	0.58	-
1994-95	0.62	0.57	-
1995-96	0.65	0.62	-

** In US $ pound^{-1} in New York market*

Table 4. International market prices* of ginger exported by major exporters

Year	India	China
1991-92	0.83	0.69
1992-93	0.81**	0.65
1993-94	0.75	0.61
1994-95	0.79	0.62
1995-96	0.56	1.25**

** In US $ pound^{-1} in New York market*

*** Export restricted to few months of the year*

Table 5. International market prices* of cardamom exported by major exporters

Year	India (Extra bold /bold)	China (Bold green /bold)
1991-92	16.22	11.62
1992-93	15.88	9.89
1993-94	15.93	10.24
1994-95	17.39	7.66
1995-96	9.58	6.33

**In US $ kg^{-1} in Middle East market*

its quality and preferential demand.

What makes a spice crop to command a high trade reputation in quality and associated market preference and premium price is generally known to the farmers, traders and the scientists. It is also generally known that either a

specific variety or any variety grown in a specific area substantially contributes to the quality of the produce, which in turn contributes to its market reputation.

It is possible to establish whether a quality of a spice crop commanding such market reputation be traced either to its varietal makeup or to the geographic region where it is grown or to both. Role of geographic niche on the quality of a variety or varieties could be excluded when such quality is realized across wide geographical latitudes. When such quality, on the other hand, is achieved, from one or more varieties of the crop grown in a territory, region or locality within the territory with a reasonable identifiable boundaries, to the extent that such quality is not always or totally achieved when the same varieties are grown outside the identified boundary, the quality in question could be appellated or indicated to the defined geographical region. Such a geographical appellation indication (GI) can also get complexed with the varieties endemic to the region as well as specific cultural and processing practices being traditionally mastered by the farmers. GI, in the agricultural context, hence may mean a given quality, reputation or other unique characteristics of an agricultural commodity that is essentially attributable to the territory of a country, or of region or locality in that territory where such commodities are either produced or processed or prepared.

WTO and GI

Trade Related Intellectual Property Rights (TRIPs) is one of the multilateral agreements bound to the WTO. Articles 22,23 and 24 of TRIPs seek to provide qualified trade protection to geographically indicated goods and commodities of Member countries. According to these Articles a GI can be protected only when it is legally protected in the country of origin and during the period when such protection is available in that country (Article 24.9). Such a legislation undertaken by members shall provide the legal means for interested parties to prevent the use of any means in the designation or presentation of goods that indicates or suggests that the goods in question originate in a geographical area other than the true place of origin in a manner which misleads the public as to the geographical origin of the goods, or any use which constitutes an act of unfair competition (Article 22.2).

Having enacted such a legislation on GI, a Member does not automatically get trans-boundary recognition in the international market for the GI it had domestically enacted. A Member after having armed with such legal protection for GI in the country of origin may enter into negotiations with other Members for extending this protection to the territories of these Member countries. The Members who are such negotiated with shall not refuse to conduct these negotiations or conclude bilateral or multilateral agreements on the use of the said GI (Article 23.1). It means bilateral and multilateral negotiations may require to be undertaken by a Member to get its GI protection honoured in the territory of the other Members, particularly with whom the trade stakes are high.

The TRIPs further provide that in case the negotiations with other Members do not help in resolving the matter, the TRIPs Council could be approached for a resolution. According to Article 24.2 any matter affecting the compliance with the obligations under these provisions may be drawn the attention of the TRIPs Council (in WTO), which, at the request of a Member, shall consult with any Member or Members in respect of such matter for which it has not been possible to find a satisfactory solution through bilateral or multilateral consultations between the Members concerned. The TRIPs Council shall take such action as may be agreed to facilitate the operation and further the objective of Article 24.2.

The above stated provision of TRIPs clearly show that Member countries of WTO are entitled to make legal devices to provide GI protection to goods and commodities and such protection can be extended to the territories of other Member countries with their approval and the TRIPs Council could be used as a forum to secure such approval from other Members. However, so far no GI protection other than that for Scotch Whisky and Champagne is allowed under WTO. Now that the Government of India has enacted the Geographical Indications of Goods (Registration and Protection) Act, 1999 (hereafter referred to GIGA, 1999), action could be initiated to secure GI for agricultural commodities eligible for the same. However, a formal application for GI and its grant has to wait until Government of India comes out with Rules on this Act and establishment of the GI Registry. Nevertheless, the time available until then could be advantageously used to generate the adequate database required for filing the application as soon as the expected rules of GI are notified.

Indian Act on GI

The GIGA (1999), requires maintenance of a GI Registry which is controlled and monoged by the Registrar of GI. A GI can be registered in respect of any or all the goods in respect of definite territory or region or locality. The Act, however, precludes registration of GI which may deceive or cause confusion or whose use may contravene any of the law in force, or which contains obscene matter or matter hurting the religious susceptibilities of a class or section of people, or generic name or indications which have fallen into disuse or false representations on the origin of goods.

Who can apply for a GI

Any organization or authority established under law or any association of produces or persons representing the interest of producers of the concerned goods can apply to Registrar in the prescribed application form. As of now the rules of GIGA (1999) is not finalized and gazetted by the Govt. of India and therefore, information on application, procedure for making application and the fee required to pay along with the application, etc. are not available. However, the law makes it clear that organizations like the Spices Board, Indian Institute of Spices Research or the Indian Council of Agricultural Research and other such lawfully established organizations representing the interest of spices producers or association of spices farmers or such persons who represent the interest of spices farmers are eligible to apply for a GI on any spice crop. A single application may be made for the registration of a GI for different classes of goods with total fees eligible for each class of goods.

Requirements for application

The application should provide a statement how the GI serves to designate a commodity or goods, for instance a spice crop, as originating from a specified territory, region or locality in India in respect of specific quality, reputation or other characteristics of which are due exclusively or essentially to either one or more or all of the following elements: (i) the geographic environment with its inherent natural factors, (ii) with the natural factors including human factor, and (iii) factors underlying the production, processing or preparation methods unique to the geographical environment or human factors. Having delineated these exclusive or essential elements of GI, it is important to clearly define the geographic region with in which the said geographically indicated quality or reputation or other characteristics are realized. Trade considerations may also influence the delimitation of this geographic area. If the commodity for which the GI is being sought has any unique appearance attributable to the geographical factors, such appearance should be described either in words or figures or both. The application can also provide particulars of the producers of the concerned commodity or product. Such particulars may become important when the applicants are association of farmers or individuals. GI is not an exclusive trading privilege granted to either an individual or group or organization, but an officially approved identity for specified characteristics, quality and reputation of a commodity or goods originating from or produced or processed in a territory, which could be used by any person under authorization from the GI Registry.

Definition of geographically indicative factors

It is mentioned above that the eligibility of GI is based on certain specific quality, reputation of other characteristics including appearance of the commodity or goods, which are due exclusively or essentially to the described three geographical elements. These specific qualities and characteristics may be clearly definable or merely describable. For instance, it is generally perceived that the Malabar pepper, the Cochin ginger, Alleppey turmeric and Alleppey cardamom have high market reputation. This reputation in each of these produces could be attributed to certain tangible and intangible characteristics. The tangible characteristics have to be elaborately defined with the help of data base, figures, photographs, etc. depending upon whether the characteristics involve shape, size, colour and appearance, test weight, content and composition of chemical factors determining the intrinsic quality valued in the market parlour. This definition to a greater extent has to establish, by and large, an exclusive or essential bearing with geographical environment in respect to the three elements mentioned earlier.

The geographical area thus indicated is documented in a geographical map delineating the territory, or region or the locality of the country, as the case may be, and to be provided along with the application. All applications for GI are required to be advertised and to offer opportunity for opposition, if any, from interested parties prior to its consideration for approval. Therefore, the description of indicated characteristics of the commodity or goods and the definition of the geographical limits have to be carefully developed to withstand any opposition.

Advertisement, opposition, registration and authorization

An application for GI duly received by the Registrar, subjected to the conditions of limitations, will be accepted and appropriotely advertised. The time limit for opposition for granting the advertised GI will be three months from the date of advertisement. The Registrar on merits and a final decision if any, to the application considers the opposition, along with the counter from the applicant or not to register the GI, is taken on the balance of convenience. On registration, the Registrar will issue to the applicant(s) and other authorized users a certificate allowing them to use the GI. Any one who is the producer of the geographically indicated goods or commodities is entitled to apply to the Registrar in prescribed manner to get registered as an authorized user of such GI. In the event of infringement of GI, only those persons who are either applicants or authorized users are eligible for relief possible from the infringer. Normally registration of a GI is for o period of ten years. It could be renewed for subsequent tenures. However, if the Central Government thinks it necessary to provide additional protection to certain goods by notification in the Official Gazette, it may do so for such protection.

GI and trade mark

Registrar of Trade Mark is empowered to refuse or invalidate the registration of a trade mark, which contains or consists of GI. However, whereever a trade mark contains or consists of GI and the same had been applied for or registered on good faith under the Law of Trade Mark in force or where rights to such trade mark have been acquired through use in good faith either before the commencement of GIGA (1999) or before the date of filing the application for registration of such GI, the registrability of such trade shall be held identical with or similar such GI. However, no action in connection with the use or registration of trade mark shall be allowed after the expiry of five years from the date on which such use or registration infringes any GI registered under GIGA (1999) has become known to the registered proprietor or authorized user registered in respect of such GI or after the registration of the trade mark.

The GIGA (1999) provides an appellate board to resolve disputes related to GI. Offences committed under the ambit of GIGA (1999) are punishable with imprisonment for duration ranging from six months to three years and fine ranging form Rs. 50,000 to Rs. 3,00,000.

How GI can augment trade

India has a sizable global trade share in spices and its products. Nearly four-fifth of the global trade volume in turmeric, one-third in pepper, chillies and spice seeds, one-fourth in dry ginger and two-third in curry powder is exported from India (Fig.2). Some of the Indian spices, as mentioned earlier, command a high preference, often with premium price advantages. Under this trade scenario, GI offers additional trade advantage in strengthening and monopolizing the niche quality of many Indian spices. GI serves as an official stamp for these spices and their products to authenticate that the trade reputation they had been enjoying on the basis of their quality and other characteristics as originating form the uniqueness of the territory or region or locality from wherein they are produced and processed. The GI also precludes use of similar appellations to the same commodity or goods originating from regions outside the geographically indicated territory. This may ensure a consistent quality to the geographically indicated goods to facilitate creation and maintenance of a customer niche.

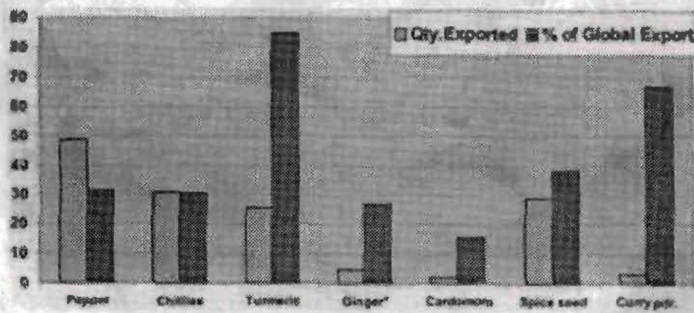

Fig 2. Volume of Indian spices export and its share in global trade.

This may promote development of a monopoly for the geographically indicated goods which, when well maintained in terms of quality standards and trade volume, may allow premium price slabs. GI with good trade practices may serve as a powerful mechanism to retain and expand markets and trade volume. Some of the Indian spice produces and products are well placed to secure GI protection.

SPICES IN AYURVEDA

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The term 'Ayurveda' means knowledge or science of life. Ayurveda is based on the 'Thridosha' theory. This theory provides a functional, holistic and field oriented approach, considering health in the equilibrium of three doshas, viz. vata, pitta and kapha and diseases due to their upsetting. This is for promotion of life and prevention and cure of diseases, which depend on 'Ahara' (diet), 'Nidra' (sleep) and 'Abramacharya' (sex). If these three factors are properly attended to and not abused, life is prolonged.

Diet and medicine are not totally separate, they often overlap each other. They are studied in the language of tastes, namely sweet, sour, salty, bitter, pungent and astringent. Of these, sweet, sour and salty act against vata, increase kapha; bitter pungent and astringent act against kapha, increase vata; and astringent, bitter and sweet act against pitta. So by studying the taste of each article we can presume how they act. In addition to this there are other properties like 'Veerya', 'Vipaka' and 'Prabhava'. By taste, post-digestive taste or by potency also we cannot ascertain the final action of a dravya or substance. There is Prabhava or a special action that overrides these. While selecting a diet, holistic property of the article is given prime consideration. A balanced food is one in which all tastes are represented, their proportion to be determined as per the type of man, his present need, climate etc. Of the 25 spices used in Ayurveda, some important ones are dealt with here. The consumption of some of the important spices by the Ayurvedic sector in Kerala is given in Table 1.

1. Garlic

(Botanical name- *Allium sativum* Linn; Family- Liliaceae; Vernacular names - Lasunah (Sanskrit), Lahasun (Hindi), Vellulli (Malayalam)).

Dravyaguna

Guna - Snighda, Tikshna, Picchila, sara

Virya - Ushna

Vipaka - Rasayana, Pacana, Krmighna, Balya, Vrsya, Hydrogaghna, Medhahita, Caksusya, Raktapittavardhhaka, Sandhaniya etc.

Table 1. Consumption of important spices by ayurvedic sector in Kerala

Name of the commodity (Malayalam)	Botanical name	1995-96						1997-98					
		Arya Vaidyasala Kottakkal		Oushadi		Total consum ption kg	Mean price Rs.kg^{-1}	* Arya Vaidyasala Kottakkal		* Oushadi		Total consum ption (kg)	Mean price (Rs.kg^{-1})
		Consum ption (kg)	Rate (Rs. kg^{-1})	Consum ption (kg)	Rate (Rs. kg^{-1})			Consum ption (kg)	Rate (Rs. kg^{-1})	Consum ption (kg)	Rate (Rs. kg^{-1})		
Ayamodakam	*Trachyspermum roxburghianum*	6000	50	6111	28	12111	39	7000	59	6028	30.96	13028	44.98
Chukku	*Zingiber officinale*	46000	72			46000	72	42000	46			42000	46
Elakkaya	*Elattaria cardamomum*	12000	329	1379	490	13379	409.5	13000	640	1757	70	14757	355
Inchi	*Zingiber officinale*			575	17.4	575	17.4			748	18.5	748	18.5
Jathicka	*Myristica fragrans*	3000	106	341	53.5	3341	79.75	3000	88	352	56.5	3352	72.25
Jathipathrika	*Myristica fragrans*	1000	256			1000	256	1000	253			1000	253
Jeerakam	*Cuminum cyminum*	42000	58	7392	63.4	49392	60.7	43000	64	6598	66.47	49598	65.235
Karayampoo	*Syzygium verum*	3000	102			3000	102	3000	115			3000	115
Karinjeerakam	*Carum carvi*	4000	20	1040	25.75	5040	22.875	4000	23	1369	29	5369	26
Kothampalari (kernel)	*Coriandrum sativum*	6000	23			6000	23	5000	33			5000	33
Kurumulaku	*Piper nigrum*	12000	82	7646	84.75	19646	83.375	12000	104	7291	122.55	19291	113.275
Malli(whole grain)	*Coriandrum sativum*			18625	23	18625	23			16498	31	16498	31
Pacha Manjal	*Curcuma longa*			2623	7.95	2623	7.95			7176	7.46	7176	7.46
Thippaly	*Piper longum*	29000	188	10598	99	39598	143.5	30000	225	11127	71.5	41127	148.25
Uluva	*Trigonella foenum*	3000	15	281	17	3281	16	4000	16	318	16.48	4318	16.24
Varattumanjal	*Curcuma longa*	8000	18			8000	18	8000	26			8000	26
Vellulli	*Allium sativum*	10000	16	1903	28	11903	22	10000	12	2365	24	12365	18

Contd.

Name of the commodity (Malayalam)	Botanical name	1997-98 Arya Vaidyasala Kottakkal		Oushadi		Total consum ption (kg)	Mean price Rs.kg^{-1}	1998-99 *Arya Vaidyasala Kottakkal		*Vydyaratnam		*Oushadi		Total consum ption (kg)	Mean price (Rs.kg^{-1})
		Consum ption (kg)	Rate (Rs. kg^{-1})	Consum ption (kg)	Rate (Rs. kg^{-1})			Consum ption (kg)	Rate (Rs. kg^{-1})	Consum ption (kg)	Rate (Rs. kg^{-1})	Consum ption (kg)	Rate (Rs. kg^{-1})		
Ayamodakam	*Trachyspermum roxburghianum*	7000	71	5180	39	12180	55	7000	71	765	35	5336	48	13101	51.33
Chukku	*Zingiber officinale*	43000	54			43000	54	48000	90					48000	90
Elakkaya	*Elettaria cardamomum*	12000	380	1801	282	13801	331	13000	664	796	502	1841	550	15637	572
Inchi	*Zingiber officinale*			585	18.35	585	18.35			4166	17.8	717	17.4	4883	17.6
Jathicka	*Myristica fragrans*	3000	150	389	68.69	3389	109.345	3000	336	186	195.28	404	160	3590	230.43
Jathipathrika	*Myristica fragrans*	1000	549			1000	549	1000	635					1000	635
Jeerakam	*Cuminum cyminum*	62000	67	7353	58.71	69353	62.855	57000	63	1725	73.4	10194	73	68919	69.8
Karayampoo	*Syzygium verum*	3000	113			3000	113	3000	71					3000	71
Karinjeerakam	*Carum carvi*	3000	40	1253	46	4253	43	4000	48	332	47	1089	53.45	5421	49.48
Kothampalari (kernel)	*Coriandrum sativum*	5000	31			5000	31	5000	23					5000	23
Kurumulaku	*Piper nigrum*	11000	207	6902	191	17902	199	11000	197	1795	198.75	6131	189	18926	194.92
Malli (whole grain)	*Coriandrum sativum*			15756	34	15756	34			946	21.35	14266	20	15212	20.68
Pacha Manjal	*Curcuma longa*			5286	7.93	5286	7.93			880	39.2	7358	8.74	8238	23.97
Thippaly	*Piper longum*	28000	195	10527	92	38527	143.5	29000	186	3653	117.65	9606	125	42259	142.88
Uluva	*Trigonella foenum*	4000	21	759	21.9	4759	21.45	4000	23	126	20	1836	24.5	5962	22.5
Varattumanjal	*Curcuma longa*	8000	42			8000	42	8000	40					8000	40
Velluli	*Allium sativum*	10000	21	1467	34.9	11467	27.95	11000	31	911	31.45	1435	38.5	13346	33.65

Contd.

Name of the commodity (Malayalam)	Botanical name	1999-2000									
		*Arya Vaidyasala Kottakkal		*Sitaram		*Vydyaratnam		*Oushadi		Total consum ption (Kg)	Mean price Rs.kg^{-1}
		Consum ption kg	Rate Rs. kg^{-1}	Consum ption kg	Rate Rs. kg^{-1}	Consum ption kg	Rate Rs. kg^{-1}	Consum ption kg	Rate Rs. kg^{-1}		
Ayamodakam	*Trachyspermum roxburghianum*	7000	87	1150	35	977	56	4180	42.5	13307	55.13
Inchi	*Zingiber officinale*			406.5	17	5332	25.4	738	29	6476.5	23.80
Chukku	*Zingiber officinale*	55000	84							55000	84.00
Elakkaya	*Elettaria cardamomum*	14000	510			947	494.4	1632	434.5	16579	479.63
Inchi	*Zingiber officinale*			406.5	17	5332	25.4	738	29	6476.5	23.80
Jathicka	*Myristica fragrans*	3000	332	344	215	210	229.6	323	168	3877	236.15
Jathipathrika	*Myristica fragrans*	1000	640	108	410					1108	525.00
Jeerakam	*Cuminum cyminum*	58000	95	2872	135	2153	85.18	7078	80	70103	98.76
Karayampoo	*Syzygium verum*	3000	179							3000	44.76
Karinjeerakam	*Carum carvi*	4000	84	724	63	549	64.8	1044	84.5	6317	74.17
Kottampalari (kernel)	*Coriandrum sativum*	6000	23	364	35					6364	29.00
Kurumulaku	*Piper nigrum*	13000	236	1148	135	1891	200.45	5940	226	21979	199.36
Malli (whole grain)	*Coriandrum sativum*					888	16.9	15640	23.4	16528	20.15
Pacha Manjal	*Curcuma longa*					1053	37.4	7620	8.82	8673	23.11
Thippaly	*Piper longum*	33000	184	2896	175	4554	157.08	10366	124.8	50816	160.22
Uluva	*Trigonella foenum*	5000	24	128	22	158	22	1396	21.9	6682	22.25
Varattumanjal	*Curcuma longa*	10000	34	1085	35					11085	34.50
Vellulli	*Allium sativum*	12000	20	682	28	1493	28.55	1820	29	15995	26.39

* ayurvedic firms

Distribution

Cultivated in richer soil at higher elevation (3000-4000 ft)

Phytochemistry

Mixture of strong smelling aliphatic mono and polysulphides is present in the juice. In addition, thioglycoside, amino acids, fatty acids, flavanols, vitamins, trace elements, volatile oils etc. are also present.

Garlic contains moisture 62.8; protein 6.3; fat 0.1; carbohydrates 29.0; Ca. 0.03; P. 0.31%; Fe. 1.3mg; vitamin c. 13 mg/100g and copper.

The bulbs on distillation yield 0.06-0.1% of an essential oil (dl 14.5°, 1.0525) containing allylpropyl disulphide, $C_6H_{12}S_2$ (6%), diallyl disulphide, $C_6H_{10}S_2$ (6%) and two more sulphur containing compounds.

Ayurvedic uses

Preparation of garlic have been given in pulmonary phthiasis, bronchiectasis, gangrene of the lung, and whooping cough. Laryngeal tuberculosis, lupus and duodenal ulcers are treated by garlic juice. Inhalation of fresh garlic juice is useful in pulmonary tuberculosis. It has been found in atonic dyspepsia, flatulence and colic.

In external applicotion juice is used as a rubefacient in skin diseases and as ear-drops in ear-ache. The juice diluted with water can be used as a lotion for washing wounds and foul ulcers.

Garlic has been used as a food and medicine in India, China and Middle East for thousands of years. Charaka has ascribed significant medicinal properties to garlic. Hippocrates and other Greek physicians olso oscribed the use of garlic. Garlic is used in folk medicine.

Garlic has significant carminative effect with a release or nausea. It brings about a decrease in trighycenides and calestrol, garlic oil drops are good for ear ache.

2. Coriander

(Botanical name- *Coriandrum sativum* Linn; Family – Apiaceae; Vernacular names – Dhanyaka, Kustumburu (Sanskrit), Dhaniya (Hindi), Kottampala, Kottamalli (Malayalam)).

Dravyaguna

Guna - Snigdha, Avrsyam, Laghu, Mutralam, Hrdyam, Dipanam, Pacanam

Rasa - Tiktam, Katu

Virya - Ushna

Vipaka - Madhuram

Karma - Tridosasamana, Trsnahara, Dahasamana, Vamihara, Svasaprasamana.

Distribution

Coriander is a native of the Mediterranean region and is extensively grown in Russia, Central Europe, Asia minor, Maracco and in all states of India.

Phytochemistry

Fruits contain moisture, 11.2; protein, 14.1; fat (ether extract), 16.1; carbohydrates 21.6; fibre 32.6; mineral matter 4.4; calcium 0.98; and phosphorus 0.37%; iron 17.9 mg/100g. Vitamin C 250mg/100g and carotene (5,200µg/100g) are also seen in leaves. The aromatic odour and taste of coriander fruits is due to the essential oil. This oil is a pale yellow liquid having characteristics odour and taste of coriander. The chief constituent of the oil is coriandrol ($C_{10}H_{17}OH$), a terpene tertiary alcohol, now known to be identical with d-linalool, the concentration of which varies from 45-70%. The other minor constituents of the oil are: α and β – pinene, ρ-cymene, depentene, α-terpine, phellandrene, terpinolene and traces of geraniol, borneol, n-decylic aldehyde and esters of acetic and decyclic acids. The oil causes irritation when in contact with skin for a long time. Besides the essential oil, the seeds contain 19-21% of fatty oil having dark brownish green colour and an odour similar to that of coriander oil.

Ayurvedic uses

The fruits are considered carminative, diuretic, tonic, stomachic, antibilious, laxative, refrigerent and aphradisiac. The fruits and leaves are also used against colic, dizziness, kidney stones, indigestion, sore throat etc.

3. Cumin

(Botanical name - *Cuminum cyminum Linn*; Family - Apiaceae; Vernacular names – Jiraka, Jira (Sanskrit), Jira, Zeera (Hindi), Jeerakam (Malayalam))

Dravyaguna

Guna - Snighda, Laghu, Ruksha, Dipanam, Pacanam

Rasa - Tiktam, Katu

Virya - Ushna

Vipaka - Katu

Karma - Vathakaphahara, Rochana, Dipana, Shothagna, Grahi, Chakshushya.

Distribution

The plant is grown extensively in South-Eastern Europe, North Africa bordering the Mediterranean Sea, India and China

Phytochemistry

Seeds contain moisture 11.9; protein, 18.7, ether extr. 15.0; corbohydrates, 36.6; fibre, 12.0; mineral matter 5.8; calcium, 1.08; and phosphorus, 0.49% besides iron 31.0mg/100g. Caratene calculated as vit. A, 870 IV/100g; and vitamin C, 3 mg/100g.

The seeds yield on distillation a volatile oil (oil content, 2 - 4%) with an unpleasant characteristic odour and somewhat bitter taste. The chief constituent of the volatile oil is cumaldehyde, $C_{10}H_{12}O$ (p-iso propylbenzaldehyde), which forms nearly 20-40% of the oil. Besides the aldehyde, the oil contains p-cymene, pinene, depentene, cumine, cumic alcohol, α-phellandrene and β-terpenol. Cumine is produced by distilling cumic acid with lime or baryta. Cumaldehyde is used in perfumery, and cumine for sterilizing catgut. The former can be converted into thymol.

Besides the volatile oil, the seeds contain 10% fixed oil, which is greenish brown in colour with strong aromatic flavor.

Ayurvedic uses

Cumin seeds are stimulant and carminative. They are stomachic, astringent and useful in diarrhoea and dyspepsia. They are also used in veterinary medicine.

Charaka and Sushrutha describe this as an appetite stimulant and a good digestive. It is used for common gastro intestinal upsets, and is also used as a carminative.

4. Turmeric

(Botanical name - *Curcuma longa L.;* Family - Zingiberaceae; Vernacular names – Haridra, Rajani (Sanskrit), Haldi Holada (Hindi), Manjol (Malayalam))

Dravyaguna

Guna - Laghu, Ruksha

Rasa - Tikta

Virya - Ushna

Vipaka - Katu

Karma - Vatakaphahara, Dipana, Shothahara, Tvakdosahara, Vranasodhana, Ropana, Kantivardhaka, Kandughna, Grahi

Distribution

The plant is native of

Southern Asia and is cultivated extensively throughout the warmer parts of the world.

Phytochemistry

Turmeric rhizomes contain moisture 13.1; protein, 6.3; fat, 5.1; mineral matter, 3.5; fibre, 2.6; carbohydrates, 69.4%; carotene calculated as vitamin A, 50 IV/100g. The essential oil (5.8%) obtained by steam distillation of dry rhizomes contains d-α- phellandrene, 1; d-sabinene, 0.6; cineol, 1;borneol, 0.5; zingiberene, 25; sesquiterpenes (turmerons) 58 percent. The crystalline colouring matter, curcumin is a diferuloyl methane of the formula $C_{21}H_{20}O_6$. It dissolves in concentrated sulphuric acid giving a yellow-red colouration. The antioxidant properties of curcuma powder are probably due to the phenolic character of curcumin. The choleretic action of the essential oil is attributed to P-totlylmethyl carbinol. The dyestuff acts as a cholagogue causing the concentration of the gall bladder.

The colouring matter of the turmeric can be extracted from the powder either by direct solvent extraction or by extraction with aqueous alkali and subsequent precipitation with acid. Products containing the total active constituents of turmeric and useful in the treatment of gall complaints have been prepared from aqueous extracts of the rhizomes. Curcumin is used as a dye for silk, paper, wood and food stuffs.

Ayurvedic uses

It is used variously as condiment, curry powder, a dyeing agent and particularly as a medicine even in vedic times. It is a symbol and token of auspiciousness. Rhizomes are used in many ceremonies in Hindu families. For improving complexion and for removing unwanted hairs a paste of it is regularly applied on the face. As an ingredient in curry powder it improves the flavour and functions as an antiseptic, antipoison factor. It is recognized as an aromatic, stimulant tonic, carminative and anthelmintic. Juice of emblic myrobalons and turmeric with honey is given for diabetes. Turmeric with *Ocimum sanctum* is a common remedy for insect bites. Turmeric powder is sprinkled for stopping bleeding. In small pox and chicken pox a paste of turmeric and neem leaves is applied to facilitate the process of scabbing. Turmeric and tamarind boiled in water is used as a lotion for sore eye and conjunctivitis. Turmeric is good for treating eosnophilia. Rajanyadi choornam, Saraswatha choornam and many other recipes intended for promotion of health and intelligence of children contain turmeric. A very popular recipe with turmeric is 'Haridra-khandum' which is the best medicine for curing pruritus and urticaria and all skin diseases.

In Indian system of medicine, turmeric is used as a stomachic, tonic, blood purifier, antiperiodic, alterative etc. It is also prescribed for common cold, skin infections, indolent ulcers, inflamed joints and ophthalmia.

5. Cardamom

(Botanical name _ *Elettaria cardamomum* Maton; Family - Zingiberaceae; Vernacular names – Ela (Sanskrit), Elayachi (Hindi), Elam (Malayalam).

Dravyaguna

Guna	-	Snigdha, Lakhu, Dipanam, Rochanam, Ruksham, Hrdyam, Pttolam, Vrsyam
Rasa	-	Katu, Madhuram
Virya	-	Sitam
Vipaka	-	Madhuram
Karma	-	Vathahara, Kapha-Svasa-Kasa haram, Mutrakrcchaharam, Asyavairasya samanam, Garbhapatakaram, Hiddhma-daha samanam.

Distribution

Two types of 'Ela' namely 'Sookshma ela' and 'Sthoola ela' are mentioned in Ayurvedic literature. 'Sookshama ela' (small cardamom) grows in South India and Sri Lanka. The drug has been mentioned in Sushrutha Samhita. Ayurvedic practitioners and the experts dealing with medicinal plants are of the opinion that *Elettaria cardamomum* Maton is the 'Sookshma ela' and seeds of *Amomum subulatum* Roxb., the 'Sthoola ela'

Phytochemistry

Cardamom capsules contain moisture 20.0; protein, 10.2; ether extr., 2.2; mineral matter, 5.4; crude fibre, 20.1; carbohydrate, 42.1; calcium, 0.13; and phosphorous 0.16% besides iron, 5.0 mg/100g. Also contain volatile oil (2-8%), which causes the aroma and therapeutic properties.

The principal constituents of the oil are cineol, terpinene, limonene, sabinene and terpineol in the form of formic and acetic esters. Fatty acids like caprylic, oleic, palmitic, myristic etc. are also present.

Ayurvedic uses

In medicine it is used as an adjuvant to carminative drugs. Powdered cardamom mixed with ginger, clove and caraway is good stomachic and useful in atonic dyspepsia.

Cardamom is used as a home remedy for indigestion, nausea, halitosis and bronchial infections. It is used in Yogas to cure skin diseases, colds and inflammations. 'Eladigana' as the name signifies starts with Ela as its first ingredient used for curing vata and kapha diseases, itching and poisons and improving digestion, curing vomiting, cough etc. It is used to stimulate in cases of snake bite poison.

6. Nutmeg

(Botanical name -*Myristica fragrans* Hautt; Family - Myristicaceae; Vernacular names – Jotiphalah, Jatipatri (Sanskrit), Jaiphal, Javitri (Hindi), Jathikai, Jathipatri (Malayalam)

Dravyaguna (*Jathipatri*)

Guna - Tikta

Rasa - Laghu

Virya - Ushna

Vipaka - Snigdha

Karma - Kasa, Swasa Dravyaguna (*Jathikka*)

Guna - Ushna

Virya - Ushna

Karma - Krimighnam, Deepana

Distribution

Myristica fragrans, is a native of Maluccas, now cultivated in many tropical countries of both hemispheres. In India, it is grown in Tamil Nadu, Kerala, Assam and other hotter parts of India.

Phytochemistry

Nutmeg kernel

Nutmeg kernel contains moisture, 14.3; protein, 7.5; ether extr., 36.4; carbohydrates, 28.5; fibre, 11.6; and mineral matter 1.7%; calcium, 0.12; and phosphorous, 0.24% besides iron, 4.6mg/100g. It also contains a volatile oil (6 -16%), starch (14.6-24.2%), pentosans (2.25%), furfural (1.5%) and pectin. The principal constituents are a fixed oil, a volatile oil and starch. The flavour and therapeutic actions are due to the volatile oil.

The percentage of volatile oil in nutmeg varies from 6-

16% according to the origin and quality of the spice. Commercial oil is derived from broken and wormy nutmegs. Oil of nutmeg is a mobile, almost colourless or pale yellow liquid with characteristics odour with d-pinene and d- camphene as the major components. Together they constitute 80% of the oil. Other constituents are β-pinene, dipentene, p-cymene, d-linalool, 1-terpinen-4-ol, *dl*-α-terpineol, geranil, safrole, eugenol, isoeugenol, an aldehyde with citral odour, myristicin (3-methoxy-4, 5- methylenedioxy-1-allylbenzene), myristic acid and esters of myristic and other fatty acids. Myristicin is toxic when ingested in large amounts and is liable to cause fatty degeneration of the liver.

Nutmeg starch resembles legume starche in appearance and individual grains show, under the microscope, a well developed cracked hilum. The grains are irregular in shape and vary in size from 5μ to 50μ; compound grains with upto ten components are common.

Mace

Mace contain moisture, 15.9; protein, 6.5; ether extr., 24.4; carbohydrates, 47.8; fibre, 3.8; and mineral matter 1.6%; calcium, 0.18%; and phosphorous, 0.10% besides iron, 12.6mg./100g. It also contains a volatile oil (4-15%) amylodextrin (25%), reducing sugars, pectin and resinous colouring matter. The chief constituents are the volatile oil (oil of mace). The oil closely resembles nutmeg oil in odour, flavour and composition and no distinction is made between them in trade.

Mace yield a fat similar to that from nutmeg but in a much smaller amount. A sample of Indian mace gave 26% of red coloured fat (18-20% after removal of volatile oil an extraction with carbontetrachloride.

The amylodextrin is present in mace in the form of granules, visible under the microscope (size, 5-7 μ). They are compound and irregular in shape with a distinct hilum.

Ayurvedic uses

Both nutmeg and mace are used as condiment and in medicine. In eastern countries they are used more as a drug than as condiment. Nutmeg is stimulant, carminative, astringent and aphrodisiac. It is used in tonic and electuaries and forms a constituent of preparations prescribed for dysentery, stomach ache, flatulence, nausea, vomiting, malaria, rheumatism, sciatica and early stages of leprosy. Excessive doses have a narcotic effect, symptoms of delirium and epileptic convulsions appear after 1-6 hours. Mace is also chewed for masking foul breath.

Oil of nutmeg or mace has been recommended for the treatment of inflammations of bladder and urinary tract. The oil is some what toxic and should be used with caution.

Nutmeg butter is used as a mild external stimulant in ointments, hair lotions and plasters and forms a useful application in cases of rheumatism, paralysis and sprains.

Alcoholic extracts of nutmeg show antibacterial activity against *Micrococcus pyogenes var. aureus.*

It is also useful in helminthiasis, cough, asthma, amenorrhoea, dysmenorrhoea etc.

7. Black cumin

(Botanical name - *Nigella sativa* Linn. Family - Ranunculaceae, Vernacular names –Upakunchika, Krsnajirakam (Sanskrit), Kalonji, Kalajira (Hindi), Karinjeerakam (Malayalam))

Dravyaguna

Guna - Lakhu, Tikshna, Madhyam, Ruksam

Rasa - Tiktam, Katu

Virya - Ushna

Vipaka - Katu

Karma - Kaphanilajit, Agnivardhakam, Sulaghnam, Garbhasayavisadhanam

Distribution

Occasionally found as a weed of cultivated crops in Punjab, Himachal Pradesh, Bihar and Assam.

Phytochemistry

Total ash, 3.8 – 5.3; ash insol. in HCl, 0.0 – 0.5; volatile oil 0.5 –1.6; ether extr. (fatty oil), 35.6 – 41.6; and alcoholic acidity (as oleic acid), 3.4 – 6.3%. The yellowish brown volatile oil obtained from steam distillation has an unpleasant odour. The oil contains carvone (45 – 60%), d-limonene and cymene. A carbonyl compound nigellone ($C_{18}H_{22}O_4N$, m.p. 195-97°) has been isolated from the oil. Besides fatty volatile oil, black cumin contains a bitter principle (nigellina) tannins, resins, proteins, reducing sugars (mostly glucose) saponins and other alcohol – soluble organic acids. The free amino acids present in dormant seeds are cystine, lysine, aspartic acid, glutamic acid, alanine, tryptophan, valine and leucine. An amorphous saponin ($C_{20}H_{32}O_7$ m.p. 310°) which on hydrolysis yield a yellow phenol ($C_{14}H_{22}O_2$ m.p. 275°) and glucose and toxic saponin, melanthin, which gives on hydrolysis melanthigenin ($C_{30}H_{48}O_4$ m.p. above 325°, probably identical with hederagenin) are also identified. A lipase is present in the seeds. Leaves contain ascorbic acid (257.70mg/100g) and dehydroascorbic acid (29.5mg/100g)

Ayurvedic uses

Seeds of *N. sativa* are carminative, stimulant, diuretic, emmenagague, galactagogue and are used in the treatment of mild cases of puerperal fever, skin eruptions. Alcoholic extract shows antibacterial activity. It is also used as a preservative against insect attack of woolen and linen cloths.

8. Long pepper

(Botanical name - *Piper longum* Linn. Family Piperaceae; Vernacular names - Pipali (Sanskrit), Pipli (Hindi), Thippali (Malayalam)

Dravyaguna

Guna - Snighda, Lakhu, Tikshna

Rasa - Katu

Virya - Anushnashetta

Vipaka - Madhura

Dosha - Kaphavathahara

Karma - Deepaniya, Swasakasahara, Shaalaprashamana, Anahaghna, Vrishya, Panchani, Jwarahara, Medhya.

Distribution

Occurs in the hotter parts of India. The main sources of supply are Assam, West Bengal, Nepal and Uttar Pradesh. Small quantities are also available from ever green forests of Kerala. Cultivated in Maharashtra, Andhra Pradesh, Tamil Nadu, Kerala etc.

Phytochemistry

The recent work on the fruit of *P. longum* has shown the presence of the alkaloids piperine (4-5%) and piplartine (m.p. 124-125°), and two new liquid alkoloids, one of which is designoted as alkaloid A. This is closely related to pellitorine producing marked salivation, numbness and tingling sensation of mucous membranes of mouth. Alkaloid A shows significant *in vitro* antitubercular activity against *Mycobacterium tuberculosis* H-37. RV strain. It inhibits the growth of the bacillus in 20 ìg/ml. Sesamin ($C_{20}H_{18}O_6$, m.p. 122°), dihydrostig-masterol and a new steral, piplasterol are also present in the spikes.

Dried fruit of *P. longum* on steam distillation gave 0.7 per-cent of an essential oil with spicy odour resembling that of pepper and ginger oils. The oil containes, n-hexadecane, 0.7; n-heptadecane, 6.0; n-octadecane, 5.3; n-nonadecane, 5.8; n-eicosane, 4.7; n-heneicosane, 2.5; a-thujene, 1.7; terpinolene, 1.3; zingiberene, 7.0; p-cymene, 1.3; p-methexy aceto phenone, trace; dihydrocarveol, 4.3; phenethyl alcohol, 2.1; and 2 new monocyclic sesquiterpenes 15.5, 11.1%, respectively.

The piplamul (roots and thicker parts of stem) contains piperine (0.15 – 0.18%) piplortine (0.13 – 0.20%) and traces of yellow crystalline pungent alkaloid (m.p. 116 -17°). Other constituents found in the drug include triacontane, dihydrostigmasterol, an undefined steroid (m.p. 122-23°), reducing sugars and glycosides. Two new alkaloids, named piper longumine (probably identical with piplartine;, ($C_{17}H_{19}O_5N$, m.p., 124°; 0.2 – 0.25%) and piperlonguminine ($C_{16}H_{19}O_3N$, m.p., 166-68°; 0.12%), besides piperine have been isolated from the roots .

Ayurvedic uses

Charaka has described the medicinal properties of the plant as an appetite, stimulant, anti colic, anti-tussive and inducing resistance to infections.

Alcoholic extracts of the dry fruits and aqueous extracts of the leaves show activity against *Micrococcus pyogenes* var. *aureus* and *Escherichia coli*. Ether extract of the fruit shows larvicidal properties.

Fruits and roots used for diseases of respiratory tract viz. cough, bronchitis, asthma etc. as counter – irritant and analgesic when applied locally for muscular pains and inflammations; as a snuff in coma and browsiness and internally as corminative; as sedative in insomnia and epilepsy; as general tonic and haematinic; as cholagogue in obstruction of bile duct and gall bladder; as an emmenogogue and abortifacient and for miscellaneous purposes as anthelmintic and in dysentery and leprosy.

For all liver and spleen disorders long pepper is a good medicine. It is an ingredient in rejuvenating medicine. It has rasayanic effect. It is good for caugh, consumption, breathing troubles, hiccough, piles, dyspepsia, irregular fever, voice troubles and all diseases due to vata and kopha.

Vardhamana pippali – ten long pepper ground and pasted with milk on the first day; then increase by ten each day. When the number reaches 100, start reducing by ten each day. Thus 1,000 long peppers are taken in during nineteen days. Each day after the medicine is digested special diet of rice with milk and ghee is given. This is very effective in curing ascitis due to liver and spleen. This treatment is good for increasing semen, prolonging life and improving intelligence. Long pepper is used in many ways against lung, beriberi, asthma and bowel disorders.

9. Black Pepper

(Botanical name- *Piper nigrum* Linn; Family – Piperaceae; Vernacular names - Maricham (Sanskrit), Kalimirch (Hindi), Kurumulaku (Malayalam))

Dravyaguna

Guna - Lakhu, Tikshna

Rasa - Katu

Virya - Ushna

Vipaka - Katu

Karma - Kaphavatajit, Dipana, svasakasahara, Sulahara, Krimihara, Vrsya, Cakusya

Distribution

Mostly found in the hot and moist parts of India, Sri Lanka and other tropical countries.

Phytochemistry

Analysis of a sample of green pepper gave moisture 70.6; protein 4.8; fat 2.7; carbohydrates, 13.7; fibre, 6.4; and mineral matter 1.8% calcium, 270; phosphorous, 70; iron, 2.4; thiamine, 0.05; riboflavin, 0.04; nicotinic acid 0.2; and ascorbic acid, 1 mg/100g; carotene (as vitamin A), 900 IU/100 g.

Starch is the predominant constituent of pepper. It accounts for 34.1 percent in black pepper, 56.5% in white pepper and 63.2% in decorticated white pepper. Pepper is rich in lysine, histidine and cystine. Other amino acids identified in black pepper are arginine, asparagine, serine, glutamic acid, threonine, β-alanine, γ- aminobutyric acid, and pipecolic acid.

The alkaloid piperine ($C_{17}H_{19}O_3N$, m.p., 129 -30°) is considered to be the major constituent responsible for the biting taste of black pepper.

Piperitine ($C_{19}H_{21}O_3N$, m.p., 146 - 49°) a vinyl homologue of piperine was found to the extent of 0.23 – 0.82% in Indian samples of black pepper. Methyl caffeic acid piperidide and an optically active β-methyl pyrroline are also reported.

The volatile oil present in the cells of pericarp consists of terpenes, 1-phellandrene; caryophyllene and dipentene. Along with this, piperonol, caryophyllene oxide, cryptone and an alcohol have been identified.

Ayurvedic uses

It is useful as an aromatic stimulant in cholera, weakness following fever, vertigo, coma etc, as a stomachic in dyspepsia and flatulence, as an antiperiodic in malarial fever and as an alterative in paraplegia and arthritic diseases. Externally it is valued for its rubefacient properties and as a local application for relaxed sore throat, piles and some skin diseases.

Pepper is acrid and bitter, light, hot and appetizer, stimulates digestion, diminishes semen and is abrosive and emationive, increases pitta, decreases kapha and vata and destroys worms, good for treating asthma, cough, heart troubles, diabetes and piles.

White *pepper* is good for eyes. 5 to 10g of *powder* with honey, ghee, sugar or joggery cures fever. A decoction of pepper and *Ocimum sanctum* will cure influenza. In places where filaria is endemic, daily use of pepper is protective practice. In various skin diseases with itching, external application of pepper paste with coconut milk is prescribed. Its' fumes are made to inhale by epileptic patients when they fall down.

For Nyctalopia, pepper with curds is applied in the eyes as callyrians.

10. Clove

(Botanical name- *Syzygium aromaticum* Linn.; Merrill & Perry. Family - Myrtaceae; Vernacular names - Lavangam (Sanskrit), Lavang (Hindi), Karayampu, Grampu (Malayalam))

Dravyaguna

Guna	-	Lakhu, Snigdha
Rasa	-	Katu, Thiktam, Katu
Virya	-	Seethalam
Vipaka	-	Katu
Karma	-	Nethra hitham, Deepanam.

Distribution

The clove tree is a native of some islands of the Moluccas. It is cultivated in

Zanzibar and Pemba (Tanzania), Indonesia, Penang, Malagasy, Mauritius and Sri Lanka. In India it is grown in Tamil Nadu and Kerala.

Phytochemistry

Analysis of dried cloves gives the following values, moisture, 25.2; protein, 5.2; fat, 8.9; fibre, 9.5; other carbohydrates, 46.0 and mineral matter, 5.2%; calcium, 740; phosphorus, 100; iron, 4.9mg. and iodine, 50.7µg/100g. The vitamins reported to be present are; carotene, 235µg; thiamine, 0.08mg and riboflavin, 0.13mg. Nicotinic acid (1.51mg/100g) is also present. The cloves contain 13 percent tannin (gallotannic acid); oleanoic acid has been isolated from spent cloves (residue from the distillation of essential oil).

Clove oil

Steam distillation of clove buds yield a colourless or pale yellow oil (14-23%), with the characteristic odour and taste of cloves. The yield and properties of the oil vary according to the origin and quality of clove and the method used for distillation. The products obtained from whole buds contains a higher percentage (97%) of eugenol than that in oil distilled from crushed cloves (eugenol, 94%). Water distillation yields an oil of better quality and lower specific gravity (eugenol, 85-89%) than that obtained by dry steam distillation (eugenol, 91-95%); the two oils are distinguished as 'soft' and 'strong' oils'.

The clove bud contain free eugenol (70-90%), eugenol acetate (2-17%) and caryophyllene ($C_{10}H_{16}O_4$; chiefly the b form) as its main constituents. Among the other constituents present, the most important is methyl-n-amyl ketone, to which the oil owes its fresh and fruity aroma. The oil obtained by solvent extraction of clove contains little or no caryophyllene, but contains epoxydihydrocaryo phyllene.

The oil from flower stalks (clove stalk) and leaves contain a lower percentage of total eugenol than the clove bud oil.

Ayurvedic uses

Cloves are aromatic, stimulant and carminative. They are used in various forms of gastric irritation and dyspepsia. They are administered in the form of powder or infusion to relieve nausea and vomiting to correct flatulence and to excite languid digestion. The oil is used as a local analgesic for hypersensitive dentines and carious cavities;

a mixture of oil and zinc oxide is used as a temporary filling for tooth-cavities. Used externally, the oil acts as rubefacient and counter-irritant. Internally it is carminative and antispasmodic. Claves are useful in halitosis cough, asthma, burning sensation, neuralgia, fever, general debility, tuberculosis etc. The oil is useful in cough, bronchitis, etc.

11. Ajowan

(Botanical name- *Trachyspermum roxburghianum* (DC) Craib; Family - Apiaceae; Vernacular names - Ajamoda (Sanskrit), Ajamud (Hindi), Ayamodakam (Malayalam))

Dravyaguna

Guna - Dipanam, Pacanam, Ruksam, Tiksna, Hrdyam, Vrsyam, Laghu

Rasa - Katu, Thiktam

Virya - Ushna

Vipaka - Katu

Karma - Kaphapittaharam, Krmighnam, Sulaharam, Netramayaharam, Chardi-Hikka-Prasamanam, Vastisulaharam.

Distribution

Cultivated in many parts of India.

Phytochemistry

Fruits contain moisture 7.4; protein, 17.1; fat., 21.8; fibre, 21.2; carbahydrates, 24.6; and mineral matter, 7.9%; calcium, 1,525; total phosphorous, 443; phytin phosphorous, 296; iron, 27.7; sodium, 56; potassium, 1390; thiamine, 21; riboflavin, 28; and nicotinic acid, 2.1mg/100g; carotene, 71μg/100g. Ajowan owes its characteristic odour and taste to the presence of an essential oil (2-4%). Other constituents in the fruits include sugars, tannins and glycosides. The alcoholic extract is found to contain a highly hygroscopic saponin, with a haemolytic index of 500. A yellow crystalline flavane (m.p.291-94°) and a steroidal substance (m.p.140-150°) have also been isolated from the fruits.

The essential oil obtained by steam distillation of the fruits is known as Ajowan oil ('Ajowan ka tel'). The oil for a long time was the principal source of thymol. The yield of oil is reported to vary usually between 2.0 & 3.5% depending upon the area from where the fruits are collected.

Ajowan oil is colourless or brownish yellow liquid possessing a characteristic odour of thymol and a sharp burning taste. The principal constituents of the oil are the phenols, mainly thymol (35-60%) and some carvacrol. Thymol easily crystallizes from the oil on cooling and is known in the trade as 'Ajowan Ka phool' (flowers of ajowan). The remainder of the oil is called thymene. Thymene which constitutes 45% of the oil has the following composition: p-cymene, 50-55; α-terpinene, 30-35; α – and –β pinenes, 4-5; and dipentene, 4-6%. Presence of minute amounts of camphene, myrcene and ▲³ – carene are also reported.

The fatty oil from the original fruits was sharp in taste due to the presence of essential oil (3.3%) while that from the exhausted fruits had a bland taste. A sample of solvent extracted oil had the following fatty acid composition: resin acids 2.6; palmitic, 5.3; petroselinic, 48.1; oleic, 23.9; and linoleic, 20.1%. Presence of ▲⁵'⁶ – octadecenoic acid is also reported in the oil. Petroselinic acid has attracted considerable attention because of its capacity to form a number of derivatives.

Ayurvedic uses

Ajowan is much valued for its antispasmodic, stimulant, tonic and carminative properties. It is administered in flatulence, atonic dyspepsia and diarrhaea, and often recommended for cholera. It is used most frequently in conjunction with asafoetida, myrabalans and rocksalt. Ajowan is also effective in relaxed sore throat and in bronchitis, and often constitutes an ingredient of cough mixture. Taken with buttermilk, it is a common remedy for relieving difficult expectoration due to dried up phlegm. Externally, a paste of the fruits on the chest is a common remedy for asthma. Ajowan is also used in the preparation of lotions and ointments, applied for checking chronic discharge. It has been shown to possess antibiotic activity against *Salmonella typhosa, Micrococcus pyogenes,* var. *aureus* and *Escherichia coli.* The roots of the ajowan plant are reported to possess diuretic and carminative properties and are used in febrile conditions and in stomach disorders.

12. Fenugreek

((Botanical name - *Trigonella foenum-graecum* Linn; Family - Fabaceae; Vernacular names – Methika, Methi, Kalanusari (Sanskrit), Methi, muthi (Hindi), Uluva (Malayalam))

Dravyaguna

Guna	- Laghu, Ruksha
Rasa	- Katu, Thikta
Virya	- Ushna

Vipaka - Katu

Karma - Vatakaphahara, Dipani Raktapittaprakopini, Jwaranashini, Balya, Amilamika, Shothaghna, Grahi, Medohara

Distribution

Distributed in the Mediterranean region, Europe, Asia, South Africa and Australia. Grows wild in Kashmir, Punjab and upper Gangetic Plains. Cultivated as a short term cash crop in many states.

Phytochemistry

Seeds contain moisture, 13.7; crude protein, 262; fat, 5.8; fibre, 7.2; other carbohydrates 44.1 and ash 3.0%. The values for some of the mineral constituents of the seed are: Ca, 160.0; P, 370 (phytin P, 151); Fe, 14.1 (ionisable Fe, 1.5); Na, 19.0; and K, 530mg/100g.

The seeds contain 6-8 percent fatty oil (fenugreek oil) with a foetid odour and bitter taste. The seeds contain a small quantity (less than 0.02%) of a brown- coloured essential oil of intense odour

The other components of the seed are flavonoids and steroidal saponins. Quercetin and luteolin have been identified as the free aglycones. Another sapogenin, tigogenin is reported to be present in traces. The presence of a few more sapagenins including gamogenin has also been reported.

An alkaloid, trigonelline ($C_7H_7O_2N$), methylbetaine of nicotinic acid is present in the seeds in a concentration of about 0.38 percent. It yields nicotinic acid on heating with hydrochloric acid at 260-70°. The alkaloid exerts no marked physiological action. The seeds also contain chlorine.

Dravyaguna

Guna - Lakhu, Snigdha

Rasa - Katu

Virya - Ushna

Vipaka - Katu

Karma - Vatakaphahara, Rochana, Hridayam Vrishya, Soolahara, Deepana.

The plant contains a number of steroidal sapogenins. Two furostanol glycosides and hederagin glycosides have been reported. The alkaloids trigonellines, triga coumarin, trimethyl coumarin and nicotinic acid are also present. Mucilage is abundant in seeds.

Ayurvedic uses

The seeds are aromatic, carminative, tonic and galactagogue. They are used externally in poultices for boils, abscesses and ulcers and internally as emollient for inflammations of the intestinal tract. They find application also in veterinary medicine, and are used in poultices, ointments and plasters and form a constituent of condition powders for cattle, horses and sheep. Seeds are used to render musky hay and compressed fodder palatable. The aqueous extract of the seeds shows antibiotic activity against *Micrococcus pyogenes* var. *aurues.*

Because of anti arthritic property methi seeds are used in rheumatic disorders and spondylosis. It is also used for chronic bronchitis, hepato and splenomegoly in the unani system of medicine. The seeds and leaves are used in the treatment of obesity.

13. Ginger

((Botanical name- *Zingiber officinale* Rosc; Family - Zingiberaceae; Vernacular names - Ardrakam (Sanskrit), Adarak (Hindi), Inchi (fresh ginger) Chukku (dried ginger) (Malayalam)

Dravyaguna

Guna - Lakhu, Snigdha
Rasa - Katu
Virya - Ushna
Vipaka - Katu
Karma - Vatakaphahara, Rochana, Hridayam Vrishya, Soolahara, Deepana.

Distribution

The plant is widely grown in India, Bangladesh, Taiwan, Jamaica, Nigeria, Sierra-Leone, Sri Lanka and South East Asian countries.

Phytochemistry

The composition of ginger varies according to the type and the agro-climatic conditions under which it is grown. Dried ginger contains moisture 8.5 – 16.5% crude protein 10.3 – 15, crude fibre 4.8 – 9.8, starch 40.4 – 59, total ash 5.1-9.3 water soluble ash 40 –8.8 water extr., 14.4 –25.8, cold alcohol extr. 3.6 - 9.3, acetone extr. 3.9 –9.3 and volatile oil 1.0 – 2.7%. Whereas green ginger contains moisture 80.9; protein 2.3; fat 0.9; fibre 2.4; carbohydrates, 12.3; and minerals, 1.2% besides Ca, 20;P, 60 and Fe, 2.6mg/100g. Ginger contains traces of iodine and fluorine.

The vitamins present in green ginger are thiamine 0.06; riboflavin 0.03; niacin

0.60; and vitamin C 6.0 mg/100g. The value reported for carotene in the fresh rhizome is 40µg/100g

The characteristics pleasant and aromatic odour of ginger is due to the essential oil, which can be separated from the rhizome by steam distillation. The pungent principles of ginger are non-volatile. They are oxymethyl phenols

Ayurvedic uses

Ginger is valued in medicine as a corminative and stimulant to the gastro intestinal tract. It is much in vogue as a house hold remedy for flatulence and colic. An extract of ginger is used as an adjunct to many tonic and stimulating remedy. Externally ginger is used as a local stimulant and rubifacient. Alcoholic extracts of the spice have been found to stimulate the heart. Ginger is reported to contain an antihistaminic factor. It is included among antidepressants and it forms an ingredient of some anti narcotic preparations. In veterinary practice, ginger is used as a stimulant and corminative in atonic indigestion of horses and cattle.

Ginger, long pepper and pepper are together called 'Trikatu'. These three acrids as a group form an ingredient formulation for digestive troubles. 'Trikatu' as such is a medicine for cough, obesity, elephantiasis, indigestion, asthma and cold (Ashtanga Hridaya). Ginger, though acrid in taste, in post digestive (Vipaka) act as a sweet, cures Vata and acts as a tonic. It promotes virility and is a good appetizer. In veerya (potency) it is hot but unctuous and light and increase digestion. In distension of stomach it is given with castor oil. It is very effective in 'Amavata' with pain on the joints. Stomach pain and nausea due to purgative are relieved if taken with powder of dry ginger. Ginger is used as a remedy for diarrhoea and constipation. In head aches caused by excess 'pitha' a paste of dry ginger and sandal wood is applied on the fore-head. In hysteria and insanity, ginger is used as collyrium and errhines mixed in water or salt water. For anorexia and indigestion, juice of fresh ginger, lemon juice and rock salt are taken together before meals.

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OPERATIONAL GUIDELINES

TECHNOLOGY DEVELOPMENT AND TRANSFER FOR PROMOTION OF HORTICULTURE

1. Objectives

* Popularaztion of new technologies/tools/techniques for commercialization/adoption.
* Introduction of new concepts to improve farming systems
* Upgradation of skills by exchange of technical know-how.
* Consolidating research efforts for specific problems.
* Identification/collection, rapid multiplication & popularization of indigenous crops and other flora of horticultural importance with emphasis on domestic and export promotion.
* Familiarization and exposure towards the newer scientific concepts/temper and research & development from hitherto unknown, unexplored and traditional status of farming and post harvest management on to the modern lines.

2. Eligible Components

1. Introduction of new technologies
2. Visit of progressive farmers
3. Promotional and extension activities
4. Expert services from India/abroad
5. Technology awareness
6. Organisation/participation in seminars/symposia/exhibitions
7. Udyan Pandit
8. Publicity and films
9. Observation-cum-study tours abroad
10. Honorarium to scientists for effective transfer of technology.

IISR THROUGH YEARS

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Indian spices played a major role in the political history of India. Spice trade between India and Mediterranean countries thrived prior to Christian era and fame of Indian spices indirectly resulted in discovery of America by Columbus and landing of Vasco-de-Gama in 1498 at Calicut directly led to colonization of India, firstly by the Portuguese followed by the French, the Dutch and the British and finally the country becoming part of the British Empire.

These high value export oriented crops continue to play an important role in the agricultural economy of the country. India is the leading producer of black pepper, large cardamom, ginger and turmeric. During 2000-2001 the country is expected to earn about Rs.2025 crore from export of spices and value added spice products.

Genesis of spices research

The combined Madras Presidency initiated spices research in 1949, by establishing Pepper Research Scheme at Panniyur and during early fifties, research on cardamom was initiated at Mudigere in Karnataka and Pampadumpara in Kerala. Realizing the need for research and development of spices in the country, Govt. of India constituted a Spices Enquiry Committee in 1951 and based on the Committee's recommendation submitted in 1953, the Govt. of India entrusted the spices research work to the Indian Council of Agricultural Research. To assist the ICAR in advising, planning and co-ordinating the implementation of the recommendation of the Spices Enquiry Committee, a Central Spices and Cashewnut Committee was also set-up.

Improvement of spices in the country received a boost with the initiation of All India Coordinated Spices and Cashewnut Improvement Project in 1971 with its headquarters at the Central Plantation Crops Research Institute, Kasaragod established one year earlier. The All India Coordinated Project on Spices and Cashewnut had the main thrust on increasing production and productivity of these crops. Initially the project with few centers had the mandate to evolve high yielding varieties, standardization of fertilizer and management practices and control measures for pests and diseases of black pepper, cardamom, ginger and turmeric. Grain spices namely, cumin, coriander, fennel and fenugreek were included during the V Plan Period and the project was bifurcated and All India Coordinated Research Project on Spices was shifted to Calicut with the establishment of the National Research Centre for Spices in 1986. The scope of the spices project gradually enlarged through the plan periods and at present the project has 20 centres in 15 states devoted to R & D work on 12 spice crops including large cardamom.

During the Fifth Five Year Plan, the ICAR realized the need to initiate basic and applied research on major spices, viz. black pepper, cardamom, ginger and turmeric and also tree spices. With this objective, a Regional Station of CPCRI for spices was established, which started functioning in a rented building at Calicut on 10th November, 1975. The then Director of CPCRI, Dr. K.V. Ahamed Bavappa, asked this author to head the Regional Station and the team consisted of one scientist (Dr. T. Premkumar, now at CTCRI, Trivandrum) one Technical Officer (Dr. M.J. Ratnambal, now at CPCRI, Kasaragod) and one junior clerk and a Jeep. Within a year Dr. Y.R. Sarma (the present Director of IISR, Calicut) and Dr. P.N. Ravindran (the present Project Co-ordinator, AICRP(Spices) joined the team. We recall with nostalgia, that this small group of workers with minimum facilities were able to lay the foundation to establish the largest genebank of spices in the world, initiate crop improvement programmes in major spices, standardize input requirements for higher yield and also develop plant protection techniques. Joining of three other scientists viz. Dr. Rohini Iyer (now Head, Plant Protection, CPCRI, Kasaragod), Dr. A.K. Sadanandan (now Emeritus Scientist, IISR) and Mr. B. Krishnamoorthy, (now Principal Scientist, IISR, Calicut,) during the V Plan Period was a boost to this hand-picked team of scientists.

Here it is worth mentioning the visionary role played by the then Director General, ICAR Padmavibhushan Dr. M.S. Swaminathan. Originally it was contemplated by ICAR to establish the center exclusively at Peruvannamuzhi about 51 KM north east of Calicut in a dense forest. On the advice of Dr. M. S. Swaminathan, we organized the first National Seminar on Pepper at Calicut on 19th Dec. 1977 which Dr. Swaminathan himself in augurated. During the field visit he realized the remoteness of Peruvannamuzhi and the hardship scientists have to face, if the entire center is established at Peruvannamuzhi. He directed me to find a suitable location at Calicut city for the main office, laboratory and residential complex. Fortunately for us, about 14 ha. of land assigned to ESI Carporation was available at a nominal price of Rs.3.00 lakh within Calicut corporation and Dr.M.S. Swaminathan sanctioned the amount on the spot and that is how the head quarters of IISR is at Calicut.

It was a matter of pride for the scientists working at the Regional Station, that within a decade of its establishment, the station was upgraded to the National Research Centre for Spices (NRCS) during the VIII Plan (April, 1986) and I had the privilege of working as the Director of NRCS, Calicut for more than an year in addition to my regular job as the Director of CPCRI, Kasaragod. The Cardamom Research Centre, Appangala, which was transferred from Indian Institute of Horticultural Research, Bangalore to CPCRI, Kasaragod earlier (1974) was also merged with the National Research Centre for Spices in April, 1986. Dr. A. Ramadasan succeeded me as the Officiating Director of NRCS for a short while, before Dr. K.V. Peter (now Vice-Chancellor, Kerala Agricultural University) was appointed the regular Director of the center. Based on the efforts of Dr. K.L. Chadha, the then DDG (Horticulture) and Dr. K.V. Peter, the QRT of the center and Parliamentary Committee (Rajya Sabha) recommended to upgrade the center to a full-fledged Institute for Spices Research and the Indian Institute of Spices Research become a reality in July, 1995.

I. Achievements of Indian Institute of Spices Research

It is appropriate to mention the major achievements of the center, on the occasion of celebrating Silver Jubilee.

1. Germplasm

The IISR maintains one of the largest spices germplasm in the world consisting of 3097 black pepper accessions, 313 accessions of cardamom, 637 accessions of ginger, 786 turmeric, 478 nutmeg, 227 clove, 299 cinnamon, 29 Garcinia and 180 allspice besides paprika(38) and vanilla (40).

2. Varieties

Five high yielding varieties of black pepper, five varieties of turmeric including the first open pollinated progeny selections, two cardamom varieties, one ginger variety and two varieties of cinnamon were evolved/selected and released for cultivation. Two more ginger varieties, and one each in cardamom and nutmeg are proposed for release.

3. Propagation

Plant propagation technique has been standardized with a high multiplication rate of 1:40 in black pepper and 1:30-40 in cardamom (trench method). A trench method to produce rooted cuttings of pepper directly from single node is also developed at the Institute. Clonal propagation technique has been standardized for cassia (air layering), cinnamon (cuttages), clove (approach grafting) and nutmeg (epicotyl grafting).

4. Biotechnology

Protocol for micropropagation has been developed for 40 spices including black pepper, large and small cardamoms, ginger, turmeric, cinnamon, cassia and nutmeg. Somatic embryogenesis and/or regeneration have been achieved in pepper, cardamom, cinnamon and ginger. Work on molecular characterization of germplasm of spices, genome mapping, and transgenics are in progress.

5. Crop production

High production technology has been standardized for black pepper and cardamom. Fertilizer recommendations and spacing have been standardized to obtain high yield.

6. Crop protection

Technologies have been developed for effective management of *Phytophthora* foot rot and slow decline of black pepper, *kotte* and seedling diseases of cardamam and rhizome rot of ginger. IPM technologies have been developed to effectively control *pollu* beetle, top shoot borer and scale insects in black pepper; thrips, shoot and capsule borer and root grubs in cardamam and shoot borers and rhizome scales in ginger and turmeric.

II. Gaps in production and productivity

It is estimated that during 1997-98, India exported 59.7% of black pepper and 4.4% of the cardamom out of 57,300 metric tons of black pepper and 5900 MT of cardamom produced in the country. However, the country exported only 7.9% of the total spices produced in the country, thereby capturing 50% of the world spice import. India is also the largest consumer of spices in the world. To achieve enough exportable surplus after meeting the domestic need, there is need to increase productivity and thereby production.

From the resume of research achievements mentioned earlier, let us examine whether research support is available for increasing productivity. The average national productivity of major spices has been far below the productivity level achieved by the progressive farmers and also the productivity achieved at research stations as indicated in the Table. 1

It is clear that utilizing the available research results, substantial increase in productivity of black pepper, cardamom, ginger and turmeric can be achieved.

There is an impressive list of high yielding varieties in spices released in the country including those from IISR,

Table 1. Potential for productivity increase at national level (kg ha^{-1})

Crop	National	Progressive farmer	Research station
Black pepper	290	2000	2445
Cardamom	128	1625	450
Ginger	2421	5500	8250
Turmeric	2738	6200	10700

Source: Sivaraman, K and Peter, K.V. (1999). An overview of spices development in India. Proc. Summer School on Improvement of Plantation Crops. CPCRI, Kasaragod.

Calicut. The spice farmers have the choice of 12 high yielding varieties in black pepper, 14 in cardamom, 7 in ginger, 18 in turmeric, 13 in coriander, 5 in cumin, 4 each in fennel and fenugreek, 2 in nutmeg and 3 in cinnamon. In spite of impressive production technologies available, the low national average yield can be attributed to in-effective transfer of technologies to the farmers.

In view of the globalization and fall in prices in all the plantation crops including spice, the only alternative available to the spices farmers is to increase the productivity. Now let us briefly examine the strategies to be adopted to increase the productivity through research and transfer of technologies to the spice farmers.

III. Strategies to increase production and productivity of spices

1. Planting materials – need and availability

Disease free planting material in sufficient quantity is one of the basic pre-requisite for boosting spices production. It is estimated that by 2002-03, 11,795,300 pepper cuttings, 4888.9 MT ginger, 80.3 MT chilli seeds, 14020 MT turmeric, 491.8 MT coriander, 2573.5 MT garlic, 178.2 MT cumin, 8.2 MT fennel, 93 MT fenugreek, 1.0 MT celery, 28600 clove seedlings, 43650 nutmeg seedlings and 9075 cinnamon seedlings will be needed in the country. The need of the hour is to make available adequate healthy, rooted planting materials to the needy farmers either through centrally sponsored schemes, State Departmental nurseries or through other private/public sources.

2. *Management of diseases and pests scenario*

For the major diseases and insects attacking spices, chemical pest control strategies are available. However, often pesticide residue in spices results in problems especially in case of the exportable commodities. Further, many of the plant protection chemicals are not ecofriendly. In view of this, biological control strategy combined with resistance breeding will have to receive utmost priority. It has been estimated that by 2006, there would be 5-6 fold increase in organic market all over the world. India has the capability in organic spices production and this lead needs to be fully exploited to the country's advantage. Technologies developed at the Indian Institute of Spices Research, in the field of biocontrol of pests and diseases are given in Table 2.

In spite of many biocontrol agents available barring *Trichoderma* Spp. and VAM, the effectiveness of other biocontrol agents in large scale field trials is yet to be demonstrated. It is also to be ensured that these biocontrol agents are easily available through many outlets at affordable rates.

3. Resistance breeding

Another thrust area of relevance is resistance breeding, to

Table 2. Biocontrol of diseases and insect pests

Spice	Pests	Biocontrol agents
Black pepper	*Phytophthora capsici*	*Trichoderma* Spp. in combination with VAM.
	Scale insects	*Chilocorus* Spp.
	Top shoot borer	*Apanteles cypris* – parasite
		Trichoderma Spp. with VAM
	Nematodes	*Verticillium chlamydosporium*
Cardamom	Rhizome rot and root knot nematode	*Trichoderma* Spp. and *Paecilomyces l ilacinus*

develop disease and insect pests tolerant varieties. In black pepper, two *Phytopthora* tolerant (Coll: 1041& P 24) and two drought tolerant lines are identified besides two inter-specific hybrids in *Piper* having resistance to 'pollu' beetle. Coll. 1041 and P 24 may be released as new varieties. The cardamom varieties, RR-1 and IISR Vijetha recommended for release from IISR, Calicut are having resistance to rhizome rot and 'Katte', respectively. Few more resistant lines in cardamom are in pipeline.

Biotechnological tools may be pressed into service in case of ginger and turmeric to evolve disease resistant varieties, though farmers acclaim that IISR ginger variety Varada, is not affected by diseases.

4. Value addition

In case of export of spice oils and oleoresin, India has virtual monopoly. During 1999-2000 India exported 3368 tons of spice oil and oleoresin valued at Rs.32330.58 lakh. Lines have been identified/varieties released at IISR, with high piperine in black pepper, and high curcumin ha^{-1} in turmeric. Farmers are to be encouraged to cultivate them with a buy-back arrangement by the processors, with quality linked price structure.

5. Input technology and productivity

The spice farmers require specific recommendations to suit different farming situations. Though high production technology has been demonstrated in black pepper and cardamom, average productivity in spices is very low. Input technologies to specific problems and location are to be developed instead of a universal package of practices to varying farming situation under different agro-climatic conditions.

6. *Holding size*

In coconut, holding size has been found to have a direct relation to the management of the plot and yield. Probably a similar situation exists in spice holding also. When the holding size is small, adequate income is not generated, leading to neglect of the crop. Neglect of the homestead small holding leads to low productivity and high cost of production. Small holding also contributes to crowded population of component crops, and poor fertilizer and pests management. Effective technologies are to be developed for spice farmers with small holding.

Let me conclude this article by congratulating the scientists at IISR for the rapid progress achieved by them in a matter of two and a half decades. I have utilized this occasion to share some of my ideas for further lines of research in spices.

THE LEGENDARY HISTORY OF SPICES

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Spices have played a very fascinating role in shaping the history of human culture and civilization. Spices, condiments, frankinscence, myrrah and other aromatic plant products were the first articles traded by ancient people. Spice trade was associated with the rise and fall of great empires, particularly in West, and had led to the great explorations, sea voyages etc. in the ancient world. The story of spices is one of the romantic parts of our history and also a story of adventure, exploration, conquest and fierce battles and rivalries among the countries, particularly of the Arabs, Persians and the western countries. The value of spices in ancient and medieval age was so great that they were often equated with gold and precious stones. Centuries before the birth of Greece and Rome, sailing ships were carrying Indian spices to Mesopotamia, Arabia and Egypt. Relics of spices found from excavations of Indus valley indicate the use of spice by Indians even before 3500 BCE*. The great Ayurvedic masters like Charak and Sushruta wrote great treatises on Ayurveda between 2000 and 1000 BCE and described the properties of spice particularly pepper, long pepper, cardamom, turmeric and ginger. In the chronicles of King Solomon, we read that when Queen of Shebha visited King Solomon in 992 BCE, she carried one hundred camel loads of presents for Solomon. The most important thing mentioned about this was that the Queen of Shebha personally presented certain gifts to Solomon telling that "Your majesty, I bring forth here and offer you some of the most precious things on earth". Then Solomon asked, "What's that?". To this, Queen of Shebha replied: "Pepper, ginger, cardamom and sandalwood from Indies". King Solomon smiled and said: "They are certainly

*BCE = Before Current Era; CE = Current Era; These abbreviations correspond to the long used BC and AD, respectively.

the most precious things, but my ships are going regularly to Kollangode" (a place near Calicut in Kerala in Western coast of India) "to procure them". From this one can infer about the trade of spices in those days and also about their importance.

The ancient Greeks imported spices such as pepper, cinnamon, cardamom, ginger, etc. from India. Alexander the Great founded Alexandria in 332 BCE and it became an important trading centre of spices and other goods between India and Mediterranean while Alexander came Northern India to gather more knowledge of spices. Hippocrates (460-357 BCE), Theophrastus (372-287 BCE), Pliny (CE 23-79) and Dioscorides (CE 40-90) had mentioned about spices of India in their writing. Shortly after Julius Caesar established the Roman empire, Pliny, the elder, issued a public complaint on the ever increasing value of spice and medicine imported from India that was causing a serious drain in the Gold treasury of Rome.

The ancient trade routes to import spices and other goods from India to the west were by sea from various ports in the west coast of India to Charax on the Persian Gulf or round the coast of Arabia to Aden and up through the Red sea to Egypt. An over land route went up to the Indus valley to Attack and from there to Basra on the Silk Road. In the 1st century CE, Romans discovered the monsoon, which permitted easier sea transport to India. Constatinople became the trade centre where Indian spices were brought by Arabs and Persians and then traded to the west. Pepper was the most priced item among the spices and it is said that pepper was sold in equal measure or weight of gold. The south west monsoon, which blow from April until October assist the voyage from Egyptian coast of Red sea to the Malabar coast of India, returning with north east monsoon from October to April, the journey then taking less than a year. This reduced the importance of Arab over land and sea routes and thus helped Rome to break the Arab monopoly on Indian spices. The Romans were extravagant users of spices. In addition to flavouring food and wines, they were also using spices for medicine and cosmetics. When the Alaric, the King of Goths, besieged Rome in 408 BCE, among his demands to prevent the sacking of city was 3000 pounds of pepper. This proved only a temporary expedient as Rome fell to the invading Goths in 410 BCE, thus leading to the collapse of western Roman empire.

Emperor Constantine founded the city of Constantinople in 330 and it become the eastern capital of Roman world until it was captured by the Turks in 1453. The Arabs and Persians used to bring spices and other goods from India to Constantinople and Alexandria, and traded them to the western nations. The spice trade was a so lucrative business that the Arabs zealously guarded the information about the source of spices from India and deliberately spread false rumours and horrifying stories about the insurmountable difficulties in crossing the sea and about the monsters, big enough to swallow the ships, and blazing sun that could burn one to a crisp and even cause the sea to boil, and the terrifying ghosts and beasts, who according the Arabs, guard the pepper, ginger and other valuable spices. The Arabs also spread the story that it was with the power of the 'Gin' that they could manage to procure the pepper. Arabs sold pepper at Constantinople against gold, weight by weight, and it was during this period that pepper began to be known as the 'Black Gold'. Pepper corns soon became a legal tender equivalent to the gold currencies in Europe during the middle ages.

The fall of western Roman empire and occupation of Alexandria by the Arabs in 641 CA greatly reduced the spice trade in Mediterranean until the time of Crusades. By the middle of 8^{th} century the Muslim empire was extended from Spain to the borders of China and began to control the spice trade. The Arab spread again the same old terrifying stories about pepper and other spices of India. The Crusades that began in 1096 and continued upto 1291 did much to open up this trade between the East and West. In 11^{th} and 12^{th} century the whole Europe almost believed the horrifying stories spread by Arabs about the pepper land and the difficulty in reaching there. It was the adventurous journey of three Vential traders, the Polos, which dispelled these stories. Certain countries such as Venice were permitted to establish trading centres at Constantinople and this led to the greatly increased import of spices in Europe. By 14^{th} century, Venice had accumulated unprecedented wealth and it was said the spices contributed towards the renaissance of Europe.

A 'Pepperers'Guild' of wholesale merchants later to be incorporated into 'Spicerers' Guild was founded in London in 1180. This was succeeded in 1429 by the Grocers' Company, which was granted a charter by Henry. During the middle ages spices had become very expensive and were in great demand. Pepper corns were began to be used as currency to pay taxes, tolls, rents and even dowries.

Nicolo Polo with his brother and son Maffeo Polo and Marco Polo made an adventurous over-land journey in 1271 to locate the pepper land and landed in Mongolia and China. Kublai Khan, the Great Mongolian king was the ruler of China at that time. Marco Polo recorded shiploads of pepper arriving at Sayto in South Eastern China and ginger and cassia in Kaindu (Peking), the capital of Kublai Khan's kingdom. He also described that pepper, ginger and cinnamomum were from Malabar Coast of India. It was also said Marcopolo traveled with Chinese and reached India's western coast (Kollangode) in 1294.

The story told by Marco Polo was published in Venice in 1299. The story starts with Marco himself. As far as back in 1260, when Marco Polo was a boy of six, one day he heard his father Nicolo Polo and his trading partner brother Maffeo Polo discussing about their jouney to Constantinople. The boy requested his father to take him along. He also heard his father and Maffeo discussing about venturing to eastwards to Bokhara where the Mighty Mangolian Emperor of China reached. The boy was eagerly hearing the discussion and begged his father: "father, take me with you and I can help you to locate the pepper land". Nicolo Polo said, "son, you are only a small boy now, let you grow up to a strong young man, then we will take you". The boy then asked his father some searching questions: "Father, I understand that the pepper, the most important article of your trade comes from India – Why don't you go straight to the pepper land and get it rather than paying so heavily to the Arabs". Father replied: "My dear son you don't know that we cannot reach India. The Arabs tell us that the pepper and ginger plants in India are guarded by ferocious ghosts and deadly beasts and only the Arabs with their power of 'Gin' could alone manage to procure it". The boy then said:

"Father, I just don't believe it. Let me ask you from where you get the silk". The father replied:, "The Chinese travelers bring it through the Silk Road". The boy then said "Father let us go by the silk road and reach China and I am sure from there we can certainly locate the pepper land". The explanation he offered to his logic was that Pepper and Ginger are the only spices known to the whole world and that the Chinese may also be using them and therefore if one could reach China the pepper source can be located. Nicolas was astonished hearing such an intelligent logical view of the young boy. He said: "my dear son, we will make the journey to China once you become a young man". Thus in 1271, Nicolas, his brother and Marcos finally left Venice for China. It was a very difficult journey from Italy to Hormuz, Persia, Kherman, through Khurosan to Balk (Afghanistan) and to Pamir. And then crossing the vast desert of Gobi, the Polos reached the north western boundaries of China, and finally after 3 years of journey they reached Shangai-the summer city of Great Kublai Khan. They were brought to the court of the Great Kublai Khan who welcomed the Venetian travelers with great delight and honour. The Great Khan was marveled at the sharp intelligence and alertness of the young Marco who had then reached the age of 21. He has already learned the local language and he performed effortlessly as the interpreter for his father and uncle and the king Kublai Khan. Marco soon became a favorite of Kublai Khan and he was appointed as Governor of some provinces in China. Marco travelled extensively in China upto Yunan and even said to have crossed over to Burma. In his book Marco described about the pepper, cardamom, and ginger etc. which the Chinese traders brought regularly from the south west coast of India. The Polos wanted very much to go with the Chinese traders to the spice land. But the Great Khan didn't allow them to leave. Finally, after 17 years of their stay at China Kubali Khan permitted the Polos to join the Chinese traders sailing to India by sea. Kublai Khan gave many precious jewels and other gifts as parting gifts to the Polos.

In 1292, the Polos' sailed from the harbour of Amoy in Ful-Kien with a fleet of fourteen masted junks, each manned by 250 seamen. They sailed via Java, Sumatra and finally reached the Kollam (Quilon) and perhaps Calicut in the western coast of India. And from there they went by land route and reached Gujarat and the silk route and at Constantinople. They finally returned to Venice in 1295 after 24 years. The Palos told the Venetians about the fabulous wealth and prosperity of China and India they had visited. Marco Polo dispelled the horror stories about India and said there was no ghosts or beasts in the pepper land of India. Anybody who could reach there could procure it by paying the locals gold or precious stones. But it was very difficult for the Venetians to believe. In the mean time there broke a war between Venice and Genoe, and Marco Polo joined the Venitian fleet as a commander and fought at the decisive battle of the Curzola island. The Genoese were victorious and Marco Polo was taken as prisoner. In the prison cell he had another co-prisoner from Pisa who was a literary man named Rusticiano. Rusticiano wrote the adventaurous journey of Polos as narrated to him by Marco Polo. In 1299, Marco Polo was released and after reaching he published it. Marco Polo for the first time brought a treasure of new knowledge about the world and broadened their conception of the earth. He had thus inspired the Europeans to travel and explore.

Prince Henry of Portugal, known popularly as the Navigator, established a naval school at Ságres in 1418, which attracted shipbuilders, cartographers, spirited adventurers, geographers and navigators of those days. His aim was to trace the source of pepper and gold. Prince Henry made many explorations in the west of Africa, but had failed to reach the pepper land. He died in 1460. In 1487, two young men from Venice, Christopher Columbus and Amerigo Vespucci, joined the naval college in Portugal. Columbus was son of a weaver and Vesputchi was son of a trader. The Prince of Portugal was also taking the training with these Italoian young men. In 1491 all the three completed their naval training. Columbus, who happened to read the Marco Pola book, got the idea to travel through the Atlantic and to circumventing Sauth of Good Hope to reach India. But this idea was against the contemporary faith of Europe and therefore his attempt to convince the King of Portugal was not successful. On other hand he was charged with blasphemy and he had to run away from Portugal. It is believed that the Prince of Portugal had indeed helped Columbus to escape from Portugal to Spain.

Spain was then ruled jointly by Ferdinand of Aragon and Isabella of Castile. Columbus approached King

Ferdinand, who found the scheme not only impractical but also against the contemporary faith. But to his luck, Queen Isabella summoned Columbus and she asked him first to swear by bible that the Earth was flat. Columbus did it. Then the Queen said: "I don't care how you reach India, but if you could reach India can you popularize my faith there. If you can do this "I can arrange finance for your voyage". Columbus readily agreed. Isabella called the merchants of Spain and told them: "Look, here is an young spirited navigator. He is convinced of reaching Indies by an alternate route. Can you fund him?". The merchants said if the Queen can stand guarantee they can fund Columbus. But he must bring pepper or gold. The deal was finally agreed and Columbus sailed from Palos on 3rd August 1492 in three ships with ninety men. After a month sailing in Atlantic towards south west they came across the island "Canoria" off the coast of Africa and they spent few days there to collect provisions and drinking water and then continued the journey. After three weeks the ships reached the south end of the African continent, the powerful waves of the Atlantic sea drifted the ships down to the Carribean sea and on Oct. 12, 1492. Columbus touched one of the Carribean islands, which he named as San Salvador, and then reached Bahmas. Columbus thought these islands were of the Indies as it matched well with the description of the vegetational wealth described in Marco Polo's book. But the people he confronted were not blackish or brownish as described by Marco Polo. Their color he found some what reddish and so Columbus called them 'Red Indians'. However, Colombus could not get pepper in these islands. He showed to the islanders the pepper sample that he had brought with him. On chewing they found it hot and then they brought the Capsicum – the Chilli pepper and gave to Columbus. Columbus found it too hot and collected a few baskets. Columbus now decided to return home in the Ship Nisia. He left a colony of 44 Spanish on the isla [illegible] and took with him half a dozen natives for baptism as evidence of his reaching India and spreading the faith as desired by Queen Isabella. Columbus returned to Spain in March 1493. Queen Isabella was very happy to see the natives of the Carribean islands brought by him. Columbus explained to the Queen about his success of reaching India and how he popularized her faith and that he brought some of them to show the Queen. But the merchants who funded his voyage came and asked for pepper and gold. He then showed them the baskets of Chilli pepper that he had brought. The merchants were not happy with this. Columbus had to run away from Spain, as the merchont were not satisfied with the chilli pepper he brought from Spain.

There was one man who was secretly following all what was happening with Columbus- Amerigo Vespucci, who was jeolous of Columbus. He was secretly collecting all information about Columbus. Vespucci went to see the King of Portugal. Vespucci said to the King: "Your majesty, Columbus who ran away from here claimed to have reached India by a new sea route. But the information what I collected of his voyage I am certain that the land he visited was not India. It must be some new land. He could not find pepper or ginger or any other thing that we know from India. Also the people he braught with him also appeared to be not from India. It is in all probability a new land and we must possess it". King was thrilled of such a prospects. Spain and Italy were perpetual enemies and the King of Portugal immediately took interest. He asked Vespucci, can Portugal achieve this? Vespucci said: "your majesty, I made all the ground for the same. I have already smuggled out all details of the Columbus journey from his fianci's house in Madrid. Columbus has run away to Italy to escape from the wrath of the much agitated merchants of Spain." He requested the King to provide him a fleet of good ship and powerful seamen and he assured the King that he would reach those land and bring them under the flag of Portugal. King agreed soon a fleet of ships, and other necessary things were made available to Vespucci and Vespucci finally left Lisbon in June 1494. Vespucci was following the Columbus trail and he was meticulously noting about the journey. He also touched the Canary islands, spent few days after stocking food provisions and drinking water and continued the journey. Vespucci was a very keen, alert and intelligent navigator. When came to the southern tip of African continent, he recorded that the ship was drifting away and not circumventing the south of Africa. His ships also landed in the same Caribbean island where Columbus reached and Vespucci soon realized it. He then traveled further through Caribbean island and finally reached Amazon basin. Here

Vespucci was astonished to find two continents of America and he was then fully convinced that what Columbus discovered was not India, but a new continent. Later this new continent was named as America in memory of Amerigo Vespucci, who actually recognized it as a new continent and Columbus' name is remembered as the individual who discovered the route of America.

Vespucci came back to Portugal with many stronge fruits, capsicum chillies and gold. Queen Isabella got infuriated by hearing the prospects of Portugal reaching India, following the route discovered by Columbus. Columbus was called back with honour and in 1496 Columbus thus made his second voyage to West Carribean islands and then to the South American continents.

Columbus also made two more journeys to these places and unto his death in 1906, he believed all these islands as part of India. However, both Portugese and Spanish could not find pepper and other spices of India in these Carribean islands or American continent. Instead they got the American spices such as caposicum chilly, pomento (All spices) and many delicious fruits. But pepper and such Indian spices were the most sought out articles in Europe and therefore their efforts, particularly by the portugese to locote India were continued.

Vasco de Gama in 1497 approached the King of Portugal with the request that if two good ships along with 100 powerful Negro sea men were provided to him, he will be able to circumvent the South of Good Hope and then reach the Eastern coast of Africa and from there it may be possible to locate the route to India. Finally Vasco de Gama was given all what he sought from the Portugese king. Thus Vasco de Gama was able to circumvent South of Good Hope and reach the eastern coast of Africa. According to some historians, Vasco de Gama reached Mozambique where he came in contact with some Muslim traders who did not approve the Portuguese's efforts to reach India. However, the Portuguese with the efforts of some traders of Malabar (in the western coast of Kerala) were able to reach Calicut (a trading port town of Kerala). The Portuguese thus became the first European who could get direct access to pepper after a gap of over 1000 years. This also marked the beginning of the colonization of India by Europeans. The news of Vasco de Gama's discovery of an alternative route to reach India became known to the whole Europe. And many other countries like Dutch, French, British, and Scandinavian began to send explorers/traders to India for fetching pepper and other spices. This has led to great rivalry and sea wars among the various European powers. Each one was trying to establish the monopoly in spice trade in India.

Till the end of 16th century the spices were highly priced and Indians accepted only gold in return for their spice and such other articles of commerce to outsiders. It was the Portuguese who changed this kind of barter system. In 1670s a Portuguese sailor/soldier happened to see and collect some quantity of South American chilly from some traders in Portugal and brought it to Goa. The Goans found the taste of Capsicum chilly to their satisfaction and came back to the Portuguese sailor for getting more of the American chilly. And this was the most critical turn of events in the history of India. The Portuguese sailor asked the Goans to give 100 pounds of pepper to get one pound of Capsicum chilli. This was the beginning of the exploitation of the Indians by Europeans. The Portuguese traders began to import Capsicum chillies from South America and sold them in India for Pepper. This Trade of Capsicum chilli for Pepper was kept as a secret by Portuguese for sometime. But the news began spreading other coastal areas. In Madras, the British East India company was controlling the spice trade. At the port of Madras, there was a petty clerk named Mr. Elihu Yale, working with the East India Company. Mr. Yale approached his master and suggested to him to follow the example of the Portuguese and to import Capsicum chilly from America and sell it for pepper and amass enormous profit to which his master did not agree. But in six months time, he managed to establish contact with some British traders who trade with America. On his request a ship with large quantity of Capsicum chilli from America reached Madras port some time in 1680s. Mr. Yale called some local people, particularly the Nadar community who were the traditional toddy tappers in the region. Mr. Yale could convince them to get 1 pound of Capsicum chilli against 50 pounds of pepper. Nadars agreed and a new trading pattern of pepper was started. Mr. Yale sold a large quantity of Capsicum chilli for pepper and within a short time he become one of the richest men of those days. The East India company appointed him as the Governer of Fort St. George, a british trading centre in Madras. With the money her amassed through the chilly pepper trade, Mr. Yale established the Yale foundation" in USA, which later gave birth to the famous Yale University.

East India company could

soon popularize Capsicum chilli in many parts of Madras and in Southern India. This 'Chilli' is known as "Koppal Milago" the pepper that was brought by ship.

To dislodge East India companys' dominant position in pepper trade, the Portuguese sought the help of the Jesuit fathers. The Jesuit fathers were engaged in educational activity and also in the popularization of Christian faith in India. Portuguese arranged to send a team of Jesuit fathers to Tirunelveli a coastal place in the South east Madras, and other parts of the Madras in the pretext of carrying out their routine activity. Portuguese gave seeds of Capsicum chilli to the Jesuit fathers and told them to give to the local people in Tirunelveli as well as at other parts of the coastal areas of Madras with instructions to sow it and raise Capsicum chilli plant to get the chilli pepper in their own land. The Jesuits fathers thus established a stronghold in S. India with their educational activities and were able to convert many of the Nadars to Christianity. They also persuaded many Nadars to take up cultivation of Capsicum chilli. It may be mentioned here that Nadar community was only a toddy tapping community and they never did cultivation of any plants. It was their love for the Capsicum chilli that Nadars became cultivators/farmers and later became successful traders in India.

Pepper thus played a very fascinating role in shaping the course of modern history and destiny of India. It used to tilt the balance of power or make any influence in the political equations of countries of the world. Pepper and other spices are no longer luxury items of great cost. With the advent of refrigeration and other preservation technologies as well as the fast transport system, the importance of spice was almost diminished. But, with the revival of interest in natural products, particularly those for consumption, the demand of spices once again revived. With an improved knowledge on the chemistry and biological activities of spices, the uses of these items are likely to be increased many fold in coming years. It is therefore both a challenge an opportunity for India. Let us reestablish the preeminent position of India both in her spice wealth and indigenous medicine system.

DEVELOPMENT OF SPICES – GENESIS, ISSUES AND STRATEGIES

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Spices constitute an important group of horticultural crops which are virtually indispensable in the culinary art. Spices are well known as appetizers and large quantities of spices are consumed for flavouring foods which otherwise, would have been insipid. Spices or their extracts are also used in medicine, pharmaceutical, perfumery, cosmetics and several other industries. Their functional properties as antioxidants, preservatives, anti-microbial, antibiotic and medicinal have been well recognized and made use of. Spices have also characteristic, often very attractive colours which are an important part of their appeal to be used as natural colours in the foodstuffs. The concept of flavour in spices comprises a range of olfactory and taste perceptions. The constituents responsible for these sensations are the volatile / essential oil and resinous compounds, which belong to a wide range of different natural organic chemicals and which generally have little or no nutritional value. They are also widely used for making 'herbal' teas and other medicinal applications.

Spices in the international trade

Annual world import of spices over the past five years averaged 500,000 tons, valued at US$ 2.3 billion. Imports have recorded strong growth averaging 8.5% a year over the past five years. This growth rate is a good indicator of the growth of consumption of spices, the causes of which have been the increasing trend towards eating ethnic or oriental foods in the developed countries and the increasing affluence of consumers in Asian, Latin American and Middle Eastern developing countries. In the developed countries, the growth in consumption of ethnic and oriental foods has been spurred by the larger number of people travelling abroad and replicating their favorite new dishes at home, thereby growing ethnic communities as well as a general trend to eat a greater variety of foods. The usage of spices and herbs by consumers is increasing also because they are appreciated as completely natural, rather than artificial. The developing countries are responsible for the vast majority of spices consumed world-wide: 95% of the world's spices are grown in the developing countries. As disposable income accumulates in these countries, their populations are able to afford greater quantities and varieties of spices. The main importers are developed countries (EU, USA) which import tropical and sub-tropical spices from developing countries. By far, the most important spices for developed country markets in quantity and value terms are chillies (paprika) and pepper, respectively. Imports of pepper are in excess of US$ 1 billion in value and the chillies close to US$ 400 million. Pepper is used in all types of cuisine whilst paprika is gaining ground because of the trend towards ethnic foods. Other important spices that also find wide application are ginger, cardamom, turmeric, cinnamon, nutmeg, caraway, thyme, bay and mace. Spices that have grown in popularity as a result of the trend towards ethnic and oriental foods are coriander, cumin, turmeric and clove. The two largest markets, EU and USA, purchased over half the world's exports between 1995 and 1998 (32.1% and 22.5% respectively). The following five importing countries took another quarter of the world's exports: Singapore (8.7%), Japan (8.5%), Canada (2.8%), Malaysia (2.5%) and Mexico (2.2%). The concentration of markets is likely to fall in future. As the Asian and Latin American economies grow, they will start to import more spices. Even major producers such as India and China have become major importers of certain spices as consumption increased.

India alone produces 3 million tons of spices and consumes 2.7 million tons. The equivalent in value terms would be phenomenal. In addition "spices" like mustard seeds and sesame seeds do not figure in the calculation. If all these values were taken into account, the real economic significance of the spice industry would be more apparent.

Emerging trends in production

The global spice Industry is

poised for a major leap in the 21st century with global trade in spices expected to attain even higher levels due to the anticipated advances in the global food industry. However, equally to be noted are the new challenges facing global spice trade in the coming century. Of great concern to the spices industry will be the implications of the WTO and the growing green sentiment in the world. The Agreement on Sanitary and Phytosanitary Measures (ASPS), the Agreement on Technical Barriers to Trade (ATBT) and the treaty on Trade Related Intellectual Property Rights (TRIPs) will have significant implications to the global spice trade. Similarly the Multilateral Environmental Agreements (MEAs), the Packaging Regulations and the progressive tendency to evaluate environmental impacts of commodities and products from a "total life cycle" perspective, will have its bearing on traded spices in the coming years.

History of spices development in India

The development programmes on spices date back to 1951 by setting up of a high level Spices Enquiry Committee by the Planning Commission in view of the significant role spices play among agricultural commodities produced in India. The committee felt the immense value of these commodities in building up the national economy and observed lack of organized efforts to improve their production and marketing as being done to other plantation crops like tea, coffee, rubber etc. The committee in their report submitted in October 1953, stressed the need for better planning, research and coordinated efforts in the proper development of these crops.

The Government of India accepted above recommendations and provided necessary funds to ICAR for implementing various schemes on Research, Development and Marketing in all the regions of the country. An ad-hoc Central Spices and Cashewnut Committee, a semi autonomous body consisting of government officials and representatives of growers and traders was set up in 1961, devoting special attention in solving the problems confronted the crop development and financed research schemes to be implemented by the State Governments.

Based on the report of the Agricultural Research Review Team, appointed by Government of India, the Central Spices and Cashewnet committee was abolished in September 1965 and research being conducted was integrated with that being done by the ICAR. The Government of India took over development and marketing functions handled by the Committee by setting up of a Regional Office of the Ministry and subsequently created the present Directorate of Arecanut & Spices Development as a subordinate office under Ministry of Agriculture with effect from 01-04-1966 at Calicut in Kerala, for paying adequate attention in different aspects of crop development. Simultaneously Indian Spices Development Council and Indian Arecanut & Cocoa Development Council were constituted in order to continue the association of various official and non official interest with the development programmes on these crops and have the benefit of the continued advise. The Directorate served as the Secretariat of the Development Councils.

As per Cardamom Act 1965, cardamom has been recognized as a plantation crop and activities on the development of the crop was separated and assigned to the Cardamom Board, a statutory body set up under the Ministry of Commerce. Simultaneously, Spices Export Promotion Council was also constituted for export promotion. By the Spices Board Act, 1986 Government of India established Spices Board under the Ministry of Commerce by merging Cardamom Board with Spices Export Promotion Council to look after overall export promotion activities on spices including crop development and research aspects of cardamom as done by the erstwhile Cardamom Board.

No systematic programme for development of spices was undertaken in the First Five Year Plan (1951-56). The Second Five Year Plan (1956-61)contained provision to the tune of Rs 15.49 lakh while the Third Five Year Plan (1961-66) had an outlay of Rs 35 lakh for spice development with which planting material production was taken up for the development of major spices in the important growing states. In the Fourth Five Year Plan (1969-74) development programmes were concentrated for large scale production and distribution of high yielding varieties of important spices with a financial provision of Rs 13.9 lakh.

A well organized effort for spice development was mooted in the Fifth Five Year Plan (1974-79) with a plan provision of Rs 175 lakh with due stress for the development of export orientation. In this plan period a special component plan costing over Rs 30 lakh was also taken up for the development of spices cultivation in the Andaman & Nicobar Islands.

In the Sixth Five year Plan (1979-84) centrally sponsored schemes on spices were transferred to State Governments on the recommendations of the National Development Council. However, development programmes were continued in the Union Territories and autonomous organizations like State Agriculture Universities and ICAR Institutes with the limited financial resources available.

Majority of the state governments continued the development programmes on spices particularly planting material production so as to encourage area expansion with high yielding varieties released by the research stations. The above arrangements were continued in annual plans (1984-85) and first two years of the Seventh Five year Plan (1985-87).

As this arrangement was found inadequate in view of the growing demand for spices for domestic consumption and export, it was felt necessary to pay more attention towards spices development with adequate central assistance. Thus centrally sponsored scheme for spice development was revived with the launching of an Integrated Programme for the Development of Spices with an outlay of Rs 435 lakh with a central share of Rs 240 lakh for providing 50% of the financial requirement in respect of the schemes to be implemented by the state governments and 100% requirements for the schemes implemented in Union Territory administrations and autonomous organizations.

In the Annual Plans 1990-91 and 1991-92, centrally sponsored schemes for the development of spices were intensified by increasing the financial outlay to the tune of Rs 244 lakh and Rs 574 lakh, respectively by providing cent percent financial requirements. The Integrated Programme for Spices Development was further intensified in the 8th Plan (1992-97) with a financial outlay of Rs 125 crore comprising programmes for the overall development of 27 commercially important spice crops grown in India and the developmental activities were extended throughout the country particularly to the non traditional areas.

The following are the salient achievements during implementation of the 8th Plan period.

- Achieved an annual growth rate of 3 per cent and 8 per cent in area & production, respectively.
- Produced and distributed 38 lakh nucleus planting material of black pepper, 1183 tons of nucleus seed rhizomes of ginger & turmeric and 156 tons of nucleus seeds of chillies and seed spices for further multiplication.
- Produced 491 lakh rooted cuttings of high yielding varieties of black pepper, 10.47 lakh seedlings of tree spices and 9758 tons of certified seeds of garlic for field planting.
- Adopted integrated plant protection measures over 2.66 lakh ha of area under black pepper, 5900 ha under ginger, 1,84000 ha under chillies.
- Established field demonstration plots numbering 8371 for black pepper, 18700 for ginger, 22200 for turmeric, 32100 for chillies, 3987 for tree spices, 37400 for seed spices and 5777 for garlic.
- Established and maintained 12 demonstration cum progeny gardens of spices in the North-Eastern Region.
- Distributed 51500 plant protection equipments at subsidised rates.

A sum of 104.83 crore have been utilized against the overall plan outlay of Rs.125 crore. Similarly an amount of Rs. 142.42 crore have been earmarked for the development of spices during IX plan period. An amount of Rs. 400 crore has been proposed for development of spices during X plan.

Strategies for future issues

In the spice sector, the main emphasis during the Ninth and Tenth Plan will be on increasing productivity, accelerating the replanting activities and rapid expansion of crops in the non-traditional areas, particularly the North East. The main strategy for product development will be on the adoption of improved agricultural practices, adherence to strict phyto-sanitary norms and upgradation of post-harvest technology. These measures are aimed to bring down the unit cost of production and improving the competitive edge for our exports. Strengthening of infrastructure for value addition and quality control have been identified as the core areas in market development and export promotion. In order to establish a competitive presence in the international market, quality maintenance deserves topmost attention and quality improvement will be achieved through research and development intervention. Dissemination of information will receive due importance so also of modern technologies for cultivation, processing and packaging to internationally accepted standards. Efforts will be made to promote organically produced commodities.

The North-Eastern region will receive special focus with increased flow of resources and higher level of assistance under various spice development programmes for exploiting the natural resources which this region is endowed with to their advantage. This region has tremendous potential for spices besides, other plantation crops like tea, coffee and rubber. The constraints of the North-Eastern region such as lack of skilled manpower, infrastructure, resources / credit flow and high transportation cost etc. will be specifically addressed to. Extension service through demonstrations and trainings to the tribal growers assume considerable importance. A substantial portion of the resources of the various Commodity Boards will be for the North-Eastern region. During the Plan schemes, onform water management for increasing production in North-East/Eastern India and schemes for increasing the consumption of fertilisers and increased flow of credit for the agriculture sector are being envisaged.

An integrated approach will be adopted for the development of black pepper, ginger, turmeric, chillies, tree spices like clove, cinnamon and seed spices. The identified thrust areas include increasing productivity to bring down the cost of production, developing cultivation of export-oriented varieties such as low fibre ginger, chillies with bright red colour, developing cultivation of vanilla, saffron, herbal spices etc. and encouraging women in cultivation of spices and community processing of the produce. The Plan programmes will focus their attention on post-harvest management, quality improvement through supply of planting material, developing organic farming, modernisation of processing / manufacture, development of warehousing and mechanisation of spices farming.

SPICES IN PLANTATION BASED CROPPING SYSTEMS

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Plantation sector plays an important role in the industrial and economic development of the country contributing a major share in the country's export trade. Major plantation crops grown in the country are coconut, arecanut, oil palm, cocoa, tea, coffee and rubber. These plantation crops together constitute an area of 73.25 lakh ha with a production of 160 lakh tons of plantation produces, earning a foreign exchange of 8480.50 crore through export of various products. Coconut, arecanut, cardamom and black pepper are being cultivated in India from time immemorial. Cocoa and oil palm are however comparatively recent introductions.

This paper reviews the scope for growing spices in plantation crops. Among the plantation crops the palms like coconut, arecanut, oil palm and palmyrah offer tremendous scope for crop integration. These palms have ideal rooting pattern and canopy coverage for integrating a variety of crop combinations in the inter spaces. They are widely spaced perennials stand committed to the land almost permanently, and are highly congenial for adopting cropping system. Coconut, areconut, and oil palm are the common palms grown on plantation scale. These palms together occupy an area of 22.40 lakh hectares in India. Palms do not fully utilize the basic natural resources like soil and sunlight available in the garden owing to their unique physical stature. For example, the active root zone of coconut is confined to 25 per cent of the available land area and the remaining 75 percent of the area could be profitably exploited for raising subsidiary crops. The space utilization of coconut is very low and plenty of sunlight infiltrates and falls on the ground which remain unutilized. Similarly, in arecanut and oil palm too, plenty of space is available for utilization. In the recommended spacing of 2.7 x 2.7m for arecanut, nearly 80% of the roots are within a radius of 75 cm from the base. This works out only 31% of the area and remaining 69% is not effectively used. It was reported that arecanut roots are concentrated within 60-90 cm around the base of the palm and 61-67% of the roots are found within 50cm radius of the palm, and only few roots extended beyond 100cm. Thus the arecanut plantations are also ideal for inter/mixed and multistoried cropping.

The orientation of palm leaves allows part of the incident solar radiation to pass through the canopy and fall on the ground. The diffused sunlight facilitates growing a number of shade tolerant crops in the interspaces. The crops can be accommodated in the unutilized area enabling better use of natural resources.

Spices in plantation based cropping systems

India is considered as the home of spices and as one of the major supplier of important spices like pepper, cardamom, ginger, turmeric, chillies, fennel and fenugreek. Pepper is raised exclusively as a mixed crop in homestead gardens in Kerala and Karnataka and is trained on coconut, arecanut, *Erithrina* and other tree crops. Cardamom is cultivated as an understorey crop in forest ecosystem at high altitudes and the system in a typical "silvi -horticultural" agro forestry system yielding very high returns. In Uttar Kannada District of Karnataka and in parts of Kerala, raising cardamom as an understorey crop in arecanut plantations is in vogue. There are reports that ginger and turmeric could be raised successfully as understoreyed crops in coconut and arecanut plantations.

Both annual and perennial spices can be selected for crop mixing based on the suitability of soil location, marketing facility, demand etc. The annual spice crops commonly grown with palms on plantation scale are ginger, turmeric, chillies, garlic and the perenniols grown in the interspaces are pepper, clove, nutmeg, all-spice, cinnamon etc.

Intercropping with spices

Intercropping in coconut and arecanut with annual spices like ginger and turmeric is a common practice adopted for increasing income from unit holdings. They are planted in raised beds of 1-1.2 m width, 30 cm height and suitable length. Farmyard manure is mixed with soil of the pits after planting. Ginger is planted at a spacing of 25cm X 25 cm at a depth of 4.5 crn with bud facing upwards. Turmeric rhizomes are planted at a spacing of 15cm X 30 cm covered with dry powdered cattle manure. Covering the seedbeds with green leaves is done after planting and this practice is repeated after 50 and 100 days of planting. The yield of ginger and turmeric as intercrop under average management conditions ranges from 7,000 to 8,000 kg ha^{-1}.

The economic feasibility of raising turmeric and ginger along with fruit crops and tubers like elephant foot yam, cassava, sweet potato and colocasia in a middle aged WCT coconut garden was investigated at CPCRI, Kasaragod. In the trial, spice crops registered a satisfactory yield. The maximum profit was received from turmeric (Table 1.)

Mix cropping with spices

Perennial spices like pepper, nutmeg, cinnamon, betelvine, and vanilla have been proved to be highly remunerative for mix cropping. Black pepper (*Piper nigrum*) is commonly raised as a remunerative mix crop with coconut in the West coast of India. Pepper varieties viz; Karimunda, Panniyur-2 and Panniyur-5 are found to be suitable for mix cropping. It can be planted in the coconut basin using coconut trunk itself as the standard and also in the interspace. The vines are trained along the ground and then on the palms by tying to the trunk during the first two years. Pepper begins to yield from third year onwards and comes to stabilized yield by 7-8 years. On an average, one kg of dry pepper can be obtained from a vine. Pepper was being raised on areca standards in Kerala in earlier days. Now the crop is becoming a popular mixed crop in all the coconut and arecanut growing regions.

Clove (*Syzygium aromaticum*), an important commercial crop is also grown

Table 1. Yield performance of intercrops in coconut gardens

Intercrop	Tuber rhizome yield, kg ha^{-1}	Expenditure Rs. ha^{-1}	Gross income Rs. ha^{-1}	Net profit (+) or loss (-) Rs. ha^{-1}
Elaphant foot yam	5233	2683	3141	+458
Turmeric	4441	6285	8882	+2597
Ginger	2426	6679	7290	+611
Sweet potato	588	3235	147	-3088
Cassava	13823	2706	3906	+1200
Colocasia	338	3676	169	-3507

as a remunerative mix crop in coconut gardens with fertile, well drained soil and assured irrigation in the west coast as well as elevated areas of Karnataka. Even though the yield potential of clove under coconut shade is slightly reduced, the unit income from a small coconut holding would be more profitable than the income from a monocropped holding.

Cinnamon (*Cinnamomum verum*) is another tree spice, which is coming up well as a mixed crop. It can be planted in the double hedge system at a spacing of 3m between plants. Harvesting can be started from the fourth year and continued in alternate years. Shoots of finger thickness and uniform brown colour are cut and the bark is extracted by peeling. Harvesting is a labor-intensive operation and hence mix cropping with cinnamon will be profitable only when family labor or labor on cheaper rate is available.

Nutmeg (*Myristica fragrans*) is also a profitable mix crop in coconut garden. Twelve months old nutmeg grafts are planted at the centre of four coconut palms. It is preferable to use grafts prepared from high yielding female trees because of the dioeceous nature of the plant. Nutmeg flowers at 5-8 years of age and full bearing comes at 15-20 years. Fruits are to be harvested when they split and aril turns bright red in colour. The mace is dried in the sun for 10-15 days, till they become brittle and turn yellowish brown from the initial red colour. The nuts are dried till the kernel rattles within the shell. On an average 1500-2000 fruits yielding 8-12 kg nuts and 1.5 – 2.0 kg mace will be obtained per tree.

Cultural requirements of spice crops for mix cropping in coconut garden as per the experimental trials of CPCRI could be seen from Table 2.

Herbal spices like long pepper has got greater potentiality as mixed crop in the palm plantations.

Table 2. Cultural requirements of spice crops for mix cropping in coconut gardens

Crop	Planting unit	Pit size (cm)	Spacing (m)	No. of plants per ha.	Fertilizer dose g plant^{-1} year^{-1}		
					N	P_2O_5	K_2O
Pepper	Rooted cuttings	50x50x50	7.5x7.5 (at the base of the palm)	175	100	40	140
Clove	Seedlings	60x60x60	7.5x7.5 (at the centre of four palms)	175	300	250	750
Nutmeg	Grafts	60x60x60	7.5x7.5 (at the centre of four palms)	175	500	250	1000

Multistoreyed cropping with spice crops

Coconut palms above 20 years old are suitable for multistoreyed cropping where an intensive combination of crops having different morphological characteristics are planted in the interspaces so as to intercept sunlight at different levels and feed at different soil depths. In this system, pepper is a suitable combination for coconut. Black pepper trained on coconut along with cocoa and pineapple consists of the four-crop combination in one system of multistoreyed cropping. The pepper vine having its' canopy at 2-8 m height on the coconut trunk, forms the second floor crop of the system.

At the Central Plantation Crops Research Institute, Kasaragod, several crop combinations were tested in a multistoreyed cropping system experiment in order to identify the most remunerative combinations. Of the several combinations of perennial crops tested, the most productive and remunerative combinations under West Coast conditions was coconut, pepper (trained on coconut trunk), cocoa and pineapple. The results of the experiment are shown in Table 3.

High density multispecies cropping system with spice components

High density multispecies cropping system (HDMSCS) involves growing a large number of crops to meet the diverse needs of the farmer such as food, fuel, timber, fodder and cash. This is ideally suited for smaller units of holdings and aims at maximum production per unit area of land and time simultaneously ensuring sustainability. This system includes annuals, biennials and perennials. The crops selected include spices, cash crops, food crops and fodder crops. The biomass other than the economic part is recycled within the system. The annual crops are removed as the canopy size of perennial crops increase. Coconut based HDMSCS model consisting of tree spices was also tried at CPCRI , Kasaragod.

Under the All India Coordinated Research Project on

Table 3. Economics of multistoried cropping

Crop combination	Man days $year^{-1}$	Total expenditure on cultivation (Rs ha^{-1})	Net profit (Rs.ha^{-1})
Coconut monocrop	220	3500	6050
Coconut + Cocoa	300	6200	14300
Coconut + Cocoa + Pineapple + Pepper	360	7520	17430

Palms, the coconut based high density cropping systems as applicable to different agroclimatic regions were evaluated involving spice crops preferably pepper at Ambajipet, Arsikere, Kahikuchi and Ratnagiri. The crop combinations evaluated and profitability assessed at various centres were:

Centre	Crop
Andaman	Pepper, clove, cinnamon, ginger, turmeric and allspice
Ambajipet	Acid lime, guava, pomegranate, pepper, pineapple, banana and coffee
Arsikere	Clove, nutmeg, pepper, pineapple, mango, banana, and coffee
Kahikuchi	Pepper, betelvine, citrus, pineapple and banana

Cropping systems in coffee and tea plantations

In the coffee industry, nearly 97 per cent of the growers come under small sector. Robusta coffee is becoming less remunerative and farmers are compelled to diversify cropping in such plantations with introduction of crops as banana, pepper, ginger, turmeric, oranges, sapota, papaya, annona, and silk cotton trees. It is reported that arabica coffee planted with pepper has given the highest total income than other combinations. Crop diversification and multiple cropping will be increasingly adopted in coffee plantations in future. In coffee estates of Karnataka, there is interest nowadays to grow pepper in the shade trees In the tea estates of Kerala and Tamil Nadu, tea planters try to raise arecanut and pepper in tea gardens. If these efforts prove beneficial, they will become the success stories of multistoreyed cropping in coffee and tea plantations.

Mix farming system

The integration of animal enterprises like dairying, poultry, beekeeping, sericulture, pisciculture etc. along with crop mix including fodder crops is termed mix farming system. This system is instrumental in maintaining soil health and ecological sustainability. Table 4. depicts mean annual output from 1 ha of mix farming unit, where pepper is used as a component.

The crop mixing in plantations offers several complementary interactions between component crops in the system. The beneficial effects include improvement in soil fertility status, increase in soil microbial activities, interception of sunlight and microclimate. It will reduce the weed growth as well. All these factors would ultimately help to achieve higher productivity.

Transfer of technology

The technologies developed by the Research Institutions are transferred to the farming community for adoption. The development organisations like Coconut Development Board, State Agri./Horti. Departments and

Table 4. Mean output per ha of mix farming unit (1972-88)

Item	Output
Coconut	11270 nuts
Milk	7089 L
Pepper	80kg
Banana	250kg
Beef (estimated)	350kg
Biogas	2.8-3.5 m^3 day^{-1}
* Dung	14.6 MT
* Urine	3600 L

* Recycled within the system

Extension wings of SAUs are instrumental in popularising the practices for adoption. The Coconut Development Board implements a programme for promoting the inter / mix / multi cropping systems in coconut holding under one of its development programmes for improving the productivity. The farmers are given incentive subsidy for adopting multi species farming practices, which will ultimately help to improve the productivity of coconut holdings. The selection of suitable spice crops can be made along with the complementary crops depending on the agroclimatic conditions prevailing in respective states, market demands, etc. The Directorate of Arecanut & Spices Development is also implementing programmes for expansion of area under spices; distribution of quality planting material etc. through which spices cultivation can be improved in palm based cropping system.

Conclusion

In the present context of shrinking valuable agricultural land due to urbanization and industrialization, increasing unit income from unit holdings in unit time shall be future strategy. Growing high value commercial crops will help fetch higher income from the holdings. Spices are high value commercial crops and are highly suitable for growing along with the plantation crops. Perennial palms like coconut, arecanut and oil palm throw more scope for this purpose. Plantations of cardamom, coffee and tea are also going for mixed cropping with black pepper on shade trees. Moreover, in the free world trade depending on solo crop, which is always subject to the threat of price fluctuation, need to be discouraged. Hence it is necessory to promote multicropping/mix farming system which can provide continuous and sustainable income, tremendous employment opportunities, better utilization of natural resources and applied nutrients, improvement in soil fertility, as well as protection against the market risks.

COFFEE BASED SPICES CROPPING SYSTEMS

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As the international market is becoming increasingly competitive, there is no way out except to increase the production and productivity of spices by bringing down the cost of cultivation so as to make Indian spices globally competitive. The economics of spices production and marketing is recently undergoing rapid shifts. Production economy is presently passing through a phase of tough competition from producers elsewhere. Thus the global competitiveness of spices particularly under the post WTO/ GATT scenario needs to be looked into seriously to retain/ regain the premier position for Indian spices in the global markets. Price of spices is being increasingly influenced by production and price status in other countries, with the result, the form level prediction of prices turns out to be difficult. Immediate response of the growers to these competitive market forces has to be crop diversification. Spice based multistoreyed cropping systems are fast emerging in the Western Ghats of India. Though the prime motive for diversification seems to be profit and economic risk aversion, the emerging cropping systems symbolize a higher degree of ecological sustainability. Multiple cropping systems effectively utilize the limited dimensions of time, space and resources.

Coffee based spice cropping systems

In the present scenario of global surplus production and the declining price in the international and internal market particularly under post GATT scenario, diversification of coffee with compatible crops like pepper, cardamom, tree spices and vanilla assumes greater importance. Cultivation of these associate/ companion crops is sure to improve the cash inflow position of coffee planters (growers) thereby overcoming the total dependence on a monoculture of coffee. Encouraging price for pepper in recent years and the least or almost negligible cost of cultivation of pepper when grown as a mixed crop with coffee, tempted the planters to go in for intensive cultivation of pepper on largest areas in coffee plantations. Well-distributed rainfall during June-July is required for a good crop of pepper. The favourable rain received during June-July in the Western Ghats of India offers great scope for cultivation of pepper on a large scale quite often mix cropped with coffee.

As the common companion crops of mandarin (orange) is severely infested by virus/ greening complex diseases in recent years, the most hopeful and economically feasible crop to cultivate on shade trees in coffee plantations is undoubtedly black pepper. Amongst all the plantation and spice crops, vanilla and cardamom prices have been quite encouraging in recent years. Hence, the cultivation of these high value and low gestation crops as mixed crops in coffee plantations assumes greater economic and ecological significance. The results and practical utility of various on farm coffee based spice mix cropping systems are explained below

1. Diversification of coffee with spices and other crops at CCRI sub station, Chettalli, Karnataka

Although cultivation of associate crops in coffee plantations has been in vogue, no systematic studies were conducted to find out the efficacy and economics of growing such crops amidst coffee. Therefore, the diversification farm was started at CCRI, sub station at Chettalli, North Coorg in Karnatako during 1973. The first trial was on diversification of the existing associate crops of citrus, black pepper and banana with coffee either singly or in combination with a pure coffee plot as a check both in arabica and robusta. In the second trial, the multistoreyed cropping pattern combined with strip cultivation was utilized so that the coffee, the shade trees and associate crops like pepper were all grown in organized strips to reduce the interference within the crops to a certain extent. There was not much difference in the cost of cultivation between pure arabica blocks and arabica blocks with mix crops like pepper, banana and mandarin (orange), whereas income from these crops was much higher when compared to negligible expenditure incurred on them. The receipts from coffee alone in these blocks were not significantly different indicating no adverse effect of these crops on coffee yields. In the erratic rainfall (bad) years when coffee yields are not economical, the subsidiary crops will come to the rescue of farmers.

2. Mix cropping of pepper with robusta coffee for sustained yield and income

Onfarm trials on mix cropping of robusta coffee and pepper (4 ha) in an actual farmers plantations of Karnataka at Chettali, were taken up from 1980-81 to 1991-92.

Fredonia variety of robusta coffee was planted at 2.7 x 2.7m spacing (1379 plants/ ha) during 1980 crop season. Pepper (Panniyur-1) was planted simultaneously at a spacing of 5.4 m x 5.4m (343 vines ha^{-1}) and trained on Dadaps (*Erythrina lithosperma*). Pepper was also trained on silver oak trees planted at a spacing of 10.8 m x 5.4m (171 vines ha^{-1}). in additon to the vines planted on 61 forest shade trees/ha (within and border of the plantation). Thus the total number of pepper vines was 575 ha^{-1}.

During the first crop, moderate yield of coffee 530 kg (dry) ha^{-1} parchment was recorded (1984-85) followed by 817 kg ha^{-1} in second crop season (1985-86). The yield jumped to 1025 kg ha^{-1} during the 3rd crop season (1986-87). However, the average of 8 crop seasons (1984-85 to 1991-92) recorded 946.5 kg dry parchment coffee ha^{-1} $year^{-1}$. In case of pepper during 1984-85, i.e., first year of cropping season, a moderate yield of 345 kg ha^{-1} dry pepper was harvested followed by 525, 862, 1275, 1580 and 2028 kg ha^{-1} in subsequent years from 1985-86 to 1989-90. The pepper yield came down to 1325 kg (dry) ha^{-1} during the 7th crop season (1990-91) and again shot up to 1838 kg ha^{-1} during the 8th crop season (1991-92). However, the average of 8 crop seasons i.e., 1984-85 to 1991-92 was 1222.2 kg dry pepper $ha^{-1}year^{-1}$.

Economic anolysis reveoled that total investment towards establishment was Rs. 54776 (actual expenditure Rs. 32432 + compound interest @ 14% Rs. 22344 ha^{-1}). The annuity value @ 14% was Rs. 11808 ha^{-1}. Annual maintenance cost towards cultivation of both coffee and pepper was Rs. 18672 ha^{-1}. However, total cost per year was Rs. 30480 ha^{-1}. The average gross income of Rs. 66553 ha^{-1} and net return of Rs. 36073 ha^{-1} obtained in this trial were quite encouraging. The Benefit Cost Ratio (BCR) was 2.62. Average labour requirement during bearing was 483 labour days ha^{-1} $year^{-1}$ both for cultivation of coffee and pepper as mixed crops. Thus this cropping system generated gainful employment.

3. Mix cropping system of robusta coffee, coorg mandarin, pepper and cardamom (single hedge)

Onform field experiment were initiated during 1990 in a 13 year robusta coffee plantation at Chettalli, Kodogu, Karnatoka. Black pepper was planted and trained on *Erythrina lithosperma* standards in 1980. In the plantation coffee and mandarin were planted simultaneously during 1978. Cardamom was introduced during 1990 without removing coffee plants (rows) but by trimming only the alternate row side branches of coffee so as to make room for the introduction of cardamom in a single hedge.

In this multistoreyed cropping system, the overhead shade trees (15-18 m) formed the topmost storey (tier), followed by coorg mandarin (8.0-8.5m) which constituted the second tier, black pepper trained on *Erythrina spp* (6m) constituted third tier, cardamom (2.0-2.5m) the fourth tier and coffee (1.6-1.8m) the fifth and lower most ground tier. Photosynthetically active radiation (PAR) was highest (295.50 μ mol m^{-2} sec^{-1}) in coffee as a monocrop, while in the mix cropping system, coffee recorded the highest PAR (205 μ mol m^{-2} sec^{-1}).

Dry yield of coffee was significantly higher when it was grown as monocrop (2163 kg ha^{-1}) compared to mixed crop (1568 kg ha^{-1}). Cardamom introduced as a single hedge with coffee by trimming the side branches of alternate rows of coffee, recorded yield of 204.83 kg ha^{-1}. Black pepper vines trained on live standards of shade trees yielded 1222 kg ha^{-1} (dry). As Coorg mandarin trees were severely infested with greening/virus complex disease, no appreciable yield could be observed. The study indicated feasibility of introduction of high value crops like cardamom and black pepper as mixed crops in increasing the production and productivity of coffee plantations.

Out of the total cost of cultivation of Rs. 46322 ha^{-1}, the labour accounted for 72 per cent (Rs. 33222 ha^{-1}) and rest (28%) of the cost was shared by other cash inputs like fertilizers, pesticides and irrigation charges. A common expenditure of Rs. 6190 ha^{-1} was incurred towards combined cultural operations like weeding mulching, shade regulation etc which helped to bring down the total cost of cultivation in the cropping system.

Monocrop of robusta coffee required 245 man and 289 woman labour days per ha. On the contrary mix cropping system required 331 man and 427 woman labour days which was 1.50 times more than the monocropping system. Mix cropping of robusta coffee, pepper and cardamom generated gainful employment to onfarm and hired agricultural labourers in the high ranges of Western Ghats round the year.

Cost of cultivation was highest (Rs. 46322 ha^{-1}) in mix cropping as against Rs. 27672 ha^{-1} under mono cropping. The net return of Rs. 105191 ha^{-1} realized in the mix cropping was 3.69 times more than the monocropping. The incremental net gain in mix cropping was Rs. 78700 ha^{-1} (269%) over the monocrop. The financial feasibility measures such as NPW and BCR were also found to be higher by 3.35 and 1.56 times respectively in mix cropping. Mix cropping of cardamom with robusta coffee generated income to the farmers over a period of ten months (July-April)

4. Mix cropping of robusta coffee with cardamom (double hedge)

This trial was conducted to study the compatibility and productivity of cardamom with 38 years old robusta coffee (which was planted at 2.7 m x 2.7 m) by removing alternate rows of coffee to introduce cardamom in paired rows (double hedge) during 1985. The comparative performance of both the mix cropping of robusta coffee with cardomom and monocropping of robusto coffee was studied in this experiment.

Robusta coffee mix cropped with cardamom recorded 1988 kg ha^{-1} as against 2626 kg ha^{-1} as a mono crop in spite of half the plant population in the former system. Cardamom as a mixed crop with robusta coffee in double hedge recorded the highest yield of 1400.5 kg dry capsule ha^{-1} during the fourth year of its planting and the average of seven crop seasons was 672.30 kg ha^{-1}.

Microclimate and physiology

Monocrop of coffee received higher amount of light (86.8%) compared to that in mix cropping system (57.5%). In mix cropping, cardamom intercepted 57.8 % light due to mutual shading by the canopies of both the crops. Monocrop of coffee received significantly higher amount of PAR (1188.8μ $molm^{-2}sec^{-1}$) than mixed crop of coffee (787.5μ $molm^{-2}sec^{-1}$) and cardamom (792.5$\mu$$molm^{-2}sec^{-1}$). Relative humidity and leaf and air temperature in the mix cropping system did not vary significantly. Relative humidity ranged from 23.6 to 24.0%; air and leaf temperature ranged from 27.3 -29.4°C and 29.6°C-30.0°C, respectively in the mix cropping system.

Photosynthetic rate, transpiration rate, stomatal conductance and intercellular CO_2 concentration showed significant variations in cropping systems of cardamom and coffee. Photosynthetic rate was 4.2μmolCO_2m^{-2} sec $^{-1}$ in monocrop of coffee compared to 2.9μmolCO_2m^{-2} sec $^{-1}$ in coffee grown as a mix crop. A 45 per cent increase in photosynthetic rate was observed in monocrop of coffee due to higher light availability. Cardamom recorded a photosynthetic rate of 3.2μmolCO_2m^{-2} sec^{-1}. The transpiration rate (5.9μmol H_2Om^{-2} sec^{-1}) was higher in monocrop of coffee compared to mixed crop (4.4μmol H_2Om^{-2} sec^{-1}). Stomatal conductance was low in the monocrop than in mixed crop.

The study indicats that coffee-cardamom mix cropping systems is compotible and the productivity of these crops could be increased by resorting to intensive mix cropping systems.

Employment potential

Mix cropping of robusta coffee with cardamom vs. monocrop of robusta coffee also revealed the greater potentiality of labour employment in mix cropping compored to monocrop of robusto coffee. The monocrop of robusta coffee required 180 men and 407 woman labour days per ha while the mix cropping system requires 237 men and 710 women labourers per ha. To carry out various operations of both robusta coffee and cardamom, labour requirement is 1.67 times higher than the monocropping system. The correlation coefficient of yield and labour requirement in both mono and mix cropping systems are high and significant. Further, the mix cropping of cardamom with robusta coffee generated gainful employment to onfarm and hired agricultural labourers in the high ranges of Western Ghats round the year.

Economics

The total cost of cultivation of mix and monocropping was worked out to be Rs.40235 and Rs.26727 ha^{-1}, respectively. In both the systems, the cost of labour accounted chunk share i.e. 71.91 per cent in mix cropping and

68.98 per cent in monocropping. In the mix cropping, a common expenditure of Rs.6831 (16.95% of cost of cultivation) was incurred on various combined cultural operations and other items.

The cost of cultivation was highest Rs. 40234.67 ha^{-1} in mix cropping as against Rs.26726.80 ha^{-1} under monocropping. The net returns of Rs.142689 ha^{-1} realized in mix cropping were 4.06 times more than monocropping. The incremental net gain in mix cropping was Rs. 107584 ha^{-1} (306.46 per cent) over the monocrop. The financial feasibility measures such as NPW and BCR were also found to be higher by 2.57 and 1.74 times, respectively in mix cropping. The mix cropping of cardamom with robusta coffee generated income to the farmer over a period of 9 months (July-March).

5. Mix cropping of arabica coffee with cardamom (single hedge)

This trial was conducted to study the compatibility and economic returns of arabica coffee with cardamom in the alternate rows. For the study, alternate rows of 10 years old coffee were removed so as to introduce cardamom as a mix crop.

Yield pattern

Dry yield per plant and per hectare of arabica coffee as a sole crop was significantly higher compared to mix cropping with cardamom. Dry cardamom yield was highest (626 kg ha^{-1}) during the third year of mix cropping with arabica coffee. There was reduction in the yield of arabica coffee per hectare when mix cropped with cardamom as the population of arabica coffee retained was exactly half by removing an alternate row (1134 plants ha^{-1}). The encouraging yield of cardamam with its high value provided higher returns to the farmers.

Microclimate and physiological parameters

Micro climatic and physiological parameters showed the same trend as that of robusta coffee system.

Employment potential

The mix cropping of arabica coffee with cardamom was able to generate gainful employment to the extent of 1.90 times higher than the mono crop of arabica coffee. In both the crops, the utilization of women labourers was maximum. A significant correlation between yield levels and labour requirement was observed in arabica coffee. In cardamom, the variation in labour requirement in tune with the yield levels was observed as indicated by their coefficient of variation. Thus, mixed cropping of arabica coffee with cardamom was found superior both with respect to generation of gainful employment and income in the high ranges of Western Ghats.

Economics

The cost of cultivation was highest Rs.55001.70 ha^{-1} in mix cropping as against Rs.27781.70 ha^{-1} under mono cropping of arabica coffee. The highest net returns of Rs.202690 ha^{-1} in mix cropping during third year (1994-95) of the study was due to bumper crop of cardamom. On an average (average of 3 years) the net returns of mix cropping was more by 4.04 times of monocropping with an incremental net gain of Rs.47346.30. The financial feasibility measures such as NPW and BCR were also found to be higher by 3.41 and 1.26 times respectively in mix cropping. The mix cropping of cardamom with arabica coffee generated income to the farmer over a period of 8 months (July-February).

6. Multistoreyed cropping system with coffee, clove and pepper

The agro climatic conditions prevailing on the slopes of Western Ghats are suited for cultivation of tree spices and there is an immense scope for increasing the area and production of these crops. India is almost the net importer of some of these tree spices and hence, there is an urgent need to increase the production of these high value tree spices.

The multistoreyed cropping of clove with pepper and sanramon coffee was studied in Makkandur, Coorg, Karnataka. This crop combination was planted in 0.8 ha area along with pepper and sanramon coffee during 1982.

One year old silver oak (*Gravillia robusta*) saplings were planted at a spacing of 6m from row and 2m from plant to plant with intention that they would grow and prove an overhead shade for sanramon coffee and young clove plants. Sanramon coffee (compact type) was planted at 1.5m x 1.5m and clove was planted at 6m x 6m (Triangular) so as to adjust with the above crop combination. Banana (Local & tall Cavendish) was planted during the same year to provide adequate shade for clove and coffee and to generate an early income. Pepper (Panniyur-1) was planted at the base of the silver oak trees after 4 years (1986) when the latter attained a sizeable growth and girth to act as a live standard for pepper.

Though, clove commenced yielding from the year 1988-89 onwards with just a stray crop in certain tree, moderate yield of 100g per plant was recorded during 9th year (1990-91) followed by better prospectus of the crop in subsequent seasons.

The sanramon coffee commenced yielding from 1986-87 onwards with a moderate crop yield of 250 kg acre^{-1}. However, the average of crop yields for 6 years from 1987-88 to 1992-93 in 530 kg acre^{-1}.

Though pepper commenced bearing from 1987-88 onwards, the highest crop of 175 kg acre^{-1} was obtained during 1990-91.

Some of the common cultural operations like weeding, mulching etc can be commonly shared together by bringing down the total cost of cultivation. The crops in above combination do not press for labour at a time. Coffee can be harvested during December-January followed by clove in March and pepper in April. Thus there is a vast scope through introduction of clove and pepper in coffee plantations for increasing the productivity per unit area.

7. Prospects of mix cropping of ginger and turmeric with arabica coffee (Cattimora/cauvery)

Though recently released popular cattimora (Cauvery) coffee can came to bearing early, at least 3 years after planting are required for getting a sizeable crop. Thus there is great scope to raise short duration high value spice crops during the first and second years of planting cattimora coffee and also to establish both temporary fruit plant like banana and high timber value permanent shade trees like silver oak and Balanji to provide adequate shade, and to generate early income, providing gainful employment to small and marginal farmers. Pepper vines can be trained on to the trunk of silver oak and Balanji after 3-4 years of planting using them as live standards.

An onfarm trial was monitored in 2.0 ha to study the integrated use of inputs, yield and returns of ginger and turmeric in the first and second years of planting coffee respectively in the interspaces with an objective of increasing the productivity per unit area and to bring down the cost of cultivation.

Local variety of tall banana was planted at 9.0 x 9.0 m (124 plants ha^{-1}) during 1989 to provide quick shade to coffee and component crops. Both robusta coffee (6.2 m X 3.1 m) 520 nos. and arabica coffee i.e., Cattimora cauvery (1.55m) 3642 nos. (4162-520) were planted simultaneously in 1989 itself.

Permanent shade trees viz., silver oak (*Gravillia robusta*) and Balanji (*Acrocarpus fraxinifollius*) were planted alternately at a spacing of 12m x 6.3m, 247 nos each. Local variety of ginger (1500 kg ha^{-1}) was raised as an intercrop in 1990-91 and turmeric (1850 kg ha^{-1}) in 1991-92 crop seasons respectively in the interspace of coffee rows on raised beds of 1.2m x 1.5m. Pepper vines (494 ha^{-1}) were planted in the base of Balanji and silver oak trees during July 1993. The recommended package of practices was carried out as per calendar of operations and the input costs were monitored from the first year 1989 to 1992-93 crop seasons.

Coffee being a perennial crop both pre bearing (upto 3 years) and bearing i.e., 4th year onwards has to be considered for working out cost of cultivation.

A sum of Rs.7169.6 ha^{-1} was incurred towards the cost of cultivation during the first maiden crop coinciding with the 4th year of planting coffee. A maiden coffee crop of 750 kg dry cherry ha^{-1} was obtained during 1992-93, 4th year after planting. The gross income of Rs. 9750 ha^{-1} was obtained from the sale proceeds of coffee. Since, the total cost of cultivation of coffee was Rs. 42461.3 (from 1st year to 4th year) still a total cost of Rs. 32711.3 ha^{-1} has to be adjusted from the coffee yields in the subsequent cropping seasons.

Out of the total cost of cultivation of Rs. 31511 ha^{-1} (seed plant material) costed the maximum of Rs. 15000 (49.12%) followed by labour charges Rs. 7242 (22.99%). Mulching is most important operation in raising ginger. A gross income of Rs. 79800 ha^{-1} was recorded from the yield of 11400 kg wet ginger.

Out of the cost of cultivation, Rs. 31098 highest cost was incurred towards seed material i.e., 15450 (49.7%) followed by labour charges Rs. 6906 (22.20%). A wet yield of 4525 kg (2421 kg dry ha^{-1}) was obtained from turmeric. A gross income of Rs. 60525 ha^{-1} was recorded. After deducting the cost of cultivation of Rs. 31098, a net income of Rs. 29427 ha^{-1} was realized.

The total cost of cultivation for raising all the three crops i.e., main crop of coffee (Rs. 42461.3) and subsidiary crops of ginger (31511) and turmeric (31098) was Rs. 105070.3/ha as against the gross income of Rs. 150075 from these crops. Raising of ginger and turmeric crop could generate substantial income in the prebearing period of coffee, otherwise wherein the farmer has to wait for a long period to make good of expenses had he gone in only for raising mono crop of coffee.

Conclusion

In the present scenario of surplus global production and declining price both in international and national markets, diversification of coffee with compatible high value spices like pepper, cardamom, tree spices in the established plantation and ginger and turmeric in the initial years of establishment of coffee, has been found to be ecologically compatible and economically sustainable in high ranges of Western Ghats of India.

The climate of tropical forests is more ideal for multistoreyed cropping. As coffee and spices like pepper, cardamom and tree spices require more or less the similar agro ecological conditions, it is quite imperative to have these crop mixtures harmoniously for sustained production and yield.

As majority of coffee plantations are owned by the small and marginal farmers, productivity of these coffee plantations should be increased by intensive cultivation resorting to diversification with suitable mix crops of spices to improve and sustain high income.

Among the spices suitable for cultivation with coffee, prices of cardamom and vanilla is quite encouraging. Considering global and domestic demands for spices, it is quite imperative to cultivate them as mixed crops with coffee. India is still the largest producer, consumer and exporter of spices. Increasing the production and bringing down cost of cultivation of coffee and spices with make these commodities globally competitive.

RANDOM THOUGHTS FOR INCREASING EXPORT OF SPICES

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Export of spices from India is at crossroads. Our export of spices was 1,30,734 MT in volume and Rs.418.64 crore in value in 1992-93. We have been continuously increasing export of spices since then for 5 years both in volume and value. In 1998-99 our export went up to 2,40,863 MT in volume (creating an all time record) and Rs.1796.10 crore in value. But, from 1999-2000, export performance in volume has started declining. In this year the volume of export came down to 2,36,142 MT, but the value increased to Rs.2025.09 crore, the highest amount ever earned. In 2000-01 the value of export also declined making a serious concern to all of us. While the quantity exported decreased only marginally further to 2,30,000 MT, the value has fallen steeply down to Rs1612.07 crore in 2000-01. Percentage-wise decrease in quantity was 4.5 and in value 20.34 compared to the highest levels achieved in 1998-99 for quantity, and in 1999-00 for value. This situation is not encouraging for a country like India, which boasts herself as the largest producer and exporter of spices in the world. We have to change the course of our spice export to progressive direction and keep at least 3% growth in volume and 5% in value.

We should make an in depth analysis of our spice industry to find out where the problem lies. It is an often-repeated fact that no country in the world produces spices in variety, extent of area and volume of production as India. Research is carried out for production by establishing National Institute, Regional Stations and an All India Co-ordinated Research Project under Indian Council of Agricultural Research and State Agriculture Universities. National laboratory and Regional Research Laboratories under Council of Scientific and Industrial Research are working for better processing technology and developing new end products. Modern processing units are set up for cleaning and grading and for making value added products by the private sector. For export promotion an autonomous body, namely Spices Board with sufficient manpower and finance has also been created under the Act of Parliament. On account of these and other steps taken, India has become the number one producer and exporter of spices compared to any other country.

We have already lost our position in cardamom production and export to Guatemala about one and a half decades back. With great difficulty we enhanced our production to about 10,000 MT now. But Guatemala already reached 18,000 MT a few years back. Currently their production is same were around 12,000 MT only due to natural calamities. However, they are sure to increase the production and cross the level already reached by them in the next three-four years. Our export of cardamom, which recorded the highest level in 1985-86 at 3272 MT, has dropped to as low as 173 MT in 1989-90. Last year there has been a spurt in cardamom export to 1100 MT, but unlikely to reach anywhere near the highest level achieved in the past.

The scenario of black pepper is also not encouraging. The international prices steeply came down in August 2001 to less than one-third of what prevailed in 1999. There is no indication when the price would move up. Many farmers are holding the stock on the expectation that there would be some improvement in price in the near future. If the present price level is continued indefinitely they will brake down with financial burden. The present fall in price is due to improvement in production in Indonesia and Brazil and substantial area expansion and production in Vietnam. It is reported that Vietnam, which produced hardly 10,000 MT nearly ten years back, has increased production by more than four times and reached 45,000 MT in 2000. We have enough potential for area expansion in Kerala and Karnataka (particularly in coffee estates), some of the North Eastern states and Andaman and Nicobar Islands.

There is immense potential for increasing productivity of both cardamom and black pepper. Our innovative farmers have proved this capability beyond doubt by producing more than 1500 kg cardamom and 3000 kg black pepper per hectare. Many programmes are implemented with reasonable amount of subsidy for productivity increase.

More than the low productivity of the crops, our main problem is the conventional harvest and post harvest management practices. Take the case of black pepper. We harvest this crop in one go, though the maturity of the berries varies much from tender to ripe stage because of the long flowering period extending to over one month. When such harvested crop is dried, there will be a mixture of light pepper, good quality black pepper and pepper corns with skin partially or completely removed. We may remove light pepper while cleaning and grading, but berries with the skin off partially or completely can never be separated in this process. Many buyers are willing to pay a premium price for uniformly black coloured berries with skin intact. One can avoid immature and ripe berries by selective harvesting of the crop. This will require three times plucking to complete the harvest. A simple way to proceed in this matter is to harvest pepper when most of the spikes are at the right maturity and sort them into three category after harvest viz., spikes with immature, mature and ripening berries. Dry separately immature and mature berries after removal from the spikes to give light pepper and good black pepper. Ripening berries can be processed profitably for making good quality white pepper. Light pepper is ideal for making oil and oleoresin, as yield is better than that of black pepper.

Blanching by dipping mature berries in boiling water for one minute before drying is very important to impart uniform black colour to the dried product. This operation helps to improve the product as the dust and dirt adhering to the berries will get mostly washed away along with insecticide and fungicide residues if any. Another advantage of this operation is that the drying time taken will be reduced by one third, which also helps to reduce the contamination due to drying in the open yard. How many of our farmers have adopted this practice which improves the quality of the black pepper at least cost?

White pepper is a value-added product, which our farmers can make in their own farms provided there is water source. Though there are instances of having lower price for white pepper than black pepper in certain years, on an average this product fetches more than 50% of the price of black pepper. The cost of production including a reasonable profit is available if the price of white pepper is 30% more than the black pepper price. Nearly double the price of black pepper can be obtained if the white pepper has uniform cream white colour without any black berries and uniform size. A massive campaign has to be launched for producing white pepper in large quantities for export, as the European market will consume about 35,000 MT annually.

We have done fairly well in developing chilli export and the export growth kept an encouraging trend in the last few years. From 6555 MT in 1991 volume of export increased 68,019 MT in 1998-99, but decreased in subsequent years to 64,776 MT in 1999-2000 and further to 61,000 MT in 2000-01. In the export of chilli, the major complaint is pesticide residue, fungal infection and presence of aflatoxin. Though it is difficult to change the traditional drying method for the entire production of chilli amounting to over one million MT, possible to produce about one lakh MT following improved method of drying in a period of 3-5 years. We should also produce the chilli variety preferred by buyers abroad in sufficient quantity.

Paprika belongs to the chilli family. Though reasonably good quality varieties have been developed, cultivation of paprika on a commercial line is yet to be developed in our country. Spain that was once a major producer is today not a significant supplier as the cost of production scaled up with movement of Spanish workers to other European countries for better jobs. We should take up major programmes for paprika production without delay joining hands with the oleoresin manufactures.

Ginger is another product, which we neglected both in production and processing. Our researchers have identified few varieties suitable for making dry ginger with low fibre content and also for using as fresh ginger, but very little work has been done in popularizing them in a systematic way among our farmers. Many exporters complain that half hazard and careless distribution of the new varieties has resulted in adulteration of the traditionally well reputed Cochin ginger produced in the selected pockets of Kerala.

Another point, which we should seriously consider, is the unscientific processing of dry ginger. A couple of decades back the bleached ginger produced in Kerala used to fetch a higher price than the unbleached ginger. This situation is entirely different now. This is probably due to the reason that we use inferior quality ginger for making bleached ginger. As a result, we have damaged the market developed for bleached ginger in the Middle East. The world's best quality dry ginger comes from Jamaica. It is cream white in colour with lemony flavour. Another speciality of Jamaican ginger is its clean surface without even bits of skin. Cochin ginger is very poor in appearance with lot of skin particularly in the angles. Some times, it is muddy, as we don't wash fresh ginger before removing skin. Because of the superior quality of Jamaican ginger, it fetches nearly three to four times the price of Cochin ginger. It is important that we grow the right variety suitable for making dry ginger and process properly for exports.

Alleppey Finger Turmeric is known for its high curcumin content, normally more than 5.5%. Oleoresin manufacturers often complain that the availability of pure Alleppey Finger Turmeric is becoming scarce. A programme to produce sufficient quantity of Alleppey Finger Turmeric retaining the purity of the variety is called for.

The costliest spice, saffron is cultivated in Pampore valley of Kashmir and Kisthwar district of Jammu. Attempts were made to grow commercially saffron in Sangla Valley of Himachal Pradesh and in Almora Hills of U.P. Spain, which was till recently the largest supplier of saffron with 50-60 MT is now producing hardly 15-20 MT. Iran has taken advantage of the situation and increased production to around 100 MT, but saffron of Iran has not earned the name as Mancha saffron of Spain. Spain is willing to share the saffron production technology to India. Why not we avail it and increase our production utilizing the potential areas in the Northwest Himalayan region?

We have started vanilla cultivation one decade ago. Initially there were problems, like scarcity of planting material, lack of refinement of production and processing technology and poor understanding of marketing potential. Now we have fair information on how to cultivate the crop and make good quality processed beans. Enough planting material can be produced through rapid multiplication of stem cuttings and also through micropropogation. The fear of competition from synthetic vanillin though persisting even now, there is likely to be large number of consumers who look for natural products. It is heartening that the Spices Board has taken decision a couple of months back to expand vanilla cultivation to another one thousand hectares in a short period. We had covered nearly one thousand hectares by 2000-01. A sound programmes should be taken for this. It is reported that the total production from the existing area is low, say less than 50 MT cured beans. A reasonably well maintained vanilla plantation will produce about 250 kg cured beans per hectare. Hence it is necessary to take up a study on the reasons for the low productivity of the presently planted area.

Westerners have not looked at large cardamom as a spice for their kitchen because of the crude and unhygienic way we process it. At present large cardamom is processed through "Bhotti" system and some of the capsules are charred and many smoky. If large cardamom is processed like small cardamom, the product will be clean and have the characteristic aroma and acceptable pink colour. If sufficient propaganda is given for large cardamom processed by the improved method it may get acceptance of the Westerners and earn a better price.

Mint oil is an important item in our spice export basket. Our export is mostly without refinement. The importing countries segregate the oil into various fractions and give value edition. China is the major competitor with India in the export of mint oil. It is important that we look at the mint oil industry afresh from production to processing and revamp it in the modern lines to earn higher income.

India is strong in the production of many seed spices. But our quality is inferior. In the case of coriander, bulk of the production is large sized fruits with easily splitting character and very low oil content. Coriander of Bulgaria is known for its product quality particularly with reference to the oil content. Since we don't adequately dry coriander immediately after harvest and store properly, moisture is absorbed leading to fungal infection and colour fading. We have good varieties of fennel, but we do not care to harvest at the right maturity. Resultantly the oil content is low and the original sweet taste is lost. For our cumin and fenugreek the main complaint is higher percentage of extraneous matter which can be avoided by a through cleaning process. We have done fairly well in the case of celery. For some of the seed spices, particularly fenugreek and cumin, Egypt is a major competitor. They follow better farming technology and have set up good cleaning machines to deliver quality product.

A group of spices on which we are giving very little attention is culinary herbs. While large-scale cultivation of all of them is not necessary, a few selected herbs like sage, parsley, thyme, oregano etc., can be grown commercially for export. It is to be remembered here that fresh herb fetches better price for unit raw material than the dehydrated. Egypt and Israel have done well in the production and export of culinary herbs competing with France and Spain. India has good potential to grow some of them in the temperate climate of the NorthWest hill region and also in the selected pockets of states, like Karnataka and Tamil Nadu.

There is a growing market for organic spices. We have entered into production and export of organic spices in a very limited manner. Black pepper, white pepper, ginger, turmeric, clove, nutmeg and mace are the organic spices exported from India. There is demand for organic chilli and certain culinary herbs and seed spice. A comprehensive programme to produce organic spices is a worthwhile attempt for their export development. It may be noted here that Sri Lanka, Indonesia and Guatemala are already in the production of organic spices such as black pepper, ginger, nutmeg, mace, clove and cardamom and compete with India in the international markets.

Consumers everywhere are looking for clean spices. A large number of our growers are not aware of the use of safe pesticides in cultivation and improved harvest and post harvest operations. As a result, our inherently superior quality spices ar· getting their due importance in the export market. The Spices Board has done a good job in educating many of our growers on how to ensure quality of spices. But this work has largely been done in Kerala and only to a small extent in other producing states. We have to strengthen our programme on quality improvement covering all spices and more producing areas.

ORGANIC SPICES - A PARADIGM SHIFT IN CONSUMER PREFERENCE

Koshy John

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Soil is the soul of infinite life" (SOIL) and the old belief that the soil is a dead body of earth's mass no longer sustains. In nature, there is a built in mechanism to ensure that the static plant is supplied with every ingredient that it needs with the help of different organisms which are responsible for synthesising what is needed from what is available. It, therefore, follows that if we wish to give a proper direction to our agriculture, a paradigm shift is necessary, first in our thinking and then in our practice. It is time that we adopt the most scientific system but the same time not forgetting the ground realities.

With the new liberalised trade policy, the Indian farmer has to be equipped to stand in competition in the world, which is now one market. It should be clear to our policy makers that we are in buyer's market and, therefore, we have no choice but to produce what is in demand. Can an agrarian society that India is, sustain itself with these shifts in policies?. One way is organic agriculture.

Organic production

Organic production and processed farm products is the practice of a production process that develops viable and sustainable agro-system in a production environment.

Organic agriculture limits its impact on the environment by operating as far as possible within closed cycles, along the whole of the food chain. As these systems evolved, production increased but not to the same level as in industrialized agriculture, although negative side effects have been less. A major contributor to the difference in production is the greater investment in research and development over a longer period that has gone into non-organic agriculture.

Current research indicates that organic production levels can be similar to those from non-organic and that it should be possible further to improve production while simultaneously reducing environmental impact. To deliver these objectives will require policy changes in terms of funding for agriculture, with a particular shift in R&D for organic and sustainable agriculture and for its delivery to the farmer.

Objectives and dimensions

Some of the main objectives and dimensions of organic agriculture are:

A. Natural capital:

I. Improve the structure and fertility of soil.

II. Work within closed cycle systems using local resources.

III. Give livestock condi-tions that confirm to their needs

IV. Maintain and encourage wildlife and their habitats.

V. Minimize the use of non-renewable re-sources and avoid pollution.

B. Human capital

I. Produce food of high nutritional quality and sufficient quantity.

II. Enable producers to earn a living and to develop their potentiality.

III. Create systems that are aesthetically pleasing.

IV. Use decentralized systems for local processing, distribution and marketing.

C. Dimensions

I. Ecologically sound

II. Economically viable

III. Socially just and equitable

IV. Culturally sensitive

V. Promotes appropriate technology

VI. Based on holistic science

VII. Total human development

To achieve these objectives and dimensions, one requires a holistic view of the food chain and the many interactions involved. Organic agriculture has standards that formalize the applications of these objectives and dimensions and that are under constant review.

Consumer preference

In modern society where consumers are becoming increasingly health conscious and environmentally aware, a major market for natural foods has developed and the organic sector, in particular, has sprung back into life to become one of the most dynamic sectors of the international food market.

In tune with the consumer preference, more and more area are brought under organic farming. The number organic producers and processors are also increasing (Tables 1 & 2) .

In 1999-2000, the projected figure for organic food sales in the UK was expected to be approximately 546 million. Total household food and drink sales for 1999 was 54,152 bn. So, organic food accounts for approximately 1% of all food sales. Total organic sales are expected to reach 1070 million by 2001-2002. Consumer demand for organic food has risen for the past two years at 40%. In 1996-'97 the total retail value of organic food sales in the UK was 200 million and in 1998-'99 it was 390 million. The percentage of organic produce sold in the European Union now accounts for 3% of food sold, up from 1% in 1992. Currently 70% of organic products sold in the UK have to be met by imports.

Consumer attitudes to organic foods in the UK, according to a survey indicates that one third of the public buy organic food, primarily perceiving it as either healthy/better for you (53%), tasting better (43%), genetically modified (GM) free (30%), environment friendly/ animal welfare (25%).

A study by UNCTAD indicates that the sales of organic products in most industrialized countries represent one or two percent of the entire food sector. The United States is a leader in

Table 1. Land area under organic farming in Europe

Country	1999-00(ha)	% agricultural land
Sweden	268,000	11.2%
Austria	345,000	10.0%
Denmark	160,000	6.0%
Germany	422,000	3.0%
Italy	900,000	5.3%
UK	425,000	2.5%
France	220,000	1.0%
EU average		2.2%

Table.2 Organic processors and producers registered with Soil Association certification Ltd in U.K.

Year	organic producers	organic processors
1995-'96	476	188
1996-'97	559	264
1997-'98	639	327
1998-'99	897	555
1999-'00	1,504	1,030
January 2001	2,038	1,660

this area with sales of 8.0 billion dollars in organic foods annually, or 1.5 percent of the food trade. Germany follows, with 2.2 to 2.4 billion dollars, a portion that varies between 1.25 and 1.5 percent of that country's food market. But the nations with greatest relative expansion in the consumption of organic products are Denmark, with 2.5 to 3.0 percent of the domestic food market, Switzerland, 2.0 to 2.5 percent, and Austria, at 2.0 percent. Certified organic production of foods exists in more than 140 countries, including 90 from the developing world, of which 210 are found on the UN list of least developed countries. Despite the rather limited absolute figures, the organic foods market has expanded in recent years at rates varying from 10 to 30 percent.

Organic spices

A paradigm shift takes place with the consumer preference for a change in food habit. World-wide consumers prefer/switch over to ethnic foods because of health orientation and freedom from chemical contamination. The ingredients of ethnic foods have nutritional, nutraceutical and medicinal values of spices. In this context, the international consumers are seeking organically produced spices and herbs for preparation of healthy foods.

Similarly, there is a definite shift towards tradition/ethnic/folk medicines. As chemical based medicines cause many side effects to the consumers, they are looking for traditional medicine systems like Ayurveda, Homoeopathy, Unani, Sidda and Naturopathy. The spices and herbs like pepper, ginger, pepper long, chillies, cumin, garlic, fenugreek, mint and the like have lot of medicinal properties and hence they are used primarily in these systems of medicines. Now, these systems of medicines look for chemical contaminant free, quality spice and herbs. Organically produced spice satisfies this requirement.

Synthetic colours are used for colouring food preparations as well as in industrial applications. Now, synthetic colours are not preferred because of the harmful effects to the human system and these synthetic colours are replaced by natural colourants extracted from plants. Spices like turmeric and chilli are preferred for colour extraction particularly for yellow and red pigments. It is obvious that organic production of turmeric and chilli has to be taken up to meet this growing demand.

Similarly, synthetic flavours like vanillin are used for flavouring food preparations and confectionaries. Now, the consumers hesitate to consume synthetically flavoured food items because they are hazardous to health. Hence, they are preferring for natural flavours obtained from plants. Nowadays, the natural vanillin extracted from the orchid vanilla replaces the synthetic vanillin. There is vast potential for production of organic vanilla to replace the synthetic vanilla, because of the growing demand. Further, the demand from industrial consumers especially from pharmaceuticals, cosmetics, confectionery and beverages is for organic oils, oleoresins and spice extracts looking for contaminant free and pesticide residue free products.

Taking note of the scenario, India has started production and export of organic spices, thanks to the thinking by the Government of India as well as non-Governmental organisations. Major producers and exporters of Indian organic spices are given in Annexure 1. The exports of organic spices at present is less than 100 tons from the country. Vast potential to increase organic spice exports exist because of the paradigm shift induced with transitional consumer preference in the food, pharmaceutical, natural colour and flavour sectors.

Organic certification

It is imperative that the spices produced under organic farming needs certification from recognized international certification agencies before marketing as organic. The major bottleneck is the exorbitant cost charged by the international agencies for certification of farms of small and marginal growers who go for certification. The Government of India has taken steps to have indigenous certification system to help the small and marginal growers to acquire organic certification.

Through Public Notice No.19 & 25 (RE-2001)/1997-2002 dated 11th June 2001 and 2nd July 2001, in exercise of the powers conferred under paragraph 4.11 & 11.1 of the Export and Import Policy, 1997-2002 of India (incorporating amendments made upto 31-03-2001), the Director General of Foreign Trade, laid down procedures for export of certified organic products. An agricultural product will be allowed to be exported as "Organic Product" only if it is produced, processed or packed under a valid organic certificate issued by a certifying Agency duly accredited by one of the Accreditation Agencies, viz. (i) Agricultural and Processed Food Products Export Development Authority (APEDA) (ii) Coffee Board (iii) Spices Board (iv) Tea Board. This will be affective from 1st October 2001.

National Programme for Organic production containing the standards for organic products and for labeling as 'India organic' was announced as early as March 2000 by the Department of Commerce, Ministry of Commerce and Industry, Govt. of India. Guidelines at first for organic production of important export oriented spices, coffee, tea, joha rice, pineapple, sugarcane and passion fruit have also been developed with provision for extending to other needed crops.

Conclusion

Niche markets for organic agricultural products hold promise for producers in developing countries like India, where traditional system of agriculture is still in vague in many places and use of chemical fertilizers and pesticides are at a low key. The world-wide heightened consumer concerns in the area of food safety and quality, has generated renewed demand for organic food. A review by the International Trade Centre, Geneva has indicated that while the market share of organic food on an average is not more than two percent in most developed countries, in several of these markets the rate of growth is 25 to 30 percent per year. There is a need to collect information on the potential supply of organic food products and to identify the supply constraints. The NGOs can effectively promote this trade by establishing direct links between producers and buyers, producers and exporters in developing countries as well as between importers and consumer organisations in developed countries. UN experts say organic foods could be a key for developing countries, hemmed in by the protectionism of the industrialized world, to open a space in the global market. Organic farming is the only sustainable growth engine for ensuring safety food.

Annexure 1

Major producers and exporters of Indian organic spices

Agency for Integral Developmet Action (AIDA), Nagaland.
AIDA, Provincial House, Don Bosco,
PB No:40,
Dimapur, Nagaland- 797 112,
Tel: 91-3862-44118, 44631,
Fax: 91-3862-44674,
E-Mail:aida@gwl.dot.net.in.

Bosco Reach-Out, Guwahati, Assam
Bosco reach out, don Bosco,
Guwahati, Assam-781 001,
Tel: 91-361-546162,515501,510458,633733,
Fax: 91-361-510457/522822,
E-Mail: Bosco@gwl.vsnl.net.in

Destitute Women's Upliftment Society (DWUS), Imphal, Manipur.
Negamapal Lamabam, Leikai,
Imphal-795 004, Manipur.
Tel: 91-385-311152,
Email-appollorajkumar@hotmeail.com

Health of People And Environment (HOPE), Nilgiris, Tamilnadu
Women's Organisation for Health of People and Environment (HOPE) in the Nilgiris,
Cinchana Village, Dodabetta Post,
Ootacamund-634 002, Nilgiris,
Tamil Nadu, Tel/Fax: 91-423-47784

Indian Organic Food
Himalaya House, 1-142, Kirti Nagar,
New Delhi 110 015
Tel: 91-11-5935513, 5123901,
Fax: 91-11-5437247,5115109

Magosan Exports Private Limited
C 10, Industrial Estate, Yeyyadi,
Mangalore 575 008
Karnataka, India. Tel: 91 6842 53022,
Fax: 91 6842 52605

Malanadu Development Society (MDS), Kanjirapally, Kerala.
Kanjirapally,
Pin: 686 507, Kerala.
Tel: 91-482-802718,802665,802756,802746,
Fax: 91-482-803356.

Mr. Raju Joseph
Vechurattu House, Ettumanoor Post,
Kottayam, 686 631, Kerala.
Tel: 91-484-30354,Fax: 91-481-535588

Peermedu Development Society (PDS), Peermedu, Kerala.
Peermedu Development Society, PB no.11,
Peermedu-685 531, Idukki District, Kerala
Tel: 91-486-332497,332197,
fax: 91-486-332096,
E-mail: pedes@md2.vsnl.net.in

Samanwita.G.Udayagiri Orissa
G.Udayagiri District, Kandhamal,
Orissa –762 100.
Tel: 91-6842-530022, Fax: 91-6842-53905,
E-mail: Phulbhani@md2Ori.nic.in

Shanthi Sadana Ashram, Guwahati, Assam.
Shanthi Sadana Ashram,
Shantivan, Basistha,
Bettola, Guwahati- 781 028, Assam.

Wynad Social Service Society (WSSS), Wynad, Kerala.
PB No. 16, Mananthavady,
Wynad-670 645, Kerala.
Tel: 91-493-540314, Fax: 91-493-542388

RESEARCH GAPS IN SPICES

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India is the land of oriental spices. Indian spices are used in over 130 countries and their intrinsic quality in terms of taste, colour and fragrance has further increased the demand for Indian spice. During 2000-01, India exported about 2,30,000 tons of spices valued at Rs.1612 crore. Major spices and spice products exported are black pepper, cardamom, ginger, turmeric, chillies, oils and oleoresin. India has a very bright future in spice production and export provided the weaknesses, if any, are converted into opportunities.

Of the different mandates of the Indian Institute of Spices Research (IISR), its role to serve as an Institute of excellence for conducting and coordinating research on all aspects of spices improvement, production, protection and post harvest technology; to develop high yielding and high quality spice varieties and sustainable production and protection systems using traditional and nontraditional techniques and novel biotechnology approaches; and to develop post harvest technologies of spices with emphasis on product development and product diversification for domestic and export purposes are areas directly related to research. Organized research activities of spice production is now over 25 years old. In the fast changing global context, the production, processing and marketing scenario of spices would require frequent evaluation to refine the research approaches and fill up the gaps so as to remain internationally competitive. The gap analysis presented in this paper is against this background.

1. Genetic resources and biotechnology

The main objective of research in this area is identification of genetic variability, conserve the same for immediate and future use in crop improvement programmes either deploying conventional breeding methods and modern biotechnological tools alone or in combination. Here, it is important to keep in mind the type of the reproductive / propagation methods of each crop and adopt techniques to release the locked up variability or to obtain recombinants or to develop transgenics through gene transfer. Considerable work has been done in the collection and conservation of germplasm of different spices. The collections made in respect of different spices are given in Table 1. To what extent these collections represent the total variability is anybody's guess and concerted efforts are needed to intensify the collections.

India is the centre of origin for black pepper, small cardamom and large cardamom. With the threat to the native genetic diversity, due to the replacement by improved varieties, deforestation etc. on one hand and misuse of patent rights on the other hand, collection, conservation, cataloging and registering every possible genetic variability assumes great importance. Selection of germplasm on the basis of morphological and molecular characterization hitherto being done will have to be intensified to locate resistance / tolerance to diseases and pests, drought and quality. While the indigenous germplasm collection is to be undertaken on a war footing as a time bound programme, search for resistance/tolerance to pests and diseases, drought and quality in the appropriate seasons in endemic areas should receive focused attention. Concurrent to this, research to standardize the techniques to quickly screen the germplasms *in situ* or as seedlings / vegetatively

Table 1. Genetic resources of spices at IISR genebank, Calicut

Crop	Number of accession	Special type
Black pepper	3097	*Phytophthora* tolerant lines and hybrids, 'Pallu' and draught tolerant lines, nematode tolerant lines
Small cardamom	313	Rhizome rot tolerant lines, natural *Katte* escapes , multi-branched types
Ginger	637	Low fibre types, bold rhizome types, putative wild types, tetraploids
Turmeric	786	High curcumin lines , black turmeric,kasturi turmeric, seedling progenies
Nutmeg	478	Double seeded type
Clove	227	Dwarf type, King clove
Cinnamon	299	Chinese cassia
Allspice	180	
Vanilla	40	
Paprika	38	
Garcinia	29	

propagated plants should be undertaken so that potential gene sources are not lost forever. Both techniques and facilities for field application of such a programme have to be standardized. The *in vitro* genebank established for medium and long term storage of germplasm should be enlarged adequately to store the additional collections.

In crop improvement research, varieties evolved have qualitative traits distributed widely in them. In turmeric (Table 2) it appears that the breeding objectives had not been defined quantitatively so that a variety when released meets the minimum standard fixed for each character. While Suguna (PCT-13), with its short duration is highly suited for oleoresin industry, Prabha and Prothibha with top yields are good for drying. Interestingly these two varieties are obtained by open pollinated progeny selection. The potential for evolving high yielding lines with superior quality traits through hybridization in vegetatively propagated spices should receive priority attention. The varieties to be released should also be concurrently tested for their resistance / tolerance to pests, drought, quality and responsiveness to nutrient inputs and other management conditions.

Among the different spice crops, black pepper, cardamoms and ginger are suscep-

Table 2. Some improved varieties of turmeric and their salient features

Name	Pedigree	Average yield (fresh, t ha^{-1})	Duration (Days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%)	Essential oil (%)	Remarks
Co.1	Mutant of Erode local	30.5	285	19.5	3.2	6.7	3.7	Tolerant to drought
Krishna	Clonal slection	9.2	240	16.4	2.8	3.8	2.0	Tolerant to major pests
Sugandham	Germplasm selection	15.0	210	23.3	3.1	11.0	2.7	Tolerant to pests
BSR-1	Mutant of Erode local	30.7	285	20.5	4.2	4.0	3.7	Suitable for drought prone areas and problem soils of Tamil Nadu
Suvarna (PCT-8)	Germplasm selection	17.4	200	20.0	4.3*	13.5	7.0	
Suguna (PCT-13)	Germplasm selection	29.3	190	12.0	7.3*	13.5	6.0	
Sudarsana (PCT-14)	Germplasm selection	28.8	190	12.0	5.3*	15.0	7.0	
IISR Prabha	Open pollinated progeny selection	37.5	205	19.5	6.52	15.0	6.5	High curcumin ha^{-1}
IISR Prothibha	Open pollinated progeny selection	39.12	225	18.5	6.21	16.2	6.2	"

* provisional

tible to devastating diseases such as slow and quick wilt, *Kotte* disease, *Chirkey* and *Foorkey* and soft rot. In breeding for resistance to these crops ,intensive search in endemic areas of disease incidence under diverse situations to locate the healthy plants can yield useful results. The tolerance to root (wilt) disease observed in the native population of West Coast Tall indicates the potential of such an approach in resistance breeding. In the allied species of these crops resistance has been recorded for the above diseases. An all out effort should be mounted to transfer these genes to the background of the released high yielding varieties having the maximum qualitative traits, adopting conventional and biotechnological tools. These efforts should be supplemented with induction of variability through somaclones. The crop improvement programmes should be inter-disciplinary in nature involving breeders, biotechnologists, agronomists, entomologists, pathologists, physiologists and biochemists. It is imperative that breeding objectives are defined in advance with the minimum standards fixed for the more important parameters.

2. Crop production

Availability of quality planting material in adequate quantities continues to be a major constraint in spice production. In addition to the genetic quality of the crop, there are a host of other factors that determine the successful establishment and performance of the crop in the field. In black pepper, nematode and *Phytophthora* infestation adversely affect the establishment of the rooted cuttings and increase the incidence of slow and quick wilt. Rhizome rot of cardamom caused by *Pythium vexans* and *Rhizoctonia solani* gets aggravated when cardamom roots are damaged by the nematode, *Meloidogyne incognito*. In the absence of stringent sanitary conditions and effective control measures to totally eliminate the pathogenic fauna from the nursery, the distribution of pests and diseases through planting material is taking place leading to affect the production of the crops, adversely.

The role of the VAM fungi in enhancing the growth of rooted pepper cuttings in the nursery, their role in suppressing nematodes of pepper and cardamom, and control of diseases caused by *Phytopthora*, *Pythium* and *Rhizoctonia* by antagonistic fungi such as *Trichoderma* Spp. and *Gliocladium* Spp. have been reported. Information on the environment of the nursery medium and that of field for the fast multiplication and growth of the antagonist fungi is minimal. Detailed studies in this area to understand the dynamics of pathogenic forms, their interaction among themselves and with antagonistic species to develop a package for nursery management and production of healthy planting material and a working arrangement with concerned development agencies for nursery certification and quality check are of urgent importance and need immediate attention. In ginger, infection by *Pythium* causes soft rot both in storage and in the field. Development of a system of production, of healthy planting material of ginger and its storage under a suitable environment supplemented with favorable organisms needs priority attention.

Spices in general are cultivated in cropping systems involving diverse crops. Reducing the cost of production with sustainable high yield has the greatest relevance at all times. A system approach offers considerable scope for achieving this objective. However, research efforts in this area have been meagre. A clear analysis of the dynamics of the existing systems in areas of soil health, soil moisture, microbial load, their antagonistic and synergestic interactions, fate of applied nutrients, solar radiation profile etc. would open up new vistas for intervention to make the system self-generating and cost effective. Microlevel manipulation in water harvesting, soil conservation, organic matter generation and recycling, supplementing with favourable micro-organisms after providing the environment for their rapid multiplication and regulation of the population density of the system would substantially improve the productivity. Well planned interdisciplinary studies are called for in this vital area.

Since the number of variables in the spice production systems are large, it will be rather difficult to arrive at optimum levels or variables to make an efficient working system. Scope exists for the development of computer aided alternative models through extrapolation. Studies to generate data with this objective should prove highly useful.

Quality standards in the spice importing countries are being made more and more stringent. Of late, there is also a demand for organically produced spices. This scenario calls for a fresh look of the ongoing spice production techniques. The sources which, supply nutrients and the product that provide protection to the crop have to be so chosen that they meet the standards fixed by the importing countries. Also, little or no information is on hand about the influence of different nutrients from different sources on the quantity and quality of active principles in different spices. Development of an Integrated Pest and Nutrient Management System (IPNMS) with data on the effect of the same on quality is the answer for this.

The high production technologies (HPT) developed for black pepper and cardamom included phytosanitary measures for management of the disease, rejuvination of the gardens by planting high yielding varieties, integrated plant nutrient as well as pests and disease management and adoption of appropriate cultural practices. Adoption of HPT in pepper and cardamom increased the yield considerably over conventional systems (Tables 3 & 4).

Further studies to capitalize on this research results are urgently called for. The studies should cover the relative role of each of the inputs in enhancing the yield gaps in the presently developed HPT technology such as shade and population density regulation, ensuring a sustainable organic matter base, and fortifying the system with favorable isolates of VAM fungi like *Glomus fasiculatum*, *Acaulospora leavis* Ram and *Gigaspora margarita* which are suppressive to nematodes of pepper and cardamom, other antagonistic fungi such as *Trichoderma* Spp. and *Gliocladium* Spp. which have been observed to control the diseases caused by *Phytophthora*, *Pythium* and *Rhizoctonia* and native strains of earth worms. A data based

Table 3. Adoption of HPT in black pepper

Technology	Peruvannamuzhi	Puthupaddy
Conventional	0.400	0.487
HPT	1.085	1.678
% increase	171	244

Values indicate yield (kg vine^{-1})

Table 4. Adoption of HPT in cardamom

Technology	Bhagamandala	Madikeri	Somawarpet	Yeslur
Conventional	32.50	73.55	80.00	66.80
High Production Technology	455	475	530	518
Per cent increase	1300	546	563	675

Values indicate yield (kg ha^{-1})

package would make this lead in research sustainable.

The type of experimentation and interpretation of results in cropping system research involving perennials needs looking into from the point of methodologies and techniques designed for the purpose.

3. Plant protection

Occurrence of the following diseases is the major production constraint in spices. (Table.5)

Work done so far has enabled isolation of a number of biological agents from the rhizosphere soils, which are antagonistic to the above pathogens. Search for more virulent strains having antaganism with larger number of pathogens is to be intensified. Since the effectiveness of such biological agents are influenced by the environment and nutrients, studies in this direction will be highly rewarding. What is needed is a well-planned investigation to isolate virulent strains of antagonistic flora and fauna, study their interactions at various levels and work out the environmental conditions that favor their growth and effectiveness in the control of disease causing pathogens. This study should also cover the component crops of the system and their reaction to the disease causing pathogens. The report that Glyricidia is tolerant to nematode and its leaves suppress nematode growth indicates the role which the component crops can play in the disease control.

Table 5. Major soil borne diseases of spices

Crop	Disease	Causal agents
Black pepper	Foot rot (Quick wilt)	*Phytophthora capsici*
	Slow decline	*Radopholus similis*
		Meloidogyne incognita
Cardamom	Damping off	*Pythium* Spp.
	Rhizome rot	*P. vexans*
		Rhizoctonia solani
Ginger	Rhizome rot	*Pythium aphanidermatum*
		P. myriotylum
	Ginger yellowing	*Fusarium* Spp.

In spice production programmes, the role of varieties resistant to pests and diseases have the greatest relevance in view of the present day challenges that the industry has to face in reducing the cost of production and keeping up to the quality standards fixed by the importing countries. Innovative screening techniques including biochemical tests to suit field conditions, so as to cover larger populations should receive special attention. The available results indicate that there is considerable variability in nature for disease resistance and this could be augmented by induced variability through somaclones. What is needed is intensive efforts to exploit this for practical ends.

4. Post harvest processing

About 80% of the volume of spices is traded in whole unground form. Consumer packed spice enters global trade in small quantities only from the producing countries. There is considerable scope for value addition in this area. Little or no research has been done in the quality standards of the spices used for packaging, their shelf life, type and size of packages to meet the demand in different consuming countries. The quality parameters should include the very cleanliness and appearance of the product, hygienic standards like bacteria and fungal loads, moisture content, presence of toxic biological products like aflatoxin, pesticide residues and active principle of the spice concerned. In packaging, the gas used, and the appearance of the packet are important factors worth giving research attention. The packet should exhibit data on the above, which should meet the standards fixed by the importing countries. Such an effort would give India an edge over many others and help to strengthen the good will that the country has in spice production and trade.

Yet another area needing research attention is the processing of spices for obtaining value added products at farm level. As at present, oleoresin industry, which indeed requires technical skill and sophisticated equipments, is in the hands of a few entrepreneurs, thus totally debarring the farmers from getting any share of the profit obtained from processing. Research is needed to develop techniques for on-farm processing of the spices to extract the active principles on crude basis adopting standards acceptable to the final processors for sale internationally. Such a system will reduce the cost of transporting the raw materials from producing areas to the processing factories.

5. Transfer of technology

Researches conducted on production, protection and processing of spices have yielded wide range of results of practical utility. However, the outflow of these results to the farmers' fields and their adoption to achieve a quantum jump in the production has not taken place so far. While this is the joint responsibility of the researchers and extension agencies the problem needs urgent study for finding solutions. A variety of extension methods are commonly used in technology dissemination programmes to help farmers form opinions and make management decisions. Individual and face-to-face group extension methods still hold priority in less developed countries as they offer more opportunities for closer clientele interaction and feed back. However, in the present era of electronic media, live messages based on success stories and demonstrations in farmers' fields, coupled with understandable experimental information and cost effectiveness may attract the farmers to adopt the technologies. The concerned scientists should study the problem along with social scientists and extension specialists giving leadership.

In conclusion, it is important that the scientific community involved in spice research keeps in mind the ever increasing challenges before them and plan studies with broad base and vision taking cognizance of the major challenges, the contributing factors and interactions and find adaptable and economically viable solutions, working as a well knit interdisciplinary team. In final analysis, increased per unit area production with low levels of applied inputs combined with quality and sustainability on one hand and on-farm value addition on the other, in each crop have to be achieved.

ಹುಳಗೋಳ ಸೇವಾ ಸಹಕಾರ ಸಂಘ ನಿಯಮಿತ, ಭೈರುಂಬೆ

ತಾ: ಶಿರಸಿ (ಉ.ಕ.)

ಫೋನ್ : 79343, 79344

ದಿನಾಂಕ: 31-03-2001 ಕ್ಕೆ ಇದ್ದಂತೆ ಸಂಘದ ಸಾಂಪತ್ತಿಕ ಸ್ಥಿತಿ (ರಕಂ ಲಕ್ಷ ರೂ.ಗಳಲ್ಲಿ)

ಸ್ವಂತ ಭಾಂಡವಲು	122.36
ದುಡಿಯುವ ಭಾಂಡವಲು	930.71
ವ್ಯವಹಾರ	3965.53
ಠೇವುಗಳು	598.82
ಹುಟ್ಟುವಳಿ ಮಾರಾಟ	520.79

1. ಸದಸ್ಯರಿಗೆ ಅವಶ್ಯಕ ಸಾಲ, ಜೀವನಾವಶ್ಯಕ ವಸ್ತು ಹಾಗೂ ಇನ್ನಿತರ ಯಾವತ್ತೂ ಅವಶ್ಯಕತೆಗಳ ಪೂರೈಕೆ.
2. ಆಕರ್ಷಕ ಬಡ್ಡಿ ದರದಲ್ಲಿ ವಿಧವಿಧದ ಠೇವುಗಳ ಸಂಗ್ರಹಣೆ.
3. ಸಾಗಾಟಿಕ್ಕೆ ಮೋಟಾರು, ಟ್ರ್ಯಾಕ್ಟರ್ ವ್ಯವಸ್ಥೆ.
4. ಬಂಗಾರ, ಬೆಳ್ಳಿ ದಾಗೀನೆಗಳ ಮೇಲೆ ಹೆಚ್ಚಿನ ಪ್ರಮಾಣದಲ್ಲಿ ದಾಗೀನು ಸಾಲ ಪೂರೈಕೆ.
5. ಅವಲಕ್ಕಿ, ಹಿಟ್ಟು, ಎಣ್ಣೆ ಗಿರಣಿಗಳ ವ್ಯವಸ್ಥೆ ಹಾಗೂ ಡ್ರೈಯರ್ ಸೌಲಭ್ಯ.
6. ಸೇಫ್ ಡಿಪಾಜಿಟ್ ಲಾಕರ್ ವ್ಯವಸ್ಥೆ.

ಶ್ರೀ ಎಂ.ಆರ್. ಹೆಗಡೆ
ಮುಖ್ಯ ಕಾರ್ಯನಿರ್ವಾಹಕ

ಶ್ರೀ ವಿ.ಎಸ್. ಹೆಗಡೆ
ಅಧ್ಯಕ್ಷರು

CHILLI RESEARCH IN INDIA

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Chilli is an important spice cum vegetable crop of commercial importance in India. India leads in area (0.9 million ha.) and production (0.9 million tons) of dry chilli (Table 1). Andhra Pradesh ranks first in area and production of chilli in the country. A major consumer of chilli, India exports only 5% of the produce mainly to USA, UK, Russia, Canada, Italy, Netherlands, Singapore, Saudi Arabia, UAE, Israel, Japan and West Germany in the form of dry pod, chilli powder and oleoresin. Average yield of chilli in India is low (1t ha^{-1}), as compared to 3-4 t ha^{-1} in the USA, South Korea and Taiwan. Main reasons for low yield are low coverage of high yielding varieties/hybrids, heavy incidence of pests and diseases and lack of adoption of scientific package of practice in cultivation. Only 2.6% of chilli area is under hybrids in India while in South Korea and Taiwan more than 90% of area is under hybrid varieties. However, among the chilli growing Indian states, Andhra Pradesh and Punjab ranks top in average yield with about 1.5 to 1.8 t ha^{-1}.

Table 1. Area and production of chilli in India

Year	Area ('000 ha)	Production ('000 tons)	Yield t ha^{-1}
1990-91	816.2	719.0	0.881
1991-92	846.3	617.5	0.730
1992-93	962.1	862.1	0.896
1993-94	930.0	800.1	0.860
1994-95	829.2	794.7	0.958
1995-96	883.7	809.7	0.916
1996-97	956.5	945.5	0.988
1997-98	840.6	870.1	0.104
1998-99	892.2	921.33	0.103

Source: Directorate of economics and statistics, MOA, New Delhi

Uses

Fruits are consumed fresh, dried or processed as vegetable or spice. Colour extracted from fruit is extensively used in food, pharmaceutical preparations and cattle feed industry. Destalked chilli hybrids are being developed to avoid manual removal of fruit stalks for bulk chilli export. Aflatoxin free chillies have much demand in export sector.

Cultivated species of *Capsicum*

The genus *Capsicum* consists of 22 wild and five cultivated species viz. *C. annuum, C. baccatum, C. chinense, C. frutescens* and *C. pubescens* (Table 2).

Most of the chilli cultivars commercially grown world wide belong to species *C. annuum.* This is a highly variable species in terms of morphological characters. Plants are herbs or shrubs, erect, 0.5 – 1.5m tall, highly branched and bear fruits which are highly variable in size, shape, colour and degree of pungency.

Germplasm collection, evaluation, utilization and varieties

Chilli improvement projects are in progress at many Agricultural Universities and ICAR institutes. The major germplasm maintenance centres are given in Table 3. National Bureau of Plant Genetic Resources (NBPGR), New Delhi has the major responsibility for collection of chilli germplasm. Satellite centre of NBPGR at Amaravathi carries out evaluation and characterization of hot pepper germplasm.

Few cultivated species other than *C. annuum* are identified as resistant/tolerant sources against biotic stresses (Table 4.) and are being crossed with *C. annuum* to develop resistant varieties against biotic stresses.

In chilli, several varieties are still popular such as NB-34, NP-46 A, NP-51, Pusa Red, Kalyanpur Red, Pant C1, Pant C2, G-3, G-4 and G-5(Selection); Pusa Jwala, Arka Lohit, LCA-235, Pant C-5, CH-1(F1), LCA-218, Jwalasakhi, Jwalamukhi (hybrids) which were developed through selection from indigenous

Table 2. Cultivated species of Capsicum and their distribution

Species	Distribution
Capsicum annuum L. (syn. C. purpureum, C. grossum, C. cerasiformae	Colombia to Southern U.S.A. and throughout Latin America, Asia
C. baccatum (syn. *C. Pendulam, C. microcarpum , C. angulosum*)	Argentina, Bolivia, Brazil, Colombia, Equador, Paraguay, Peru
C. frutescens L (*syn. C. minimum)*	Coloumia, Costa Rica, Guatemala, Mexico, Puertorica, Venizuela
C. chinense Jacq. *(syn.C. luteum, C. umblicatum, C. sinense)*	Bolivia to Brazil, Costa Rica, Mexico, Nicaragua, West Iindies
C. pubescens R *and* P	Bolvia to Brazil, Costa Rica, Guatemala, Honduras, Mexico.

Table 3. Germplasm collection in chilli at various Research Institutes/State Agricultural Universities other than NBPGR*

Centre	Type of material
Indian Institute of Horticultural Research, Bangalore	Local land races, advanced lines, released varieties, male sterile lines
Indian Institute of Vegetable Research, Varanasi	Land races, advanced lines, released varieties (all *C. annuum*) commercial exotic cultivars. *(C. chinense)* male sterile lines (both genetic and CMS), special collection of land races of pickle type chilli.
Regional Research Station , Acharya N.G. Ranga Agril. Univ., Lam	Land races, commercial exotic cultivars, released and indigenous varieties
Punjab Agricultural University, Ludhiana	Released varieties, advanced lines, male sterile lines
University of Agril. Sciences, Dharwad	Land races of Karnataka, released varieties, advanced lines
C. S. Azad Agril. Univ.& Tech., Kanpur	Land races, released varieties, advanced lines

* Maintained as active collection:

Table 4. Resistant/tolerant sources against biotic stresses in *Capsicum*

C.baccatum	Anthracnose, *Phytophthora* rot and Cucumber Mosaic Virus
C. chinense	Anthracnose, Leaf curl virus, Tomato mosaic Virus and *Verticillium* wilt
C. frutescens	Leaf Curl Virus

collections for desirable attributes, in addition to varieties released through All India Coordinated Vegetable Improvement Project (Table.5).

At several Research Institutes, male sterile plants are identified. Both genetic and cytoplasmic genetic male sterility are introduced. Using these sources, male sterility systems are developed in the background of well adapted genotypes at Punjab Agricultural University (PAU), Ludhiana, Indian Institute of Horticultural Research, Bangalore and at Indian Institute of Vegetable Research (IIVR), Varanasi (U.P). One such popular male sterile line is MS-12 in the background of Punjab Lal variety developed at Punjab Agricultural University, Ludhiana from the material introduced from France. At Indian Institute of Vegetable

Table 5. Chilli varieties released through All India Coordinated Vegetable Improvement Project

Varietiy	Source	Suitable zones	Productivity	Remarks
Andhra Jyothi	Lam	1,4,5, 6,7,8	4-6	Stout fruits, high seeded, pungent, glossy red pericarp
Bhagyalakshmi	Lam	1	1.6 – 45 (dry)	Fruit length 8.2 cm:width 0.7 cm
K2	Kovil patti	1,5,6	3.1 (dry)	Fruit pendulous length 6.1 cm, girth 4 cm, bright scarlet red fruits, tolerance to thrips
J 218	Jabalpur	6	6.5 (dry)	Plant dwarf, fruits long (10-11 cm), 3 cm girth
Musalwadi	Rahuri	1,3	1.93 (dry)	Average plant height 52-83 cm, fruit length 6.83 cm, width 0.95 cm.
X 235	Lam	6,7	3.7 (dry)	Highly suitable for pickles and export

Zone: 1. Humid Western Himalayan Region. 2. Humid Bengal Assam Basin 3. Humid Eastern Himalayan Zone and Bay Islands 4. Subhumid Sutlej – Ganga Alluvial plains 5. Subhumid to humid Eastern and South Eastern Uplands 6l . Arid Western plains 7. Semi Arid Lava Plateau and Central Highlands 8. Humid to semi-arid Western Ghats and Karnataka plateau

Research, further characterization of this line along with a CMS line introduced from AVRDC (Asian Vegetable Research and Development Centre), Taiwan is in progress. Screening of germplasm for heat tolerance is an urgent need to fulfil the demand of South Asian farmers for growing off season chilli at a relatively high temperature. In addition to public sector institutes private companies are also involved in chilli research and improvement. (Table 6).

Table 6. Hybrids in chilli developed by private sector companies

Company	Hybrid
Ankur	ARCH 006, ARCH 228, ARCH 236
Haechst	HOE 888, HOE 808, HOE 818
Novartis	SHPH –54, SHPH - 35, SHPH – 47, Picador
Namdhari	NS 1701, NS 101, NS 1420, NS 1101
Nath	NATH 70, NATH 120
Sungrow	Sungrow No. 16, Sungrow 86235
Bejco	BSS 138, BSS 141, BSS 273
Korean Hybrid	Kiran, Surya
Indo American	No.5
Pro-agro	PROH 01, PROH 02
Century	Hybrid 3, Hybrid 4
Semis	Guntur Hope Picobello
Mahyco	MPH 5, MPH 58, MPH 59, MPH-1
Zuari Agro	ZCH-2
Nagarjuna	NARDI - 712

Agrotechniques developed

General agronomic practies were formulated for the crop (Table 7). Fertilizer recommendations are proposed for each chilli growing states (Table 8). Problems of flower fall and low fruit set during summer are managed through application of Naphthalene Acetic Acid (NAA) (15 ppm) sprayed 30,45 and 60 days after transplanting.

Management of pests and diseases

Chilli is affected by a large number of fungal, bacterial, viral and complex diseases (Table 9) in addition to a number of sucking insects. The Indian Institute of Vegetable Research, Varanasi formulated a set of recommendations to manage pests and diseases (Table 10). The chilli varieties Manjari and Ujwala developed by the Kerala Agricultural University, Vellanikkara are highly resis-

Table 7. Agronomic practices recommended for chilli

Variety	Centre	Type of cultural practice	Recommendation
Pant C_1	Faizabad	Fertilizer	120-150 kg N ha^{-1}. Split into 60 kg basal and rest in 2-3 equal quantities
Local	Coimbatore	Fertilizer	100 kg N ha^{-1} split into 50 kg basal and 50kg top dressing 30 days after planting.
Pant C_1	Faizabad	Fertilizer	Application of 90kg N ha^{-1} along with basal doses of 60 kg P_2O_5 and 40 kg K_2O ha^{-1}

Table 8. Fertilizer recommendation of chilli in different states

Zone	State	M	P_2O_5	K_2O
Northern India	Haryana	60	30	30
	Himachal Pradesh	75	75	50
	Punjab	62	30	30
	Uttar Pradesh	80-100	40-60	40-60
Southern India	Andhra Pradesh	60-160	30-90	60-75
	Karnataka	150	75	75
	Kerala	75	40	25
	Tamil Nadu	75	35	35
Eastern India	Assam	70	40	60
	Bihar	140	80	90
	Orissa	110	70	75
Western India	Madhya Pradesh	150	60	40
	Maharashtra	60-150	30-60	50
	Rajasthan	70	48	50

tant to bacterial wilt caused by *Ralstonia solanacearum.*

Seed production

Chilli is an often cross pollinated crop. Cross pollination to an extent of 78% is reported. Isolation distance of 250-400 m is suggested to get pure seeds.

Hybrid chilli seed production is yet to take root in differet states of India. At present, Punjab is the only state where maximum efforts are being made in this line. Training is imparted to the local farmers every year by May at Punjab Agricultural University, Ludhiana. Parental materials of chillies and technical knowhow are provided to the farmers. In addition, State Governments are encouraging farmers in hybrid vegetable production by giving an incentive of Rs. 2500 ha^{-1}. Average yield of chilli can be boosted in Karnataka, Orissa, Maharashtra, Tamil Nadu, U.P. and West Bengal by bringing more area under hybrid chilli.

Marketing of chilli

Marketing chilli is as important as production. Major chilli marketing centers in India are in Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu (Table 11).

There are three major regions for export of chilli such as (1) WANA region (West Asia and North Africa) (2) Commonwealth of Russia and other E.E countries (3) Western Europe, USA,

Table 9. Diseases of chilli

Complex disease	Causative organism
Pepper virus complex	Two strains of TEV, a common strain of Potato virus Y and Pepper virus
Leaf curl complex	Tobacco leaf mottle curl virus, Pepper mottle virus, mites, thrips and aphids
Rapid decline	*Fusarium oxysporum , Fusarium vasinfectum, Phytophthora capsici – Fusarium equiseti* and *Rhizoctonia solani*
Mosaic complex	Potato virus Y., Potato virus X, TMV, CMV, Chilli mosaic virus, TEV, Alpha alpha mosaic virus
Moria disease	Lack of crop rotation, accumulation of organic matter, high soil temperature and several fungi.
Fungal disease	
Verticillium wilt	*Verticillium albo atrum*
Fusarium wilt	*Fusarium annuum*
Leaf spot	*Cercospora capsici*
Ripe rot	*Colletotrichum capsici*
Bacterial disease	
Soft rot	*Erwinia carotovora*
Leaf spot	*Xanthomonas vesicatoria*
Wilt	*Ralstonia solanacearum*

Table 10. Pest control measure in chilli

Variety	Pest/diseases	Control measure
G-4	Pod borer	Cypermethrin (0.1kg a.i.ha^{-1}) 3 sprays fortnightly
G-5	Pest complex (Pod borer, mites, thrips and aphids)	Cholrpyriphos (0.5kg a.i.ha^{-1}.) spray at 15 days interval
Sindhur	Fruit rot	Dithane M 45 (0.25%) 2-3 sprays during fruiting stage.
Pusa Jwala	Dieback and fruit rot	Seed treatment with ceresan wet (0.1%) + four sprays of Bavistin (0.05%).
Pusa Jwala	Fruit rot, powdery mildew and thrips	Three sprays at 15 days interval with combina tion of Dithane M 45, Karathane (0.1%) and Metasystox (0.1%).
Local	Diseases and pest complex, (fruit rot, dieback, thrips, mites)	Practice spray schedule of Dithane M45 (0.3%) alternated with monacrotaphos
Pusa Jwala	Bacterial leaf spot and fruit rot, Pod borer	Practice spray of Agrimycin 100 ppm + Blitox (0.36%) during rainy season, 3 sprays in October + Dithone M45 (0.25%) at 15 days in terval from last week of November- January

Table 11. Major chilli marketing centers in India

State	Centres
Maharashtra	Nasik, Ahmed Nagar, Shalapur, Aurangabad, Lasalgaon
Karnataka	Dharward, Mysore, Hassan, Bangalore, Bellary, Ranibennur, Hubli, Byadagi.
Tamil Nadu	Pollachi, Ramanad, Madurai, Trichi, Theni, Dindigul, Virudunagar, Sattur

Canada, Japan and Australia. The WANA region is a potential area. Paprika has high export potential. Though several areas in India are suitable for paprika production, we have to either import non pungent paprika varieties or develop varieties of our own. Tomato chilli is suitable for production of paprika oleoresin when compared to Zimbabwe variety.

Value addition

Chilli is valued for its pungency and colour. The pungent forms are used as spice. These are used as whole dry chilli, chilli powder, chilli paste, chilli sauce, chilli oleoresin or as mixed curry powder. Fruits with deep red colour without pungency are used as paprika. The trade and use of paprika in powder form are increasing rapidly. Besides, paprika oleoresin, a value added product is in great demand at international level. Cultivation of paprika is almost negligible in India. The *'Byadagi Dabbi'* cultivated in Dharwad district of Karnataka and the Tomato chilli grown in Warangal in Andhra Pradesh are similar to the paprikas. They are being used for production of paprika olearesin. Only a very little quantity is available for oleoresin industry. It is necessary to increase their production to meet the requirement of Indian paprika industry.

Byadogi and Tomato chilli are suitable for production of paprika and oleoresin. But their post harvest handling needs to be geared to preserve the maximum amount of colour. Since paprika is a new spice crop, unless a system of contract farming or a guarantee market of reasonable prices are offered or a co-operative system to cell the produce with reasonable returns are available, it is not likely that farmer will come forward to cultivate paprika. The Spices Board of India is engaged on devising a suitable mechanism to capitalize the export potential of paprika.

MUSINGS OF A SPICES RESEARCH EXPERT *

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Prologue

20 May 1498! This day perhaps changed the history of India primarily due to the landing in of Vasco da Gama at *Kappad near Kozhikode (Calicut) in search of Indian* Spices. The dialogue with the Zamorins of Calicut ultimately led to not only a brilliant trade on black pepper and other spices but also paved the way for the influx of the foreigners especially from Europe. As a result, this country became a part of the British colony and remained so for nearly 3 centuries! History apart, the fame and fortune of the Indian Spices *were known to the world over even 3000 years ago, going* by the records of Egyptian mummies preserving in black pepper in large volumes. Nevertheless, India enjoys the rightful place even today amongst the spice consuming countries. It is stated that nearly 130-140 countries around the world import spices of Indian origin either directly or indirectly. Needless to say that the intrinsic value and character of our spices and the spice-mix have attracted people from various civilizations.

India, the home of spices, is the largest producer, exporter and consumer of this inevitable ingredient in any cuisine. We do grow over 60 out of the 107 recorded spices in the world, prominent among them being black pepper, cardamom (small & large), ginger, turmeric, seed spices like cumin, coriander, fennel, fenugreek, aniseed, dill & celery, tree spices like clove, nutmeg, cinnamon & kokam, rare species like saffron, rosemary, star anise, bay leaf, thyme, etc. notwithstanding an omnipresent chill. India has been holding almost a virtual monopoly contributing to 30-35% of world trade on spices by volume and at least 20% by value. The 2.8 million of spices produced from approximately 2.5 million ha entails in a valuable saving/income of foreign exchange of Rs.2000 crore during 2000-2001. There is

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a very strong spice industry and a few export houses with modernized facilities that compete in the world trade.

In retrospect

Since the production or extraction of spices has been just like extraction of minor forest produce, there was very scanty attention from the organized sectors to increase their productivity, nay understand their biology, technological inputs or processing and the export sector. Since independence, during 1949 the erstwhile Madras Province initiated a humble research activity at Panniyur and Ambalavayal in Malabar Region (presently in Kerala) on black pepper, ginger, etc. Over the years, the research schemes were conducted in Khandaghat (Himachal Pradesh), Fulia (West Bengal), Tasgaon (Maharashtra), Bijapur/Jagudan (Gujarat), Dergaon (Assam), Kallar – Burliar (Tamil Nadu) and Pottangi (Orissa). All these scattered efforts could not make much of an impact and hence there was a need for initiating an organized research network. It was in 1971 that the ICAR initiated the All India Coordinated Research Project on Spices and Cashew with a dozen centres, spread out in the major spices growing states *viz.* Kerala, Karnataka, Gujarat, Himachal Pradesh and Orissa. Over the years, this Coordinated Project assumed greater significance and the Government of India supported expansion and intensification of research by opening new research centres under the State Agricultural Universities. By the end of 8th Plan (1997), we have nearly 20 full fledged research centres and 8 voluntary research centres with a staff of nearly 100 scientists to take care of the programmes almost on a war footing. The regular conduct of the annual / biannual research workshops / group meetings could deliver a veritable output for the benefit of the spice growers throughout the country. Thus this project has now its jurisdiction in almost 15 States of the country and operates through the various State Agricultural/Horticultural Universities. The North Eastern Region is being taken care by the ICAR Research Complex with its appendages located in all the 7 states with self contained research programmes.

A very distinct and major step on emboldening the comprehensive spice research in the country was taken up during 1975 by establishing the Regional Station of Central Plantation Crops Research Institute to work exclusively on spices and the same is blissfully and rightfully located in

Calicut, the very place where the Portuguese sailor landed five centuries ago. This Regional Station was later upgraded into the National Research Centre for Spices in 1986 to provide undivided and independent attention on spices research, thus delinking it from the plantation crops research. Not satisfied with these arrangements, the Planning Commission decided to further upgrade the status of the Research Centre to that of an Indian Institute of Spices Research in 1996. Another significant step has been the opening of a separate National Research Centre for Seed Spices in 2000 in Ajmer, Rajasthan for R & D activities of seed spices exclusively. The Ministry of Commerce also started a Research Institute for Cardomam in 1976 in Idukki District in Kerala. The studies of technological, post harvest and processing aspects of the various spices have been concentrated at the Central Food Technological Research Institute, Mysore and the Regional Research Laboratory at Trivandrum. Quality being the watch word, the above two Institutions have done a yeomen service for a better understanding of these aspects and help develop a surging export market for Indian spices.

Research output

Over the years, several leads have been made in enabling an excellent technology transfer due to the following achievements:

* Development of nearly 70 varieties of various spices – hardly a dozen were available two decades ago. A comprehensive list of improved varieties of spices is provided in Table 1.
* Development of a mechanism to produce and distribute quality planting materials on a large scale since the Seventh Plan.
* Integrated management techni- ques (including biocontrol) for major pests and diseases of spices.
* Quality assurance and upgradation to meet the stringent needs of importing countries.

In prospect

Despite the significant strides made on various achievements, there are gaps, which deserve our attention both in the research and development fronts. It is our resolve to find that the research results fit into cropping systems, judicious use of available resources like water,

Table 1. Improved varieties of spices

Crop	Variety
Black pepper	Panniyur – 1, Panniyur – 2, Panniyur – 3, Panniyur – 4, Panniyur – 5, Panniyur - 6, Panniyur - 7, Subhakara, Sreekara, Panchami, Pournami, PLD –2.
Cardamom	Mudigere –1, Mudigere – 2, PV –1, CCS –1, ICRI –1, ICRI – 2, ICRI –3, ICRI – 4, RR-I, Nnjallani green gold, Elarani-I, Elarani-II
Ginger	Suprabha, Suruchi, Surabhi, Himgiri, IISR Varada.
Turmeric	Co-1, Krishna, Sugandham, BSR-1, BSR-2, Roma, Surama, Ranga, Rashmi, Rajendra, Sonia, Suvarana, Suguna, Sudarshana, IISR Prabha, IISR Prathiba, Kanthi, Sobha, Megha turmeric.
Coriander	Co-1, Co-2, Co-3, CS-287, Guj. Coriander-1, Guj. Coriander-2, Rajendra Swati, RCr-41 Sadhana, Swathi, Sindhu, RCr-20, Hisar Anand (Pant Dhania).
Cumin	S-404, MC-43, Guj.Cumin-1, Guj.Cumin-2, RZ-19
Fennel	S-7-9, PF-335, Guj. Fennel-1, Co-1, Guj. Fennel-2.
Fenugreek	Co-1, Rajendra Kanti, Rmt-1, Lam Sel.1, Hisar Sonali, Pusa Early Bunching
Cinnamom	Nithyasree, Navasree, YCD-1, Konkan Tej.

utilization of fallow and waste (d) lands, measures to overcome temperature limitation to grow plantation spices in areas with less than 10°C and crossing 40°C, captive area cultivation eg. bird eye chilli, high curcumin turmeric, assured market etc. may be easy to mention but difficult to achieve. A few more thoughts are listed below which deserve attention of the R & D efforts:

* Lack of adequate varieties – we have just 75 varieties so far released on all the spices.
* Inadequate infrastructure and refinement in ultimate techniques in production of quality (disease free) planting material and the delivery system.
* Production technology packages to be user-friendly – like Panniyur 7 released but still Panniyur-1 is popular & in great demand. Sreekara & Subhakara varieties from Karimunda selections are shy in adoption rate.
* Emphasis on quality assurance, upgradation, fixation of premium price for organic spice. Payment as per quality parameters.
* Integrated pest and dis-

ease management methods and use of low cost, biocontrol measures especially for dreaded problems like *Phytophthora* foot rot in black pepper, rhizome rot in ginger and turmeric, Azhukal and Katte in small Cardamom, mildews, wilts and root rots in seed spices.

* Proper post harvest handling technologies both in farm-front, transit and storage in wait-in godown price for export.
* Study tours, and HRD of spice research scientists similar to the mega-process followed in the commercial sectors.
* Exposure to production technologies on spices in countries like Malaysia, Indonesia, Vietnam, China, Brazil & Guatemala.
* Special R &D programmes for exploring potentialities in North East and A & N Islands
* Search for medicinal values of spices.
* Market intelligence and forecast & impact of crop produce predictions.
* Market driven production and buy back guarantee system.

Epilogue

The strategic advantage of India in the SAARC Region with its imminent potential for improving spices trade with the neighbors, healthy global competition with other spice producing countries like Malaysia, Brazil, Vietnam and Guatemala, by tactfully adjusting stock, carry over stock, pre-harvest bidding and on intelligent forex debate could make India a strong spice exporting nation and regain its glory as the World's leader not only in spice production but also in exports.

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES-ACHIEVEMENTS AND VISIONS

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India, rightfully designated as the 'Home of Spices', cultivates about 63 spices. India is the centre of origin and diversity for important spices such as black pepper, cardamoms (small and large) and possibly for ginger and turmeric. Among these spices a dozen spices are more important in terms of area and production as well as export value. The prominent states growing the major spices viz. black pepper, cardamom, ginger and turmeric have been primarily in the Southern belt of Kerala, Karnataka, Andhra Pradesh and Tamil Nadu besides certain pockets in Orissa, Chattisgarh, Bihar and North East Region. Another group of spices viz. the seed spices or grain spices such as cumin, coriander, fennel, fenugreek, celery, dill, aniseed, bishops weed and poppy seed are grown in Rajasthan, Gujarat, Andhra Pradesh, Chattisgarh, Tamil Nadu, Punjab, Bihar, Karnataka, Uttar Pradesh, West Bengal and Orissa. They form a very important component of the cropping system in North India. The climate requirements of these crops are also suiting the arid and semiarid tracts in the country.

India produces about 2.6 million tons of spices annually, valued at amount Rs. 33,000 crore from 2.5 million ha. India has a pre-eminent position in the production of spices in the world and accounts for about 30% of the global trade. The domestic demand of spices is also growing fast. Even though we produce about 26 lakh tons, exports are hardly 10%. India earned Rs. 1,612 crore in 2000-01 by export of 2.30 lakh tons of spices.

All India Co-ordinated Research Project on Spices - AICRP(Spices) a brief history

The ICAR launched a major programme for the first time to organize spices research in this country by establishing the All India Coordinated Spices and Cashewnut Improvement Project in 1971. This project, started with four centres on spices, grew steadily to 12 centres in 1986 (VII Plan), and subsequently to 20 centres by the end of VIII Plan. In order to give adequate and undivided attention to spices, the combined project was bifurcated. AICRP on Spices came into existence in 1986 with its headquarters at the Indian Institute of Spices Research (IISR) (formerly CPCRI, Regional Station) Calicut, Kerala.

The establishment of All India Coordinated Research Project on Spices, as a separate project by ICAR is a milestone in spices research system in the country. The spices research activity was strengthened in due course to cover 12 spices (black pepper, cardamoms, ginger, turmeric, coriander, cumin, fennel, fenugreek, clove, nutmeg and cinnamon) with 20 centres spread over in 15 State Agricultural Universities (SAUs.). In addition to the 20 centres, there are 8 cooperating / voluntary centres working under AICRP on Spices.

Mandates of AICRP (Spices)

Conduct and coordinate spices research in the country with the following objectives : 1) Evolving high yielding varieties, resistant/tolerant to pests and diseases and their multilocation testing under varied agroecological situations, (2) Developing location specific varieties and standardizing agrotechnologies for spice production through integrated nutrient management for increasing productivity, (3) Evolving suitable pest and disease management technologies through integrated pest and disease management and to act as an interface between Indian Council of Agricultural Research /State Agricultural Universiteis/Indian Institute of Spices Research /Directorate of Arecanut and Spices Development.

Organisational set up

The AICRP(Spices) operates from the headquarters of the Project Coordinator (Spices) located at the Indian Institute of Spices Research, Calicut, Kerala.

Research on 12 spice crops are carried out under the AICRP(Spices) in 20 coordinating centres and eight voluntary / participating research centres. The centres are operating in the State Agricultural Universities in 15 states (Table 1) representing the major agroclimatic regions of India.

The AICRP(Spices) has a total staff strength of 83 con-

Table 1. AICRP (Spices) centres and mandate crops

Name of centre and location	Crops handled	State	Established
Pampadumpara (Kerala Agricultural University)	Cardamom and Black pepper	Kerala	1971 IV Plan
Mudigere (University of Agricultural Science, Bangalore)	Cardamom and Black pepper	Karnataka	1971 IV Plan
Panniyur (Kerala Agricultural University)	Black pepper	Kerala	1971 IV Plan
Solan (Y.S. Parmar Univerisity of Horticulture and Forestry)	Ginger and Turmeric	Himachal Pradesh	1971 IV Plan
Coimbatore (Tamil Nadu Agricultural University)	Coriander, Fenugreek and Turmeric	Tamil Nadu	1975 V Plan
Guntur (Acharya N.G. Ranga Agricultural University)	Coriander, Fenugreek	Andhra Pradesh	1975 V Plan
Jobner (Rajasthan Agricultural University)	Cumin, Coriander, Fennel, Fenugreek	Rajasthan	1975 V Plan
Jagudan (Gujarat Agricultural University)	Cumin, Coriander, Fennel, Fenugreek	Gujarat	1975 V Plan
Pottangi (Orissa University of Agricultural and Technology)	Turmeric and Ginger	Orissa	1975 V Plan
Yercaud (Tamil Nadu Agricultural University)	Clove, Nutmeg, Cinnamon and Black pepper, Cardamom	Tamil Nadu	1981 VI Plan
Sirsi (University of Agricultural Sciences, Dharwar)	Black pepper	Karnataka	1981 VI Plan
Chintapalli (Acharya N.G. Ranga Agricultural University)	Black pepper and Ginger	Andhra Pradesh	1981 VI Plan
Jagtial (Acharya N.G. Ranga Agricultural University)	Turmeric	Andhra Pradesh	1986 VII Plan
Hissar (Choudhary Charan Sing Haryana Agricultural University)	Coriander, Fennel and Fenugreek	Haryana	1993 VIII Plan
Dholi, (Rajendra Agricultural University)	Turmeric, Coriander and Fenugreek	Bihar	1993 VIII Plan
Dapoli (Konkan Krishi Vidyapeet	Black pepper, Nutmeg and Cinnamon	Maharashtra	1995 VIII Plan
Raigarh (Indhira Gandhi Krishi Viswa Vidyalaya)	Ginger, Turmeric & Coriander	Chattisgarh	1996 VIII Plan
Kumarganj (Narendra Dev University of Agriculture and Technology)	Ginger, Turmeric, Coriander, Fenugreek, Fennel	Uttar Pradesh	1995 VIII Plan
Pundibari (Utter Baga Krishi Viswa Vidyalaya)	Black pepper, Ginger & Turmeric	West Bengal	1996 VIII Plan
Voluntary centres			
Ambalavayal (Kerala Agricultural University)	Black pepper, Clove and Cinnamon	Kerala	1992
Pechiparai (Tamil Nadu Agricultural University)	Clove, Nutmeg and Cinnamon	Tamil Nadu	1993
Thadiyankudisai (Tamil Nadu Agricultural University)	Clove, Nutmeg and Cinnamon	Tamil Nadu	1993
Myladumpara (Indian Cardamom Research Institute)	Cardamom	Kerala	1993
Sakleshpur (Indian Cardamom Research Institute)	Cardamom	Karnataka	1993
Thadiyankudisai, (Indian Cardamom Research Institute)	Cardamom	Karnataka	1993
Gangtak (Indian Cardamom Research Institute)	Large cardamom	Sikkim	1999
Bhavanisagar (Tamil Nadu Agricultural University)	Cardamom	Tamil Nadu	1993

sisting of 51 scientists and 32 technical / auxiliary positions. The project has at present 85 research programmes in different centres covering the respective mandate crops.

Spectrum of activities

The major activities of the AICRP(Spices) are given below.

Crop improvement

Germplasm collection, conservation, evaluation, cataloguing and exchange of germplasm among various centres, (SAUs) within the country as well as with the National Bureau of Plant Genetic Resources (NBPGR), Indian Institute of Spices Research (IISR) and ICRI etc, conduct and monitor Coordinated Yield Trials, Multi Location Trials etc. in different agroecological zones, develop and release spice varieties having high yield, quality and resistance to biotic and abiotic stresses.

Crop production

Standardization of planting methods, spacing, season, vegetative propagation techniques, location specific agrotechniques to sustain spices production. Developing spices based cropping system, formulation of production technologies for different spice crops., integrated nutrient management, weed management, irrigation schedule etc.

Crop protection

Standardization of plant protection measures, integrated pest and disease management including biocontrol.

Planting material

An important activity is production and distribution of high quality, elite planting material, nucleus / foundation seeds of new, high yielding spices varieties. The centres are also participating in the seed / planting material production through the Integrated Programme for Development of Spices (IPDS) of GOI; Spices Board; Development Departments of Agriculture / Horticulture of State governments.

Linkages

Develop, promote and sustain inter-institutional linkage with SAUs, Directorate of Arecanut and Spices Development; Spices Board; Regional Research Laboratory (CSIR), National Bureau of Plant Genetic Resources, Departments of Horticulture / Agriculture etc. for spices development.

Publications

Publishes annual report,

research highlights, periodic documents on transfer of technology, popular articles, technical bulletins, specific package of practices for individual spices as relevant to different agroclimatic zones.

Extension training programmes

The research findings of the different AICRP(Spices) centres are disseminated through extension and training activities. The centres conduct series of training programmes to farmers and department officials on different aspects of spice production technology. The centre conducts field days, farmers fair, kissan mela, exhibitions and field visits annually and also conducts demonstration trials and onfarm trials.

Cess fund / ad-hoc schemes

Identify, advice, assist and review the cess fund adhoc research schemes on spices and help in the clearance of proposals for funding from ICAR / SAU's / other agencies.

Monitoring/Workshop

The Project Coordinator (Spices) stationed at IISR, Calicut, Kerala has the responsibility to monitor, coordinate, review and evaluate the research work of various projects at different centres.

The AICRP(Spices) conducts biennial Workshops / National Group Meeting (NGM) which is the forum for presentation / discussion and finalization of research programmes and to review the progress made at national level.

The NGM formulates need based, location specific research programmes and also recommends technologies / package of practices including recommendations for release of improved spices varieties. The proposal for release of varieties from AICRP(Spices) centres, Indian Institute of Spices Research (IISR) and other organizations working on spices are discussed and recommended for release. The improved, technologies which are economically viable are recommended to extension agencies for adoption. So far 15 Workshops were conducted.

Highlights of Achievements

The AICRP(Spices) has made substantial contributions to spice research and development during the last three decades since its inception. A number of proven technologies were evolved and passed onto extension agencies and farmers, and these technologies have been making good impact.

Crop wise achievements are given below.

Black pepper

- Collected, evaluated and conserved 367 germplasm accessions.
- Seven high yielding varieties are released including two hybrids.
- Technology developed for bush pepper production and management.
- Improved technologies are developed for large scale planting material production.
- Agrotechniques, (source of planting material, planting methods, spacing, best standards, cultural practices, nursery management, ideal mixed cropping system etc) are evolved to suit the producing states.
- Plantation management – irrigation and fertilizer schedules for plantations and for pepper + arecanut mixed cropping system as well as High Production Technology (HPT) developed.
- Package for management of *Phytophthora* foot rot and other diseases and pests are formulated and popularized.
- Planting material production and distribution of high yielding varieties.
- Floral biology of black pepper .
- Hybridization technique in pepper has been standardized

Cardamom

- Collected, conserved and characterized 336 germplasm accessions
- Seven high yielding varieties were developed and released
- Package of technology developed for rapid clonal multiplication of planting material, best time for seed capsule collection, seed germination, raising nursery, scarification of seed for better germination, technique of enhancing seed germination in winter, optimum time of planting, spacing, seed treatment for disease free seedlings, nursery disease management, high density planting, cultivation under artificial shade, enhancing productivity by maintaining bee colonies etc.
- A High Production Technology (HPT) was evolved for managing cardamom gardens for increasing production and productivity.
- Manurial and fertilizer recommendations including

micronutrients are standardized.

- Package for disease and pest management developed and popularized.

Ginger

- Assembled, studied and conserved 406 ginger germplasm accessions.
- Four ginger varieties are released.
- Cultivation practices- size of seed rhizome, planting season, bed size, spacing, advantages of mulching, type of mulch, optimum time of harvest for quality produce, weed control, compatible crop combination, after-care, cultural operations etc standardized
- Pre-treatment of rhizome with biocontrol agents recommended for control of seed borne diseases.
- Control measures of storage rot in ginger standardized.
- Management practices for pest and disease are evolved.
- Method of seed rhizome storage under pit-system is standardized.
- Fertilizer and irrigation schedules for ginger worked out.
- Processing techniques for production of quality ginger evolved.

Turmeric

- Assembled, studied and conserved 1136 turmeric germplasm accessions.
- Seven turmeric varieties released.
- Cultivation practices- size of seed rhizome, planting season, bed size, spacing, advantages of mulching, type of mulch, optimum time of harvest for quality produce, weed control, compatible crop combination, after care, cultural operations etc standardized.
- Recommended the package of practices for profitable turmeric cultivation.
- Technology for minimizing rhizome rot in field by pre sowing seed treatment perfected.
- Processing and production of quality turmeric is standardized
- Effect on long term storage on quality evaluated.

Seed spices

- Germplasm accessions – coriander-1467, cumin-495, fennel-420, fenugreek-944 are collected, evaluated and are being conserved.

- Technologies regarding seed rate, sowing season, time of sowing/ planting, method of sowing, spacing, pre-sowing seed treatment, irrigation requirement, weed control measures, fertilizer package, plant protection measures.
- Measures are evolved for managing diseases and insect pests
- Recommendations for production of quality seeds are standardized.
- Participated in IPDS & Spices Board schemes for seed production.
- The storage effect on quality deterioration is evaluated.

The improved varieties in the above mondote spices released through AICRP(S) are given in Table.2

Prospects and potential

Though most of the spices produced are consumed internally, India earned Rs. 1612.07 crore from export of 2,30,000

Table 2. Improved varieties of spices from AICRP (Spices)

Spice	Varieties released	Yield range, kg ha $^{-1}$ (dry)
Black pepper	Panniyur-1, Panniyur – 2, Panniyur –3, Panniyur – 4 Panniyur – 5, Panniyur –6, Panniyur –7	1270 – 2570
Cardamom	Mudigere – 1, Mudigere –2, PV – 1, ICRI – 1, ICRI – 2, ICRI – 3, ICRI – 4	250 – 475
Ginger	Suprabha, Suruchi, Surabhi, Himgiri	2700 – 3500
Turmeric	Co-1, BSR-1, BSR-2, Roma, Suroma, Ranga, Rasmi	4000 – 6000
Coriander	Co –1,Co-2, Co-3, CS- 287, Gug Cori –1, Guj. Cori –2, Rajendra Swathi, Rcr – 41, Sadhana, Swathi, Sindhu, Rcr-20, Hisar Anand, RCr-435, Rcr-436, Rcr-684	500 –1400
Cumin	S – 404, MC – 43, Guj. Cum – 1, Guj Cumin 2, RZ – 19	500 – 700
Fennel	S-7-9, PF – 35, Guj. Fennel 1, Co – 1, RF-101	570 – 1650
Fenugreek	Co –1, Rajendra Kanti, RMt – 1, Lam Sel – 1, Hisaar Sonali, RMt-303, Guj. Methi-1	600 – 1900
Cinnamon	YCD-1	360
Nutmeg	Sugadham	-

tons of spices during 2000-2001. On the global front, India has a competitive edge over the exporting countries in black pepper and cardamom as well as spice oils and oleoresin. Indian spices have a high production potential. Yield gaps and production constraints of some of the important spices are given in (Table 3.). Efforts are being made through an integrated nutrient/ pest and disease management approach for doubling productivity of Indian spices. There has been remarkable increase in the productivity during the post two decades after the establishment of Coordinated Research Project (Table 4). But the productivity of seed spices remains low due to various reasons. Reasons attributed low productivity are traditional cultivation in marginal lands and low fertility areas, lack of adoption of improved package of practice, inherent weakness of the seed spices like slow germination, resulting in poor stand of crop, slow growth resulting in severe weed problem, high incidence of disease and poor social and economic status of the growers. Yield and productivity increase is achievable through the new integrated system of cultivation using high yielding varieties, improved agratechniques, production technology and plant

Table 3. Average and potential yield as well as production constraints in spices

Spices	Average yield (kg ha^{-1})	Potential yield (kg ha^{-1})	Production constraints
Black pepper ('Pollu',	290	2445	Low productivity, *Phytophthora* foot rot, virus disease (stunted disease), pest attack mealy bugs), burrowing nematode, drought susceptibility.
Cardamom	128	450	Low productivity, 'katte' and vein clearing viruses, thrips, drought
Ginger	2421	8250	*Pythium* (rhizome rot), bacterial wilt, Phyllosticta, leaf spot
Turmeric	2733	10700	Leaf blotch, leaf spot, rhizome rot.
Clove	400	1100	Lack of genetic diversity and improved variety
Nutmeg	600	885	" "
Cinnamon	200	400	" "
Coriander	800-1000	1900	Inherent low productivity, wilt, blight, powdery mildew, stem gall (coriander).
Cumin	500-600	2000	" "
Fennel	1800	2500-3000	" "
Fenugreek	600-800	1500-2000	" "

Table 4. Productivity increase of major spices (base year 1970-71)

Spice	1970 -71			1997-98 / 98-99			
	Area (ha)	Production (t)	Productivity (kg ha-1)	Area (ha)	Production (t)	Productivity (kg ha-1)	increase in production (%)
Black pepper	119960	26160	218	181530	57300	315.65	45
Cardamom	91480	3170	35	72444	7900	149.0	325
Large cardamom (1980-81)	25685	4000	156	26358	5265	236	1424
Ginger	21590	29290	1357	77570	252110	3250.1	140
Turmeric	80500	150600	1871	139700	549200	3931.28	110
Coriander	272300	101200	372	676500	337700	499.19	34
* Cumin (1975-76)	86880	28170	324	288530	116270	402.97	24
* Fennel (1975-76)	14566	17443	1434	25107	28380	1130	-
* Fenugreek (1975-76)	31164	43473	1395	38.490	49970	1298.26	-

** Include figures of major growing states.*

protection measures that are now available. Due to the concerted effort of researchers, farmers and traders, spices production and export recorded an all time high in 1998-99 and during 2000-2001.

Conclusion

The future needs in the area of spice R & D are:

* Enhancement of potential and realizable productivity
* Enhancement of quality
* Alleviation of biotic and abiotic constraints through integrated constraint alleviation programmes.
* Evolving and popularising very efficient post harvest technology programmes including product intensification.
* Tailoring production to meet the export needs and international requirements.

The spice R & D machinery in the country should gear up to meet the above challenges through an integration of trade ——> production ——> extension ——> research components.

INTEGRATED PLANT NUTRIENT SYSTEM FOR YIELD AND QUALITY OF SPICES

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Mineral nutrients play a pivotal role in the growth, production and quality of spice. Integrated Plant Nutrient System (IPNS) is an approach that combines biological, organic and mineral sources of nutrients for obtaining sustainable crop production. This system aims at preventing environmental degradation and optimizing soil quality and crop productivity. Decontrol of phosphatic and potassic fertilizers in August 1992 has widened the N: P: K consumption ratio thereby nutrient ratio in soil. No doubt in modern farming, fertilizer would continue to be the dominant contributor for meeting the nutrient requirement of the crops. However, the importance of organic manures should not be underestimated as it has the ability to nip several budding nutrient deficiencies especially of secondary and micronutrients. It's decomposition products mediate improvement in soil physical, chemical and biological environment that further enhance the merit. India's production of FYM is estimated to be 500 million tons annually yielding a rate of 3.5t ha^{-1} distributed over an area of 145 million ha of cultivated field. Timely availability of organic manures is a major problem. Integrated Plant Nutrient Management (IPNM) therefore assumes significance. Research efforts made during the last 25 years by the Indian Institute of Spices Research towards increasing crop productivity and quality of spices are discussed below.

Green house and field experiments were conducted in the institute's farm as well as in farmers' fields during the last 25 years, with improved varieties of spices. Agricultural lime, organic manures like FYM, Coir Compost (CC), legumes, animal bone meal, inorganic and biofertilizers (*Phosphobacteria* and *Azospirillum* Spp. (BF) were used. The effect of IPNM was studied in the typical spice growing soils under varying climatic conditions, with reference to nutrient availability, yield response and disease incidence and quality parameters.

Nutrient availability

Availability of soil nutrients significantly increased by adoption of IPNM (Table.1). In black pepper there was 50% increase in Organic Matter (OM) status, while increase in P and K status were 88 and 43% respectively, compared to farmers' practice over the years. Adoption of IPNM package in mono and mixed cropping systems of black pepper increased the yield by 222% and 170 %, respectively over farmers' practice.

The *Phytophthora* disease incidence was brought down from 6.1 to 2.4% due to adoption of IPNM. The IPNM system has significantly accelerated the nutrient availability in the soil that lead to increased crop yield and suppression of pathogens in the soil.

Yield and quality

IPNS studies also indicated significant increase in black pepper yield when coir compost and biofertilizers were included in the fertilizer schedule of black pepper (Table 2). The effect of biofertilizer was only marginally reflected towards the increase in quality. In case of ginger and turmeric, introduction of biofertilizer, though not increased the yield significantly, marginally enhanced the oleoresin in ginger and curcumin in turmeric (Table.2).

Fundamental issues in balancing of nutrients

Balanced application of organic and inorganic fertilizers helped to maintain and/or increase nutrient reserves

Table 1. Effect of IPNM on soil nutrient availability, yield response and disease incidence of black pepper

Treatment	Soil nutrient availability			Yield ($t\ ha^{-1}$)		Disease incidence	
	OM (%)	P ($mg\ kg^{-1}$)	K	mixed cropping	mono cropping	*Phytophthora* (%)	slow decline (%)
Check (FP)	1.8	17	108	0.40	0.49	6.1	6.4
IPNS	2.7	32	154	1.08	1.58	2.4	2.6
Increase %	50	88	43	170	222	-	

IPNS - FYM @ 5 $t\ ha^{-1}$ + NPK @ 100:40:140 $kg\ ha^{-1}$ + agricultural lime, neem cake and bone meal each @ 500 $kg\ ha^{-1}$

Table: 2 Effect of IPNS on yield and quality of black pepper, ginger and turmeric

Treatment	pepper			ginger		turmeric	
	yield ($t\ ha^{-1}$)	quality piperine (%)	quality oleoresin (%)	yield ($t\ ha^{-1}$)	quality oleoresin (%)	yield ($t\ ha^{-1}$)	quality curcumin (%)
Check	2.33	6.94	9.19	1.76	3.34	2.6	6.00
NPK	3.62	6.74	9.08	2.44	3.69	3.85	6.20
FYM+CC+NPK	2.98	7.12	7.11	3.20	3.79	4.59	6.37
FYM+CC+½NPK+BF	4.03	6.99	7.08	3.44	4.48	3.78	7.26
CD (P = 0.05)	0.41	0.15	0.19	0.66	0.20	0.90	0.42

FYM 10 $t\ ha^{-1}$ CC 2.5 $t\ ha^{-1}$ BF 20 $kg\ ha^{-1}$

NPK @ 100: 40: 140 (pepper), 75:50:50 (ginger) and 60:50:120 $kg\ ha^{-1}$ (turmeric)

in the soil. There are several reports that excess use of chemical nutrients, particularly nitrogenous fertilizers pollute the ground water and increase the nitrate content in ground water. Balance in the absolute use and relative application of nutrients is a component of IPNS. Deficiencies can be corrected by the application, whereas it is hard to correct excessive application of nutrients.

Striking a balance between nutrient requirement of plants, and nutrient reserve in the soil, is imperative to maintain soil fertility, crop productivity and to prevent environmental degradation.

A fundamental component in IPNS is organic manures that are often not available in adequate quantities to meet the crop requirement. The use of urban waste as an organic source often leads to heavy metal contamination in the soil, introduction of parasites and pathogens that would not be beneficial to plants and soils. The use of man made inorganic fertilizers, is not available to the farmers as and when required. But growing leguminous cover crops improves nutrient reserves in the soil, uptake of nutrients and crop quality. Introduction of leguminous crops often reduces the use of chemical fertilizer- N by abou 20 – 30 per cent.

IPNS enhances the uptake of nutrients. New techniques such as coating urea with neem oil, mixing urea with powdered neem cake, often increase the use efficiency of applied nitrogen. These innovations coupled with timely application enhances the crop productivity and reduce the input requirements.

Continuous use of straight fertilizers often leads to deficiency of micronutrients. Studies on the use of micronutrients for spices showed that application of Zn, B and Mo @ 5, 2 and 1 kg ha^{-1} in conjunction with the recommended organic and inorganic fertilizers not only enhanced the yield, but also increased the quality.

Location specific response of crops

AICRP (Spices) is taking up location specific research in 20 centres based in different State Agricultural Universities (SAUs). IPNS studies are in progress since 1995 in different AICRP centres. Investigations in major cardamom growing tracts of Kerala and Karnataka, showed that in soil rich in organic matter, use of inorganic fertilizers, though superior, is statistically on par with the application of half the recommended dose of fertilizers as combination of organic manures. Use of *Azospirillum* and *Phosphobacteria* in combination with organic and inorganic fertilizers in the nutrition of clove and nutmeg at Yercard in Tamil Nadu proved beneficial in increasing yield. In cumin, trials at Jagudan (Gujarat) in sandy loam soils, proved that by combining mustard cake with NPK fertilizers, the rate of application of recommended doses of nutrients can be scaled down to half for optimizing the yield.

Conclusion

The study shows that the system of IPNM will be an effective tool in augmenting production and quality upgradation of spice crops. Future research must concentrate on developing relationship between soil fertility/ soil enzyme activity/crop productivity, taking the factors that confound relationship between soil fertility, productivity and quality of spices for the export.

INDUSTRY - RESEARCH LINKAGE IN SPICES

Sanjay Mariwala

Managing Director
Kancor Flavours and Extracts Ltd.
Angamally, Kerala.

Reasingly research institutions, whether Govt. funded, University funded or Private, are being asked the same questions, How do you raise more funds? How do you justify your work in the economic context?

Success. One word defines it all. How do you choose and appropriately adapt technologies for a new product, process or a service, while adapting R&D programs to the realities of the world around them. Successful Institution, are the ones that will attract more funding, better manpower and will continue to build on successive successes.

The game has changed over the years. Competition has forced the advantage in favour of those institutions that are able to choose among the vast number of technological options and pick the best ideas, and not necessarily the largest number of ideas or the technically sound ideas. Focus and quick success have become the benchmarks of performance Speed to market, quick solutions and adaptability to local conditions are the norms being used to evaluate appropriateness of research.

Traditionally, isolated research groups would explore new technologies and techniques and choose which ones the development organization would use; the development organization would refine them and the new process or product would then be passed on for commercialization to a form or a commercial organization, which would remove the bugs. Because there was no process to taking a view of the entire project when choosing technologies, many of the choices were poor. The new models that emerged changed all this. Forces of competition ensured that research organizations work with technology users and technology integrators to ensure that they picked appropriate technologies, suitable to local conditions, adaptable quickly so that specific problems that existed could be addressed and new niches in the market created or filled.

In Spices, farmers are the users and industry the adapter. Industry must play the active role in refining the technology expectations, so that appropriateness could be designed into the processes, and no time is lost in removal of bugs at the time farmers are adapting the new technologies into their programs. Industry is the window to the world. They face the problems of competition. New competition that did not exist 5 years ago today owns part of the market; take the example of pepper. Vietnam did not produce pepper 6 years ago. Today it has emerged as the largest competitor to India having replaced India as the largest exporter last year. Nigeria is new to ginger cultivation; Cochin ginger was the preferred variety, today the cost of ginger production in India is so high, no one wants to buy Indian ginger. Even Indian oleoresin industry is using Nigerian ginger in place of Cochin!

New pressures like the consumer lobbies of the western world are putting new demands on exporters of spices. Certified GMO free spices are being demanded by consumers around the world. Genetically modified varieties help the farmers in combating disease; improving yields and improving inherent qualities of spice, and that way are an ideal choice for a producer. But, they do not bring buyers to your door! What should be done in such a case is what industry and R&D together should design as an appropriate response. Which pesticides are acceptable and which are not, falling prices and expectations of new competitive equations, these are the questions under debate at industry forums around the world. Industry and R&D linkages will bring these issues to the top of the agenda in designing solutions for the coming future.

How well we design such interactions and linkages into our programs will help us define our approach to the changes taking place around the world in our industry.

SILVER JUBILEE CELEBRATION
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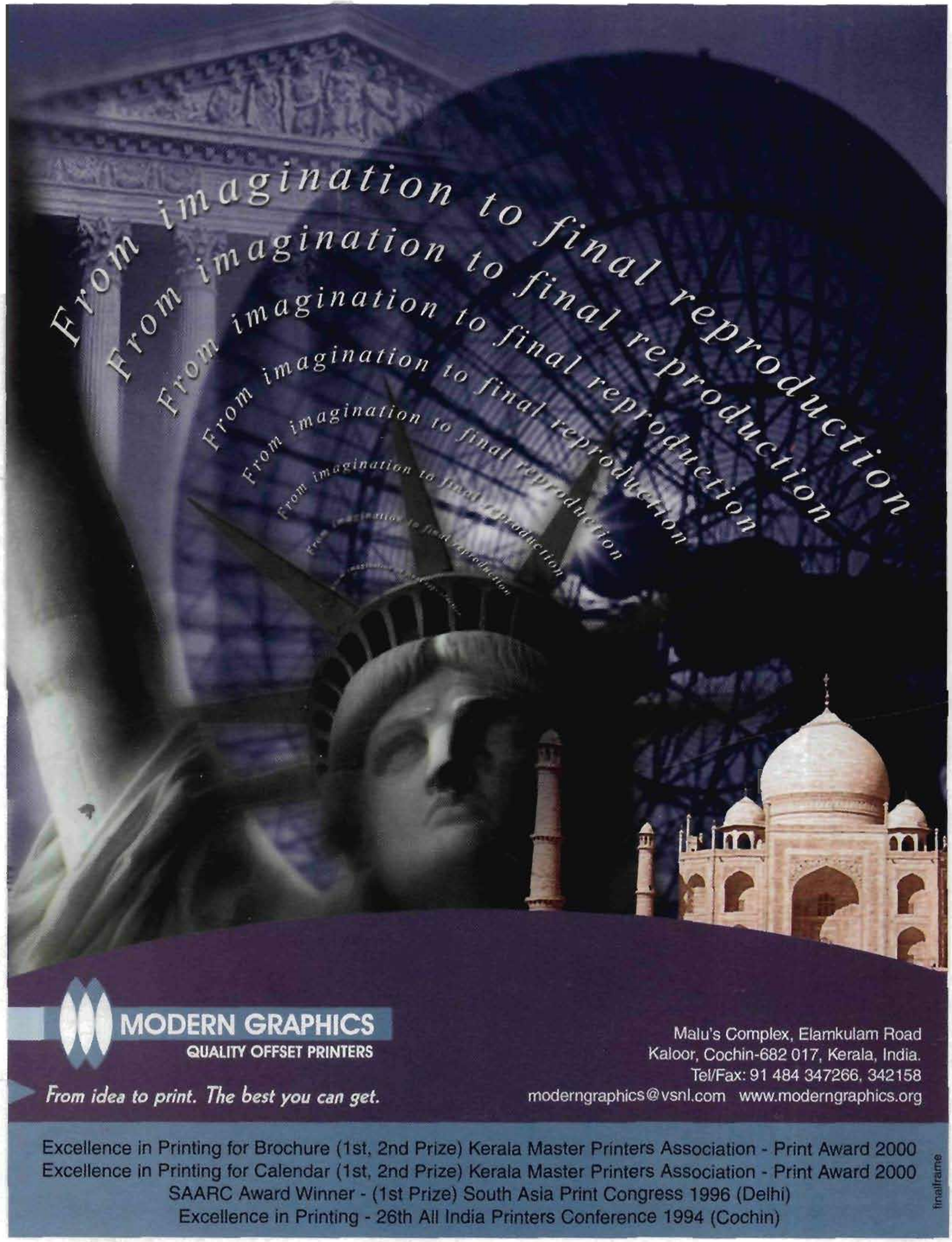
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