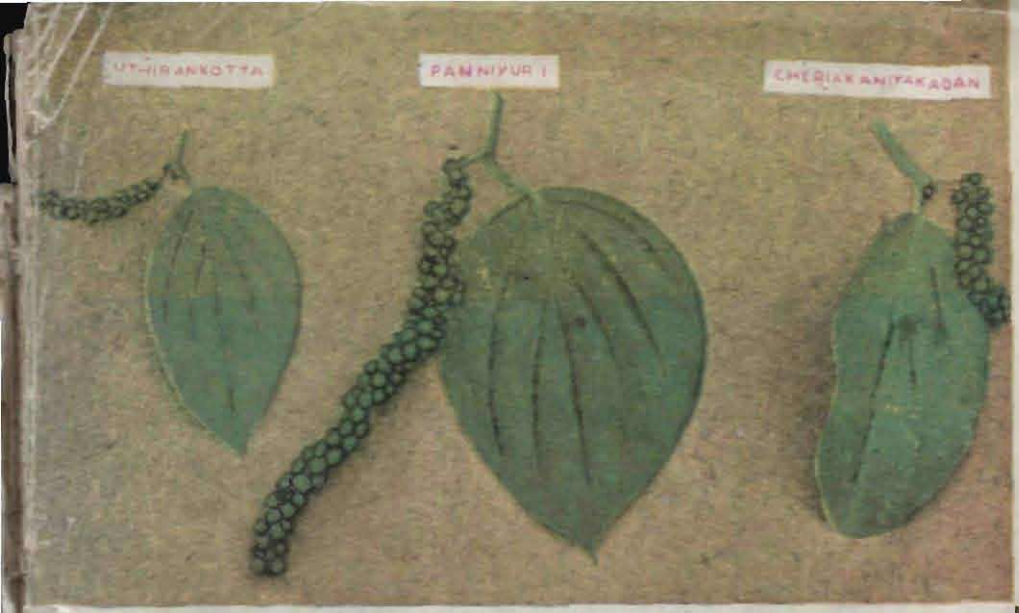

Proceedings Series III

Proceedings of the

NATIONAL SEMINAR ON PEPPER

held at Calicut on December 19, 1977

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

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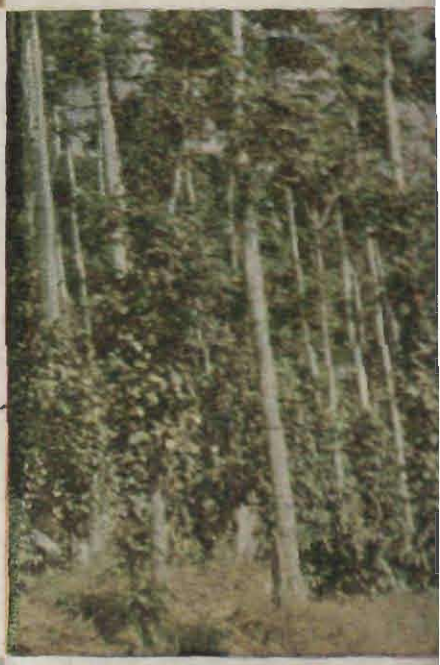

ICAR

Proceedings Series III

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NATIONAL SEMINAR ON PEPPER

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CPCRI Regional Station, Calicut on
December 19, 1977

Editors
MK NAIR
M HARIDASAN

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
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* Earlier publications in the series

I. Increasing production and productivity of cashew in India
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Some of the participants of the Seminar

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INAUGURAL ADDRESS

M. S. Swaminathan
Director General
Indian Council of Agricultural Research, New Delhi

I. Role of pepper in enhancing income

This Seminar is being held at an appropriate time, since programmes for the next plan starting from 1-4-'78 are now being developed. The Government of India has already announced that the overriding priority in the next plan will go to Agriculture and Rural Development. *The aim hereafter, will not only be on producing more food but on generating more income and employment in the rural sector.* Priority will have to be given to profits which can help to enhance the income and purchasing power of landless labour, marginal and small farmers. This can be achieved in the agricultural sector only by (a) making the optimum use of the land and water resources of each area; and (b) linking production and post-harvest technologies into an integrated system at the village level, so that value-added products are sent out of the village for marketing.

In garden lands, optimum use of land and water can be made by using both the horizontal and vertical space effectively. Plant architects will have to design crop combinations which co-operate with each other in a multi-level crop canopy through (a) maximum interception of sunlight; (b) non-overlapping nature of sensitivity to pests; and (c) ability to remove nutrients and water from different layers of the soil profile. Pepper holds great promise in such a drive for enhanced income from small garden land plots through diversified cropping. Research on pepper and other spices is hence being intensified. ICAR has set up a spices research centre at Calicut with a large experimental farm at Peruvannamuzhi, which delegates will be visiting tomorrow. This Centre is part of the Central Plantation Crops Research Institute. The All-India Co-ordinated Project on Spices will be strengthened with additional centres for pepper research in Andhra Pradesh, Karnataka, Konkan area of Maharashtra and Assam. The Panniyur Pepper Research Station will be strengthened further. The suggestions of this Seminar will be valuable in finalising the outline of the accelerated research thrust. The Kerala Agricultural Development Project, with credit from the World Bank, will provide an opportunity for transferring the latest research results to farmers.

II. Production trends

In 1947, India produced about 30,000 tonnes of black pepper, which then amounted to about 80% of the total world production of 38,000 tonnes. In 1976–77, we produced 31,580 tonnes of black pepper from about 1.14 lakhs hectares. During this 30 year period, the world production of pepper went up from 38,000 to 1,40,000 tonnes. Thus, our share of total world output went down to about 24%. Indonesia, Malaysia, Brazil and Sri Lanka became important exporters of pepper. During 1974, Indonesia, Malaysia and Brazil accounted for 23%, 22% and 14% of the world output, respectively. The demand for pepper in the world market is growing. In contrast to 95,000 tonnes imported in 1974 by countries like the USA, USSR, Canada, Japan and European nations, the estimated import, according to the International Trade Centre, will be nearly 1,20,000 by 1983.

Are we going to wake up and take steps to improve the production and productivity of pepper? The purpose of this Seminar is to develop a research and development strategy which will help us to compensate for the past neglect of this crop and launch an era of accelerated advance in pepper production.

III. Pepper yield

The present average yield of pepper is about 275 kg/ha in our country. In contrast, the average yield is about 529 kg in Indonesia, 3400 kg in Brazil and 4130 kg in Malaysia. Assuming that there are 1100 pepper vines in a hectare, our present yield works out only to about 250 gm of dried berries per vine.

In contrast to such a low average yield, several farmers in Kerala, which has nearly 96% of the acreage under pepper in our country, have harvested over 1 kg per vine. At the Panniyur Pepper Research Station, an yield of over 5 kg per vine has been recorded. At Vittal, the pepper vine on a mango tree has yielded upto 12 kg. Thus, from the data available at present we can assume that the maximum potential for yield in a hectare having 1100 vines may be upto about 10 tonnes.

IV. Yield gap and constraints analysis

The difference between potential and actual farm yields can be designated as "Yield Gap". Taking the yield of 1 kg/vine/year obtained by several good farmers as the immediately realisable yield, we find that the present average yield of 250 gm/vine represents only 25% of the realisable yield. Thus, the Yield Gap is of the order of 75%. It should however be emphasised that this may be an overestimate of the size of the gap, since there may not be 1100 vines/ha in all gardens. We can however confidently say that there is scope for at least doubling the yield in the next few years. The highest priority should hence be accorded to identifying the constraints responsible for this gap and removing them. This will involve paying attention to all aspects of management, extension and input supply. It would be advisable to initiate a few operational research projects to demonstrate the scope of increasing pepper yields.

V. Increasing the area under pepper

While the highest priority should go to increasing the yield of the area already under pepper, systematic rehabilitation and replanting schemes and identification of new areas for the popularisation of pepper need to be undertaken. New garden land cropping patterns such as coconut with pepper, cocoa and pineapple need to be

taken up on a large scale. The potential for pepper cultivation in Assam and eastern India as a part of the diversification of cropping in tea gardens, and in Andhra Pradesh, Konkan Coast of Maharashtra and Karnataka needs to be studied and exploited.

VI Research thrusts

(a) *Collection, conservation and utilisation of pepper genetic resources :* Pepper probably had its centre of diversity in the forests of Western Ghats. Hence, a systematic collection of genetic material from Kerala and Karnataka is important. Such collection work has already been initiated. The Assam and N. E. Himalayan region also need to be surveyed for wild pepper material. *Gradually, the Peruvannamuzhi spices research centre should become a world centre for the conservation, classification and utilisation of pepper germ plasm.* A National Pepper Hybridization Garden will have to be established there for making crosses in different combinations and for distributing hybrid material for selection under different growing conditions.

(b) *Breeding :* Panniyur I evolved by crossing Uthirankotta and Cheria Kaniyakadan represents the promise held by cross-breeding in developing superior varieties. Thanks to vegetative propagation, hybrid vigour can be fixed in pepper. *Therefore, a dynamic cross breeding programme involving Panniyur I, Karimunda, Kalluvally and other commercial varieties and a wide range of primitive cultivars and allied species needs to be initiated at the National Pepper Hybridization Garden.* The emphasis should be on combining yield and quality with stability of performance through resistance to important diseases and pests.

(c) *Resistance to pests and diseases :* While breeding for resistance to quick wilt *(Phytophthora palmivora)*, slow wilt and other diseases should be intensified, the immediate need is for the standardisation of integrated pest management systems involving agronomic, crop sanitation, biological and chemical methods of control. Quarantine procedures should be introduced with regard to distribution of vines from areas affected by quick and slow wilts. The available methods of control of "pollu" beetle and other insect pests should be demonstrated in operational research projects.

(d) *Fertilizer and cultural practices :* Unfortunately, our knowledge of the optimum manurial practices for pepper is very scanty. Generally, there is no separate manuring schedule for pepper. If we want to increase yield, the nutrient needs of pepper must receive specific attention. Agronomists should develop location specific recommendations.

(e) *Research on standards :* The scope for using nonliving standards like wooden posts, granite pillars, etc., needs to be assessed critically. Among living standards, preference should be given to leguminous trees, since they will also fix nitrogen and thereby reduce the fertilizer requirements.

(f) *Processing, marketing and export :* The problems in this area were discussed in March, 1976 in Cochin at an International Seminar sponsored by the Spices Export Promotion Council. What is now important is the extraction of oils and oleoresins within each compact pepper growing area, so that value added products are prepared in the producing area itself. The scientists of CFTRI and CSIR have made a valuable contribution in this area. The technology needs to be introduced in operational research projects involving an integrated system of scientific pepper production, processing and marketing.

Trends in Pepper Cultivation

M. C. Nambiar
Central Plantation Crops Research Institute, Kasaragod

India, Indonesia, Malaysia, Brazil and Sri Lanka are the major pepper producing countries in the world today. Pepper is reported to be indigenous to the Western Ghat area of peninsular India. It was introduced into Indonesia from India. In the beginning of the 19th century, Indonesia, Malaysia and other Far East countries started commercial cultivation of pepper, and very soon, Indonesia became a major supplier of pepper in the world market.

The Second World War brought out a complete change. Pepper plantations in Indonesia were totally destroyed by the Japanese when they occupied Indonesia and the West had no alternative but to look to India and once again India became the major supplier of pepper in the world market. The prices started moving up in the world market and hit the ceiling in 1949 – 50. Stimulated by the high price incentive, the world production of pepper increased substantially during the early 1950's. Malaysia increased her production from 6000 tonnes in 1947 to 17,000 tonnes by 1955 and Indonesia reached a production level of 24,000 tonnes by 1955.

One important consequence of this phenomenal increase in production was a sharp fall in prices. The growth rate in the consumption of pepper during the early 1950's was considered very low even though the price level was considered very much against the interests of the producer.

After 1955, the demand for pepper increased considerably. The demand from Africa and Asia and the entry of Japan in the world market as a buyer appear to have added to the encouraging situation in the pepper economy. The demand growth rate in the world market has been placed at 4% per annum by the V Session of the Pepper Community held at New Delhi in July 1977. Quantitatively, this would mean that the world would require over 1,70,000 tonnes of black pepper by the end of this decade — an additional requirement of 22,000 tonnes. The National Commission on Agriculture, New Delhi, in its report on pepper has projected the likely future requirement of pepper in India at 41,000 tonnes in 1980, 45,000 tonnes in 1985, 51,000 tonnes in 1990 and 58,000 tonnes in 2000. Thus, there is an immediate need to increase our pepper production not only to meet our internal demand, but also to exploit the opportunity in the international market to enhance our export earnings.

The main question that we should try to answer today is how we can increase our present production and productivity. We have 1,14,000 ha of pepper and our total production today is 31,580 tonnes of dried

berries. The average yield is estimated to be 250 gm/vine which works out to 275 kg/ha if we assume a plant density of 1100 vines/ha. In our country, pepper cultivation is confined to the foot hills of Western Ghats in the states of Kerala, Karnataka and Tamil Nadu. Andhra Pradesh and Maharashtra also have introduced pepper in recent years. Kerala contributes about 96% of the total production, Karnataka 3% and Tamil Nadu less than 1%. Large scale pure plantations of pepper is confined to Cannanore and parts of Calicut and Idukki districts, and together, they account for over 40% of the total area; small holdings ranging form 0.3 to 1.5 ha form about 45% and homestead gardens having a few vines account for the rest of the area. The number of growers engaged in cultivation of this crop is estimated to be about 80,000. The average holding size in Kerala is 0.73 ha.

As in any other crop, the first factor to be considered is whether we can hope for more area to be brought under pepper in the future. Or should we rely on increased productivity from existing areas only? The possibility of extending pepper as monocrop on plantation scale to new areas seems to be limited. First, there is a scope for expansion in coffee and cardamom plantations where 200 — 250 standards can be maintained per hectare. A second possibility is the planting of more vines in homesteads/small holdings as intercrop with coconut, arecanut and other crops. The present estimate is that 45% of the total area of 1,10,000 ha under pepper in Kerala (which works out to 50,000 ha or nearly 50 million standards) is accounted for by small holdings. Even if we consider coconut alone there are nearly 1 million ha of land which can be brought under pepper or nearly 160 million "ready-made" standards. Add to this the total number of arecanut palms available and we can come up with some wild estimates of possibilities of increasing the number of pepper vines.

As much as we don't ignore this possibility of increasing the area under the crop in mixed gardens, we should recognise that any immediate increase in production will have to be achieved through higher productivity of existing vines.

The most important factor in this regard probably is to arrive at a reliable figure of our present productivity level. The estimates of average yields which we often quote today — 250 gm/vine — is in my opinion a low estimate. These figures are computed on the basis of total estimated production and the total area assumed to be under the crop. What is erroneous in these computations is the estimate of the number of vines per unit area. If we visit contiguous areas under the crop in Cannanore and Calicut districts, we will realise that there are several standards — as much as 30% or more on which the vines are either dead or have become senile, but we still assume a plant population of 1000 – 1100 vines/ha. Most of these vines have died due to diseases like quick/slow wilt or because of age. The surviving vines are invariably in favourable situations like valley bottoms and therefore, the real productivity is more likely to be about 0.5 kg/vine.

Secondly, we don't have relaible estimates of the area under different known varieties. Establishment of nurseries and distribution of cuttings of Panniyur I and other local varieties to farmers are only a recent phenomenon in the improvement of the crop. Also, adequate data on minikit trials in different agroclimatic regions are yet to be gathered. However, we may safely assume that an average yield of about 1 kg/vine is easily attainable if only we can assure better management practices and pest and disease control. Foremost among

the problems faced by the farmers today is the loss of vines due to wilt diseases This problem will be discussed by pathologists in this Seminar and I don't intend to dwell on this aspect as it is more of a research problem today than a question of non-adoption of recommended control measures by the farmers.

Then comes the question of replanting and replacing diseased vines with new planting material. As long as we don't have known disease resistant varieties, we can only recommend the known high yielding hybrid Panniyur I and other local varieties like Karimunda, Kalluvally and Balankotta. It is gratifying to note that the Central and State Government agencies are taking necessary steps to ensure an adequate supply of superior quality planting materials to the farmers.

Where we lag behind sadly is in our understanding of the nutritional and agronomic requirements of the crop. In earlier days, most of our pepper was cultivated on virgin soils along the Western Ghats after forest lands were cleared. Today, this ideal ecoclimate and soil conditions are no longer available which is reflected in our present day poor yields.

What can we honestly recommend to the farmers ? Do we have enough research data for any specific recommendations ? Unfortunately the answer is an unqualified "no".

As much as we may claim that research input was meagre until the initiation of the All India Co-ordinated Project on Spices and Cashewnut Improvement and the establishment of the CPCRI Regional Station at Calicut, we must recognise the manurial experiments were conducted on the crop as early as in the early 1920's by the then Madras State Department of Agriculture. The Panniyur Research Station was established in the 1950's. It is true that the station has Panniyur I to its credit, but what of other agronomic and fertilizer trials? Many agronomic trials were initiated as early as twenty years ago, but unfortunately inspite of the forethought and planning, the technical reports of the projects were mostly a case of missing data. No statistical interpretation was possible because data are missing in too many plots. This has happened probably because of lack of adequate manpower and facilities. This situation must change. We cannot find another location like Panniyur where we can get a plantation of bearing vines for agronomic and other trials. It will take years to establish such a farm. What is lacking at Panniyur is a good laboratory and qualified staff in disciplines like pathology, entomology, soil science and agronomy. If adequate facilities are provided I am sure that by the time we celebrate the golden jubilee of the Panniyur Station we will have a lot more to talk about our achievements as in the case of the Pattambi Station which is celebrating its golden jubilee later this week.

Finally, I would like to identify the areas in agronomy/soil science that require our immediate research attention.

1. The nutritional requirements of the crop, especially when grown in homestead gardens, and trained on coconut, arecanut and other live standards.

2. The role of mineral nutrition in relation to the wilt diseases and spike shedding.

3. Shade requirements of varieties especially of Panniyur I which is reported to be less tolerant of shade than other local varieties like Kalluvally and Karimunda.

4. Water management for the crop, especially the need for a water stress durng flowering/bearing stage.

5. The choice of standard, with special attention on the role of live standards in harbouring pests and pathogens *vis-a-vis* the cost of dead standards.

Adaptability of Panniyur I

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Panniyur I, the hybrid Pepper variety, evolved at Pepper Research Station, Panniyur has the maximum yield potential among the cultivated varieties in this country. The adaptability of this variety under different agroclimatic conditions is discussed in this paper.

The earliest yield data available for Panniyur I at the Pepper Research Station, Panniyur, is from a plot consisting of about 200 vines planted at a spacing of 2 x 2 m in 1965. An average yield of 6.3 kg of green berries (2.2 kg black pepper) is being obtained per vine annually from this plot. The highest yield of 16.8 kg green berries was obtained from a single vine from this plot. The comparative yield data for the two other popular cultivars Karimunda and Kalluvally are given in Table I and II.

TABLE I. **Yield of green berries in three pepper varieties***

	Panniyur I	Karimunda	Kalluvally
1. Average yield/vine/year (green berries) in kg.	6.26	3.22	0.82
2. Maximum yield from a single vine (green berries) in kg.	16.79	11.50	4.91

* The data for Panniyur I are from 196 vines collected during 1972-76 and for the other two varieties are from 330 and 160 vines respectively, collected during 1974-76.

TABLE II. **Stability of yield of some pepper varieties**

Sl. No.	Name of Variety	Yield of green pepper / vine / year (Average of 10 plants in germplasm collection in kg)				
		1973	1974	1975	1976	Average for four years
1.	Panniyur I	4.20	3.96	6.42	7.29	5.47
2.	Karimunda Type I	1.36	0.62	1.74	1.56	1.33
3.	Kalluvally I	1.67	0.87	3.92	3.00	2.37
4.	Cheriyakaniakadan	3.99	0.50	3.97	0.97	2.35
5.	Balankotta Type I	1.89	0.45	1.09	1.50	1.23
6.	Kottanadan	1.44	0.28	0.93	1.97	1.15
7.	Kuthiravaly	1.76	0.02	0.80	2.97	1.24
8.	Narayakodi	1.82	0.58	1.20	1.46	1.27
9.	Uthirankotta	0.62	—	0.32	0.71	0.55
10.	Veluthanamban	2.42	0.38	2.29	2.89	2.00

It is evident from this that Panniyur I is superior to the other two varieties. The maximum yield from a single vine of Panniyur I obtained at Pepper Research Station, Panniyur, was 32.5 kg green pepper.

A single vine of Panniyur I planted in 1968 at the Central Plantation Crops Research Institute, Regional Station, Vittal yielded 37 kg green berries (11.8 kg black pepper) in 1972, as against an average yield of 1.2 kg green pepper (0.4 kg black pepper) and a maximum yield of 5.6 kg green pepper (1.8 kg black pepper) per vine obtained from the variety Kalluvally. Though this may be considered as an extraordinary performance, it shows the yield potential of this hybrid variety under good management.

At Pilikode, Panniyur I was found to out-yield Balankotta and Kalluvally when grown as an intercrop in coconut garden. Panniyur I has been found to yield well even at higher elevation. (Table III).

TABLE III. **Yield data of Panniyur I for 1976 from the Horticultural Research Station, Ambalavayal**

Particulars		
1. No. of vines	—	136
2. Green weight of pepper	—	899 kg
3. Dry weight	—	319 kg
4. Average yield/vine	—	2.35 kg (dry)
5. Percentage of black pepper from green berries	—	35.4%
6. Calculated yield/ha	—	2345 kg (dry)

The above data shows the adaptability of Panniyur I under different agroclimatic conditions. The same view was held by a committee of experts which surveyed Panniyur I plantations in Kerala State some time back. They found the yield performance of Panniyur I satisfactory throughout the State under good management.

A number of multi-location trails are in progress in different parts of Kerala to compare the performance of Panniyur I with local cultivars. However, it has been found that under excessive shade, the hybrid has a tendency for excessive vegetative growth and poor setting resulting in reduced yield. Higher doses of nitrogen also promote only luxuriant vegetative growth and result in corresponding decrease in yield.

Current Breeding Programmes in Pepper

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Over 75 varieties of pepper are being cultivated in India, among which Karimunda, Kalluvally and Balankotta are popular in Kerala and Malligesara and Doddigya are popular in Karnataka, besides Panniyur I, a hybrid between Uthirankotta and Cheria Kaniyakadan. Panniyur I is the only hybrid pepper evolved from programmed breeding research in this country. This hybrid is outstanding in its yield potential. Average yield is reported to be about three times that of the popular North Kerala variety Kalluvally. Establishment of Panniyur I orchards in different regions of Kerala, Karnataka and to a limited extent, in Andhra Pradesh and large scale multiplication have resulted in extensive areas being brought under this hybrid variety. However, it cannot be taken for granted that Panniyur I will continue to yield high under all agro-climatic conditions. Our survey in different pepper growing regions in Kerala has indicated that the adaptability of the hybrid is not universal. For example, the hybrid has been observed to produce luxuriant vegetative growth, but gives only poor yield under excessive shade and at higher elevations. The percentage of light berries in Panniyur I has been reported to be about 10% as compared to only 3% in Karimunda. Also, it is not superior to local cultivars in tolerance to diseases and pests.

Among the established cultivars of pepper, Karimunda is the most popular among the growers in central Kerala. It is also popular with the processors. This cultivar has the capacity to yield uniformly even under adverse climatic conditions. It has lesser light berries compared to Panniyur I. The short spike length of Karimunda is compensated by the greater number of spikes per vine and the higher percentage of fruit set.

From the breeder's point of view, *Piper nigrum* has certain advantages like the presence of rich genetic diversity, largely cross fertilised nature, and heterozygosity, all of which could be exploited by programmed breeding. Clonal propagation makes it possible to fix hybrid vigour.

The centre of origin of pepper is assumed to be the forests of Western Ghats and survey conducted in the Karnataka Forests by the CPCRI has shown that there is rich genetic variability available for exploitation in berry size, spike length, percentage of female and bisexual flowers, percentage of dry to green pepper, non-volatile ether extract, volatile oil, crude piperine, crude fibre, starch and crude protein.

The Kerala Agricultural University has made a beginning, to survey and collect the natural variability available in the forests of

Kerala but the major areas in Kerala are yet to be surveyed.

Majority of the cultivated types of pepper are monoecious though variations from complete male to complete female have been reported. Protogyny in a majority of the cultivars suggests cross pollination. The pollination is assumed to be largely due to a combination of geitonogamy and rain drops.

The chromosome number in the cultivated varieties has been reported to be 2n = 48, 52 and 128. Intraclonal variation in chromosome numbers has also been observed and this is to be expected under large scale vegetative propagation. The reported chromosome numbers indicate polyploidy even among cultivars. The study of seedling population from individual cultivars, has shown wide variation for morphological characters indicating heterozygosity. This, combined with polyploidy, offers considerable scope for selection.

Quick wilt and slow wilt of pepper are becoming increasingly serious problems in parts of Kerala. It is necessary to locate resistance / tolerance to these diseases. None of the cultivars is found to be resistant to *Phytophthora* causing quick wilt, though two wild species, i.e. *Piper colubrinum* and *Piper obliquum* are reported to be resistant to *Phytophthora* in Indonesia and Sarawak. It is neccessary to screen the available germplasm for resistance to this pathogen and transfer resistance to the cultivated types.

Taking into consideration the above points, a breeding programme has been initiated at CPCRI Regional Station, Calicut to evolve improved varieties of pepper with respect to yield, quality and resistance.

The available germplasm collections are being evaluated for their yield and associated characters, quality aspects and tolerance to diseases and pests. The programme envisages raising about 20,000 seedlings every year either from open pollinated seeds of popular cultivars or from appropriate crosses made for combining desirable characters. About 5–10% vigorous seedlings among them are transplanted in the field. The unselected seedlings are screened against *Phytophthora* by inoculation. Seedlings showing relative tolerance at this stage are also transplanted in the field. The clonal multiplication, initial evaluation and screening against *Phytophthora* and nematodes will run concurrently. The final selection will be based on yield and quality against Panniyur I and Karimunda, and tolerance to diseases and pests.

The current pepper breeding programmes offer considerable scope and hope for evolving improved varieties with respect to yield, quality and resistance. We are fortunate that the centre of origin is in this region and the untapped genetic variability available for exploitation is tremendous.

Diseases of Pepper in India

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Ravages due to diseases play a major role in limiting pepper production in India. Though 15 fungi have been reported to be associated with pepper in India, only a few are economically important.

Quick wilt is the major disease of pepper in India. It is popularly known as foot rot in other countries and is reported to inflict considerable damage to plantations in Indonesia, Sarawak, Puerto Rico, Brazil and Jamaica (Holliday and Mowat, 1963). In India, the disease is noticed during the South West monsoon in all the pepper growing tracts of Kerala and Karnataka. The occurrence of pepper wilt in Wynad, Kerala was reported in 1906 by Butler. Though Venkata Rao (1929) isolated a *Phytophthora* sp. from pepper, he did not consider it a pathogen. The causative agent of wilt was first identified as *Phytophthora palmivora* var. *piperis* by Muller (1936) in Indonesia. In India, the pathogen was first isolated by Samraj and Jose (1966). They reported losses of upto 20% in plantations in Kerala due to the disease. But losses are higher in some endemic areas.

The disease is characterised by leaf infection, die-back of twigs and foot and root rot. The fungus also attacks spikes causing their shedding. In foot rot, the stem at the ground level and above (upto about 1 m) contracts the disease. The affected bark decays and peels off. Depending on the degree of rotting, the infection results in partial or total death of the bush. In the initial stages, only a few leaves of the affected vines show yellowing. With the advancement of the disease, the entire foliage turns yellow. Death occurs within 10 — 21 days of infection. The rotting at the collar region progresses downwards to the root system. Exclusive root infection alone also occurs. Often, small feeder roots are infected first. By the time the main roots contract infection, the feeder roots will have disintegrated. The predisposing factors of infection are high humidity and rainfall, low temperature (20–22°C) and poor drainage. Generally the disease occurs during the South West Monsoon period. But, when pepper is grown on arecanut under mixed cropping systems, the pathogen will be active even after the monsoon, from October to January. Since arecanut is grown under irrigated conditions in northern Kerala, the microclimatic factors will be congenial for the growth of the fungus during the post-monsoon period also.

A proper solution to this problem can only be the evolution of resistant cultivars. Wild species of pepper like *Piper colubrinum* and *P. obliquum* have been reported to be resistant to foot rot (Turner, 1971). Ruppel and Almeyda (1965) reported partial resistance in *P. aduncum*, *P. scabrum* and *P. treleasanum* in Puerto Rico. Though grafting was tried using these resistant lines as root stocks, poor establishment under field conditions was a hurdle in accepting this technique. Even if grafting is successful, aerial vines are still prone to infection resulting in foliage decay, die-back of twigs and spike shedding. Hence, incorporating resistance into the high yielding cultivars by hybridisation will only be the ultimate solution to this disease.

An array of wild types of pepper is available in the forests of Western Ghats in India. With a view to locating resistance in them screening work has been taken up at the CPCRI Regional Station, Calicut. None of the types tested so far has been found to be resistant.

At present, we are recommending only prophylactic control measures against the wilt disease. This is done by spraying the vines and drenching the soil around the vines with Bordeaux mixture and applying Bordeaux paste in the collar region. This is done twice, in May–June and August. In the event of a prolonged monsoon, a third application is necessary. Field trials are in progress to find out the critical time of application of the fungicide.

Once the pathogen establishes in a locality, it is difficult to eradicate it completely since it is soil–borne. Sufficient care should hence be taken not to transport nursery stock or soil from diseased garden to healthy ones. Nambiar and Sarma (1975) stressed the importance of phytosanitary measures in diseased gardens to avoid further crop losses. This includes removal and burning of completely wilted plants and their roots. Before gap filling, the planting pits should be treated with fungicides like 1% Bordeaux mixture or burnt with trash to kill the pathogen. Adequate provision for drainage is to be made in the garden, especially in mixed cropping systems.

The other important disease is "slow wilt". The disease was first reported from Wynad as early as in 1902. Krishna Menon (1949) reported mortality of upto 10% of the vines due to the disease. In Guyana, a similar disease called 'yellows' has been reported to inflict 30% loss to the crop. The disease is usually observed after the monsoon. The leaves of affected vines show general pallor and flaccidity and later fall off. After symptom expression, the vines decline slowly. The root growth is crippled as a result of attack and roots decay and perish.

Fungi like *Fusarium*, *Diplodia* and *Rhizoctonia* have been isolated from roots of affected vines (Krishna Menon, 1949). The root–knot nematode (*Meloidogyne incognita*) and burrowing nematode (*Radopholus similis*) have been observed in the root system of affected plants. Butler (1906) reported root–knot eelworm in pepper in Wynad. Recently, we have noticed a high population of *R. similis* in the root system of Panniyur I trained on arecanut palms in Bandadka (Kasaragod) and *M. incognita* in pepper plantations in Alacode (Taliparamba). Root–knot infection is becoming a serious problem in pepper nurseries too. Hubert (1957) observed that *R. similis* caused 90% damage to pepper plantations in Banka. Ting (1975) found that *Meloidogyne* sp. was associated with gradual decline of pepper in Malaysia. There are indications that deficiencies of some plant nutrients like P and K and soil moisture stress also play a role in the

disease incidence. This has been corroborated by the findings of Harper (1974). Ward (1969) reported disorders due to nutritional deficiencies in Sarawak.

Drenching the soil around the vines with 0.1% Ceresan wet in May – June and September–October has been recommended to control the pathogenic fungi. Application of Dasanit granules @ 20 gm / standard has been found to alleviate yellowing symptoms caused by nematodes. To prevent root-knot infestation in nurseries, disinifestation of potting mixture with methyl bromide @ 500 gm / tonne of soil under polythene cover for 24 – 48 ha is recommended. Alternatively Nemagon at 40ℓ a. i. / ha may be used. Out of the many common standards used for pepper, only *Garuga pinnata* has been found to be resistant to root-knot nematode (Koshy, Sosamma and Sundararaju, 1977). Hence great care is to be taken while selecting the standard. Because of the involvement of many factors in the incidence of the disease, this vexed problem is to be tackled on a multidisciplinary approach for evolving effective control schedules.

"Pollu" disease is caused by *Colletotrichum necator*. The fungus infects berries and leaves. Usually the discoloured berries occur in groups of two to five. The affected berries show in the early stages, water-soaked, brown, sunken, linear areas. The lesions turn dark brown and become larger in size. In later stages, the berries may split at the lesion site and acervuli of the fungus develop on the surface. The affected leaves show spots with concentric zonations. The disease was earlier reported by Krishna Menon (1949), as causing more than 25% loss. Vimuktananda and Celino (1940) reported a similar disease in the Philippines. Wilson (1960) recorded *Dioscoria triphylla* as an alternate host of the pathogen. Field screening of cultivars assembled at the Pepper Research Station, Panniyur, for two seasons (1973 and 1974) showed that the mean disease incidence ranged from 6 to 24%. Spraying with 1% Bordeaux Mixture or 0.2% Dithane Z-78 is recommended to control the disease. Shade regulation also helps in reducing the disease incidence to an extent. The mode of survival of the fungus, the most susceptible stage of the berries for infection, microclimatic factors which predispose the berries to infection, and the critical period at which spraying is necessary are, areas which require further investigations.

"Stump rot" caused by *Rosellinia bunodes* was first noticed in 1895 in Mysore (Butler, 1918). At first, a vine or several in a group appear to be affected by drought. The leaves wither, turn brown and drop off. In some cases, death is very sudden. New shoots rarely arise. Usually, the disease spreads in ever widening circles unless control measures are adopted.

The fungus also infects forest trees like *Grevillea robusta* and *Holigarna longifolia*. Digging trenches 50 cm. deep all around the vine helps to isolate diseased vines from healthy ones, and the affected vines are completely removed and burnt.

Other diseases of minor importance are the sclerotial wilt caused by *Sclerotium rolfsii*, damping off caused by *Rhizoctonia solani*, and red rust caused by *Cephaleuros mycoides*. Chowdhury (1943) observed sclerotial wilt in Assam, causing losses up to 67% in some of the plantations.

Pepper plantations are also prone to several other diseases against which careful vigil has to be observed, especially against the mosaic disease reported from Sarawak (Costa *et al*, 1970).

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Pests of Pepper

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Twenty species of insect pests are known to be associated with black pepper in India. The most important ones among them are the 'pollu' beetle, the top shoot borer, the marginal gall forming thrips and the scale insects and mealy bugs. Recently, two species of stem borers also have been recorded as new pests of black pepper.

The 'pollu' beetle, *Longitarsus nigripennis* Mots. (Coleoptera: Chrysomelidae), commonly known as 'flea beetle', is small, shining brownish black and is capable of jumping long distances. The adult beetle lays eggs in small shallow depressions made on the rind of tender pepper berries. The eggs hatch out into pale yellowish grubs which in their turn bore into and feed on the contents of tender berries making them hollow. The external indication of infestation is the presence of dark drying berries possessing characteristic circular holes in the midst of green healthy berries. A single grub destroys three or four berries. Fully fed grubs drop to the soil, construct oval earthen cocoons and pupate inside them. The total life cycle of the pest takes 40–50 days. It completes four generations between July and January. Egg laying stops by December when the pepper berries mature (Nair, 1971). The extent of damage caused by 'pollu' beetle goes up to 40% of berries in certain endemic areas. Observations on seasonal abundance of this pest reveal that the beetle is active in the field from July to February. But the maximum pest population has been noticed in November. No alternate host or natural enemy of the pest has been hitherto recorded.

Studies on the intensity of incidence of 'pollu' beetle on different cultivars of pepper available in the germplasm assemblage maintained at the Pepper Research Station, Panniyur during three crop seasons from 1972 to 1974 have shown that high yielding cultivars like Karivally, Karimunda and Panniyur I suffered very heavy incidence of the pest ranging from 40 to 57% spike infestation whereas Kalluvally Type II, a popular north Kerala cultivar, recorded only 0.2 to 1.8% spike infestation. Though cultivars like Uthirankotta I and II, TMB V and Shimoga were practically free from pollu beetle infestation, the total number of spikes and berries on the vines were very small.

Cultural operations like raking the soil and regulation of shade of standards are reported to be beneficial in reducing pollu beetle infestation. Soil application of insecticides can also be effective in controlling the grubs falling to the ground for

pupation. However, chemical control trials carried out with granular insecticides like phorate, thiodemeton, carbaryl, carbaryl + lindane, lindane, carbofuran, mephospholan and trichlorphon did not bring about any significant reduction of pest incidence. Rahiman and Nambiar (1967) recommended spraying of pepper vines with 0.2 % DDT twice in July and October for the control of pollu beetle infestation. In view of its high retentive toxicity, DDT spray is not being recommended in recent years. Pillai and Abraham (1974) recommended two sprayings with 0.1% dimethoate or 0.1% quinalphos in late July and early October. These insecticides were more effective than 0.2% DDT.

Where 'pollu' disease caused by the fungus *Colletotrichum necator* is also responsible for crop losses, a spray schedule involving a combination of both fungicide and insecticide would be more economical.

The top shoot borer *Cydia (Laspeyresia) hemidoxa* Meyr. (Lepidoptera : Eucosmidae) is another major pest of pepper. The caterpillars of this tiny crimson and yellow coloured moth, damage the terminal shoots of pepper vines by boring into them. The intensity of incidence of this pest will be more during the period from August to December, when succulent shoots will be available on pepper vines. As the caterpillar bores into the terminal shoot the growing point is damaged and this results in drying of the terminal portions of the vines. The pest takes about a month to complete its life cycle. The intensity of top shoot borer incidence on different age groups of Panniyur I vines (planted in 1970, 1971 and 1972) recorded in 1972 was 23.8%, 26% and 6.4% respectively. The maximum intensity of incidence of upto 48% shoot damage was noticed in a newly raised one-year old plantation in south Kerala. Three species of hymenopteran parasites, viz., *Apanteles* sp. (Braconidae), *Eduderus* sp. (Eulophidae) and *Goniozus* sp. (Bethylidae), have been reported as natural enemies of pepper top shoot borer. The former two species parasitise late stage caterpillars and the latter early stage caterpillars of the pest (Visalakshy and Joseph, 1965). Spraying the vines with dimethoate or phosphamidon at 0.05% concentration has been found to be effective in controlling top shoot borer infestation.

The marginal gall forming thrips *Liothrips (Gynaikothrips) karnyi* Bagnall (Thysanoptera: Thripidae) is a persistent pest problem in almost all the pepper growing tracts of India. The thrips make marginal galls on the leaves within which they live in colonies. Due to the rasping and feeding activity of the adults and immature stages of thrips, the leaf tissues become thick and in severe cases of infestation the whole leaf presents a crinkled or malformed appearance. As a result of thrips infestation, hyperplasia or proliferation of parenchymatous cells sets in, and finally the leaves become brittle. An anthocorid bug and a species of mite have been recorded as predaceous on this thrips. They are found within the marginal galls feeding on the immature stages of thrips only and not on adults (Visalakshy and Joseph, 1967) Spraying the vines with 0.1% malathion or 0.05% dimethoate or quinalphos was efficaceous in controlling thrips infestation.

The scales and mealy bugs also often cause considerable damage to pepper. The scales *Lepidosaphes piperis* Green (Coccidae) appear as small dark grey boat shaped encrustations on the stem and leaves of pepper vines. These suck plant sap and the badly infested vines dry up gradually. Other coccids like the mussel scale *Lecanium marsupiale* Green, the hard scales *Aspidiotus destructor* Sign., *Pinnaspis aspidistrae* Sign., *P. marchalis*

Cockll. and *Chionaspis varicosa* Green, and the mealy bug *Ferrisia virgatus* Ckll. also infest pepper vines and spikes. Spraying 0.1% malathion or 0.05% dimethoate will be effective in controlling coccid infestations.

The maggot of the gall midge *Cecidomyia malabarensis* Felt. (Diptera: Cecidomyidae) is embedded in the pulp of berries and at the attachment of berry to the spike. The full grown maggot falls to the ground and pupates in the soil. Eggs are laid on the spikes. Infested berries increase in size in the beginning but appear stunted later. Swelling may be caused on the tender stalks and shoots also.

The flea beetles. *Pagria constatipennis* J. and *Neculla pollinaria* B., feeding on leaves and the weevil *Eugnathus curvus* Fst. damaging tender foliage have been reported (Nair, 1975) Severe infestation of pepper foliage by the weevils *Myllocerus* sp. has been observed by the author.

Recently, *Pterolophia annulata* Chevr. and *Diboma procera* Pasc. (Coleoptera: Cerambycidae: Laminae) have been recorded as new stem borer pests of pepper vines. The grubs of these longicorn beetles tunnel into and feed on the central core of the stem. The tunnels will be tightly packed with frass as the grub progresses forward. The grubs are often found in older and dead vines. They are also noticed tunnelling into the live vines at the collar region or slightly above. However, the grubs prefer dead and dried tissues (Dubey *et al.*, 1976). Biology and seasonal abundance of these pests are still under study. No natural enemies of these pests have been recorded. Chemical control schedules against them are yet to be worked out.

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Pepper Cultivation in Kozhikode District

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Kozhikode is the second largest pepper growing district in Kerala producing about 4800 tonnes from an area of about 20,500 ha. It is a very important cash crop grown all over the district except for the sandy coastal areas. It is a major source of income for a large number of small farmers.

Pepper enjoys a unique position in the cropping system adopted by farmers in the district in as much as every homestead has a few pepper vines trained on tree crops like coconut, arecanut, jack and mango. Small scale plantations, where pepper is trained on standards like *Erythrina*, are common in areas occupied by settlers from the southern districts of Kerala. However, mainly because of the poor economic conditions of the growers and lack of knowledge of the modern methods of cultivation, the crop seldom receives scientific management. In most cases the vines are not high yielders. Yields were high in the initial stages when virgin soils were brought under cultivation but yields have declined considerably. There is therefore, an urgent need to popularise high yielding varieties and scientific agronomic practices. *Erythrina*, the most frequently used standard, is a short lived plant particularly when raised from cuttings. Moreover, it does not provide the requisite shade for pepper vines during summer. The live standards in general compete with the vines for plant foods and harbour pests and diseases. Hence, we need suitable alternate standards for pepper.

A sizeable percentage of vines in most gardens are extremely low yielders. Even when the farmers are convinced of the need for replanting, they are reluctant to do it, because of the sudden loss in income. If proper encouragement is given for replanting, through distribution of rooted cuttings and financial assistance, these gardens can be rejuvenated.

The pests and diseases affecting the crop have assumed alarming proportions in recent years. The quick and slow wilt diseases have practically wiped out many pepper plantations, small and large. This malady is spreading fast in all the pepper areas. The recommended control measures — spraying with Bordeaux mixture and application of organomercurial compounds in the soil — have not been able to control the diseases to any appreciable extent. The cost of the plant protection operations is prohibitive with the result that the ordinary farmer is unable to adopt them. Cheap and effective control measures are to be evolved for this disease. The 'pollu' pest is also inflicting severe crop losses every year.

The farmers are reluctant to take up replanting in areas where the vines have been destroyed by wilt since there is a widespread belief that the new vines planted may also get affected very soon. In view of this uncertainty, the farmers are switching over to other crops like coconut and cocoa. This problem therefore is to be looked into.

There is a great demand for rooted cuttings of the high yielding hybrid pepper Panniyur I. The farmers are not getting this material in sufficient quantity. The cuttings are distributed in very small numbers and are priced very high on account of the transporting charges levied. There is thus a need for establishing a few nursery centres for production and distribution of rooted cuttings in sufficient numbers.

Although credit facilities to meet the requirement of growers are provided by banks and co-operative societies, most of the farmers are not utilising the facilities due to procedural delays involved. There is urgent need to simplify these procedures for farmers seeking financial assistance.

With the present marketing practices in vogue, the growers do not get reasonable prices for their produce with a good portion of the profit going to the middle men. The activities of the co-operative marketing societies are to be strengthened and procuring centres have to be opened in all the major pepper growing areas. The growers in most cases sell their crops before harvesting itself to meet their urgent needs for money. This also results in their getting very low prices. If co-operative societies can advance loans to the farmers on the guarantee of the standing crops, this loss could be avoided.

The Programmes and Prospectives of Pepper Development in India

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During 1976 – 77, India produced 31,580 tonnes of black pepper from an estimated area of 1,14,180 ha. The present production is not adequate to meet the increasing demand for export and domestic consumption. The global requirement of pepper for import by 1980 as estimated by the International Trade Centre is 1,17,000 tonnes against the quantity of 95,000 tonnes imported in 1974. In other words, about 4% increase per annum in the world import of pepper is anticipated. India has therefore to produce about 45,000 tonnes of pepper by 1983 to retain its present share of 25–30% in the world export and to make available 10–12 thousand tonnes for internal consumption. The increase in production required by 1983 can be achieved if the annual growth rate of production is maintained at 9% during this period.

The production of pepper remained almost static around 26,000 tonnes for a number of years in the past. Although there has been a notable increase in the area, this has not proportionately reflected in production. The average yield of pepper in India is 275 kg/ha, which is the lowest in the world as compared to 529 kg in Indonesia, 3421 kg in Brazil and 4130 kg in Malaysia.

Whatever may be the present level of maintenance of the gardens in India, increasing the production of pepper here is not a stupendous task. A concrete effort by the development agencies to educate the farmers on the scientific cultivation of the crop is the immediate need. India has the maximum area of 1,14,180 ha under pepper (96% of this area is in Kerala State and the rest in Karnataka, Tamilnadu, Goa and Pondicherry) while all the other producing countries jointly have only less than this or an equal area. A rise in the average yield of pepper by 120 kg/ha during a period of five years gives an additional production of about 13,500 tonnes. This is a plausible proposition, as by the adoption of the known package of practices alone the per hectare yield can be raised to 600 kg under normal conditions. The yield

could be further increased by growing the hybrid variety Panniyur I, which under average management gives a minimum of 1 tonne/ha.

Pepper development programmes envisaged and implemented in the V Plan had a two pronged approach of both extensive and intensive cultivation. Emphasis was given for the multiplication and distribution of planting materials of Panniyur I on a large scale. An area of about 72 ha has already been covered under progeny orchard of this variety in Kerala and in potential areas of other states and nearly 18 lakhs rooted cuttings of this pepper have been distributed to cultivators. Demonstration plots of Panniyur I numbering 680 have already been laid out in the traditional and non-traditional areas.

A comprehensive programme implemented for increasing the production of pepper on a rapid phase is the package scheme. As per this scheme, about 30,000 ha of pepper in Kerala were programmed to be brought under scientific cultivation practices by the end of V Plan. To facilitate the implementation of the package scheme effectively, the area has been divided into smaller units of 1000 ha, and each unit is manned by a qualified technical officer. In every unit, about 360 manurial-cum-plant protection demonstrations are laid out for educating the farmers on the scientific method of manuring and control of pests and diseases. These demonstrations will have an effective area of about 80 ha which is nearly 8% of the area under each package unit. The plots are maintained for five years with the objective of demonstrating the effects of balanced manuring and timely plant protection operations. During the first three years, 75% of the cost of plant protection and fertilizers, and in subsequent years 50% of the cost of these inputs, are borne by the Government.

Since more than 10% of vines in the pepper gardens of Kerala are senile, diseased or dead, a replanting programme to rejuvenate the gardens is necessary to increase production. To induce the farmers to take up replanting, the planting materials are distributed at a subsidised rate of 10 paise/cutting.

The success of implementation of these programmes depends upon the extent of adoption of the scientific cultivation practices by the farmers. A majority of them are marginal and small farmers and they require finance for purchasing various inputs required for scientific cultivation. It is the responsibility of the officer of the package unit to prepare a production plan for each pepper holding and to arrange loan from institutional agencies. He has also to help the farmers in solving their field problems while they adopt scientific cultivation practices in their gardens. So far, 20,000 ha have been brought under the package scheme, 3500 manurial-cum-plant protection demonstrations laid out and 2 lakhs rooted cuttings of Panniyur I distributed for replanting.

The effect of these development measures in increasing production is reflected gradually and will become notable only during the ensuing plan.

The strategy for the development of pepper followed in the V Plan, viz., adoption of intensive cultivation as well as expansion of area under the crop is proposed for the VI Plan also. In order to achieve an increase in production by the end of 1983, it is necessary that the package scheme is continued in the VI Plan with a programme to cover about 60,000 ha in Kerala. The components of the scheme may be the same ; but the size of the package units has to be reduced to half for effective implementation of the development measures and

for personal contact of the farmers by the technical officers. Similarly, the programme for multiplication and distribution of planting materials of high yielding variety of pepper for enlarging the area under cultivation and to take up replanting programmes has to continue. As the size of the existing progeny orchard is insufficient to meet the increased requirement of rooted cuttings, the area may be increased, or new ones established in potential areas.

The prevailing price of pepper is very attractive to the farmers. A growing awareness has already been created in the minds of farmers to pay more attention to pepper. Therefore, the targetted production of 45,000 tonnes is likely to be achieved by the end of VI Plan.

Pepper Development Programme in Kerala

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India is the largest producer and exporter of pepper with an estimated annual production of 31,580 tonnes from 1,14,180 ha during 1976-77. Kerala alone contributes about 96% of the country's production.

In Kerala, pepper is cultivated on an extensive scale in Cannanore, Idukki, Calicut, Ernakulam, Kottayam and Quilon districts. In the northern districts, it is grown on a plantation scale but in other areas, it is grown mostly in homestead gardens along with a variety of other crops on such supports as mango, jack, coconut and arecanut. The average yield in the southern districts is about 330 kg/ha whereas in the northern districts it is only 110 kg. More congenial agroclimatic conditions and better attention from the farmers may be the reasons for higher yields in the southern districts.

Scope for expansion of area under pepper

The average size of farm holdings in Kerala is only 0.73 ha. Scope for further expansion of area under this crop is very limited, and therefore any increase in the total production in the coming years has to be planned on the basis of increase in yield per vine by intensive cultivation practices.

Programmes undertaken by the Department of Agriculture

The Department of Agriculture, Kerala provides technical know-how, distributes rooted cuttings of Panniyur I and other popular local varieties like Karimunda and Kottanadan and sells plant protection chemicals at subsidised rates to deserving farmers.

1. *Establishment of central nurseries for hybrid pepper:* One of the major programmes for the development of pepper is the multiplication and distribution of rooted cuttings of Panniyur I. The existing progeny gardens of about 20 ha at Neryamangalam and Taliparamba will be further expanded to 32 ha. In addition, two more new centres will be opened in the district agricultural farms functioning under the department. Besides the large scale multiplication of Panniyur I, some of the other popular local varieties also will be multiplied in the central nurseries.

2. *Package programme for pepper:* The Department of Agriculture has a massive package programme on pepper to pro-

mote intensive methods of cultivation, including use of high yielding varieties in selected areas. The measures include: 1) intensification of extension activities through group meetings, symposia, study classes, film shows and exhibitions, 2) organisation of field demonstrations to educate the farmers in improved methods of cultivation by providing the required inputs and credits in time, and 3) replacing old and unproductive vines with Panniyur I in a phased programme.

Demonstration on Panniyur I

Pepper demonstration plots having 50 vines of Panniyur I are being laid out in growers' lands. A total of 445 such plots were planned for the V Plan period. This is in addition to the 260 plots already laid out during the IV Plan. The expenditure for a plot is estimated to be Rs. 220/year during the first two years and Rs. 150/year during the remaining three years. The Government will bear 75% of the cost of plant protection chemicals and fertilizers for the first two years and 50% for the remaining three years.

Manurial cum plant protection demonstration in existing pepper gardens

In the package areas, a new programme for manurial-cum-plant protection demonstration in existing pepper gardens has been introduced. In addition, a scheme for replanting old and unproductive pepper vines with hybrid pepper is also contemplated for adoption in demonstration plots. The replanting programme is not restricted to demonstration plots, but has been extended to the entire package area. Each demonstration plot will be 0.25 ha in size having 275 vines. The estimated expenditure/plot including manuring and plant protection operations works out to Rs. 636/year. Seven thousand such plots are planned. The Government will meet 75% of the cost of plant protection and fertilizers for the first five years, and the remaining 25% will be borne by plot owners in the form of cattle manure and labour charges. In addition, for every such 100 demonstration plots, Government will pay Rs. 600 towards the cost of plant protection equipment (one rocker sprayer and five polythene buckets and repair charges). The equipment will be made use of on a co-operative basis under the guidance of a Junior Agricultural Officer of the Department. The plots are intended to be maintained for five years and are meant to fully demonstrate to the farmers the benefits of adopting the recommended package of practices.

Replanting programme

Though the total area covered by the demonstrations will be only 1750 ha, the replanting programme has been planned for the entire package area of 30,000 ha to be implemented in a phased manner. The pepper cuttings required for replanting will be given to the farmers at a subsidised rate of 10 paise/cutting against the estimated cost of 30 paise/cutting including transport charges. It has been estimated that a total of 136,250,000 cuttings will be required for replacement of old and unproductive vines during the V Plan period. This replanting programme will be subjected to availability of rooted cuttings from the central nurseries established in the state.

All the above programmes are being implemented simultaneously in the pepper package units of the state. Altogether 20 such package units have so far been organised in the state covering 20,000 ha at the rate of 1000 ha per unit. Ten more units will be organised during 1978-79. Ultimately 30,000 ha of pepper gardens will be benefitted by the package programme by the end of the V Plan period.

The investment required for rehabilitation of one hectare of pepper plantation by replanting of 50% of vines and maintenance of the remaining unproductive vines would be about Rs. 18,810 for a period of five years. Huge amounts will have to be provided for rehabilitation programmes, considering the vast areas which require rehabilitation. The Agricultural Refinance and Development Corporation should be moved to finance this development programme by extending credit facilities for the purchase of fertilizers and pesticides. It will be possible to enhance the production of black pepper in the country by 30%, if the scheme is implemented properly.

Programme for Pepper Development in the Kerala Agricultural Development Project

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The Kerala Agricultural Development Project (KADP) was prepared by the Government of Kerala with the assistance of a FAO/IBRD Co-operative Programme Mission which visited India in 1973. An Appraisal Mission of the International Development Association (IDA) visited India in 1976, and on the basis of its appraisal, the Project was approved for financing by the World Bank in February, 1977. The total estimated cost of the Project is about Rs. 63 crores spread over a period of seven years commencing from 1977–78. The Project has, as its main objective, the improvement in productivity of major foreign exchange earning tree crops and pepper with emphasis on improving the economic status of small holder farmers. It covers new planting and rehabilitation of coconut with systematic intercropping with cocoa, fodder and seasonal food crops, pepper rehabilitation, cashew development, establishment of seed gardens, and processing of small holder rubber. Assistance to small holders for agricultural development is offered mainly in the form of long term institutional credit and special extension services. Other support services included in the Project are research, technical assistance and training. It is proposed to deal in this paper only with programmes for pepper development under the KADP.

Pepper is grown mostly in the submontane tracts of the Western Ghats in South India and 96% of the total production of pepper in India comes from Kerala. It is mainly grown by small farmers often in mixed cultivation with coconut, arecanut and coffee. The average yield in Kerala is rather low at 275 kg/ha, as compared to 529 kg obtained in Indonesia and about 4000 kg in Malaysia. The poor yields in India are attributed to the low use of improved varieties, senile vines, prevalence of diseases like slow wilt and quick wilt and inadequate cultivation practices.

The pepper development programme under the KADP consists of rehabilitation of about 10,000 ha of pepper areas in Cannanore, Kottayam and Idukki districts. On an average, about 50% of the existing vines in these areas are estimated to be senile and uneconomic. Moreover, these older plants are susceptible to diseases. Rehabilitation activities would include replacing 50% of the vines with high-yielding types and introduction of improved cultural practices as recommended by the Department of Agriculture. Pepper reha-

bilitation is proposed to be done on the basis of 'Intensive Package Unit' approach in compact units of 500 ha each.

For replanting, rooted cuttings of the variety Panniyur I and accredited conventional varieties like Karimunda, Kalluvally and Kottanadan would be used. Latter types would be preferred for less open situations.

It is estimated that the present pepper yields in the Project area average around 270 kg/ha. The expectation is that yields would be 1100 kg/ha from the new vines and 650 kg from the rehabilitated vines. Assuming a gradual improvement in yields in the 10,000 ha replanted and rehabilitated, pepper production would more than double from 2600 tonnes to 6200 tonnes by the end of the seventh year and increase to 8700 tonnes by the thirteenth year when replanted vines reach full production.

One of the programmes included in KADP is setting up of a seed garden complex in about 500 ha of reserve forest land in Malappuram District. This is designed to meet our future needs for replanting large areas of existing plantations and for establishing new plantations. In the seed garden complex, seed multiplication for coconut, cashew, cocoa, pepper and other important spices would be undertaken. It is proposed to plant 35 ha in the seed garden complex with pepper.

It is also proposed to replant an area of about 3600 ha annually. This area, with an intensity of 3300 vines/ha, will require about 12 million rooted cuttings for planting. The present production capacity in the state is estimated at 1 million cuttings. This could be expected to increase to 2.5 million cuttings in the near future. One hectare of mature pepper has an annual production potential of 100,000 cuttings. The 60 ha garden planned by the State Farm Corporation could, in due course, produce 6 million cuttings leaving a shortfall of 3.5 million cuttings. Thus, an additional 35 ha under the Project should be adequate to fill the gap of 3.5 million cuttings.

*The package units for pepper rehabilit*ation under the KADP number 20, of which ten will be set up in Cannanore, two in Kottayam and eight in Idukki districts over a period of three years. Five units have already been set up during 1977–78. Ten more units will come into being during 1978-79 and the remaining five units in 1979-80.

The incremental output of pepper at full production as a result of implementation of the project is estimated at 6000 tonnes.

The strategy for implementation of the programme also deserves mention in this connection. In each of the 500 ha units, a team headed by a Junior Agricultural Officer and assisted by two Agricultural Demonstrators will be set up. They will contact individual farmers and prepare an inventory, of the farmer's resources. Based on this inventory, a farm plan would be prepared in respect of each farmer who is willing to participate in the implementation of the programme. The extension team will also help the farmer in preparing application forms for long term and short term loans. The applications will be processed and forwarded with the recommendation of the Junior Agricultural Officer appointed by the Special Agricultural Development Unit (SADU) to the bank which finances the farmer. The choice of the bank for financing the programme rests with the farmer. According to the banking plan prepared by the Agricultural Refinance & Development Corporation, one commercial bank has been nominated for each of the 20 units. The farmer may avail of the long term loan required for implementing the programme either from the nominated com-

mercial bank or the primary land mortgage bank that has jurisdiction in the area. In the case of the commercial bank, both long term and short term loans will be made available by the bank itself. In the case of the farmer availing himself of the loan from the Co-operative Land Mortgage Bank (CLMB), the required short term credit will be made available by the concerned service co-operative societies. To facilitate easy disbursement of loans, arrangements have been made for a supervisor of the CLMB to be available at the service co-operative society itself, so that the farmer need approach only the service co-operative society for meeting his credit requirements. Planting materials, fertilizers and plant protection chemicals will also be made available to farmers.

The total cost of the pepper rehabilitation programme for seven years excluding contingencies is estimated at Rs. 8.51 crores. The maximum loan sanctioned per hectare will be Rs. 9300 which will bear interest at 11%/annum. The period of loan will be 11 years of which four years will be treated as grace period.

A separate organisation called the Special Agricultural Development Unit (SADU) has been set up for implementing the Small Holder Development Programmes under the Kerala Agricultural Development Project. It operates through District Officers at Cannanore, Kozhikode, Malappuram, Trivandrum, Idukki and Kottayam and teams headed by a Junior Agricultural Officer and assisted by two Agricultural Demonstrators are in charge of package units of 500 ha each.

Pepper Development Programmes in Karnataka

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Pepper is cultivated mostly in the submontane tracts of Western Ghats in India. Kerala gives the needed impetus for pepper production by accounting for almost 96% of the country's total. The present area under pepper in Karnataka is 4876 ha with an annual production of 2560 tonnes of black pepper, giving the state second position both in area and production of pepper in the country.

Pepper cultivation is popular in the districts of South Kanara, North Kanara, Coorg, Hassan, Chickamagalur, Shimoga and other Malnad areas. While pepper is grown to a considerable extent as a pure crop in the districts of South Kanara and North Kanara, it is popular as an intercrop in coffee plantations in Coorg, Hassan and Chickamagalur. When grown as a pure crop, vines are trained on *Erythrina indica*. As an intercrop it is trained on coconut, arecanut, mango, jack and other trees.

The plant population and yield of pepper as an intercrop differ in areca gardens and coffee plantations. As an intercrop in areca gardens in South Kanara and North Kanara, about 400 500 vines are accommodated in one hectare. However, there is no uniformity in the number of vines accommodated per hectare. In coffee plantations the vines are trained on shade trees like *Grevillea robusta*, *Ficus* sp. and *Eugenia jambolana*. The number of such shade trees per hectare may range from 100–125. Two to three vines are planted around each tree and yields vary from 1 to 1.5 kg of dry pepper.

Normally, 120–150 kg pepper is harvested from one hectare of coffee plantations interplanted with pepper. When pepper is grown as an intercrop with coffee, the cost of cultivation is almost negligible because weeding, shade regulation and other management practices required for coffee will suffice for pepper also. There is no systematic package of practices followed for pepper when it is grown as an intercrop with coffee.

To bring large areas under pepper and to boost up its production in Karnataka, the Department of Horticulture started full fledged development programmes during the III Plan period. Nurseries were established at Puttur and Karkala in the South Kanara district, Mercara and Poonampet in Coorg, Sirsi and Kumta in North Kanara district, Mudigere in Chickamagalur district, Sakaleshpur in Hassan district and Thirtha-

* Deceased

halli in Shimoga district and these nurseries supplied about 9.88 lakhs rooted cuttings to cultivators. During the IV Plan period, 13.26 lakhs rooted cuttings were supplied and it is proposed to supply 22.50 lakhs cuttings during the V Plan period. Of this target, 13.22 lakhs cuttings have been supplied in 1976–77.

In addition to the state plan schemes, Government of India has sanctioned a scheme for establishing two progeny orchards of 4 ha each of Panniyur I at Sullia and Ramasamudra in the South Kanara district to supply 1.20 lakhs pepper cuttings with an expenditure of Rs. 1.62 lakhs during the V Plan period. Further, the State Government has accorded sanction for the establishment of one more progeny orchard in North Kanara district.

The Government of India has also sanctioned another scheme to popularise the cultivation of Panniyur I wherein it is proposed to layout 70 demonstrations during the V Plan period.

Prospects of Pepper Cultivation in Andhra Pradesh

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The cultivation of pepper in India was confined till recently to the ideal conditions of environment available in Kerala, Tamilnadu and Karnataka which constitute the traditional pepper growing areas in this country. It was only in the early 1960's that serious thought was given to introduce pepper in the Agency Areas of Andhra Pradesh. The State Forest Department pioneered this venture and pepper vines were introduced in the coffee plantations at Maredumilli in Rampa Agency in 1961–62 as a subsidiary crop trained on some of the shade trees retained in the plantations. These initial trials were more of an exploratory nature to assess the potential of pepper in this region. Though attention in the initial cultivation of pepper as an associate crop in the coffee plantations was concentrated at Maredumilli in Rampa Agency (500 m above MSL), attempts were also made to introduce it at higher elevations in Chintapalli Plateau (800 m above MSL). These trials were also encouraging and by 1972–73 the Forest Department had about 3700 bearing pepper vines in their coffee plantations. However, till the early 1970's the cultivation of pepper received only secondary attention, the prime attention being on coffee plantations. Panniyur I was introduced at Maredumilli as well as at higher elevations such as Raghavendranagar and Vangasara in Chintapalli Plateau and Minumuluru in Paderu Agency. However, because of the greater success achieved at Maredumilli, the cultivation of pepper is receiving greater importance in this place. Subsequent to 1972–73 pepper has been raised on as many as 22,760 standards at Maredumilli.

Performance of pepper in these non-traditional areas is determined by the latitude, altitude, rainfall and humidity. Maredumilli is located at an elevation of about 500 m above MSL in the Eastern Ghats in the East Godavary District. Being in the northern latitude (18°N), as compared to the traditional pepper growing areas (around 10°N), the summer here is hotter and the winter much colder. The annual average rainfall in this region is around 1500 mm. The bulk of the rainfall is received during the South West Monsoon. The quantity of the rainfall received during North East Monsoon is uncertain and is in the form of cyclonic winds combined with

heavy rainfall for short duration. The dry season commences in December and continues upto June. The summer is hot with the temperature rising upto 44°C. The minimum temperature in December-January may be as low as 5°C in Maredumilli. At Minumuluru (1000 m above MSL), the terminal shoots of pepper dry during winter.

On an experimental basis Karimunda, Kalluvally, Balankotta, Kottanadan and Arakulamunda cultivars were introduced from 1961–62. Panniyur I variety was introduced from 1971.

At Maredumilli, an average yield of 0.8 kg/vine was obtained during 1975–76 comparing very well with the yield obtained in the traditional areas. The quality has been reported to be slightly inferior to the pepper produced in Kerala. The successful experimental cropping of pepper in these non-traditional areas has shown that there is considerable scope for large scale cultivation of pepper in this region. Pepper can be interplanted in coffee plantations training them on shade trees. Considering the high target for production of pepper during the coming years and the limited scope for expanding area in traditional areas, it is necessary to pursue the programme of large scale planting of pepper in the non-traditional areas of the east coast.

A proposal for intensifying the introduction of pepper to the east coast and initiating research was considered by the 9th meeting of the Indian Spices Development Council held at Hyderabad, and accordingly, a committee was constituted to visit the pepper growing areas of Maredumilli, Raghavendranagar and Minumuluru. The Committee consisting of four experts visited these areas during 1976. The Committee recommended large scale testing of established varieties like Kottanadan, Karimunda, Panniyur I and Karimalligesara at various centres in the east coast. It also recommended to explore the possibilities of interplanting pepper in coconut and banana gardens in the east coast and to start a research centre to conduct experiments on screening varieties, standardising the agrotechniques and prevention/control of pests and diseases. The Andhra Pradesh Forest Department has already agreed to provide the infrastructure for starting the research station.

The Indian Council of Agricultural Research has accepted in principle the establishment of a research station for spices in Andhra Pradesh to be managed by the Andhra Pradesh Agricultural University and it is to be hoped that the research station when established will help to open new vistas for the expansion of pepper in these non-traditional areas.

Quality Aspects of Pepper and Pepper Products

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Pepper *(Piper nigrum L.)*, called the 'King of Spices' is the major exportable spice grown in India. As much as 20-25 thousand tonnes of pepper are exported annually earning a foreign exchange of Rs. 35-40 crores which account for 50% of the entire export earnings from spices.

It must be mentioned here that pepper, although native to India, is not very much patronised by Indians. The per capita, annual consumption is as low as 10-15 g which is mostly consumed by the westernised sector and partly in dietaries with an accent on therapeutic value. Only in some special flavourings, pepper finds use in Indian culinary practice. Because of generally good performance in export market, promotional activities in internal market have not been much thought of in India. It would be interesting to note that the per capita consumption of pepper in countries of the West, where it is not grown, is quite high (Table I). In recent years the demand for pepper in East European countries has also been going up.

The various quality factors of the spice and its end use are interrelated and so it is worth examining here what these factors

TABLE I. **Per capita consumption of black pepper in selected countries**

Country	Per capita consumption, g	
	1954-58	1964-65
Argentina	32	51
Australia	45	60
Canada	82	82
Denmark	68	88
France	50	65
Italy	32	47
Japan	3	13
Netherlands	36	51
Sweden	84	60
U. A. R.	20	31
U. S. A.	100	102
U. K.	58	51
West Germany	64	78

are in order of their importance. Table II gives approximate composition of pepper[2, 3, 4, 5]. Though starch, fibre and fat form the major constituents, from the point of view of quality, the significant constituents are the pungent principle, piperine and the aroma giving essential oil. In many products, the ultimate colour and appearance are also important.

Pungent Principles

Of all the quality factors, the trade appears to value pungency more than any other factor in each category of pepper product. The emphasis laid on aroma is not much. The main pungent constituent is piperine, which is an amide of piperic acid and piperidine. Pepper also contains small quantities of chavicine *(cis-cis* isomer of piperine, which is *trans-trans)* and piperettine which possesses sharp bite and pungency[6].

Essential Oil Association (EOA) recommends the estimation of piperine by nitrogen estimation after solvent extraction[7]. Because of other nitrogenous material present in pepper, this method estimates only 'crude piperine' and also allows adulterations of pepper product with nitrogen containing compounds like urea, glycine, hexamethylene tetramine and cinnamyl acryloyl piperidide[8]. The other method which is popular and is now commonly used is the one based on spectrophotometric reading at 345 nm in benzene or chloroform solution. It has been shown that the 'heat value' of pepper corresponds more closely to piperine content determined by spectrophotometric method[9]. In view of this, ISI has adopted this method for estimation of piperine in pepper oleoresin[10]. However, it is claimed that the spectrophotometric method is very specific for piperine and thus this method fails to measure the presence of other pungent

TABLE II. **Composition of pepper (in percentage)**

	Black pepper[2]	Fresh pepper[3]	Black pepper[4]	Black pepper[5]
Moisture	12.0	68.0	11.4	10.6 – 13.0
Volatile oil	—	2.1	2–4	0.7 – 1.6*
Total ash	5.4	—	6.1	3.1 – 6.5
Acid insoluble ash	0.02	—	—	0.0 – 1.2
Oleoresin yield	12.5	—	—	— —
Piperine	6.5	—	—	— —
Piperine in oleoresin	52.0	—	—	— —
Non-volatile ether extract	8.3	8.1	6.5	6.9 – 10.4
Crude fibre	15.8	14.1	11.5	10.8 – 18.3
Ascorbic acid	—	3.2mg	—	—
Starch	—	13.3	36.6	22.1 – 39.7
Total sugars	—	0.6	—	—

* volatile ether extract

constituents such as chavicine and piperettine. It is also reported that the piperine slowly transforms to its isomeric form chavicine[11] in dilute solutions.

The piperine content of pepper is in the range of 2–6%. The piperine contents of some popular varieties and commercial grades are given in Table III[12].

TABLE III. **Analysis of commercial grades/varieties**

Commercial grades/varieties	Vol. oil % v/w	NVEE %	Piperine %
Malabar, black garbled FAO	3.4	9.2	5.6
Malabar, black ungarbled	2.4	9.1	5.0
Malabar, light	3.4	11.5	4.8
Muntok, white	2.0	6.5	4.8
Pin heads	1.8	6.9	1.1
Kuthiravaly	2.6	9.2	5.9
Perumunda	3.4	6.4	4.7
Kottanadan	3.2	8.3	4.7
Karimunda	3.1	7.1	4.7

Jose and Nambiar[13] have reported Kottanadan, Kumbhakodi and Kuthiravaly as having over 13.5% non-volatile ether extract (NVEE) and over 9.5% crude piperine. In comparison, Panniyur I can be taken as only of medium pungency[14] with NVEE as 13.5% and piperine 6.2%[15].

Aroma constituents

The aroma of pepper is constituted by the essential oil present in the spice. The volatile oil content of some of the popular varieties[12] range from 2.4 to 3.5%. Among the commercial grades, which are a mixture of the different varieties, light pepper gives a high yield of volatile oil.

Lewis *et al*[16] have summarised the earlier work on the composition of pepper oil. In general, the chief monoterpene hydrocarbon constituents are α and β pinene, limonene, sabinene and Δ carene. Sesquiterpene hydrocarbon present is mainly B-caryophyllene. The oxygenated derivatives, which are the chief contributors to aroma in an essential oil, have not been studied extensively in the case of pepper by earlier workers. Pepper contains only about 3% oxygenated compounds[16]. In recent years, 51 oxygenated compounds belonging to acids, esters, aldehydes, ketones, alcohols and oxides have been identified[17]. The distribution of hydrocarbons in some of the major varieties[16] are shown in Table IV.

A descriptive aroma profile of ground black pepper has been arrived at after a thorough examination of the fractions of essential oils and oleoresins of five varieties namely, Balankotta, Karimunda, Kuthiravaly, Panniyur I and Mundi[18]. Although significant differences were noticed, the preferences of the judges were not significant. It is interesting to note that in the case of commercial grades, a superior grade scored better on the basis of odour qualities also. However, light pepper which has a

TABLE IV. **Composition of pepper oils**

Variety	Pinenes (α & β)	Sabinene + Myrcene	Limonene	Caryophyllene	Others*
Panniyur I	16.5	42.4	22.0	16.8	2.3
Karimunda	21.1	25.5	25.7	21.0	6.7
Chumala	40.7	—	25.8	33.3	0.2
Kuthiravaly	46.2	7.1	31.1	10.9	4.7
Karivally	26.1	30.8	26.4	15.0	1.8
Kottanadan	36.4	14.8	26.1	17.6	5.1
Vally	16.6	28.9	24.5	25.5	4.5
Kumbhakodi	46.3	9.5	24.1	18.0	2.1
Kalluvally	33.3	27.3	18.6	20.7	0.1
Karinkotta	23.0	24.9	24.9	20.7	6.5
Balankotta	24.4	24.3	24.5	22.4	4.4
Perumkodi	36.2	17.1	19.1	27.0	0.6
Mundi	43.0	Trace	26.4	30.5	0.1
Narayakodi	35.8	14.7	29.0	10.3	10.2
Arikottanadan	53.0	Trace	27.3	17.5	2.2
Uthirankotta	34.2	Trace	39.8	17.0	9.0
Karimunda-Thodupuzha	27.0	27.5	23.4	19.0	3.1

* Camphene, p-cymene, bergamotene, humulene, selinene, etc.

high oil content scored equal to ungarbled pepper.

Colour and appearance

The normal colour of the mature pepper is green due to chlorophyll. However, during drying, the colourless substrates get enzymatically oxidised to produce a black colour. If the enzyme action is arrested as in the case of pickled or dehydrated green pepper, no black colour will be formed. On the other hand, if enzyme is activated, say, by mild controlled heating, the resultant product will have more black colour. A balancing treatment to the berries for about a minute in boiling water not only reduces the microbial load on the product, but also gives a very dark glossy colour to the dried berries[19].

In black pepper, the green colour is masked by black colour. However, when a light colour is required as in white pepper, the outer skin which contains the substrates, is removed. Black colour can also be avoided by preventing enzymatic browing (blackening)[19]

In black pepper industry, a lot of importance is given to a glossy finish. In humid weather in the West Coast, due to unsatisfactory preliminary drying in the farms a thin layer of fungus appears on the finally dried product. At present, mineral oil (refined white oil) coating is given to control fungus infection and, give a glossy finish. Of late, health authorities have started questioning the use of this, and therefore, there is need to find a substitute which will give the same result.

Black pepper is sold in various size grades and therefore, uniformity and size are also important. The hollow, lighter berries form the light pepper while undeveloped berries form the pin heads. Because of the emphasis laid on appearance, the grades like light pepper are priced low. Therefore, they can be profitably used as raw materials for pepper products provided other quality factors such as piperine content, essential oil, etc. are proportionately good. Similarly, bolder and costlier grades are best used in preparations where unground whole berries are wanted.

Change in quality with maturation

Table V gives the changes in chemical composition with maturation[3, 20, 21]. It is found that the pungency decreases with maturation, so that products made out of mature samples will have less pungency. Volatile oil also decreases slightly with more maturation. Pruthi *et al*[3] have shown that starch content increases while moisture content and crude fibre decrease during maturation.

TABLE V. **Change in composition with maturity**

%	Undermature				Harvest maturity				Overmature				Ripe
	P	B	K	*	P	B	K	*	P	B	K	*	P
Moisture	..	..	..	..	68.0	..	..	..	59.2	..	..	..	59.0
Vol. oil	..	2.7	2.3	..	2.1	2.2	..	..	1.7	1.4	1.8	..	1.7
Non-volatile ether extract	..	17.2	10.5	..	..	15.1	..	..	..	5.1	11.3	..	..
Piperine (Spectrophoto)	..	7.8	2.1	5.5	..	8.0	..	5.1	..	2.1	8.8	3.4	..
Starch	..	14.3	12.8	..	13.3	22.7	..	..	18.7	3.7	20.1	..	20.4
Crude fibre	..	26.5	13.6	..	14.1	21.7	..	..	14.2	12.5	27.3	..	14.2

P – Panniyur I[3] B – Balankotta[20] K – Kalluvally[20] * – Ref. 21.

Black pepper

Black pepper is obtained by drying harvested mature green berries. Freshly harvested pepper has not only a green colour but has a 'green' or fresh flavour. The berries will have moisture content above 70%. The berries, as soon as harvested, are separated from spikes and spread out on mats for drying. In about two days the moisture content decreases to 20–25%. Due to enzymic oxidation of colourless compounds present in the skin, the colour

of pepper turns black which effectively masks whatever green colour that is left after drying. The dry product also gets the characteristic peppery top note. It is usually at this stage that pepper is purchased by an exporter. The subsequent operations involve further drying to a safe moisture level below 11%, separation of various fractions and grades and packing. Humid climate causes problems during drying and storage. When the drying is inadequately done, or when pepper is stored with a high moisture content, fungus appears on the black product which affects its appearance.

The bulk of the export and consumption of pepper is in the form of black pepper, the analysis of which is given in Table II. The raw material for oleoresin and oil industry is also mainly black pepper. Almost the entire lot of this is ground and used as powder. Because of comparative ease of powdering, a normal pin type or hammer mill will give a satisfactory grinding. There is no need to use a plate or disc mill, which tends to raise the temperature unduly, since heat produced during grinding may have adverse effect on the aroma.

Ungarbled pepper contains fractions and grades like dust, stalk, pin heads, hollows, immature pepper, overmature pepper and large berries. The grading is done by a combination of air classification and size-sieving. The major grade is the average sized black pepper known as 'Malabar Garbled' (MG). Besides MG which represents 95% of our export, other grades obtained are various bold grades of Tellicherry Garbled (TG), light pepper and pin heads. The bigger sized berries fetch a higher price and quite a lot of this finds use in salads, etc. in whole form, particularly in countries like Italy.

White pepper

White pepper is usually prepared from overmature or ripe berries. At this stage, the raw skin comes off easily and the resultant product can be dried. When skin is removed, a brown surfaced core (endosperm) covered by a thin silvery skin remains. The weight loss due to removal of the outer skin is compensated by the slightly higher weight gain due to maturation and around double the price obtained for this commerical product. The white powder obtained on grinding will not form detracts in light coloured soup and sauces and hence the preference for this product to black pepper in such preparations. In Europe, white pepper is also used in houses and restaurants.

The Island of Muntok in Indonesia has been the traditional source of white pepper. In recent years, Malaysia (Sarawak) and Brazil also have started making significant contributions of this product to the world market.

Normally, overmature pepper should show a lower piperine content. However, analysis of white and black pepper (Table VI) shows that white pepper has a slightly higher piperine content[22]. It may possibly be due to the concentration of piperine in the endosperm. Similarly, as starch also is present more in the core, white pepper made from overmature pepper will naturally have higher starch content than black pepper. On the other hand, skin contributes to the crude fibre so much so that white pepper shows a considerably lower fibre content thus enabling a fine grinding of this product. Though there is a belief that more of the oil is concentrated in the skin, the results of analysis (Table VI) show that oil content itself is not substantially affected.

In India, processors have been unwilling to leave the berries on vines for

TABLE VI **Composition of white and black pepper**

	vol. oil %	NVEE %	Piperine %	Starch %	Crude fibre %	Ash %	Acid insol. ash %
White pepper							
Indian	2.5	7.6	4.6	—	—	—	—
Sarawak	2.0	8.7	4.7	—	—	—	—
Brazil	2.0	8.7	4.3	—	—	—	—
Muntok	2.0	8.5	4.8	—	—	—	—
MGI Indian	2.3	8.5	4.2	—	—	—	—
White pepper Malaysia	2.2	8.1	—	59.4	5.2	—	—
Black pepper Malaysia	2.0	7.7	—	48.2	12.2	—	—
White pepper US Stds.	—	7.0(Min)	—	52(Min)	5.0	3.5(Max)	7.5(Max)
Black pepper US Stds.	—	6.75(Min)	—	30(Min)	15(Max)	1.5(Max)	5.0(Max)

ripening because of the loss due to falling to the ground and picking by the birds. Here, the method employed is soaking the dried black pepper and removing the loosened outer skin. Because of our generally good export performance of black pepper, late harvesting to produce white pepper has not been much practised, and thus India is lagging behind in white pepper export (Table VII).

TABLE VII. **Export of pepper products in 1976–77**

	Export from India		Value	*Estimated
	Quantity (kg)	Value (Rs.)	per kg (Rs.)	world demand (tonnes)
White pepper	1,151	43,994	38.22	1000
Canned green pepper	1,75,231	21,03,382	12.00 *	700
Dehydrated green pepper	59,840	35,38,174	59.13	500
Pepper oil	4,134	5,43,979	131.59	20
Pepper oleorsin	1,10,543	136,12,492	123.14	600 — 1000

* Dry pepper represents only 10 — 12%

The CFTRI has in recent years developed a whole buff coloured pepper and its potential is being evaluated. The value of this product over the traditional white pepper lies in that in the whole buff coloured pepper, outer skin is not removed avoiding the usual loss in weight. For preparing this product freshly harvested overmature berries are dried without the development of black colour and to get a bleached finish[19]. The product, although in the form of berries, may not be as white coloured as the normal white pepper but gives actually a lighter coloured powder on grinding.

Green pepper

In Germany, France and other European countries the 'green' or fresh flavour of pepper is liked in preparations like steak. Since it is not possible to obtain fresh green pepper, canned and pickled undermature pepper has become popular. Traditionally, Madagascar is the home of canned green pepper. Because of its connections with France and the harvesting pattern introduced, the island had an advantage over other pepper producing countries. The annual export of green pepper in brine from Madagascar is believed to be 600 – 700 tonnes.

Indian processors have been steadily increasing their export in recent years. In 1976–77, the export in this item touched 175 tonnes earning a foreign exchange of Rs. 21 lakhs (Table VII). There are two types of products, namely canned and bottled[3]. The former is heat-sterilized and packed in can, and, therefore 2% salt solution would suffice for proper protection. Because of prolonged heat treatment, the pepper tends to become very soft and in some cases berries burst with consequent liberation of gelatinized starch, which makes the product inferior. Correct maturity, optimum canning procedure etc. reduce the above difficulty. In bottled green pepper, heat processing is avoided. Therefore, for good preservation, a higher salt strength of 15-20% of the surrounding liquid is essential. The berries in this case will be firm. Use of acid and sulphur dioxide help in the preservation and the prevention of blackening of the product.

The canned and bottled pepper suffers from two disadvantages. One is the high cost of containers especially in India. Second is the high shipping cost due to the nearly 8–10 times the weight of the product as compared to dried pepper products. The additional weight is caused by the moisture in the pepper, drain liquid, container and the packing necessary to protect the containers. To overcome these difficulties, CFTRI has developed a new product, namely, dehydrated green pepper[19]. Here, slightly undermature pepper is dried, specially arresting the blackening and in a condition which allows for maximum green colour. The product reconstitutes and, *therefore, its demand is on the increase.* The present export is estimated to be about 60 tonnes (Table VII).

For preparing green pepper products, harvesting is done about a month earlier than the normal harvesting maturity. Starch content will be low and fibre content more at this stage. Piperine content will be slightly higher due to low maturity. The most significant quality aspect is that these products will have a fresh or 'green' flavour of freshly harvested pepper.

Pepper oil and oleoresin

As pointed out earlier, pepper is not valued so much for its aroma as for its pungency. Only oleoresin will combine aroma with pungency, while volatile oil represents only aroma. In view of this, oil has only a limited market. Oil is obtained by steam distillation of coarsely powdered

dry spice. It is estimated that in the world, the annual demand is in the order of 15–20 tonnes. India's share in 1976–77 was 4 tonnes (Table VII). It is used to introduce the peppery top note in products like meat preparations, sauces, soups and beverages. In perfumery, it is reported to be used to bring a spicy or 'oriental' note in some special cases.

The commercial yield of oil can be taken as 2–3.5%[23]. Light pepper, because of its low price and high oil content, is especially suited as raw material.

Oleoresin is obtained by solvent extraction of ground pepper[23]. The most important quality is the pungency due to piperine content. For obtaining a standard quality oleoresin, it is important that the choice of the solvent, particle size of the spice and the ratio of solvent to spice are properly arrived at. Acetone, alcohol, chlorinated solvent, etc. are good solvents while petroleum solvents are satisfactory for extraction of piperine. One of the most critical steps in the processing is the removal of last traces of solvent so that the product conforms to the regulations of ISI, FDA etc.

Table VIII shows the ISI specifications[10]. It has incorporated the requirements of foreign buyers. Normally, oleoresin of pepper is a heterogeneous pasty liquid with an upper oily layer and lower crystalline layer of piperine which accounts for about half the weight. However, it is also

TABLE VIII. **ISI specifications for oleoresin black pepper**

Characteristics	Requirement
(i) Odour and taste	Typical black pepper; no off odours or off flavours due to residual solvent or other causes
(ii) Essential oil	
(a) Content % v/w	10 — 20
(b) Relative density 30°/30°C	0.859 — 0.879
(c) Optical rotation 30°C	−1° — 23°
(d) Refractive index 30°C	1.439 — 1.449
(iii) Piperine content % (Minimum)	
(a) Kjeldahl's Method	55
(b) Spectrophotometric method	40
(iv) Solvent ppm (Maximum)	
(a) Acetone, ethylene dichloride or trichloroethane	30
(b) *iso* propanol	50
(c) Methanol	50

possible to make the product into viscous dark green to light brown dispersion by special treatments. Sometimes, a free-flowing consistency is also preferred. A good pepper oleoresin is soluble in essential oils, but not completely in fixed oils or alcohol. To make the oleoresin homogeneous and free flowing, 'liquid pepper' preparations are made by additions of lactic acid, propylene glycol or essential oil[12]. Dry dispersion by mixing with salt or dextrose is also sometimes used. It must be remembered that pepper oleoresin is used mainly by food processing industry rather than house wives, who prefer ground pepper. Oleoresin finds use in foods like meats, vegetables, salad dressings, ketchup and soups.

Ungarbled pepper, because of slight price advantage, will be a better raw material than garbled pepper. During grading, immature but fully formed berries with wrinkled surface separate as "half pepper". This grade, because of higher piperine content and lower price is ideal as raw material. It has been extremely difficult to estimate the world demand. It is, however, believed to be around 600 – 1000 tonnes. Most of these markets are cornered by well established Western concerns, and, therefore, Indian processors were finding difficulty in exporting. However, the Indian product has been found to be quite satisfactory and a small but steady export is being built up. It would also be worthwhile to explore the possibility of exporting spice oils and oleoresins to East European countries, which in recent years have been importing substantial quantities of black pepper.

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Grading and Processing of Pepper

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In order to ensure that only good quality pepper is shipped, all exports are subjected to compulsory quality control and pre-shipment inspection. According to trade requirements, standard grades are prescribed by the Agricultural Marketing Adviser to the Government of India under the provisions of Agricultural Produce (grading and marking) Act, 1937. The pepper grading and marking rules were introduced as early as in 1963. There are at present 15 specified grades and one non-specified grade for whole berries in addition to two grades for ground pepper. Sales are done according to the prescribed grades which have been made compulsory for any sale through the India Pepper and Spice Trade Association.

The Directorate of Marketing and Inspection keeps a watch on the analytical results of the various samples and also the trade requirements in order to revise the specifications from time to time. Accordingly, PH-Special, NSX-PH, GL-Special, UGL and Ground Pepper grades were introduced subsequently. On demand from Indian shippers, introduction of grades like GL-3 and MUG-3 are also under active consideration of the Directorate.

In the case of black pepper, 'Agmark' grades have been formulated on the basis of garbled and ungarbled berries, extraneous matter, pin heads, light berries and moisture. Thus, any type of black pepper can be exported from India provided the extraneous matter and moisture content do not exceed 7 and 12%, respectively. In fact, the basic object of quality control under 'Agmark' is to permit sales export by providing a precise and faultless common language about the quality of an agricultural commodity. These grades prescribe not only physical and chemical grade specifications but also their analytical tests and methods and thus eliminate the element of personal prejudices and errors.

The advantages of strict quality control measures and adoption of grading are discussed here :

1. *Higher prices*

Quality control under 'Agmark' has been helpful in securing a higher price for Indian pepper in the international market as can be seen from the following table :

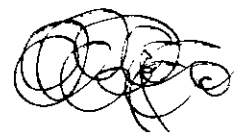

TABLE I. **Production, quantity and value of black pepper exported from India.**

Years	Production ('000 Tonnes)	Export ('000 Tonnes)	Value (00,000 Rs.)	Price (Rs./kg.)
1960 – 61	28.3	17.2	849.7	4.93
1961 – 62	28.4	21.6	807.7	3.73
1962 – 63	26.1	20.9	657.1	3.15
1963 – 64	24.5	18.9	588.9	3.10
1964 – 65	24.0	17.2	672.3	3.91
1965 – 66	23.3	25.7	1,085.5	4.22
1966 – 67	23.0	21.4	1,163.0	5.44
1967 – 68	26.0	24.8	1,297.8	5.22
1968 – 69	26.0	18.9	971.0	5.14
1969 – 70	25.0	22.3	1,619.1	7.26
1970 – 71	26.0	17.9	1,519.7	8.48
1971 – 72	26.0	19.2	1,472.9	7.69
1972 – 73	26.0	19.9	1,425.6	7.16
1973 – 74	28.70	31.6	2,942.5	9.32
1974 – 75	28.15	26.1	3,414.3	13.11

2. *Increase in the export of superior qualities.*

Another advantage of quality control is the increase in the export of superior qualities of black pepper. For example, the exports of TGSEB grades which accounted for 1.6% of the total quantity graded during 1963-64 have increased to 8.5% during 1973-74.

3. *Introduction of forward sales on Agmark grades.*

Introduction of forward sales on the basis of Agmark grades by India Pepper and Spices Trade Association for garbled variety of black pepper is another important achievement. This in turn has led to a more precise and reliable market intelligence to all including farmers who can choose an ideal time for the disposal of their produce within their economic holding capacity and get a higher return in the consumer-rupee.

4. *Reduction in trade disputes.*

After the introduction of quality control under Agmark, the number of trade disputes and rejections of consignment at the destinations have gone down considerably.

5. *Increase in farmer's returns.*

One of the important advantages of quality control under Agmark is usually an increase in the farmers' returns. Unfortunately, no scientific and systematic studies have so far been carried out to assess the benefits to the farmer of grading black pepper according to Agmark grades.

6. *Improvement in packing conditions.*

Packing conditions are prescribed under the Quality Control Scheme and the goods are cleared for export only when they are packed accordingly.

7. *Weight certificate.*

The system of issuing a certificate for weight protects the interests of buyers as well as sellers. In addition to it, the net weight is indicated on each container.

8. *Easy availability of institutional finance.*

Introduction of quality control has encouraged the flow of institutional finance, particularly from commercial banks, into the trade because the financiers are confident of the quality of goods pledged or hypothecated to them.

9. *Problems in processing.*

In this connection, an important problem that requires the attention of the trade community and the government agencies is the adulteration of black pepper. The use of mineral oils is permitted to obtain lustre and to prevent fungal growth on the berries, but often the provision of the rule is misused to increase the weight of the berries. Secondly, use of manual and mechanical methods to remove rat excreta from the berries have not given satisfactory results. We need an efficient method to eliminate rodent excreta from the produce before it is graded and shipped.

Quality Control Aspects in the Marketing of Pepper

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Introduction

Pepper occupies the most important place in the world spices trade and accounts for more than 55% of India's export trade in spices. Black pepper was one of the earliest commodities to attract compulsory quality control and pre-shipment inspection. Before 1 - 1 - 1963, when quality control was introduced into this commodity, this export item was a victim of the temptations of the traders to make easy money. The introduction of Agmark grading brought about a discipline in the pepper trade and India's image as a supplier of this important spice was consolidated.

Relevance of quality control in modern marketing

The fact that India's contribution to the world pepper market is only 25% highlights the importance of keeping up a consistent image of quality besides better productivity. It is a matter of pride that India is the first country to adopt quality control and pre-shipment inspection in pepper at the export level. When the pepper producing countries in the world are fast reaching a consensus on organising a 'Pepper Community' it becomes all the more imperative that all the countries in the Community adopt quality control measure.

The Pepper Grading & Marketing Rules of 1967 emanated out of the powers conferred by the Agricultural Products Grading & Marketing Act, 1937. In exercise of these powers, the Government of India has promulgated rules codifying the specifications to be adhered to for the different grades of pepper. I recollect the International Seminar on Pepper in 1976 where I made a suggestion that the grade designation marks, as indicated by Agmark, which is the testimony of the approval of the Agricultural Marketing Adviser, shall be indicated followed by the words "Produce of India", on each and every carton or package of pepper leaving the shores of India. This step will infuse confidence among the buyers abroad about the quality of the product.

The cumulative effects of the quality control measures have been reflected in the increase of the unit value realisation for pepper.

Grading of pepper

Indian black pepper under Agmark has been classified into eight different sche-

dules, consisting of 15 specific grades and one non-specific grade, and two grades of ground pepper. In tune with the changing consumer preferences and also on the basis of analytical results of various samples, the Directorate of Marketing & Inspection revises the specifications periodically, updating them and also introducing new grades. *PH special NSX-PH, GL-special, UGL* and ground pepper grades were thus introduced. The Directorate is actively considering the introduction of grades GL-3 and MUG-3.

Basis of grading

The Agmark grades have been formulated on the basis of garbled and ungarbled berries, extraneous matter, pin heads, light berries and moisture. The tolerance to extraneous matter and moisture has been given as 7% and 12%, respectively. Ouring monsoon, moisture tolerance is given upto 12.5%.

The quality control measures adopted by the Government of India have yielded tremendous results. It has been able to prevent admixture and treatment with hazardous materials, which was so rampant previously. Consequent to the introduction of scientific grading, there has been remarkable increase in the unit return. The gains from compulsory quality control have been many, like the increase in the export of superior grades, the introduction of forward sales, reduction in trade disputes, improvement in packaging, issuance of weight certificates, besides general improvement in quality. Grading has also been helpful in increasing the farmers' returns, besides encouraging institutional finance for the trade.

Need to bring pepper products/derivatives into the ambit of quality control

There has been a remarkable increase in the export of pepper derivatives and other conversion products. These are yet to come under the surveillance of quality control discipline. Oleoresin, dehydrated pepper, and pepper in a score of other forms are necessarily to be brought under the purview of quality control. The arguments against such a step may be that the exports are comparatively negligible or that these products are of recent origin. The question is whether we should allow complaints to originate or whether we should effectively prevent them. Product diversification will be going on at a fast rate, and the operation of quality control has to be viewed as a total action and not a partial one. The market for dehydrated pepper is fast expanding, but at the same time we run a risk when unscrupulous elements rush into the field and try to make hay when the sun shines. Any laxity on the part of us will only lead to detriment, tarnishing the image of the country, and also rendering up defenseless in the fiercely competitive international markets.

A Strategy for Sales Promotion of Pepper and its Products in Foreign Markets

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The use of spices, particularly pepper, all over the world has increased considerably over the years, and is likely to continue so. The reasons for this increase has been attributed to a very large extent to the increase in world travel and the fact that more people are now living either temporarily or permanently in countries other than from which they originate. This trend assures us a bright outlook as a spice producing nation. This fact is also borne out by the news during the Pepper Community meeting held recently at Delhi when it was indicated that a recent world survey had shown that there would be a shortage of about 20,000 tonnes of pepper in the world market by 1980.

This could therefore mean a continuing boom for pepper in the coming years. How are we, as a producing country, going to take full advantage of this, and how are we going to ensure that our export earnings continue to rise ?

For any agricultural commodity, price is going to be the single largest determining factor for exchange earnings. However, there are a few steps which could ensure that there will be an eventual growth. Today, there still exists a communication gap about the current world market trend. Apart from a handful of exporters, the majority does not have a correct feedback of information with regard to crop, weather, and statistics pertaining to both production and exports from other countries. News of weather conditions, natural calamities, etc., play a very large part in creating new avenues of export and to new destinations. Organisations like the Spices Export Promotion Council, can help in bridging this gap by collection and dissemination of such information. In our country, probably the most effective news media are the newspapers and the radio. "Time is money" is an old saying, and this adage can be very aptly applied here; for if proper information is monitored and re-fed through these channels, then greater possibilities lie ahead.

On the part of the Government, if a more simplified export procedure could be adopted, it would go a long way in removing the many hurdles that lie in the path of a would-be exporter. Today, all things being equal, there are many who would shy away from exports and take the easier solution of marketing internally. This situ-

ation should be remedied so that export opportunities are taken without hesitation. The numerous Government levies and procedures involved make paper work a tiresome procedure, and if effective methods to reduce this can be found, exports would become a more attractive proposition to many.

The second and probably the long term answer is the need to look at the export of value added items. This can be achieved in two ways. Firstly, by looking at and introducing manufactured products and, secondly by breaking away from the traditional bulk exports to packaged exports.

In the field of manufactured items, it is encouraging to note that big strides have been made in the field of oils and oleoresins. Other products which have been tried and marketed now with success include canned green pepper and dehydrated green pepper, both of which hold good growth potential. There is need for newer ideas on product use and institutions like Central Food Technological Research Institute, Mysore can continue to play a leading role in this.

The other field which has sadly remained untapped until now has been the field of packaged spices. These include both "Consumer Packs" for the housewife as well as larger packs for the institutional trade which includes hotels, restaurants and food packers. There has been no growth in this area primarily because of lack of dynamism and approach to do new things. Many exporters are still content to take shelter under the plea that acceptable packing material and machinery are unavailable in India. This is quite unjustified as almost every type of packing material is available today in this country. There are also machinery manufacturers in India who can build almost any type of packing machinery. There does however remain one problem, *viz*, product shelf life. Spices are susceptible to weevil infestation in storage. In Western countries, sterilisation by the use of ethylene oxide is well known. We need to find a steriliser which would be both inexpensive and easily available in our country.

In diversifying and expanding our exports, there will be problems on marketing, but these can be overcome by bringing these to the notice of our authorities here who can take steps to remove these hurdles. The Government on its part needs to think of ways to encourage exporters to start product diversification and a first step in this direction would be to announce preferential treatment like removal of tariffs on these. To combat the higher cost of packing materials subsidies could be considered.

All this can become a viable export strategy only if we make sustained efforts. We would then have not only export growth, but have definitely contributed to our developing economy on a durable basis.

Marketing and Export of Pepper

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Black pepper occupies an important role in India's exports of spices. The highest quantity of pepper exported during the quinquennium was 31,000 tonnes in 1973–74. Pepper export earnings from India have registered three records during the last four years ending 1976–77. According to the provisional figures received from the Director General of Commercial Intelligence & Statistics, Calcutta, export earnings of pepper attained a new peak during 1976–77 amounting to Rs. 38.2 crores. More than 80 countries of the world import Indian pepper in varying quantities. The main destinations for Indian pepper during the First Plan period were to USA, followed by UK and West European countries. During the last decade, there has been a steady and remarkable shift in the destinations with the East European countries leading in pepper imports from India followed by USA and Canada, and negligible imports by UK and West European countries with the exception of Italy.

Kerala holds almost a monopoly in India in the production and marketing of pepper in different grades and forms. Pepper is mainly produced in homestead gardens The produce arrives in the primary village markets through village merchants and the producers themselves bring the produce and dispose it off either in bulk or in small quantities. The system of pre-harvest sale also exists, ie., the producers sell their crop to contractors when the crop is yet to ripe. The contractors visit the plantations and homesteads and bid for the entire crop. The highest bidder gets the right to harvest during that particular season. This system is still popular and producers often will not be getting adequate price for their produce. Almost the entire produce is sold, keeping what is required for household use, which is a very small percentage. Producers normally sell their produce to the village merchants. The village merchants take the small lots to the primary assembling markets. The merchants in the primary markets bulk the small lots purchased from village merchants and take them to the assembling markets. Co-operative marketing societies operating in the producing areas also serve as primary collecting agencies of their grower-members. Another class of cultivators who are large scale growers or pepper planters directly sell their produce either in the village market or to the assembling markets. From the assembling markets, the produce gets assembled at the terminal markets at Cochin, Calicut and Alleppey, with the commission

agents, who effect sale, according to the directions of the owner of the goods. The sellers are charged a commission by the agents for the services rendered by them. Further, the produce goes to the wholesale traders, exporters or exporter-*cum*-wholesale trader. In some cases, the big producers, planters and merchants also sell their produce direct to the exporters.

Grading of pepper

The price of pepper is assessed according to the general conditions of the produce, percentage of moisture, light berries, pin heads etc. The produce comes to the market mostly in ungraded form and garbling and grading are done either at exporters' premises or by the wholesale trader. But, there are certain merchants in the assembling markets who garble and grade the produce in the assembling stage itself and sell directly to the export buyer. The processing of pepper is done either by the exporter or by the wholesale trader. This involves (1) drying to the required extent after washing to remove mould formation, if any; (2) winnowing to remove chaff, light berries and pin-heads; (3) sieving on sieves of different meshes to obtain berries of required size. There is no single machine to combine the above operations. There is a need to evolve a suitable machine to combine the above operations and the facility can be extended to the assembling markets so that post-harvest damages can be minimised.

Pricing of pepper

Pepper price is well reported. Producers, village merchant traders, wholesalers and exporters are aware of daily price movements through radio bulletins, newspapers, price reports published by the Indian Pepper & Spice Trade Association and trade journals. Hence, the primary producer is able to get a fair price for his produce.

The difference between the price paid by the consumer and that received by the producer is usually referred to as price spread and is accounted for by marketing costs incurred and margin absorbed by the agencies in the marketing channel. Marketing costs depend upon market changes, distance over which produce traverses, nature of processing involved, commission and brokerage.

During the last decade, marketing costs have increased from the primary producers level through various agencies and final burden has fallen on the consumer. Black pepper is a commodity where processing is limited to garbling the produce. Hence, consumers' burden can be reduced if output per unit area is increased. In the international market, our pepper is competitive to any other quality but for one reason or the other, our production and exports have not been steady. The unsatisfactoy trend in production of pepper has been mainly due to uneconomic nature of cultivation and poor productivity.

Agmark grades are popular in the international markets. However, I may stress here that Agmark grades and certificates for quality issued by the Agricultural Marketing Advisor should be accepted by other agencies like FDA or it must be converted into a guarantee for quality.

In the importing countries the consumers are not aware of the sources from which they are getting pepper. Importers import different varieties of pepper from different countries like India, Indonesia, Malaysia and Brazil. None of these is marked as Indian, Indonesian or Malaysian pepper. Therefore, the quality characteristics of Indian pepper are not generally known to the actual consumers, except in certain markets like Italy where there is a special preference for certain varieties of Indian pepper. As far as available information is

concerned, other producing countries have not evolved any such measures for strict quality control and pre-shipment inspection as is done in India. Unless other countries also impose quality control, our efforts will not achieve the desired results as our share in world trade is only about 25%. It was in this context that a suggestion was made at the International Seminar on Pepper organised by the Spices Export Promotion Council at Cochin that efforts should be made to have international standards for grading of pepper.

Exports of pepper

Black pepper occupies a place of pride in India's foreign trade. It contributes about three-fifth of India's foreign exchange earnings from spices trade. International black pepper market is dominated by four countries, USA and USSR on the demand side, and India and Indonesia on the supply side.

Table I will give a clear idea of the fluctuations in exports in terms of quantity, value and especially in terms of unit price realisations.

TABLE I. **Export of pepper from India during the years 1967 – 68 to 1976 – 77**

Year	Quantity in '000 metric tonnes	Value in million rupees	FOB price in Rs./kg
1967–68	25.06	130.98	5.23
1968–69	18.95	97.16	5.13
1969–70	22.30	161.91	7.26
1970–71	17.97	152.48	8.49
1971–72	19.25	148.25	7.70
1972–73	19.96	143.10	7.17
1973–74	31.65	295.31	9.38
1974–75	26.34	344.76	13.09
1975–76	24.23	338.84	13.99
1976–77*	20.53	382.35	18.63

(Source : DGCIS., Calcutta. *Provisional figures)

The trade estimate of India's pepper production is much higher than the estimates of the Directorate of Economics and Statistics. A comparison of exports and also of growing internal consumption could lead to the conclusion that the trade estimates which are about 30% higher than the official estimates are more realistic. According to trade estimates the higher production of pepper was in the years 1972-74 amounting to an average of about 40,000 tonnes, whereas the higher production as per the Directorate of Economics and Statistics was only 28,530 tonnes. India's highest export was 31,600 tonnes in 1973–74. In that year, as per the official estimates, the production was only 28,700 tonnes.

Product diversification

Another notable feature in our pattern of export in respect of pepper is the product

diversification. Pepper oil, pepper oleoresin, green pepper in brine, dehydrated green pepper and pepper powder in consumer pack are the main pepper products which we are exporting at present. Our export earnings from pepper products have recorded substantial increase during 1976–77. A sad feature about the situation is that the present production of pepper in India is not at all adequate to meet the demand from importing countries. Hence, for achieving higher export earnings from pepper, we have to increase our production, stabilise our prices and more flexible policies are to be taken up to develop the trade.

At present, no standard form exists for export trade in pepper. The sales are generally done on terms and conditions laid down by the foreign buyers. This places the exporters in a disadvantageous position. There is a need to explore the possibility of introducing a standard contract form which may protect the interest of exporters. The pepper trade in India is quite aware of this problem and some action in this regard has been initiated by the trade community recently. The Spices Export Promotion Council has also taken up the case actively with the Ministry of Commerce.

India's pepper trade has a very bright future provided we can increase the production and productivity of pepper, making available adequate exportable surplus for increasing exports and also to achieve substantial product diversification in our exports.

Proceedings of the National Seminar on Pepper held at Calicut on December 19, 1977

The Central Plantation Crops Research Institute organised a National Seminar on Pepper at Calicut on December 19, 1977. The aim of the seminar was to focus attention on various aspects of pepper like research, development, processing, quality control and marketing, and to suggest concrete plans for immediate future.

The inaugural session was chaired by Shri N Kaleeswaran, Vice Chancellor, Kerala Agricultural University, Mannuthy. Dr MS Swaminathan, Director General, ICAR, inaugurated the seminar with a key-note address. Representatives from Central Food Technological Research Institute, Directorate of Arecanut & Spices Development, Spices Export Promotion Council, Kerala Agricultural University, Department of Agriculture, Kerala, Special Agricultural Development Unit (SADU), Department of Horticulture, Karnataka and Department of Forests, Andhra Pradesh, growers, processors and exporters, besides the research workers of Central Plantation Crops Research Institute, participated in the seminar.

The inaugural session was followed by sessions on Research, Development, and Processing and Marketing under the Chairmanship of Dr MS Swaminathan. Shri MC Nambiar, Project Coordinator (Spices and Cashewnut) was the Rapporteur. The seminar identified the problems which required immediate attention and suggested ways and means to achieve increased production in the immediate future.

Welcoming the delegates, Dr NM Nayar, Director, Central Plantation Crops Research Institute, recalled that the Institute had organised similar seminars on cocoa, cashew and cardamom earlier. He recalled the historic importance of Calicut in spices trade and stated that it was only appropriate that the present seminar on pepper was also being held at Calicut.

Shri N Kaleeswaran in his presidential address noted with satisfaction that research organisations were giving increasing importance to pepper, one of the major dollar earning crops of Kerala. He outlined the dominant role of India in pepper production and export in recent years. He hoped that this seminar would suggest ways and means for India to regain its earlier position in the world pepper trade. He noted that the average yields of pepper was the lowest in Calicut and Cannanore districts, the major pepper growing tracts of Kerala. Slow wilt and quick wilt were causing considerable havoc in the productivity of the crop and it was imperative that remedies were found in the near future to bridge the gap in production. He considered it necessary to have a stable expansion policy to avoid wide fluctuations in the price of pepper and to assure a steady income for the farmers.

In his inaugural address Dr MS Swaminathan, pointed out that it was appropriate that the seminar was being held at a juncture when we were in the process of formulating the Sixth Plan. He stated that agricultural sector was assured of about 40% of the total outlay of this plan. He stressed the need to streamline the land and water use pattern and also the production and post-harvest technology. Dr Swaminathan commended in this regard the multilevel cropping systems suggested by the CPCRI which facilitates maximum utilisation of solar energy in compatible crop combinations.

Dr Swaminathan emphasised the urgent need to improve the productivity of pepper in the country. The average yield of pepper in India today is about 275 kg per ha which is probably the lowest among the major pepper producing countries. In Indonesia, the average yield is 529 kg, in Brazil 3421 kg and in Malaysia 4130 kg. The yields realised by the progressive farmers of the State as well as research stations indicate that average yield of 1 kg per standard is an easily attainable target as against 250 g obtained at present. He desired that all aspects of management should be studied and ways and means to improve the yields of the existing plantations should be suggested.

Dr Swaminathan suggested the following research priorities: The Western Ghat is the major centre for variability in pepper and the CPCRI has already begun to collect and conserve the germplasm to prevent gene erosion. He appealed to the delegates, especially growers, to give any valuable material available with them to the scientists for conservation of the gene pool. He also asked the CPCRI scientists to give importance to the collection of germplasm from north-eastern region including Assam. The next step should be to establish a National Hybridisation Garden. As pepper is a vegetatively propagated crop it will be easy to maintain hybrid vigour. The crop canopy, kind of standards, and the problems of pests and diseases should also receive attention of research workers. In addition to increasing the productivity of existing plantations, new areas are also to be identified to extend the areas under pepper cultivation. In this regard the non-traditional areas like the Agency Areas in Andhra Pradesh and the Konkan belt in Maharashtra are to be taken into consideration. He also explained the importance of taking up anticipatory research. For example, certain pests and diseases which are not important now could become serious threats in the future. Experimental data on the fertilizer requirements of the crop are not available at present. The economics of fertilizer response is to be worked out for recommending optimum fertilizer doses. The use of locally available low cost standards including leguminous ones are to be investigated. As a long term target, we should aim at average yields of 5–10 kg per standard. It is also necessary to give importance to processing technology and research in this direction to be undertaken in collaboration with the CSIR units. Adequate farm technology is available in the field of agricultural operations and plant protection methods, though gaps are noted in nutritional aspects, control of wilt, etc. However, the available farm technology is to be transferred to the farmers and for this an Operational Research Project could be initiated for pepper immediately. This will help to explore the operational constraints and the economic viability of practices recommended to the farmers.

He requested the seminar to suggest concrete measures to strengthen the Spices Research Centre being established at Calicut (CPCRI Regional Station).

Pepper Research

Shri MC Nambiar presented a status paper on 'Trends in pepper cultivation', Shri PK Venugopalan Nambiar on 'Adaptability of Panniyur I', Dr MK Nair on 'Current breeding programmes in pepper', Dr KKN Nambiar on 'Diseases of pepper in India' and Shri GB Pillai on 'Pests of pepper'.

Shri BR Ramabhadriah pointed out that Panniyur I hybrid was performing well in the Agency Areas of Andhra Pradesh but elevation might be limiting factor affecting setting. Wilt diseases were also being reported from these areas. He suggested the necessity for setting up a research station for spices in this area.

Dr MK Nair felt that elevation might not be a factor since Panniyur I performs well at Ambalavayal (1000 m above MSL) in Kerala. In general, the participants felt that the performance of Panniyur I in different agroclimatic conditions was not uniform and setting was poor under heavy shade. Shri MC Nambiar suggested that shade requirements of pepper at different altitudes and the effect of microclimate on production might be studied.

Dr TS Venkatesan pointed out that Panniyur I was highly susceptible to nematodes. Dr Abicheeran suggested that thorough investigations on nematode problems, identification and disposal of collateral hosts of pathogen and timely plant protection measures were to be adopted.

Shri MP Sanath Kumar pointed out that some of the local varieties outyielded Panniyur I. He called for a study on the damage caused by mercury fungicides to Silver Oak, a popular standard in Wynad area. Shri Taranath Shet urged the scientists to take up residual analysis of pesticides in pepper so that pesticide residues would not be a concern of the exporters. Shri MB Nair suggested that Assam area might be surveyed for wild types of pepper.

Dr A Ramadasan suggested that studies might be taken up on solar energy requirements of different varieties to identify suitable types for different crop combinations.

Shri EV Nelliat felt the necessity of a study on the growth habit and the possible utility of pruning in increasing yield.

Dr CK George pointed out that the fertilizer recommendations should be revised. The possibility of using sprinkler irrigation as a substitute for rain for obtaining better setting also should be explored.

Dr YS Lewis pointed out that early harvesting gave high oleoresin content and this factor might be considered in grouping varieties as high or low yielders.

Dr YR Sarma stressed the need for applying strict internal quarantine regulations in supplying planting materials from disease affected areas to non-traditional areas like Andhra Pradesh and for phytosanitary measures to be adopted by farmers to check the spread of the disease.

Pepper Development/Growers' Views

Shri MC Pothen presented a paper on 'Pepper in Kozhikode District', Dr CK George on 'The programmes and prospectives of pepper development in India' and Shri MN Kunjan on 'Pepper development programmes of Kerala'. Shri TN Jayachandran's paper on 'Programmes for pepper development in Kerala Agricultural Development Project' was presented by Shri Alexander Muthalali and Shri PS Rao's paper on 'Prospects of pepper cultivation in Andhra Pradesh' was presented by Shri BR Ramabhadriah.

Shri MK Muliyar suggested that greater attention should be paid to the establishment of rooted cuttings after the distribution of planting materials to farmers, especially in small holdings. Further, adoption of timely plant protection measures should receive attention of the development agencies.

Shri MB Nayar pleaded for the popularisation of multiple cropping programmes involving pepper and also setting up of research and development units at the village level in the Integrated Rural Development Programme.

Shri PB Kurup suggested that the planting of pepper in homesteads might be popularised to boost up the production in view of the better attention they receive.

Processing and Marketing

Papers were presented by Dr AG Mathew on 'Quality aspects of pepper and pepper products', Shri LN Sundaram on 'Grading and processing of pepper', Shri JC Ambat on 'Quality control aspects in the marketing of pepper', Shri MKK Menon on 'Strategy for sales promotion of pepper and its products in foreign markets' and Shri T Taranath Shet on 'Marketing and export of pepper'.

Dr AG Mathew reviewed the scope for utilising light berries for oleoresin extraction. The house felt that a substitute to mineral oil should be found to avoid possible health hazards. Dr YS Lewis pointed out that mineral oil treatment is adopted even in other countries to reduce fungal growth. According to him, dipping of berries in hot water for a minute, reduces mould growth considerably and also gives glossiness to the products.

Shri MB Nayar felt that since Indian markets are regulated, suitable action should be taken to ensure remunerative price to the producer. He opined that farmers could be taught to grade their produce by themselves to ensure better prices. Shri Taranath Shet however felt that grading of pepper at farmer's holding was impracticable since majority of the produce came from small holdings.

Shri Eapen George suggested that an operational research project on pepper might be set up to help the farmer to boost up production by utilising the available technology on plant protection schedules, fertilizer application and cultural practices.

Proceedings of the Plenary Session

The Plenary Session was chaired by Dr MS Swaminathan, Director General, Indian Council of Agricultural Research and the Rapporteur was Dr NM Nayar, Director, CPCRI. The Director General reviewed the deliberations of the seminar and identified the following points as requiring actions:

1. A systematic survey, collection, evaluation and conservation should be made of cultivated varieties, primitive cultivars, mutants and wild species and types. Collections should be made from throughout the country and particularly from the north-east and west coast of India (Action: CPCRI, Agricultural Universities, AICSCIP).
2. There is a need to stabilise the production in cultivated varieties. The stability of performance of high yielding varieties, particularly of Panniyur I, should be assessed (Action : KAU, AICSCIP).
3. Quality studies should be taken up more systematically. While assessing oleoresin, piperine and volatile oil content, both the relative content and production per unit area should be estimated (Action: KAU, CSIR Complex, CPCRI).
4. Research should be taken up on production physiology aspects. This will include studying the influence of sunlight on productivity, pruning trials, root studies and determining the relationship between seedling characteristics and yield (Action : Agricultural Universities, CPCRI).
5. Much more work should be done on disease and pest management. This should include studies on residue analysis and studying the effect of pesticides on live standards (Action : Agricultural Universities, CPCRI, CSIR Complex, AICSCIP).
6. There is an urgent need to intensify the study on aetiology and control of wilt diseases (Action: KAU, CPCRI, AICSCIP).
7. The present fertilizer recommendations should be reexamined. Also, the response to foliar application should be studied (Action: KAU, CPRCI).
8. The response of pepper to irrigation should be studied. This is particularly relevant in the present context of recommending pepper as an intercrop in coconut and arecanut gardens both of which are being increasingly irrigated (Action: KAU, CPCRI, AICSCIP).
9. Propagation studies should be taken up. In this context, the Director General mentioned about the great advances that have been made in utilising this technique for increasing yields of rubber in Malaysia (Action : KAU, CPCRI).
10. Internal quarantine regulations should be strictly observed, particularly while

taking materials from diseased areas to healthy and non-traditional areas like Andhra Pradesh (Action: Agricultural Universities, State Agriculture/Horticulture Departments, CPCRI, DASD).

11. The effect of time of harvest on composition yield and its relation to end-use should be studied (Action : KAU, CPCRI, CSIR Complex).

12. The extension services should give harvesting advice to farmers to suit the end-use of the produce, eg. for green pepper, black pepper, or white pepper (Action : State Agriculture/Horticulture Departments, DASD, Agricultural Universities, CPCRI, AICSCIP).

13. The pest and disease control and management recommendations should be demonstrated to farmers through operational research projects (Action: CPCRI, KAU, AICSCIP, DASD).

14. More nurseries should be established for distribution of quality planting material (Action : State Agriculture/Horticulture Departments, DASD).

15. Adequate funds should be made available for pepper research (Action: State Governments, ICAR)

16. More efforts could be made for growing pepper in non-traditional areas. The Director General observed that under the All India Coordinated Spices and Cashewnut Improvement Project, new centres could be opened in the Sixth Plan in Andhra Pradesh, Maharashtra, Orissa and Assam (Action: ICAR Headquarters, CPCRI, AICSCIP, DASD).

17. The present production statistics are not fully reliable. The methods for data collection should be urgently improved (Action: DES, DASD).

18. The agencies involved in processing and marketing should take up compulsory impact analysis of all new recommendations to assess their social and economic effects. A beginning could be made with the suggestion to ban the export of half pepper and light pepper (Action: MOC, SEPC, DASD, IPSTA).

19. The effect of mycotoxins on quality of stored pepper should be studied (Action: CSIR Complex, CPCRI).

20. An alternative should be devised for the current use of mineral oil for preventing mould attack and improving appearance. The effect of blanching should be studied more thoroughly (Action: CFTRI, CSIR Complex, DASD).

21. For avoiding the presence of rat excreta in pepper only a general recommendation can be made now, that all agencies involved in buying, transporting, grading and exporting pepper should follow stringent inspection and hygienic measures. The Director General observed that in the long run, better success might be obtained only by controlling the rodent populaltions themselves. This, he said, would be possible only by a community effort. The proposed rodent biology unit of the CPCRI, he hoped, would be able to give a lead in this matter (Action: CPCRI).

22. There is a need for disseminating greater information for promoting exports. The SEPC, IPSTA, and DASD could take a lead in this.

Additionally, efforts should be made to produce newer export products having more added value. The producers and exporters should think about bringing about greater diversification of labour use while identifying products for export. Use of more attractive packaging containers and vigo-

rous publicity through audio-visual media should also help in increasing exports (Action : SEPC, IPSTA, all exporting firms, DASD, CSIR Complex)

23. A combined drying, winnowing and grading machine may be useful in processing pepper (Action: CSIR Complex, CIAE, CPCRI).

The Director General then invited the participants to give their suggestions for consideration.

1. LN Sundaram observed that the percentage of return that the farmer receives from pepper is much more than that he receives from any other similar agricultural export commodity. He informed that the trade takes only a gross margin of about Re. 0.75 for every kg of pepper handled (at the FOB price of about Rs. 18.00 per kg).

2. PB Kurup observed that almost the entire pepper production still comes from homestead gardens and not from large plantations. He, therefore, suggested that every household, particularly in Kerala, should be encouraged to plant pepper on all the trees growing in their home gardens. This alone would ensure a significant increase in pepper production in India (Action : KAD).

3. The Director General then called for names of participants interested in formulating an operational research project in pepper. Eapen George and MB Nayar volunteered their services (Action : CPCRI).

4. MKK Menon enquired about the action being taken on sterilizing of pepper products. AG Mathew informed that the CSIR Complex was seized of this matter and work would be initiated as soon as possible (Action : CSIR Complex).

5. The Director General then called upon all the agencies to develop newer technologies, particularly in the processing of pepper. He said that the ICAR could help any of them to obtain the permission of the Ministry of Commerce to import prototypes of any manufacturing and processing machinery. He cited in this context the tremendous advance made by Japan in the years immediately following the Second World War, when she purchased from abroad the best mechinery, instruments, processes and patents that were then available in the market, and then, went all out to improve and adapt them further. He said that this would be an ideal system to follow, particularly by developing countries, since it could save them many years of R & D effort that they would require otherwise to develop the particular level of sophistication that was already available in other countries.

He felt that the National Seminar on Pepper had given a good opportunity to bring together persons and agencies working on all aspects of pepper including cultivation, research, extension, production, manufacturing, processing and export, and this helped to bring about a full interaction of ideas. This was fully reflected in the deliberations that took place during the day.

The Director General concluded his summation by stating that all agencies in trade and industry should ensure that in the final analysis, the farmer, who produces the primary produce, is not overlooked and that he is assured of decent returns for his efforts.

The National Seminar on Pepper closed with a vote of thanks proposed by MK Nair to the following agencies and individuals.

1. Dr MS Swaminathan, Director General, ICAR.
2. Shri N Kaleeswaran, Vice-Chancellor, KAU
3. Shri Meloth Narayanan Nambiar, Chairman, Kerala State Co-operative Marketing Federation Ltd.
4. M/s LR Rangaier & Sons, Calicut and the Firm's Managing Director Shri LN Sundaram.
5. M/s Brooke Bond India Limited, Spices Export Department, Cochin and Shri MKK Menon.
6. M/s Kanji Moorarji, The Bombay Oil Industries, Bombay, Shri JV Mariwala and Shri Naleen D Sampat.
7. Bayer (India) Limited, Shri PS Ranganathan and Shri Eapen George.
8. Shri MA Unneerikutty, President, Malabar Chamber of Commerce, Calicut.
9. Shri PB Kurup, Managing Director, Techno-Chemical Industries, Calicut.
10. Shri KP Chandran, Mermaid Foods, Calicut.
11. Dr AG Mathew, Scientist-in-charge, CSIR Complex, Trivandrum.
12. Shri PK Venugopalan Nambiar, Pepper Research Station, Taliparamba.
13. Dr CK George, Director, Directorate of Arecanut & Spices Development, Calicut and his colleagues, specially Shri MS Lakshmanachar.
14. Shri Musa Barami, Deputy Director of Agriculture, Calicut.
15. N Gopal, Pepper Marketing Officer, Calicut.
16. The Station Director, All India Radio, Calicut and Shri KK Kurian, Farm Radio Officer, All India Radio, Calicut.
17. Shri AP Udaya Bhanu, Resident Editor, 'Mathrubhumi', Calicut.
18. Shri Rangamoni, Hindu Correspondent, Calicut.
19. Members, Press Club, Calicut.
20. Shri NA Anantha Krishnan, Superintendenting Engineer, (Irrigation), Calicut.

Abbreviations used

AICSCIP	:	All India Co-ordinated Spices and Cashewnut Improvement Project
CFTRI	:	Central Food Technological Research Institute
CIAE	:	Central Institute of Agricultural Engineering
CPCRI	:	Central Plantation Crops Research Institute
CSIR Complex	:	Council of Scientific and Industrial Research, Trivandrum
DASD	:	Directorate of Arecanut and Spices Development
DES	:	Directorate of Economics and Statistics, New Delhi
ICAR	:	Indian Council of Agricultural Research
IPSTA	:	Indian Pepper and Spices Traders' Association
KAD	:	Kerala Agricultural Department
KAU	:	Kerala Agricultural University
MOC	:	Ministry of Commerce, Government of India
SEPC	:	Spices Export Promotion Council

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