SOCIO-ECONOMIC ISSUES IN PESTICIDE USE: AN ANALYSIS IN BITTERGOURD

By

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THESIS

Submitted in partial fulfilment of the requirements for the degree of

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DECLARATION

I hereby declare that the thesis entitled Socio economic issues in **pesticide use An analysis in bittei gourd** s a bonaf de record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree diploma associateship fellowship or other similar t tle of any other University or Soc ety

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Dedicated to
my
beloved parents

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Introduction

1 INTRODUCTION

The scenario of Indian agriculture has undergone a vast change in the post independent era The green revolut on technology increased the food grain production many fold to meet the needs of the increasing population The green revolution technology which included the introduction of h gh yield ng var eties chemical fertilizers usage of plant protect on measures together w th ntensive cultivation pract ces helped to reach the zenith of product on in food crops

The adoption of high yielding varieties and intensive methods of cultivation not only resulted in greater strides n Indian agricultural production but also resulted in increased pest damage This called for an increased usage of plant protection chemicals to subside the pest attack Pesticides together with fertilizers and high yielding varieties have helped Indian farmers to achieve significant increase in crop productiv ty s nce mid 1960s The yield of the two most important pesticide using crops cotton and r ce increased by a factor of 1 8 and 1 9 respectively between 1960 61 and 1998 99

The celebration of the wonders of the agro chemical technology soon gave way however to a growing chorus of concern by scientists and public interest groups The most dramatic statement of these concerns was made by Rachel Carson (1964) in her classic work, Silent Spring She f rst alerted the publ c to the dangers of such poison in her work While pest cides were indeed boosting yields and bringing various pests under control she warned that they were also accumulating n the environment and threatening the very existence of various forms of wild life and humans as well Carson s critique played a crucial role in inspiring government regulat on. The book catalogued many hazards like ground and surface water contaminat on, damage to soil micro organisms massive bird and fish kills negative effect on plant bio d versity contamination of foods human health impacts including cancer damage to nervous system res stance in pests environmental persistence and bioaccumulation of residues

Pesticide is an essential ally in the farmers struggle to protect their crops Inspite of pesticide use loss throughout the product on system remains high In India on an average 33 per cent of crop loss occurs due to pests and diseases (Puri *et al* 1999) which runs to an estimated loss of Rs 200 bill on (Singh 1999) Recent estimates show that the pesticide consumption n India during 2004 05 was 46530 MT There are 180 pesticides approved for use on various crops in India. Twelve pesticides have been permitted for restricted use and 25 pesticides have been banned in India. (Zachariah and Devasahayam 2005)

Pesticides are used in about 25 per cent of total cultivated area in India where in insecticide account for 73 per cent herbicide 14 per cent fungicide 11 per cent and others two per cent In normal season pestic des account for about 42 50 per cent 25 per cent and 38 per cent of cost of cultivation of cotton paddy and cole crops respectively The amount spent on pest c des var es depending upon severity of crop pests and weather cond tions n a particular season (Shetty 2004) Consumption has not been uniform in the country and it varies with the intensity of pests and d seases cropp ng pattern and agro ecological reg ons Pesticide use is high in the regions with good irrigation facilities and where commercial crops are grown For instance cotton and paddy are grown in 5 per cent and 24 per cent of cropped area and receive about 45 per cent and 20 per cent of total pesticides respectively

The pesticide consumption in our country is very low (0 38 kg per hectare) when compared with other countries like Japan (12 kg per hectare) and Taiwan (17 kg per hectare) Karnataka, Andhra Pradesh Maharashtra and Punjab account for 38 14 per cent of total amount of pest cide used n the country (Agnihotr 2000) Even though the pestic de consumption in Kerala is low compared to these states the negative effects caused by these hazardous chem cals cannot be neglected Increasing concern for environmental degradation, worker safety and public health have spawned intense polit cal and social debates over pesticide use

Hence ın thıs era, studıes related to the ıssues on pestıcıde and chemıcal use are gaınıng ımportance

Excessıve and ındıscrımınate use of pest c des not only ıncreases the cost of productıon but also results ın many human health problems and envıronmental pollutıon According to WHO estımates one mıllıon cases of pestıcıde poısonıng occur every year and consequently there are 20000 deaths globally (Nas r 1999) The most damagıng ecologıcal dısturbance of ınjurıous use of pestıcıdes ıs the exıstence of hıgh concentratıon of pestıcıde resıdues n food chaın ınclud ng cereals pulses vegetables and fruıts In addıt on they contamınate the atmosphere and water

Indıa ıs the second largest producer of vegetables ın the world next only to Chına. In 2004 Indıa produced 84 8 mıllıon tonnes of vegetables from 5 9 mıllıon hectares of land Indıa shares about 13 per cent of the world output of vegetables from about 2 8 per cent of the cropped area ın the country Fruıts and vegetable crops rece ve consıderably hıgh quant ty of pestıcıdes and wıth a cropped area of 3 per cent they consume 13 per cent of total pestıcıdes ın the country (Nıgam and Murthy 2000)

In Kerala vegetable cultıvatıon ıs taken up on a commerc al basıs and the common vegetables cultıvated are bıttergourd snakegourd ıvygourd amaranthus tomato chıllıes and cucumber Bıttergourd ıs an ımportant vegetable crop cultıvated ın the State maınly because of ıts excellent nutrıtıonal values It ıs antıdotal antıpyretıc tonıc appetızıng antıbılıous and laxatıve In ayurvedıc medıcıne bıtter gourd ıs popularly known as a plant ınsulın Bıtter gourd ıs cultıvated ın the state on a commercıal basıs ın an area of 2162 hectares Palakkad and Thrı sur dıstrıcts contrıbute 11 65 percent and 12 16 per cent respectıvely to the total area. The usage of pestıcıdes n the crop ıs found to be more when compared to other vegetables as the pest attack ıs severe ın the crop

The pesticide consumption in the state is considerably high with a consumption of 360 M T during the year 2004 05 It has been identified that high levels of pesticide residues well above the maximum residue limit has been found in the vegetable samples tested in Kerala. It is reported that vegetables such as bittergourd cowpea and okra especially had high levels of pesticide residues Indiscriminate use of pesticides has been reported from Idukki district where the consumption exceeded the state average of 343 grams per hectare Palakkad district too has shown a higher than average use of pesticide (Mathew 2005) Hence the issues related to the use of pesticides are also found to be highly relevant

In this background the present study on the Socio economic issues in pesticide use An analysis in bittergourd was taken up with the following objectives

1) To estimate the cost and returns in bitter gourd cultivation
2) To analyze the pattern of pesticide use
3) To examine the socio economic issues in pesticide use in bitter gourd

Scope of the study

Bittergourd is an important vegetable crop cultivated in the state The medicinal properties inherent in the vegetable still add essence to its importance But the indiscriminate use of pesticides on this crop has posed serious issues that mainly include the pesticide residue problem The health and the environmental concerns of the people with regard to the pesticide related issues are gaining importance day by day In this context the present study will help to throw light on the issues associated with the indiscriminate use of pesticides and framing suitable regulatory policies to tackle the menace of overuse of pesticides The study on consumers Willingness To Pay Premium (WTPP) for pesticide residue free bittergourd will prove helpful n understand ng the scope of organic production of bittergourd and evolving suitable strategies for ts marketing

Limitations of the Study

The results of the study are based on farm level data, which were collected from farmers through personal interview method Since the farmers do not maintain records for the cultivation practices responses were drawn from their memory which may be subject to recall b as However every effort was made to minimize the error by cross verification and cross checking

Plan of the thesis

The thesis consists of five chapters ncluding the present one A review of the relevant literature s given in chapter two A brief description of tl e area of study and methodology are given in chapter three The results and discussion are presented in chapter four and the summary of the major findings of the study is given in the final chapter

Review of Literature

2 REVIEW OF LITERATURE

A comprehensive review of the past studies is useful to formulate concepts methodologies and tools of analysis to be used for any research In this chapter an attempt has been made to review important past studies relevant to the present study As the study attempts to examine the costs and returns technical efficiency pesticide use of bittergourd as well as the consumer awareness regarding pesticide use studies relating to these aspects are given in four sections namely

2 1 Costs and returns

2 2 Technical efficiency

2 3 Pesticide use and related problems

2 4 Consumer awareness with regard to pesticide use issues

2 1 Costs and returns

The cost and returns in the cultivation of four vegetables viz pointed gourd lady s finger bittergourd and chilli in Olapad taluk of Surat district of Gujarat was worked out by Madalia and Kukadia (1978) based on the data collected from eighty farmers using personal interview method It was found that the average cost of production of pointed gourd was Rs 5974 96 per hectare which was the highest while that for bhindi was Rs 3230 50 per hectare which was the lowest among the four vegetables under study Human labour was found to be the most important item of expenditure followed by plant protection chemicals

Subrahmaniyam and Doss (1981) estimated the cost of cultivation of vegetables in Mallur and Chickballapur taluks of Kolar district of Karnataka The results revealed that gross returns from tomato was Rs 21?22 12 while the gross returns from brinjal was Rs 13990 29 Input output ratios of tomato and brinjal were 3 92 and 3 16 respectively It was found that manures and manuring accounted for nearly 70 75 per cent of total cost

Nahatkar and Pant (1984) conducted a study on farm profitability and resource productivity in cultivation of chillies in Chindwara district of Madhya Pradesh and found that out of the total operational costs cost of fertilizers and manures was the highest on small farms whereas the cost of hired labour was higher on medium and large farms as compared to small farms

Gupta (1987) reported that vegetables accounted for more than 70 percentage of the total income of the farmers in Solan in Himachal Pradesh It was found that income on large farms was 3 5 and 1 7 times higher than that of small and medium size farms respectively As much as 48 per cent of the total expenditure went to hired labour alone Cost of product on per unit area was lower on large sized farms making them economically more efficient

Sandhya (1992) in her study on the economics of production and marketing of vegetables in Ollukkara block in Thrissur district found that cost incurred in producing one quintal of bittergourd was higher than that of ash gourd Net income derived from bittergourd cultivation was 44 per cent more than that from ash gourd Both in the case of bittergourd and ash gourd the contribution of two inputs namely manures and fertilizers and land towards net income were found to be significant and positive explaining thereby the possibility of further increase in total income by the use of these inputs Labour was the largest item of input for both the crops (bittergourd and ash gourd) under study

Sharma *et al* (1992) in a study on economics of vegetable farming in mid hills of Himachal Pradesh found that lady s finger and chillies in kharif and cauliflower cabbage and potato in rabi were the most paying vegetable crops However cauliflower cabbage and peas in rabi and bottle gourd brinjal and bittergourd in kharif were the most remunerative vegetable crops The input output analysis suggested that farmers could increase total income by enhancing the use of labour The study also brought out that there was increasing returns to scale in cauliflower potato and brinjal thereby suggesting that more returns could be obtained if the use of the inputs like human labour bullock labour and working capital were enhanced

Brahmaiah and Naidu (1993) reported that labour was one of the major constituents of total cost incurred in the production of chillies n Guntur district of Andhra Pradesh Cost component for large and small farms indicated that manures and fertilizers took the largest share in total expenditure followed by other inputs like rent on land plant protect on. human labour and bullock labour

An economic analysis of production of vegetables in Himachal Pradesh conducted by Thakur *et al* (1994) showed that vegetable product on was highly cost intensive but at the same time h ghly remunerat ve Among the total variable costs for f ve vegetables viz tomato capsicum cauliflower cabbage and peas human labour occupied the lion s share

Prasad and Bonney (1996) conducted a study in Pananchery and Puthur Panchayats of Trichur district n Kerala to del neate the constraints in adoption of improved agricultural practices by commerc al vegetable growers The most important constraint was the increased cost of plant protection chemicals (98 per cent) followed by inadequate market facilities (88 per cent) and poor storage and other post harvest facilities (74 per cent) The other constraints in the order of importance were inadequacy of capital high labour charges and water scarcity

A study conducted in Durg district of Madhya Pradesh by Gupta and Verma (1997) to analyse the production and marketing of ivy gourd revealed that the material used to prepare the panthall and land rent were the most expensive cost items Manuring and fertilizer appl cation plant protect on and harvesting were found to be very important variable cost component

Ramachandran (1997) in the study on the econom cs of production and marketing of vegetables in Chittur taluk of Palaghat district found that the net income from tomato was higher (Rs 22686 ha) than from okra (Rs 15434/ha) The expenses on human labour were the single largest item of expenditure followed by the rental value of own land The study showed that the major constraint in vegetable cultivation in Chittur taluk was the ever increasing cost of production without a corresponding increase in the returns accruing to the cultivators

A study on the input wise cost of cultivation of potato garlic carrot and cabbage in Devikulam block of Idukki district showed that human labour cost was the single largest item of input almost occupying one half of the total cost while operation wise cost of cultivation of the above crops showed that seeds and sowing was the single largest item which occupied the major share of the total cost Stochastic frontier production function est mates revealed that 71per cent of the deviation in the yield of potato was due to the differences in the technical efficiency among farms (Karthikeyan 2001)

Nagesh (2001) in his study on production and market ng of vegetables in Trivandrum district in Kerala found that cost of panthalling and staking occupied a significant share of total input costs in the case of bittergourd and snake gourd Among the three crops snake gourd bittergourd and amaranthes snake gourd was the most labour intensive crop In terms of profit bittergourd was the most remunerative in the study area. He opined that less costly and more durable materials for panthalling and staking could bring down the total cost of production

The study conducted by Agro Economic Research Centre Un vers ty of Delhi (2004) revealed that the economics of vegetable cultivation is favourable or more attractive than of any other crop whether looked from the point of per acre income or from the point of returns per rupee of investment Vegetable cultivation absorbs substantial amount of labour Almost one third of the cost s ncurred on labour charges

A study on the production and marketing of vegetables in Palakkad district was conducted by Sreela (2005) to analyze the economics of vegetables viz bittergourd snake gourd and ivy gourd and to assess the technical efficiency marketing efficiency and constraints faced by the vegetable growers She found that the total expenditure at Cost C_3 at aggregate level was Rs 105717 Rs 103277 Rs 137498 and Rs 98711 for bittergourd snake gourd ivy gourd main crop and ivy gourd ratoon crop respectively The study revealed that the most important constraint faced by the vegetable growers in the study area was the incidence of pests and diseases It was followed by the problems of high nput cost inadequacy of capital non availability of labor and low price of the produce

Thomas *et al* (2006) in an analysis of the economics of vegetable production and marketing in Kerala in the southern northern and central zones of the state reported that the total cost in cultivation of bittergourd in Palakkad district was found to be Rs 115229 for VFPCK farmers The major item of expenditure was found to be the expenses on hired labour which contributed 21 per cent of the total cost The next highest item of expenditure was the expenditure incurred on manure (10 03 per cent) followed by panthalling material (9 94 per cent) The gross return was found to be Rs 112000

2 2 Technical efficiency

The concept of technical efficiency was elaborated by Farrel (1957) It involved the farmer s ability to obtain the maximum output from a given set of resources Clearly a farm which used the best practice methods with a similar bundle of inputs and technology was likely to be superior to another farm or section that did not do the same Farrel also observed that the input per unit of output values for such farms would lie on or above the unit isoquants He divided technical efficiency and allocative efficiency as the components which contributed to economic efficiency

Broek *et al* (1980) in their study to compare the result with various techniques for estimating deterministic frontiers op ned that the cho ce bet een deterministic and stochastic frontiers must be made on the basis of information about the quality of data, or how the data are generated and above all the purpose of study The frontier was called deterministic if all observations lie on or below the frontier and stochastic if observations lie above the frontier due to random events

The allocative efficiency and supply response of farmers growing a modem variety of rice (IR 20) and local varieties in the irrigated areas of Coimbatore district of Tamil Nadu, were examined by Kalirajan and Flinn (1981) by fitting a profit function and the associated factor demand schedules to the data The anal sis suggested that both groups of producers showed similar levels of technical efficiency The growers of local varieties appeared to be allocatively efficient given the variable factors of production included in the analysis The producers of the modem variety were not efficient with respect to pest management labour fertilizer and animal power

A stochastic profit frontier function of modified translog type was fitted for Basmati rice farmers in Pakistan s Punjab by Ali and Flinn (1989) After estimating the technical inefficiency of individual farmers the losses in profit due to technical inefficiency were obtained and regressed on various farms and farm specific variables Factors that were significant in describing the variability in profit losses were level of education off farm employment unavailability of credit and various constraints associated with irrigation and fertilizer application

Ureta and Rieger (1990) described that the stochastic product on front er possesses a distinct feature and the disturbance term was composed of two parts a symmetric and a one sided component The symmetric component described the random effect outside the control of the decision maker including the statistical noise contained in empirical relationship The one sided component captured deviations from the frontie due to ineffic ency The main advantage of the stochastic frontier production model was the introduction of the disturbance term representing the statistical noise comprising of measurement error and exogenous shocks beyond the control of the production unit in addit on to the effic ency component In this way technical efficiency measures obtained from stochastic frontier were expected to be efficient than those from deterministic models

Dawson *et al* (1991) calculated s ngle measures of farm spec fic techn cal efficiency for rice farms in Central Luzor Philipp nes from the residuals of a stochastic frontier production function Panel data from International Rice Research Institute s periodic loop survey were used They opined that the responsibility of technical inefficiency rests mainly with management

An economic analysis of technical effic ency in rice cult vation in Mandya was measured in terms of physical maximum attainable by each farmer based on Timmer measure of technical efficiency The results revealed that the farmers achieved relatively h gher levels of phys cal eff ciency n growing rice The average for the large farmers was 97 60 per cent and for small farmers t was almost same at 97 54 per cent This high level of output eff c ency implies that most farmers in the region are famil ar with the product on techniques and employed it to the best poss ble advantage Further a perusal of actual and frontier usage of inputs in the production of rice indicated that all the factors under consideration were used at levels h gher than the frontier level by both the large and small farmers The quantum of excess use of inputs in the production of rice was 15 per cent in the case of large farmers while among small farmers it was 30 per cent In other words the ex sting level of productivity on an average could be achieved by reducing the input use by 30 per cent in the case of small farmers and by 15 per cent by large farmers (Jayram *et al* 1992)

Kutaula (1993) stud ed the applicat on of front er technology to wheat crop grown on reclaimed soils in Haryana The est nated mean techn cal efficiency was found to be 0 7636 This implies that the actual output of wheat on an average is less by 23 64 per cent He concluded that the farmers were able to increase the present level of mean technical efficiency with the existing levels of inputs without any additional cost Suitable extension facilities supplemented would be helpful to increase the level of output in wheat farms

The technical efficiency of irrigated farms in a village of Bangladesh was studied using the stochastic production frontier The results exhibited a wide variation in the levels of technical efficiencies across farms Out of 99 farms 88 had technical efficiency of 71 per cent or more Thirteen farms showed technical efficiency in the range of 91 per cent to 100 per cent The average technical efficiency for the entire sample of farms was 78 per cent indicating that there was considerable scope for increasing the technical efficiency of the sample farms as a group A very interesting finding was that 10 out of 13 most efficient farms belonged to the category of small farms The least efficient farm (being also a small and owner farm) relied heavily on hired labour as the head of the farm was employed in some non farm activities (Banick 1994)

The panel data on the production of wheat in four districts of Pakistan was analyzed using stochastic production function The technical efficiency effects of the sample wheat farmers were significant in all four districts and the technical efficiencies of the sample farmers were less than one The mean technical efficiencies for wheat farmers of Faisalabad Attock Badin and Dir were estimated to be 0 789 0 584 0 570 and 0 775 respectively Their work indicated that technical efficiency effects associated with the production of wheat in Faisalabad were significantly related to the age and schooling of farmers and they had decreased over time This analysis also indicated the potential usefulness of the modeling of technical inefficiency effects on stochastic frontiers and also highlighted the desirability of obtaining data on an extensive range of variables explaining technical inefficiency effects in addition to the appropriate input output data for production function analysis (Battesse and Coelli 1995)

A study on the economic efficiency of r ce production in Kerala \ as conducted by Thomas and Sundaresan (1998) The study analysed the region wise and season wise economic efficiency by using frontier profit function model The results revealed the significance of labour and land in all the seasons of the t vo regions indicating the influence of these variables in determining the profit of the farmer The individual farm efficiency showed wide variation in both the regions The study concluded that there was ample scope for increasing the profit of the farmers by the proper adoption of technolog) and opt mum allocation of resources

The technical eff ciency in the production of Bangalore blue grapes was estimated by Poornima (1999) ndicated that only 20 per cent of the Bangalore blue grape growers were operating at more than 75 per cent efficiency 64 per cent of the farmers were operating in the efficiency range of 50 to 75 per cent and about 16 per cent of farmers were operat ng belo v 50 per cent of eff c ency Tl e mean efficiency was est mated to be 63 per cent The nefficiency was interpreted in terms of over utilisation of resources especially agrochem cals

Technical efficiency of rice growers in Tamil Nadu was est mated using stochast c frontier product on funct on bv Myth h and Sl anmugam (2000) The technical efficiencies varied widely ranging from 46 5 per cent to 96 7 per cent across sample farms The est mated mean technical efficiency was found to be 82 per cent indicat ng that on an average the sample farms in Tamil Nadu had realised only 82 per cent of their technical abil ties It means that approximately 18 per cent of the technical potentials were not realised and hence the realized output could be increased by 18 per cent \ thout any addit onal resources

Karthikeyan (2001) in his study on product on and marketing of cool season vegetables viz potato garlic carrot and cabbage in Devikulam block of Idukki district fitted a stochastic frontier production function The results revealed that 71 per cent of the deviation in the yield of potato was due to the differences n the technical efficiency among farms Mean technical efficiency was 0 78 0 80 0 71 and 0 63 respectively for potato garlic carrot and cabbage The frequency distribution of farm specific technical efficiencies showed that 22 per cent of farms were operating at a technical efficiency of more than 90 percent in the case of potato

An economic analysis of production and marketing of vegetables in Trivandrum district was conducted by Nagesh (2001) He used the frontier production function to analyze the technical efficiency of Vegetable and Fruit Promotion Council Kerala (VFPCK) and Intensive Vegetable Development Programme (IVDP) vegetable growers The bittergourd growers under VFPCK showed an estimated mean technical efficiency of 80 per cent and for IVDP growers it was 71 per cent

In an analysis of paddy productivity growth in West Bengal and Orissa, Pillai (2001) estimated the stochastic frontier production function using the farm level data by the method of maximum likelihood The estimates of average technical efficiency across local and HYVs in West Bengal in 1986 87 were not very different In Orissa, the estimates of average technical efficiencies for local and HYV paddy in kharif season were found to be 76 per cent and 78 per cent respectively Around 44 53 per cent of the farmers were found to be more than 80 per cent technically efficient

The technical efficiency in rice production in Kuttanad area of Alappuzha district was estimated using the stochastic frontier production function of the Cobb Douglas type based on Maximum Likelihood Estimate by Job and George (2002) The empirical analysis showed that even in an advanced agricultural region there was need to improve technical efficiencies of majority of farmers The technical efficiency varied widely between 58per cent and 99per cent Various socioeconomic biophysical and technological factors are responsible for the differences in efficiencies The study showed that with proper allocation of the existing technology there was ample scope for improving the productivity of rice

A stochastic frontier production funct on was est mated to determine the technical inefficiency of ind vidual farm n wheat production in the Sone canal command area of Bihar by Reddy and Sen (2004) It was found that the farms in the area were producing wheat with average techn cal ineff ciency of 18 71 per cent the maximum being 53 46 per cent and minimum 4 41 per cent It as found that factors like farm size farmer s education extension contacts and experience in production and the percentage of good farm land influenced the technical inefficiency negatively while fragmentations of farm land and age of farmer influenced it positively

Technical efficiency in the Maize product on in Madhya Pradesh as estimated by Anupama *et al* (2005) and found that on an average the sample farms operated 23 percent below the frontier output levels It was found that even though a majority of the farmers cultivated improved maize cultivars the overall technology adoption was poor Hence the maize output could be increased by 23 per cent by adopting proper technology by farmers The economic eff ciency of the maize growers in the state could be improved by increas ng the adoption level of improved package of pract ces

Sreela (2005) estimated the technical efficiency of bittergourd farmers in Palakkad district The study revealed that when land was included as variable 83 88 per cent of the variation between the actual output and the maximum possible output was due to the technical inefficiency at the farmer s level The Mean technical efficiency (MTE) was found to be 0 85 Thus the farmers were 15 per cent less eff cient in utilizing the inputs and hence they had the potential to increase the yield When mounds were added as a variable 95 per cent of the variation between the actual output and the maximum possible output was due to technical inefficiency It revealed that the farmers were not using best practice technique and various factors other than technical inefficiency had a s gnificant effect on yield

The technical efficiency in agricultural production and its determinants were analysed by Shanmugam and Venkataraman (2006) Using stochastic frontier production approach they found that Indian districts have a mean technical efficiency of 79 per cent which indicated that on an average agricultural output can be increased by about 21 per cent with existing resources In nearly half of the sample districts (123 out of 248) technical efficiency value was below 80 per cent The study showed that the relative importance of the determinants of technical efficiency across districts depended greatly on environmental factors such as agro climatic zones technological factors (such as irrigation regime) and crop mix

2.3 Pesticide use and related issues

In a study conducted to identify and estimate externalities in pesticide use Langham and Edwards (1969) found that externalities could not be studied meaningfully independently of the system which generated them They defined three participants consumers producers and others The measures chosen to determine the effect of various policies on participants were consumer surplus producer surplus

Bindra and Karla (1971) estimated insecticidal residues in vegetables of different markets of Delhi Hyderabad and Punjab Their analysis indicated that 75 per cent of the samples were contaminated and 50 per cent contained residues higher than the tolerance limits Among the 30 okra samples three samples one in each with Fenvelarate Endosulfan and Cypermethrin exceeded the MRL and four out of ten cauliflower samples exceeded the MRL with Cypermethrin Fenvelarate and Monocrotophos

Ghodake *et al* (1973) suggested that the problem of uncertainty and externalities in costs and benefits make economic analysis of pesticide use highly complex The analysis of the effect of environmental factors emphasized that the recommendations regarding pesticide usage must take into account this factor also

Horne (1973) opined that there are positive and negative external effects in using insecticides When society considers restricting the use of insecticides legislatively society is really saying that the social costs (health and environmental hazards) of using insecticides have exceeded the social benefits (quantity and quality of food and fiber) He indicated that when certain insecticides are restricted farmers still receive net returns higher than that for most of other crops

Mahalle and Jha (1977) compared the returns obtained from using recommended dosages of pesticides with those under optimal strategies and it was found that the latter yielded better returns They fitted a quadrat c production function to establish pesticide output relationship using experimental data. The results reflected that response to pesticide was determined by the level of infestation. These also implied a significant saving in the quantity of pesticides used which is quite important from the point of view of externalities

Huh (1979) classified the effects of pesticide use as beneficial and adverse The benefits identified by him were increased yield input savings and overall rise in productivity and quality of product Consumer surplus was employed to measure the adverse effects The study indicated that from societal point of view any action in relation to use of pesticides should be taken after a thorough examination of the full effects of pesticides since the existence of external economy entails an equilibrium output that is below optimal

An analysis of pesticide use decisions in agriculture was taken up by Ghodake and Jha (1981) using data from insecticidal trials on rice crop conducted by the All India Coordinated Rice Improvement Project at Coimbatore (Tamil Nadu) Maruteru (Andhra Pradesh) and Cuttack (Orissa) research stations The results ındıcated that ıf the expected ınfestat on levels were known farmers would be maxımızıng theır net returns by choosıng an appropnate pestıc de and also the level of ıts use Rarely dıd the same chemıcal or pestıcıde level prove to be optımal under all ınfestatıon sıtuatıons When pest c de use was examıned ın the context of uncertaınty unıque pestıcıde levels were naturally ındıcated as opt mal strategıes

A study conducted ın Guntur and Kurnool dıstrıcts of Andhra Pradesh to dıscrımınate the factors ın pestıcıde use revealed that educatıon fertıl zer expendıture caste and area under hıgh yıeldıng var etıes emerged as the major factors ınfluenc ng the pestıcıde use among the farmers In case of small farmers those who grow hıgh yıeldıng var etıes and use fert lızer ınclıned to use more pestıcıdes Fert lızer applıcatıon has been the maın factor ın dıscr mınatıng pestıcıde user from non user ın large farms (Rao and S ngh, 1986)

Pandurangadu and Raju (1990) ın the r study analysed the econom cs of pestıcıde use on cotton farms n Guntur d strıcts of Andhra Pradesh and concluded that the alarmıng rıse ın the cost of cult vatıon of cotton was largely attr buted to the ıncreased use of quıte expensıve and broad spectrum chemıcals lıke synthet c pyrethroıds They suggested that not only as an economy measure but also to avoıd sıde effects of excessıve use of pestıcıde farmers should adopt Integrated Pest Management practıces The use of adulterated pest cıdes was also found to be a reason for the ıneffectıveness of some of the chem cals

Wynen and Edwards (1990) reported that the prıvate net returns were sımılar for both conventıonal and chemıcal free farmıng The study ındıcated tha a favorable change ın net externalıty could be expected from a movement towards chemıcal free farmıng Major posıtıve externalıtıes of chemıcal free farmıng were mproved soıl qualıty reduced soıl erosıon ımproved water qualıty ımproved human health reduced susceptıb lıty to harsh seasons and reduced r sk of pest adaptation to farm management techniques increased personal satisfaction and so on

Arunkumara (1995) analysed the externalities in pesticide use in Cole crops based on producer survey and consumer survey and by fitting gross income function and expenditure function He found that biocides and organophosphates were the major groups of insecticides used by the sample farmers in the study area. Pesticides formed 27 per cent of the total cost of cultivation Gross income function analysis indicated that pesticides contributed significantly to the gross income at 5 per cent level The study indicated that the resistance externality was the major externality generated due to pesticides

Chand and Birthal (1997) studied the pesticide use in Indian agriculture in relation to growth in area and production and technological change and concluded that pesticide use is positively and significantly influenced by irrigation coverage percentage of rice area irrigated share of cotton in the gross cropped area and percentage of area under HYVs of cereals The regional variation in pesticide use is on account of differences in cropping pattern and the level of agricultural development Most of the high pesticide using states have better irrigation coverage and well developed credit marketing and input delivery systems which promote the use of modern crop production technology including pesticides

Kumar and Yadav (1998) analysed the insect pest population fluctuation on early season cauliflower crop under Haryana agro climatic conditions They found out that spraying the cauliflower crop blindly throughout the growing period on calendar based interval would be wasting of the pesticides In addition that would unnecessarily increase the cost of production and contaminate the human diet and environment

A study conducted in the Anthikkad block of the Kole lands of Kerala to estimate the technical efficiency in rice production and to assess the pesticide use behaviour of farmers found that market orientation of Kole farming tends to increase the probability of applying more pes c des The study concluded that the excess use of pesticides in the study area could also be reduced considerably by the input of technical knowledge and for that the role of extension was to be enlarged to equ p the farmers with superior technical knowledge for enhancing environment friendly r ce product on in Kole lands of Kerala (Rajasekharan and Krishnamoorthy 1998)

Poornima (1999) in a study in Bangalore rural district on the economics of agrochemicals found out that for resources such as manure fert lizers and plant protection chemicals the coefficients of regression were negat ve indicating that use of these inputs will reduce the yield of grapes Also the Kopp measure of technical effic ency indicated that 20 per cent of the farmers over used agrochemicals to an extent of more than 75 per cent of that used by technically efficient farmer Experience in the usage of agrochem cals gross ncome application of farm yard manure potassium fertilizers consultat on w th specialists and application of prophylact c dose were the factors wh ch significantly influenced the percentage of over use of agrochemicals

An economic analysis of externalit es in the estuarine ecosystem of Kuttanad in Kerala revealed that prof tability and pesticide costs had negative correlat on The expenditure on plant protection chem cals was lesser for IPM farmers (1 7 per cent) compared to non IPM farmers (4 7 per cent) Major ty of farmers (60 per cent) experienced health hazards due to pestic de poison ng IPM helped farmers to reduce the use of plant protection chemicals drastically and earn a better profit Farmers used huge quantities of synthetic pest cides like organophosphates which caused both health hazards and faster resistance build up among pests pest resurgence and reduction of natural enemy population (Rakhesh 1999)

A study was conducted in rainfed cotton to study the frequency intensity and determinants of pesticide use in Nanded district of Maharastra and found that the average pesticide usage was 3 2 kg active ingredient per hectare of cotton area The farmers attitude towards insect pest risk was varied and accordingly the use of pesticides Risk averse farmers used pesticides excessively and indiscriminately About 50 per cent of farmers applied 7 10 insecticide sprays and about 48 per cent of the pesticide applied belonged to organophosphate category (Birthal *et al* 2000)

Ecobichon (2001) reported that developing nations in their efforts to eradicate insect borne endemic diseases to produce adequate food and to protect forests plantations and fiber relied more on chemical pesticides Many older non patented more toxic environmentally persistent and inexpensive chemicals were used extensively in developing nations creating serious acute health problems and local and global environmental contamination He also reported that there was growing public concern that no one was aware of the extent of pesticide residue contamination on local fresh produce purchased daily and the potential long term adverse health effects on consumers

In analyzing the export problems of Indian spices Menon (2002) came out with the finding that the presence of pesticide residues mycotoxins and microbial contaminations are the major reasons for the detention of consignments of spice/spice products exported from India They are detained due to the occurrence of residues of various pesticides such as Chlorpyriphos Ethion Quinalphos Cypermethrin Fenvelarate Phosphamidon and Phosalone by the major importing countries such as USA UK Germany Spain Italy and Australia Public awareness for some chemical contaminants on raw spices and its value added products has forced importing countries to be more strict on imported spices and spices products

A study on awareness of environmental hazards caused by indiscriminate use of agro chemicals among cotton growers and agricultural assistants by Srinivas (2002) found that length of experience and attitude towards chemical fertilizers were negatively correlated with the awareness level of environmental hazards of agricultural assistants The study implied that the farmers had low adoption of bio fertilizers and biological/natural pest control measures Hence there is an imperative need to raise the level of adoption of these practices in order to reduce the quantum of chemical usage in agriculture

Jeyanthi (2003) reported that overuse of plant protection chemicals in Chillies Brinjal and Bhendi resulting in reduction of yield and increase in the cost of plant protection. The study revealed that awareness about toxicity color symbols in the pesticide package and minimum waiting period for harvest after pesticide application was very low with 10 and 19 percent respectively

A field investigation was carried out by Shetty (2004) to obtain information in the use (and misuse) of pesticides in a few districts in Karnataka Andhra Pradesh Maharastra and Punjab focusing on crops such as paddy cotton and vegetables The study revealed that pesticides accounted for a major share of the cost of cultivation In normal seasons they accounted for about 42 50 percent 25 percent and 38 per cent of cost of cultivation in cotton paddy and cole crops respectively The respondents resorted to over application of pesticides and tried irrational combinations to overcome the problem of insect pests

A study was conducted by Jeyanthi and Kombairaju (2005) to analyze the frequency intensity and determinants of pesticide use in vegetable crops in Dindigul district of Tamil Nadu They suggested that farmers need to be educated about different non chemical control methods and should be encouraged to adopt integrated pest management (IPM) practices The study examined the pest management practices in four important vegetable crops viz chillies cauliflower brinjal and bhendi using farm level cross sectional data. Average pesticide usage was 5 13 2 77 4 64 3 71 kg active ingred ent per hectare o cl Il es ca l flo ver brinjal and bhendi crops respectively

A study on the pesticide use in rice production in Kerala showed that 40 per cent of the sprayings were made to protect the crop against the Brown Plant Hopper pest 17 per cent against rice bug and 16 per cent to control the leaf folder Mostly owners (87 77 per cent) bought the chemicals to be sprayed and entrust these with the person engaged for spraying and the spraying operations were not properly supervised Only 1 5 per cent of the applicators were reported to have undergone training on any plant protection methods The toxicity level rating based on colour codes were understood by just 1 5 per cent Majority of the respondents were aware of the potent al health hazards due to exposure and need for personal protective gadgets Despite this none of them were us ng the recommended protective gadgets (Devi 2006)

The impact of environmental degradation n Punjab was accounted for in a study conducted by Singh and Sidhu (2006) The study examined the use of certain resources and its impact on the cost of production They found out that the monoculture of rice and wheat resulted in the res stance of some of the weeds insect pests and diseases overtime The dose of herbicide application has also increased over the years The costs on other pesticides have gone up a d ne v types of herbicides and pesticides were introduced which put together ra sed the annual cost of production by Rs 99 per ha in paddy and Rs 69 per ha in wheat The fall of water table deficiency of micronutrients and resistance to herbs pests and diseases together has increased the cost of production by Rs 263 per ha and Rs 698 per ha of wheat and rice respectively

2 4 Consumer awareness with regard to pesticide use issues

A survey of 1416 California farm workers indicated s gnificant under reporting of pesticide injuries in official information sources Institutions for internalization of externalities were operating inefficiently due to an imprec se data problem Seventy per cent of farm vorkers had never heard of workman s insurance and 20 per cent could not understand pestic de varning labels (Howitt and Moore 1975)

Greene and Zepp (1989) reported that a growing number of consumers have become concerned about the health effects of chemical residue on produce In a nation wide survey in USA in 1988 nearly 18 percent of consumers polled were concerned enough to change the r buying habits They indicated that some super markets and food retailers were responding by adding organic sect ons to their produce departments and by providing information for the consumer on safe levels of pesticide residues

Ott (1989) concluded that consumer interest in pesticide residue free fresh produce represents a d rect marketing opportunity for small scale growers Half of the surveyed shoppers expressed concern about pesticide use and are willing to pay more for pesticide res due free fresh produce They were unwilling however to accept cosmetic or insect damage caused by the non use of pesticides

Consumer surveys in USA revealed that Americans want improvement in the safety of foods they ate and were willing to pay more for it Consumer surveys carried out by the food marketing institute in USA since 1983 indicated that a majority of consumers expressed a high degree of confidence in the foods they bought More than 73 per cent consistently expressed apprehension over pesticide residues A 1988 survey of consumers in Florida ranked res due as the most serious concern followed by presence of bacter a and add tives (Smallwood 1989)

Harper and Zilberman (1992) opines that key problem in pest cide regulation is uncertainty about health r sks They examined the trade offs between economic benefits and worker health safety using an empirical illustration and suggested that the most appropriate public policy is a safe minimum standard which allows weighing of costs and benefits only after some minimum acceptable level of health safety has been assured

In a study conducted to estimate the externalities in pesticide use in cabbage in Bangalore about 67 per cent of the consumers were aware of pesticide residues The awareness of consumer regarding the pesticide residues in vegetable was highest in ECONET market (80 per cent) and least in Malleshwaram vegetable market (50 per cent) Majority of the consumers expressed their Willingness to Pay Premium (WTPP) for pesticide free cabbage WTPP ranged between 0 and Rs 6/ per kg of pesticide free cabbage at the retail level The average WTPP was Rs 1 60 per kg of pesticide free cabbage at the retail level (Arunkumara, 1995)

The consumers willingness to pay for elimination of one insecticide (azinphos methyl) and also a whole group of neuroactive insecticides in apple production was analysed by Roosen et al (1998) The data was analysed using non parametric statistical tests and a double hurdle model The findings showed that consumer perceptions of the product attributes change if pesticides were removed from production and that reflected the WTP changes WTP was found to be income elastic too

Poornima (1999) found out that about 82 per cent of consumers in Bangalore city were aware of pesticide residues in grapes and 68 per cent of them were aware of pesticide residues in apples and 64 per cent in mangoes The consumer awareness of pesticide residues on grapes was the highest in Indiranagar market (24 per cent) and HOPCOMS near Lalbagh (22 per cent) Majority of the consumers expressed their Willingness to Pay Premium (WTPP) for pesticide residue free grapes On an average in all markets surveyed consumers were willing to pay Rs 11 72 per kg as price premium for pesticide free grapes at retail level The price premium formed 30 per cent above the retail price

Willingness to pay (WTP) for reduction in health risk associated with consuming pesticide res dues on vegetables was estimated using the contingent valuation method Est mated median WTP for 25 per cent 50 per cent and 90 per cent reduction in the risk for developing cancer from consuming pesticide residues on a popular Taiwanese vegetable bok choy were estimated as 46 per cent 56 per cent and 75 per cent of the current price of bok choy respectively WTP was found to be signif cantlv related to the scope or magn tude of the r sk reduction although it varied less than proportionately to the risk ncrement WTP was also significantly related to measures of consumer preferences for health (TsuTan *et al* 1999)

A study was conducted to analyse the will ngness to pay (WTP) premium for pesticide free fresh fruits and vegetables in Italy using an ordered logit analysis The results ind cated that WTP is sign ficantly and pos tively related to income and risk concern and negatively related to education It was found that 11 per cent of the respondents were w ll ng to pay as much as 20 per cent abo e regular prices to avoid pesticide risk ind cating relevant market niche for these safe products (Boccaletti and Nardella 2000)

A study was conducted by Loureiro *et al* (2002) to assess the mean willingness to pay (WTP) for eco labeled apples using a double bounded logit model They found that farmers and other producers responded well to consumer concerns about pesticides by creating new marketing opportunities for products grown with environmentally sound practices It was seen that female respondents with children and strong environmental and food safety concerns were more likely to pay a premium for eco labeled apples However the estimated premium was small (about 5 cents per pound over an n tial price of 99 cents) which reflected the overall difficulty n garner ng a prem um based on environmentally sound practices

The consumer s willingness to pay for pesticide free food products in Canada was analysed by Cranfield and Magnusson (2003) A contingent valuation survey using ordered probit analysis revealed that over 67 per cent of respondents were willing to pay a 1 to 10 per cent premium relative to a conventional food product Five per cent we e willing to pay more than a 20 per cent premium The consumers were concerned about pesticides in agriculture and food Socio demographic factors proved to be relatively unimportant as compared to concern over pesticide use in agr culture

The factors that influence the consumers purchasing dec sion and the evaluation of their willingness to pay (WTP) for environmentally friendly produced vegetables (EFPV) in Thailand were identified by Anunchai and Schmidt (2004) The double bounded contingent valuat on method was used in surveying 1320 respondents The results indicated that WTP was positively related to the frequency of purchasing EFPV The respondents were willing to pay a price premium of almost 100 per cent compared to an average price increment of only 78 per cent observed in retail shop It was suggested that there was a relatively high potential demand for EFPV in Thailand

Magnusson and Cranfield (2005) described the Pesticide Free Production (PFP) as a new crop production strategy that has emerged in the Canadian prairies A consumer survey was developed and implemented to assess what food products consumers would purchase if available in a PFP form and what factors affected the demand for PFP food products Results from a probit model suggested strong consumer interest in food products containing gra ns and oilseeds produced in a PFP cropping system The results showed that the respondents who were concerned with pesticides in the environment and/or food products expressed willingness to switch to grocery stores for a PFP food product It was also found that respondents who were less than 36 years of age and had higher average household income were ready to pay a premium for a PFP food product.

Materials and Methods

3 MATERIALS AND METHODS

Appropnate research des gn ıs pre requısıte to draw meanıngful ınferences about any study The present study on the socıo economıc ıssues of pestıcıde use ın bıttergourd aıms to estımate the costs and returns ın bıttergourd cultıvat on the dıfferent socıo economıc ıssues related to pestıcıde use and the consumer awareness regardıng pestıcıde resıdues In th s chapter a bnef descr pt on of the study area and the methodology used for the study are dıscussed ın detaıl

3 1 AREA OF STUDY

The study was undertaken n Palakkad and Thrıssur dıstrıcts vhere bıttergourd cultıvat on ıs undertaken on a commercıal basıs

3 1 1 Palakkad Dıstııct

Palakkad dıstnct ıs called the Granary of Kerala and ıs sıtuated ın the Southwest coast of Indıa

3 1 1 1 Locatıon

The d stnct ıs bounded ın the north by Malappuram d stnct n the east by Coımbatore dıstnct of Tamılnadu ın the south by Thrıssur dıstnct and ın the west by Thnssur and Malappuram d stncts Palakkad dıstnct l es between north latıtude 10° 46 and 10° 59 and east longıtude 76° 28 and 76° 39 The total geographıcal area of the dıstnct ıs 4480 sq kms representıng 11 53 per cent of the state s geographıcal area For the purpose of admınıstratıon the dıstrıct ıs dıvıded ınto two Revenue Dıvısıons Ottappalam and Palakkad and 5 Taluks vız Alathur Chıttur Palakkad Ottappalam and Mannarkkard The d stnct has thırteen blocks and nınety Panchayats There are 163 vıllages ın the d stnct Nemmara block panchayat comes under Chıttur taluk

The major rivers are Bharathapuzha (Nila) Kollengode Kannad Kalpathy Chitturpuzha, Bhavani Shiruvani Thuthapuzha and Gayatri The district has some key irrigation projects and dams at Malampuzha Walayar Mangalam, Gayatri Chittur Meenkara, Pothundi and Kanhirapuzha. Malampuzha Dam irrigates over 20 000 hectares of farming land while Chittur Irrigation Project covers over 18 000 hectares and Kanhirapuzha project waters over 10 000 hectares

3 1 1 2 Geographical features

Based on the physical features the district is divided into two natural divisions midland and highland The midland region consists of valleys and plains It leads up to the highland which consists of high mountain peaks long spurs extensive ravines dense forests and tangled jungles While Ottappalam taluk lies completely in the midland region, all other taluks in the district lie in the midland and highland regions

The Western Ghats has an average altitude of 5000 feet except for two peaks of more than 6000 feet The important peaks above an altitude of 4000ft are Anginda peak (7628 feet) Karimala peak (6556 feet) Nellikotta or Padagiri peak (5200feet) and Karemala Gopuram (4721 feet)

3 1 1 3 Demographic features

The district has a population of 2382243 persons according to the 2001 census which constitute 8 21 per cent of the population of the state The density of the population is 532 per sq k m The sex ratio of the district is 1061 females for 1000 males This is in consonance with the unique pattern of the state which is contrary to the all India figure of 929 females per 1000 males The literacy rate of the district (81 27per cent) is lower than the state average (89 81per cent)

3 1 1 4 Climate and rainfall

The district has got two types of climates Ottappalam, Alathur and Mannarkkad taluks are having a humid climate with a very hot season extend ng from March to June similar to that of othe districts of Kerala whereas Palakkad and Chittur are having rather a dry climate similar to Tamil Nadu Average annual rainfall of the district is 1831 3 mm About 75per cent of the annual rain is received during the southwest monsoon period During the period December to May practically no rain is received The temperature of the district ranges from 20°C to 45° C

3 1 1 5 Soil

There are three types of soil (1) laterite so l seen in Ottappalam Alathur Chittur and Palakkad taluks (2) virgin forest so l of Mannarkkad taluk and (3) black so l in Chittur and Attappady valley which is used for the cult vation of cotton

3 1 1 6 Land utilisation pattern

The land utilization pattern of Palakkad district is g ven in Table 3 1 The total geographical area of Palakkad district is 438980 ha. The total cropped area accounts for about 72 27 percent of the total area The forest area accounts to about 136257 ha which comes to about 31 percent of the total area. The net area sown in the district is about 46 54 percent

3 1 1 7 Cropping pattern

The major crops cultivated in the district are shown in Table 3 2 The major share in the total area s contributed by paddy wh ch accounts to about 33 14 percent to the total area Coconut occupies an area of about 55655 hectare Fruit crops occupy an area of 39527 hectare in which the major share s contributed by banana, which occupies an area of about 10096 ha Of the total area, vegetables occupy 5 95 percent Bittergourd accounts for an area of about 252 ha in the district

Table3 1 Land utilization pattern of Palakkad district 2003 04

(Area in hectares)

Sl no	Item	Palakkad
1	Total geographical area	438980 (100)
2	Forest	136257 (31 04)
3	Land put to non agricultural use	53241 (12 13)
4	Barren and uncult vable land	3297 (0 75)
5	Permanent pastures and other grazing land	10 (0 002)
6	Land under miscellaneous tree crops	1446 (0 33)
7	Cult vable waste	19114 (4 35)
8	Fallow other than current fallow	10002 (2 28)
9	Current fallow	11321 (2 58)
10	Net area sown	204289 (46 54)
11	Area sown more than once	112945 (25 73)
12	Total cropped area	317234 (72 27)

* Figures in parenthesis show percentages to total

Source Farm guide 2006

Table3 2 Cropping pattern of Palakkad district 2003 04
(Area in hectares)

Crop	Palakkad
Paddy	105131 (33 14)
Coconut	55655 (17 54)
Fru ts	39527 (12 46)
Rubber	29612 (9 33)
Spices and condiments	23468 (7 40)
Vegetables	18902 (5 95)
Pepper	6079 (1 92)
Green manure crops	2625 (0 83)
Sugar cane	1592 (0 50)
Others	34643 (10 92)
Total	317234 (100)

* Figures in parenthesis show percentages to total
Source Farm guide 2006

Nemmara panchayat in Palakkad was selected for the study as it s the majo vegetable growing tract n Palakkad district A brief description Nemmara panchayat is presented below

3 1 1 8 Nemmara panchayat

The panchayat is on the south of the d strict covers an area of 36 84 sq kms The block consists of hill ranges and hence the density of population is very low There s vast area under vegetable cultivation espec ally vegetables lıke bıttergourd snake gourd ıvy gourd chıllıes etc There s scope for development of daıryıng and Nellıampathy range s saıd to be ıdeal for rearıng exotıc breed of mılch anımals

The panchayat ıs bounded on the north by Pallessena and Melarcode on the south by Nellıampathy on the east by Elavanchery and on the west by Melarcode and Alıyur panchayats The total populat on of the panchayat ıs 32456 and the lıteracy rate ıs 78 99 per cent The land utılısatıon pattern of the panchayat as gıven ın the Table 3 3 shows that the total area of the panchayat ıs 3828 91 hectares The forest area comes to around 68 21 hectares Agr culture ıs the maın source of ıncome ın the panchayat Paddy coconut banana arecanut tuber crops fruıts vegetables gınger and turmerıc are cultıvated ın the panchayat The croppıng pattern of the panchayat ıs g ven n Table 3 4

Table 3 3 Land utılısatıon pattern of Nemmara panchayat

(Area ın hectares)

Sl no	Item	Nemmara
1	Total geographıcal area	3829
2	Forest	68
3	Land put to non agrıcultural use	243
4	Barren and uncultıvable land	17
6	Cultıvable waste	86
7	Net area sown	3212
8	Area sown more than once	1250

Source Krıshı Bhavan Nemmara

Table 3 4 Croppıng pattern of Nemmara pınchayat

Crop	Area (hectares)
Paddy	1200
Coconut	720
Pepper	60
Vegetables	120
Rubber	75
Arecanut	125
Banana	180
Cashew	21
Tapıoca	25

Source Krıshı Bhavan Nemmara

3 1 2 Thrıssuı Dıstrıct

Thrıssur wıth ts rıch h story cultural herıtage and archeologıcal wealth ıs the cultural capıtal of Kerala.

3 1 2 1 Locatıon

The Thrıssur dıstrıct ıs bounded on the north by Palakkad and Malappuram Dıstrıcts on the east by Palakkad and Co mbatore Dıstrıct of Tamıl Nadu on the south by Idukkı and Ernakulam Dıstrıcts and on the west by Arabıan sea. The dıstrıct lıes between 10 ° to 10°46 North latıtudes and 75 °55 East longıtudes The Dıstrıct whıch has a total geographıcal area of 3032 Sq km ranks seventh ın the state ın respect of area The e are fi e aluks / Thrıssur Chavakkad Kodungallur Mukundapuram and Thalåpp lly There ıs one corporatıon 6 munıcıpalıt es 17 communıty development blocks and nınety sıx Panchayats

Fig 1 *Map of the Study Area*

3 1 2 2 Geographical features

Descending from the heights of the Western Ghats in the east the land slopes towards the west forming three distinct natural d visions the h ghlands the plains and the sea board Sprawling over the midland pla ns and mountainous highlands the d strict has a Coastl ne of about 53 kms

3 1 2 3 Demographic features

According to the 2001 census Thrissur district has a total population of 29 75 lakhs of which 14 22 lakhs are males and 15 53 lakhs are females Dens ty of population is 981 persons per square kilometer The sex ratio of the district indicates that there are 1092 females per 1000 males L teracy rate s 92 56 per cent

3 1 2 4 Climate and rainfall

Heavy rainfall warm humid atmosphere and almost uniform temperature throughout the year are climatic features of the district The north east monsoon in the months of October November is scanty and insufficient There are four seasons dry weather from March to May southwest monsoon from June to September and northeast monsoon from October to November The District receives an annual ra nfall of 3500 mm The average daily max mum temperature in March and April which are generally the hottest months is about 32 ° C in the Coastal regions and about 37 ° C in the interior

3 1 2 5 Soil

The soils of Thrissur and Talappilly taluks are mostly laterite which is used for making excellent bricks for construction purposes Forest so ls are confined to the eastern region comprising of Thalappilly Mukundapuram and Thrissur taluks In the backwater areas due to sedimentation of soil and organic materials soil is extremely fertile and of loamy type Here summer paddy (Kol paddy fields) is grown Ordinary clay suitable for the manufacture of bricks and tiles is found in several parts of the district viz Ollur Pudukkad Karuvannur and Wadakkanchery China clay is noticed at Kizhi pullikara near Thr ssur

3 1 2 6 Land utilization pattern

The land utilization pattern in Thrissur district as presented in Table 3 5shows that nearly 34 61 percent of the total area of the district is under forest cover The total cropped area is 65 38 percent of the total geographical area, and nearly 18 06 percent of the area s cropped more than once and the net area sown is 141685 ha

Table3 5 Land utilization pattern of Thrissur district 2003 04 (Area in hectares)

Sl no	Item	Thr ssur
1	Total geographical area	299390 (100)
2	Forest	103619 (34 61)
3	Land put to non agricultural use	35541 (11 87)
4	Barren and uncultivable land	415 (0 14)
5	Permanent pastures and other grazing land	42 (0 01)
6	Land under m scellaneous tree crops	651(0 22)
7	Cult vable waste	3038 (1 01)
8	Fallow other than current fallow	5224 (1 74)
9	Current fallow	9159 (3 06)
10	Net area sown	141685 (47 32)
11	Area sown more than once	54058 (18 06)
12	Total cropped area	195743 (65 38)

* Figures in parenthesis show percentages to total

Source Farm guide 2006

3 1 2 7 Cropping pattern

The cropping pattern of the district as shown in Table 3 6 reveals that the major crops grown in the district are paddy coconut arecanut vegetables rubber and banana. Rice s cultivated in 34158 hectares which is

21 60 per cent of the total cropped area Coconut is grown in 88307 hectares which is 44 65 per cent of the total cropped area and is the main crop in the sandy coastal belt Seasonal crops like tapioca banana and vegetables are grown in the midland regions where the soil is laterite in nature Vegetables occupy an area of about 5488 ha in which bittergourd occupies an area of 263 ha in the district

Table3 6 Cropping pattern of Thrissur district 2003 04 (Area in hectares)

Crop	Thrissur
Paddy	34158 (17 45)
Coconut	87397 (44 65)
Fruits	25771 (13 17)
Rubber	13448 (6 87)
Spices and condiments	14427 (7 37)
Vegetables	5488 (2 80)
Pepper	4959 (2 53)
Green manure crops	1531 (0 78)
Sugar cane	261 (0 13)
Others	8303 (4 2)
Total	195743 (100)

* Figures in parenthesis show percentages to total

Source Farm guide 2006

Pazhayannur panchayat n Thrissur district was selected as it is the major vegetable growing tract in the district A brief description of the selected panchayats is presented below

3 1 2 8 Pazhayannur panchaya

Pazhayannur is located to the east of Thrissur district on the way to Alathur via Vadakkanchery and Chelakkara. The total area of the panchayat is 59 03 sq km It is an agri oriented village neighboring Th ruvilwamala, Chelakkara and Puthukkod panchayats It is bounded on the north by river Gayathri on the south by reserve forest on east by Kannampra Puthukode grama panchayats and on the west by Chelakkara Kondazh panchayat The population of the panchayat is 43325 accd ng to 2001 census The literacy percentage s 96 per cent

The land utilisation pattern of the panchayat is given in Table 3 7 The total geographical area of the panchayat is 96 97 sq kms The land under forest is 1432 99 hectares

Table 3 7 Land utilisation pattern of Pazhayannur panchayat

(Area in hectares)

Sl no	Item	Pazhayannur
1	Total geographical area	5903
2	Forest	1433
3	Land put to non agricultural use	1150
4	Barren and uncultivable land	450
5	Land under miscellaneous tree crops	3007
6	Cultivable waste	1450
7	Net area sown	1570
8	Area sown more than once	780

Source Krishi Bhavan Pazhayannur

The main crops cultivated in the panchayat are paddy arecanut coconut banana, vegetables ginger turmeric pepper and tapioca The cropping pattern of the panchayat is given in Table 3 8

Vegetables are cultivated in an area of 275 hectare and the main vegetables grown in the panchayat are bittergourd snakegourd amaranthus chillies bottle gourd ridge gourd etc However the main revenue earning crop in the panchayat is rubber

Table 3 8 Cropping pattern of Pazhayannur panchayat

Crop	Area (hectares)
Paddy	696
Coconut	768
Arecanut	150
Cashew	135
Rubber	800
Vegetables	275
Banana	100
Pepper	45
Tapioca	170
Mango	105

Source Krishi Bhavan Pazhayannur

3 2 Methodology

The procedure used in the selection of sample collection of data, analytical techniques employed and the concepts used in the study are presented below

3 2 1 Selection of study area

Two districts in Kerala namely Thrissur and Palakkad were chosen for the study taking nto consideration the importance of b ttergourd cult vat on n these districts Bittergourd was chosen, as it s one of the mportant vegetable crops in the area, wh ch consumes considerable amount of pesticides

3 2 2 Sampling Design

Pazhayannur and Nemmara panchayats of Thrissur and Palakkad district respectively were selected for the study The list of the farmers cult vating bittergourd was collected from the Krishi Bhavans of the respective panchayats From the list of growers a sample of 80 farmers (40 farmers each from the two areas) was selected randomly The sample growers were further classif ed into three classes based on the area of cultivat on of b ttergourd as Class I Class II and Class III as shown in the Table 3 9

Table3 9 Classification of respondents based on size of holding

Class	Area (in cents)
I	0 50
II	51 100
III	Above 100

A consumer survey was conducted in the Thrissur corporation area as the vegetables in the study area are brought to the Thrissur vegetable wholesale market in Thrissur A sample of 75 consumers belonging to different income groups (25 in each income group) was selected randomly The class ficat on of sample consumers based on monthly income is given in Table 3 10

Table3 10 Classification of consumer based on monthly income

Class	Monthly income (Rs)
Low	<10000
Medium	10000 30000
High	>30000

3 2 3 Collection of data

The data was collected from the farmers through personal interview method using well structured and pre tested interview schedule A separate schedule for consumer survey was prepared and the data on the consumer awareness regarding pest cide use in b ttergourd and w llingness to pay was collected The survey was undertaken during June August 2006

3 2 4 Analysis of data

The collected data was analysed in order to estimate cost and returns the effects of pesticide use and consumer awareness regarding pesticide use

3 2 5 Cost of Cultivation

The cost of cult vation was worked out us ng operation w se approach and input wise approach by employing the ABC cost concepts n farm management

3 2 5 1 Input wise approach

Input wise costs were worked out for the three classes and at the aggregate level The major inputs for which the costs were worked out include seeds labour plant protection chemicals panthall fertilizers manures etc Here the analys s was carried out by making use of the cost concepts Cost A, Cost B and Cost C

Various cost concepts studied are

1 Cost A_1

It approximates the actual expenditure incurred in cash and kind and includes the following items of costs

a) Hired human labour

The actual paid wage labour engaged in crop production was considered as value of hired labour Hired labour charge included those incurred in land preparation, sowing application of manures and fertilizers and crop protection chemicals after cultivation panthall making irrigation and harvesting Hired human labour was valued at the prevailing wage rates in the area, wh ch was Rs 125 for male labourers In the case of female labourers the wage rate varied with respect to the area and it was Rs 60 in Nemmara and Rs 75 in Pazhayannur

b) Seed

The cost of seed was evaluated on the bas s of the purchase price wh ch was Rs 540 per kg of seeds

c) Manures and fertilizers (farm produced and purchased)

Expenditure on purchased quantities of manures and fert lizers has been evaluated by multiplying the physical quantities of d fferent manures and fertilizers used with their respective prices Farm produced items were also evaluated at their market prices

d) Panthalling material

The materials used for panthall making ere Gi wire co r and bamboo poles These materials were used for more than one season So the cost was worked out by divid ng the total cost for panthallmg material vith the number of times the materials were made use of Coir was used for two seasons whereas GI wire and bamboo poles were used for four seasons

e) Plant protection chemicals

Expenditure on fungicides and insecticides has been calculated by multiplying the physical quantities of different fungicides and insect c des used by their respective market prices

f) Depreciation of farm implements

Depreciation was worked out by straight line method Cost of sprayer and spade were included as depreciation the l fe spans of vh ch were 5 years and 2 years respectively

g) Interest on farm loan

Interest on farm loan was calculated at 8 5 percent

h) Interest on working capital

Interest on working capital was charged at the rate of 3 5 percent per annum

i) Land revenue

Land tax was un form through out the district and was computed on the basis of actual amount paid to the government

j) Miscellaneous expenses

These include items such as cost of sacks and bamboo baskets which were used for transporting the harvested produce from farm to market

2 Cost A_2

Cost A_2 is equal to cost A_1 plus rent paid for leased in land Since the respondents did not take land for lease in the cultivation of bittergourd the value was taken as zero

3 Cost B_1

It is equal to cost A plus interest on own fixed capital The item fixed capital included iron and wooden implements and equipments such as sprayer

4 Cost B_2

It is equal to cost B_1 plus rent paid for leased in land plus rental value of owned land The sample farmers on the study area did not take land on lease for cultivation and hence it was taken as zero Rent was imputed in the case of owned land based on the prevailing rent of Rs 25000 per hectare in Nemmara and Pazhayannur

5 Cost C_1

It is equal to cost B_1 plus imputed value of family labour The cost of family labour was imputed based on the prevailing wage rates paid to hired labour in the area during the period

6 Cost C_2

It is equal to cost B_2 plus imputed value of family labour

7 Cost C_3

Cost C_3 is equal to cost C_2 plus 10 per cent of cost C_2 that is accounted as allowance given for management of farm Input wise and operation wise cost of cultivation and their percentages to total were worked out

3 2 5 2 Operation wise approach

Operation wise costs were also worked out for the three classes and at the aggregate level Here the costs incurred by farmers were grouped under the following heads namely costs for land preparation sowing panthall making manures and manuring plant protection and application irrigation, harvesting and other miscellaneous costs

3 2 6 Cost of production

Cost of production is the cost of producing one quintal of the vegetable The total costs incurred in the production of bittergourd was divided by the yield in quintals for calculating the cost of production The cost of production was worked out for the three classes and at the aggregate level

3 2 7 Gross Income

Gross income refers to the total returns obtained from the sale of bittergourd The total yield obtained was multiplied by the market price to arrive at the gross income from bittergourd cultivation The price of bittergourd varied from Rs 6 to Rs 12 per kilogram On an average Rs 8 per kilogram was taken

3 2 8 Farm efficiency measures

Income measures and benefit cost ratios are used as the measures of efficiency in the present study Different income measures are associated with different cost concepts

Farm income measures

1 Farm business income It is Gross income minus cost A_1

2 Own farm business income Gross income minus cost A_2

3 Family labour income Gross income minus cost B_2

4 Net ıncome Gross ıncome mınus cost C_3

5 Farm ınvestment ıncome Farm busıness ıncome m nus ımputed value of famıly labour

Benefit cost ratıo

It ıs the ratıo of benefits to the costs It ınd cates the return on a rupee of ınvestment The ratıo wıll serve as a measure wh ch would ındıcate whether the costs are proportıonate w th the returns obta ned Th s has been worked out at Cost A1 Cost B Cost B_2 Cost C Cost C_2 and Cost C bas s

3 3 Socıo economıc ıssues ın pestıcıde use

As the study aıms to examıne the soc o economıc ıssues ın pestıcıde use ın bıttergourd the dıfferent analytıcal technıques to assess the same are descrıbed under the followıng sectıons

3 3 1 Gross ıncome functıon

A gross ıncome functıon was fitted to assess the economıc ımportance of plant protectıon chemıcals (Arunkumara,1995) The functıon ın lınear form ıs gıven as

$\ln Y \quad \ln b_0 + b \quad \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + \text{error}$

where

Y gross returns per farm (Rs)

X_1 Area (acres)

X_2 expendıture on plant protectıon chemıcals per farm (Rs)

X_3 – human labour per farm (mandays)

X_4 expendıture on fertıl zers per farm (Rs)

X_5 expendıture on organıc manure per farm (Rs)

Separate ıncome functıons were fitted for the two areas Nemmara and Pazhayannur to analyse the economıc mportance of plant protectıon chemıcals

3 3 2 Plant pı otectıon chemıcal (PPC) expendıtuı e functıon

Expendıture elastıcıtıes of PPCs were estımated usıng a Cobb Douglas expendıture functıon (Arunkumara, 1995) The lınear functıonal form ıs gıven as

$\ln Y \quad \ln b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + \text{error}$

where

Y– expendıture on PPCs per farm (Rs)

X_1 Area (acres)

X_2 Famıly ıncome (Rs)

X_3 expendıture on fert lızers (Rs)

X_4– expendıture on organ c manure (Rs)

3 3 3 Measurement of technıcal effıcıency

The concept of technıcal effıcıency ın a broad sense ıs used to characterıze the util zatıon of resources Thıs basıc concept may be formalızed through a frontıer productıon funct on defined as one that yıelds max mum output for gıven levels of ınputs The productıon frontıer ıs est mated usıng stochastıc frontıer approach (Aıgner *et al* 1977) The frontıer product on functıon ıs defined as the functıon that denotes the max mum feasıble or potentıal output that can be produced by a farm from a gıven combınatıon of ınputs and technology

3 3 3 1 The Stochastıc Productıon Frontıer

Usıng the method proposed by Aıgner *et al* (1977) the level of technıcal effıcıency ıs estımated usıng stochastıc frontıer model

The Cobb Douglas functıonal form ıs generally preferred ın most publıshed papers on technıcal effıcıency because of ıts well known advantages In thıs study also the Cobb Douglas functıonal form s used and ıs gıven by

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$$Y \quad \beta_0 \prod_k X_{ki}^{\beta} e \qquad i - 1\ 2 \quad n$$

whe e Y is the output per hectare of the i^th farm X_k is a vector of k input per hectare for i h farm and ε s a farm spec fic error term On natural log transformation it becomes

$$\ln Y_j - \ln \beta_0 + \Sigma \beta_k (X_{ki}) + \varepsilon_i \qquad i \quad 1\ 2 \qquad n$$

The disturbance term ε_i is d vided into two components a stochastic disturbance v and one sided efficiency d sturbance u

Thus ε_i v u

The term v represents the symmetric component and perm ts random variation in output due to factors l ke weather and plant d sease It s assumed to be identically and independently distributed as N (0 σ^2v)

The error component u >0 reflects the technical inefficiency and s generated from a one sided probability distr but on It s ass imed to be distributed independently of v u is distributed as the absolute value of N (0 σ^2u) i e the distribution of u is half normal The d sturbance u reflects the fact that each farm s output must lie on or below the frontier Thus u 0 for any farm lying on the front er while u >0 for any farm lying below the frontier

Weinstein (1964) first derived the distribution function of the compos te error The density function of ε can be stated as

$$f(\varepsilon) - (2/\sigma) f^*(\varepsilon/\sigma)[1 \ F^*(\varepsilon \lambda \sigma^{\ 1}) \qquad \infty \leq \varepsilon < +\infty$$

vhere $\sigma^2 \quad \sigma_u^2 + \sigma^2$

$\lambda - \sigma_u / \sigma_v$

and f*( ) and F*( ) are tl e standard normal de sity and distribution functions respectively

This density is asymmetric around zero with its mean and variance given by

$$E(\varepsilon) \quad E(u) - (\sqrt{2}/\sqrt{\pi})\,\sigma_u$$

$$V(\varepsilon) \quad V(u) + V(v) \quad [(\pi \;\; 2)/\pi]\,\sigma^2 + \sigma^2$$

λ is interpreted to be an indicator of the relative variability of the two sources of random error that distinguish farms from one another In addition the variance ratio σ_u^2 / σ represented by γ can also be a useful indicator of the influence of the inefficiency component in the overall variance γ ranges from zero to one in value A value of γ close to one implies that the one sided error u dominates the symmetric error v and the shortfall of the realized output from the frontier is largely due to technical inefficiency

Hence u represents the amount by which the frontier exceeds realized out put Direct estimates of the stochastic production frontier are obtained by maximum likelihood estimation procedure

A model with this error specification is called as stochastic frontier since the non positive component of the disturbance represents the shortfall of the actual output from the frontier while the frontier contains the normal component of disturbance and is therefore stochastic

3 3 3 2 Specification of the model

For the present study a Cobb Douglas production function of the following form was specified

$$\ln Y_j \quad \ln b_0 + b \quad \ln X \quad + b_2 \ln X_2 + b_3 \ln X_3 +$$
$$b_4 \ln X_4 + b_5 \ln X_5 + \varepsilon \text{ where}$$

Y Yield (kg/acre/farm)

X – expenditure on organic manure (Rs /acre/farm)

X_2 – expenditure on fertilizers (Rs /acre/farm)

X_3 – expenditure on plant protection chemicals (Rs /acre/farm)

X_4 expenditure on labour (Rs /acre/farm)

ε v u

ı 1 2 n farms

3 2 3 3 Mean Technical Efficiency (MTE)

Farm specific technical efficiencies were worked out as the ratio of production of the ith farm to the frontier production of the same farm (Aigner *et al* 1977) Mean technical efficiency was calculated by taking the average of the farm specific technical efficiencies

3 3 4 Factors influencing the overuse of plant protection chemicals

The analysis of frontier production function and the technical efficiency level of the farmers reveal the fact that there exists the overuse of plant protection chemicals in the study area The overuse of chemicals result in many externalities Several economists have addressed externality in several ways According to Baumol and Oates (1992) externality is present whenever some individuals utility or production relationship including real (i e non monetary) variables whose values are chosen by others without particular attention to the effect in the victim s welfare For this effect on the victim or beneficiary the victim does not receive any compensation or does not pay any fee

According to Bromley (1993) externality refers to instances where the action of one person result in the unwanted costs being vested on another person for which no accounting is done

Hence an analysis is made to analyse the factors influencing the overuse of plant protection chemicals A multiple linear regression model was used for the purpose (Poornima, 1999) The empirical model was

$Y = a + b X_1 + b_2X_2 + b_3 X_3 + b_4X_4 + b_5 X_5 + b_6X_6 + b_7 X_7 + b_8X_8$

where

Y ıs the dıfference ın percentage terms between expendıture ıncurred on plant protectıon chemıcals by the farmers and the optımal expendıture on plant protectıon chemıcal est mated through front er product on funct on

X_1 – age of the farmer ın years

X_2 number of years of schoolıng of farmer

X_3 years of appl catıon of PPCs

X_4 – gross returns from bıttergourd ın Rs

X_5 – FYM used per acre (Rs)

X_6 – fertılızers used per acre (Rs)

X_7 – duınmy for awareness of toxıcıty (0 for not beıng aware of tox c ty levels and 1 for beıng aware)

For findıng out the optımal expendıture of pestıcıde use the front er productıon functıon was used The functıon was also used ın est matıng the technıcal efficıency of farms

3 3 5 Consumer awıı eness wıth ı egard to pestıcıde resıdues

Contıngent valuatıon ıs a dırect method of valuatıng the envıronmental good or bad for whıch a proper market does not ex st In that case valuat on s done by elıcıtıng the consumers preference and the r value for an envıronmental change In the present study consumers preference for pestıcıde free product s el cıted by askıng theır Wıllıngness to Pay (WTP) for a hypothetıcal pestıcıde resıdue free bıttergourd

3 3 5 1 Wıllıngness To Pay Pı emıum (WTPP) foı pestıcıde free bıtteıgouı d

WTPP ıs the dıfference between wıllıngness to pay for pestıc de free bıttergourd and the prevaılıng market prıce ın Rs /kg In order to analyse the factors that affect the WTP of the consumer for resıdue free bıttergourd a logıstıc functıon was fitted (Poorn ma, 1999)

The function is

$WTPP = a + b_1X_1 + b_2X_2 + b_3X_3$

where WTPP is dichotomous in nature where it takes a value of 0 if WTP < Rs 2/kg of bittergourd over the prevailing market prices or else it takes value of 1 if WTP > Rs 2/kg of bittergourd over prevailing market prices

The variables used for fitting the regression are

X1– education level (scores are given as primary–1 Secondary–2 College and above–3)

X2– income (Rs)

X3– dummy for awareness of residues in bittergourd (0 if not aware of residues and 1 if aware)

The WTPP is used to reflect the negative externality caused to the consumers

Results and Discussion

4 RESULTS AND DISCUSSION

The present study on the Socio economic issues in pest cide use An analysis in bittergourd was aimed at examining the cost and returns pesticide use pattern and related issues in bittergourd The results obta ned from the study are presented and discussed under the following headings

4 1 General economic and social condit ons of the sample farmers

4 2 General pract ces of cultivation

4 3 Cost of cultivation of b ttergourd

4 4 Yield and returns from bittergourd

4 5 Cost of production of bittergourd

4 6 Farm efficiency measures

4 7 Pattern of pesticide use in bittergourd

4 8 Socioeconomic issues in pest cide use

4 9 Technical efficiency in bittergourd cultivation

4 10 Factors influenc ng the overuse of chem cals

4 11 Consumer awareness with respect to pesticide residues

4 1 General economic and social conditions of the sample farmers

4 1 1 Land holding

The distribution of sample farmers according to the area under bittergourd is given in Table 4 1 A sample of 80 farmers cultivating bittergourd 40 each from Nemmara and Pazhayannur panchayats were selected The respondents were classified according to the area under bittergourd Out of the total respondents 10 0 per cent had less than 50 cents (Class I) 48 75 per cent had an area between 50 cents and 100 cents (Class II) and 41 25 per cent had more than 100 cents (Class III)

Table 4 1 Distribution of respondents according to the area under bittergourd

Respondents	Holding size							
	< 50 cents		50 100 cents		>100 cents		Total	
	No	Area (cents)	No	Area (cents)	No	Area (cents)	No	Area (cents)
Nemmara	2 (5)	45 (0 82)	19 (47 5)	1405 (25 77)	19 (47 5)	4000 (73 39)	40 (100)	5450 (100)
Pazhayannur	6 (15)	135 (3 12)	20 (50 0)	1565 (36 22)	14 (35 0)	2620 (60 64)	40 (100)	4320 (100)
Total	8 (10)	180 (1 84)	39 (48 75)	2970 (30 39)	33 (41 25)	6620 (67 75)	80 (100)	9770 (100)

* Figures in parenthesis show percentage to total

Among bittergourd growers in Nemmara, 5 per cent had less than 50 cents 47 5 per cent each had an area between 50 100 cents and more than 100 cents under cultivation It showed that 95 per cent of the total farmers in Nemmara operated in an area of more than 50 cents In Pazhayannur 15 per cent of the growers had less than 50 cents while 35 per cent had more than 100 cents under cultivation and 50 per cent had land area between 50 and100 cents

4 1 2 Age

The distribution of the sample farmers according to the age is given in Table 4 2 It was found that 42 5 per cent of the total respondents were under the age group of 40 to 50 years and 36 25 per cent in between 50 to 60 years About 17 5 per cent and 3 75 per cent came under the age group of less than 40 years and more than 60 years respectively The age group distribution was showing the same trend in both Pazhayannur and Nemmara with majority of farmers falling in the age group of 40 50 years

Table 4 2 Distribution of respondents according to age

Respondents	Age				
	< 40 yrs	40 50 yrs	50 60 yrs	> 60 yrs	Total
Pazhayannur	8 (20)	18 (45)	13 (32 5)	1 (2 5)	40 (100)
Nemmara	6 (15)	16 (40)	16 (40)	2 (5)	40 (100)
Total	14 (17 5)	34 (42 5)	29 (36 25)	3 (3 75)	80(100)

* Figures in parenthesis show percentage to total

4 1 3 Educational status

Classification of the respondents according to their educational status is given in Table 4 3 It was observed that none of the respondents in both the areas were illiterate About 35per cent of the total respondents were educated up to the middle school level 20per cent up to the high school level and 3 75 per cent up to the college level while 8 75 per cent of the total sample farmers had secondary level education Similar pattern was observed in both the areas with respect to the educational status of respondents

Table 4.3 Distribution of respondents according to educational status

Respondents	Educational status					
	Primary	Middle School	High School	SSLC	College	Total
Pazhayannur	14 (35 0)	13 (32 5)	8 (20 0)	3 (7 5)	2 (5 0)	40(100)
Nemmara	12(30 0)	15(37 5)	8(20 0)	4(10 0)	1(2 5)	40(100)
Total	26 (32 5)	28 (35 0)	16 (20 0)	7 (8 75)	3 (3 75)	80 (100)

* Figures in parenthesis show percentage to total

4 1 4 Occupation

The occupation wise classification of respondents presented in Table 4 4 revealed that agriculture was the only occupation of 83 75 per cent of the total respondents In Nemmara the percentage was found to be 85 whereas ıt was 82 5 ın Pazhayannur About 14 per cent of the respondents took up agrıculture as the maın occupatıon along wıth subsıdıary occupatıon Agrıculture turned out to be subsıdıary occupatıon for 5 0 per cent of the sample farmers who took up jobs ın publıc sector and prıvate sector The occupatıonal pattern was found to be sımılar ın both th areas

Table 4 4 Classıficatıon of respondents accoı dıng to theıı occupatıon

Respondents	Agrıculture as the only occupatıon	Agrıculture as the maın occupatıon	Agrıculture as subsıdıary occupatıon	Total
Pazhayannur	33 (82 5)	6 (15)	1 (2 5)	40 (100)
Nemmara	34 (85)	5 (12 5)	1 (2 5)	40 (100)
Total	67(83 75)	11 (13 75)	2 (5)	80 (2 5)

* Fıgures ın parenthesıs show percentage to total

4 1 5 Famıly ıncome

The classıficatıon of respondents based on the r famıly ıncome shown ın Table 4 5 revealed that out of the total respondents 81 25 per cent had famıly ıncome rangıng between Rs 50 000 and Rs 1 00 000 Thıs was follo ved by the ıncome category of less than Rs 50 000 whıch ıncluded 12 5 per cent of the total respondents Only 6 25 per cent of the respondents had famıly ıncome exceedıng one lakh rupees Both the areas showed sımılar pattern wıth majorıty of respondents fallıng ın the ıncome group of Rs 50000 Rs 100000

Table 4 5 Classıficatıon of respondents based on famıly ıncome

Respondents	Famıly ıncome per annum			
	< 50 000	50 000 100 000	> 100 000	Total
Pazhayannur	4 (10)	33 (82 5)	3 (7 5)	40 (100)
Nemmara	6 (15)	32 (80)	2 (5)	40 (100)
Total	10 (12 5)	65 (81 25)	5 (6 25)	80 (100)

* Fıgures ın parenthesıs show percentage to total

4 2 GENERAL PRACTICES OF CULTIVATION

Bittergourd was found to be the most mportant vegetable crop cultivated m the study area and an attempt is made here to briefly describe the cultural practices adopted by the farmers for the cultivation of bittergourd

4 2 1 Season

Bittergourd is cultivated mainly during May August in Nemmara, vhereas in Pazhayannur the crop was cultivated during March June The durat on of the crop is 120 days (Table 4 6)

Table 4 6 Cropping season practiced by the farmers

Bittergourd	Season	Duration
Nemmara	May August	120 days
Pazhayannur	March June	120 days

4 2 2 Land preparation

Generally tractor is used for the preparation of land Mounds of 2 feet diameter and 1 1 5 feet height were taken Initially lime was incorporated in the soil followed by farmyard manure at the rate of 10 kg per mound after 10 days The practices were found to be similar in both Nemmara and Pazhayannur

4 2 3 Seeds and sowing

VFPCK (Vegetable and Fruit Promot on Council Keralam) and Kerala Agricultural University were the main suppliers of seeds for the bittergourd

Plate 1 Farmer s field in Nemmara

Plate 2 Farmer s field in Pazhayannur

farmers ın Nemmara and Pazhayanrur H gh yıeldıng varıetıes lıke Prıya, Prıyanka and Preetı were cultıvated ın both the areas In the case of Nemmara, eıght seeds of bıttergourd were sown per mound and after germınat on five healthy plants were retaıned whereas ın Pazhayannur five seeds were sown per mound and after germınatıon three healthy plants were reta ned Seed rate adopted by the farmers ın the study area was 2 5 kılogram per hectare

As gıven ın Table 4 7 spacıng adopted was found to vary from 2 5 2 75m X 2 5 2 75m ın Nemmara to 2 75 3m X 2 75 3m ın Pazhayannur

Table 4 7 Spacıng adopted by the sample farmers

Area	Spacıng followed by sample farmers
Nemmara	2 50 2 75 m x 2 50 2 75 m
Pazhayannur	2 75 3 0 m x 2 75 3 0 m

4 2 4 Manures and fertılızers

The organıc and chemıcal fert l zers were gıven n splıt doses n both the areas Fırst dose of farmyard manure was gıven whıle preparıng the land and a second dose was gıven fifteen days after so vıng Farmyard manures were applıed at the rate of 25 tonnes per hectare and weekly applıcatıon of cow dung slurry was also practıced Other manures whıch were found to be used by the sample farmers were poultry manure neem cake castor cake groundnut cake and bone meal Chemıcal fertılızers lıke Factomphos 18 18 18 17 17 17 Murıate of potash, Dıammonıum Phosphate and Urea were quıte commonly used ın the study area Fertılızers were gıven ın several splıt doses at fortnıghtly ıntervals

4 2 5 Irrıgatıon

Irrıgatıon was gıven once ın two days and crop was rr gated manually usıng water from wells If the temperature of the atmosphere was very hıgh the crop was ırrıgated daıly The ırrıgatıon frequency adopted by farmers ın Nemmara was more when compared to Pazhayannur as there existed a dry climate compared to Pazhayannur

4 2 6 Plant protection

Insectic des like Ekalux, Confidor Hostathion Lanate Furadan and Metacid and fungicides like Mancozeb Radar and Saff were used by the farmers in the area under study Pheromone trap and banana fruit trap was found to be used by most of the farmers in both the areas However the use of these non chemical methods was more common among the farmers in Pazhayannur In bittergourd insect pests like fruit fl es ep lachna beetle red pumpkin beetle and jassids were predom nant in the study area Fungal d seases l ke yellowing and leaf spot and viral diseases were qu te common in the area The usage of pesticides was found to be higher among the sample farmers in Nemmara compared to Pazhayannur Pesticide use pattern of the sample farmers is given in Table 4 8

Table 4 8 Pesticide use pattern of the sample farmers

Pests	Chemicals used by the sample farmers	Cost/l or Cost/kg
Fruit fly	Furadan	65
Epilachna beetle	Ekalux	500
Red pumpkin beetle	Ekalux	500
Jass ds	Confidor	1800
Diseases		
Downy mildew	Mancozeb	260
Yellowing	Saff Radar	900 240
Leaf spots	Mancozeb	260

While applying the plant protection chemicals farmers d d not follow the recommendation For controlling fruit flies Furadan was used instead of Carbaryl

Though furadan was cheaper ıt would not break down easıly ın the soıl and could create envıronmental problems Mostly farmers were found to depend upon the traders who prescrıbed them the needed chemıcals Few of them sought advıce from the agrıcultural officers and specıalısts The pest c de usage was found to be ındıscrımınate maınly ın Nemmara area whıch was confirmed ın the earlıer study by Sreela (2005) However most of the sample farmers ınterviewed ın Pazhayannur were resortıng to non chemıcal methods of pest control l ke banana fruıt trap and pheromone trap whıch was followed by few farmers ın Nemmara area also

4 2 7 Harvestıng

Harvestıng of bıttergourd starts after 45 days of sowıng ın both areas Harvestıng was usually done once ın four days and a total of 18 harvests were made

4.3 COST OF CULTIVATION OF BITTERGOURD

The cost of cultıvatıon of bıttergourd was worked out ın both Nemmara and Pazhayannur for three classes Class I (< 50 cents) Class II (50 100 cents) and Class III (>100 cents) here ın after referred to as Class I II and III and at the aggregate level Both the ınput wise and operatıon w se costs were orked out and the results are presented and dıscussed ın the followıng sectıons

4 3 1 Input wıse cost of cultıvatıon

The dıfferent ınputs ınvolved ın the cultıvatıon of bıttergourd ıncluded the expendıture on seeds manures fertılızers panthall ng materıal plant protectıon chem cals and labour The results on the ınput wıse cost of cult vat on for the three classes ın Nemmara and Pazhayannur are presented and dıscussed below

4 3 1 1 Input wise cost of cultivation Nemmara

The input wise cost of cultivat on was worked out using the cost concepts Cost A Cost A2 Cost B_1 Cost B_2 Cost C Cost C_2 and Cost C_3 are g ven n Table 4 9 and Fig 2 At the aggregate level the costs were Rs 66890 Rs 67002 Rs 75335 Rs 90977 Rs 99310 and Rs 109241 respectively for Cost A_1 Cost B Cost B_2 Cost C_1 Cost C_2 and Cost C_3 It was found that the total cost of cultivation at Cost A1 Cost B Cost B_2 Cost C_1 Cost C_2 and Cost C_3 were Rs 53890 Rs 54037 Rs 62370 Rs 88288 Rs 96621 and Rs 106283 respectively for Class I and they were Rs 62763 Rs 6292^ Rs 71262 Rs 89892 Rs 98225 and Rs 108047 respectively for Class II In the case of Class III the costs were found to be Rs 67660 Rs 67754 Rs 76087 Rs 90563 Rs 98896 and Rs 108786 respectively It may be noted that Cost A1 and Cost A2 were same as there was no leased in land taken by the sample farmers in the area for cultivat on of bitter gourd

An analysis of the input wise expenses revealed that human labour constituted the largest share of expenses (35 94 per cent) consisting of fam ly labour (21 95 per cent) and hired labour (13 99 per cent) followed by expenses on manure (15 27 per cent) and panthalling material (11 13 per cent) The fertilizer expenses contributed about 8 16 percent while expenses on plant protection chemicals machine labour and seeds were 4 01 per cent 2 71 per cent and 1 93 per cent respectively The other items of expense considered vere the management expenses which contr buted 9 09 per cent to the total cost and the rental value of own land (7 63 per cent)

Class wise analysis showed that in the case of Class I human labour was the largest item of expenditure (40 20 per cent) followed by manures (14 64 per cent) panthal making (10 04 per cent) allowance given for management of farm (9 09 per cent) rent paid for own land (7 84 per cent) fertilizers (6 01 per cent) and plant protection chemicals (3 58 per cent) For Class II also human labour was the largest item of input cost accounting for 35 28 per cent of the total cost

Table 4 9 Input wise cost of cultivation of bittergourd in Nemmara (Rs per hectare)

Particulars	class I	per cent	class II	per cent	class III	per cent	Aggregate	per cent
Hired labour	8475	7 97	11158	10 33	16522	15 19	15287	13 99
Machine labour	2722	2 56	3488	3 23	2778	2 55	2961	2 71
Seed	2100	1 98	2137	1 98	2092	1 92	2104	1 93
Manures	15556	14 64	16571	15 34	16375	15 05	16677	15 27
Fertilisers	6389	6 01	8581	7 94	9057	8 33	8913	8 16
Panthalling material	10667	10 04	12348	11 43	12358	11 36	12163	11 13
Plant protection	3800	3 58	4298	3 98	4419	4 06	4382	4 01
Transport charge	629	0 59	442	0 41	332	0 31	456	0 42
Land revenue	100	0 09	100	0 09	100	0 09	100	0 09
Depreciation	184	0 17	196	0 18	226	0 21	207	0 19
Interest on farm loan	1426	1 34	1672	1 55	1811	1 66	1783	1 63
Interest on working capital	587	0 55	688	0 64	746	0 69	734	0 67
Miscellaneous cost	1256	1 18	1084	1 00	844	0 78	1124	1 03
Cost A1/A2	53890	50 70	62763	58 09	67660	62 20	66890	61 23
Interest on fixed cap tal	147	0 14	166	0 15	94	0 09	112	0 10
Cost B1	54037	50 84	62929	58 24	67754	62 28	67002	61 33
Rental value of own land	8333	7 84	8333	7 71	8333	7 66	8333	7 63
Cost B2	62370	58 68	71262	65 95	76087	69 94	75335	68 96
Inputed value of family labour	34251	32 23	26962	24 95	22810	20 97	23975	21 95
Cost C1	88288	91 38	89892	83 20	90563	83 25	90977	83 28
Cost C2	96621	90 91	98225	90 91	98896	90 91	99310	90 91
Allowance given for management of farm	9662	9 09	9822	9 09	9890	9 09	9931	9 09
Total cost	106283	100	108047	100	108786	100	109241	100

whereas manures contributed a share of 15 34 percent followed by panthall ng material (11 43 per cent) Allowance given for management of farm contributed 9 09 per cent which was followed by fert l zers (7 94 per cent) Plant protect on chemicals contributed a share of 3 98 per cent towards the total cost With respect to Class III human labour contributed the highest share in the total cost (36 16 per cent) As observed in Class I and Class II here also manure was the second largest item occupying 15 05 per cent of the total cost followed by panthall ng material (11 36 per cent) and allowance given for management of farm (9 09 per cent) Fertilizers contributed 8 33 per cent to the total cost followed by rental value of land (7 66 per cent) while expend ture on plant protection chemicals was found to be 4 06 per cent

4 3 1 2 Input wise cost of cultivation – Pazhayannur

The input wise cost of cultivation as presented in Table 4 10 and Fig 3 revealed that at the aggregate level the Cost A1 Cost B Cost B_2 Cost C Cost C_2 and Cost C_3 were 63712 Rs 63971 Rs 72304 Rs 88850 Rs 97183 and Rs 106901 in the respective order For Class I it was found to be Rs 54436 Rs 54622 Rs 62955 Rs 88038 Rs 96371 and Rs 106008 respect vely and they were Rs 61999 Rs 62259 Rs 70592 Rs 91312 Rs 99645 and Rs 109610 respectively at Class II level The costs were found to be Rs 65458 Rs 65721 Rs 74054 Rs 88572 Rs 96905 and Rs 106595 respectively for Class III farmers

An analysis of the contribution of different inputs to the total cost showed that human labour constituted the highest share of 40 26 per cent in the ent re sample in which family labour contributed a higher percentage (23 27 per cent) when compared to hired labour (16 99 per cent) The second important item was the expenditure incurred on manures which contributed a share of about 15 52 per cent of the total cost The third largest item was cost of panthalling material occupying 9 00 per cent of the total cost Allowance given for management of farm was also an important item which accounted 9 09 per cent to the total cost

Table 4 10 Input wise cost of cultivation of bittergourd in Pazhayannur (Rs per hectare)

Particulars	class I	per cent	class II	per cent	class III	per cent	Aggregate	per cent
Hired labour	11977	11 30	15998	14 60	20315	19 04	18160	16 99
Machine labour	1750	1 65	2097	2 08	1770	1 66	1888	1 77
Seed	2200	2 08	2898	2 64	2267	2 12	2494	2 33
Manures	14907	14 06	15684	14 31	16031	15 03	16594	15 52
Fertilisers	9056	8 54	7631	6 96	6953	6 52	7264	6 80
Panthalling material	8278	7 81	9719	8 87	9635	9 03	9623	9 00
Plant protection	2081	1 96	3513	3 21	3796	3 56	3433	3 21
Transport charge	520	0 49	461	0 42	429	0 40	415	0 39
Land revenue	100	0 09	100	0 09	100	0 09	100	0 09
Depreciation	173	0 16	216	0 20	210	0 20	211	0 20
Interest on farm loan	1453	1 37	1716	1 57	1729	1 62	1652	1 55
Interest on working capital	599	0 57	707	0 65	712	0 67	697	0 65
Miscellaneous cost	1342	1 27	1259	1 15	1512	1 42	1182	1 11
Cost A1/A2	54436	51 35	61999	56 56	65458	61 36	63712	59 60
Interest on fixed capital	186	0 18	260	0 24	263	0 25	259	0 24
Cost B1	54622	51 53	62259	56 80	65721	61 60	63971	59 84
Rental value of own land	8333	7 86	8333	7 60	8333	7 81	8333	7 80
Cost B2	62955	59 39	70592	64 40	74054	69 42	72304	67 64
Inputed value of family labour	33416	31 52	29053	26 51	22851	21 49	24878	23 27
Cost C1	88038	83 05	91312	83 31	88572	83 09	88850	83 11
Cost C2	96371	90 91	99645	90 91	96905	90 91	97183	90 91
Allowance given for management of farm	9637	9 09	9965	9 09	9690	9 09	9718	9 09
Total cost	106008	100 00	109610	100 00	106595	100 00	106901	100 00

Fig 2 Input wise cost of cultivation of bittergourd in Nemmara

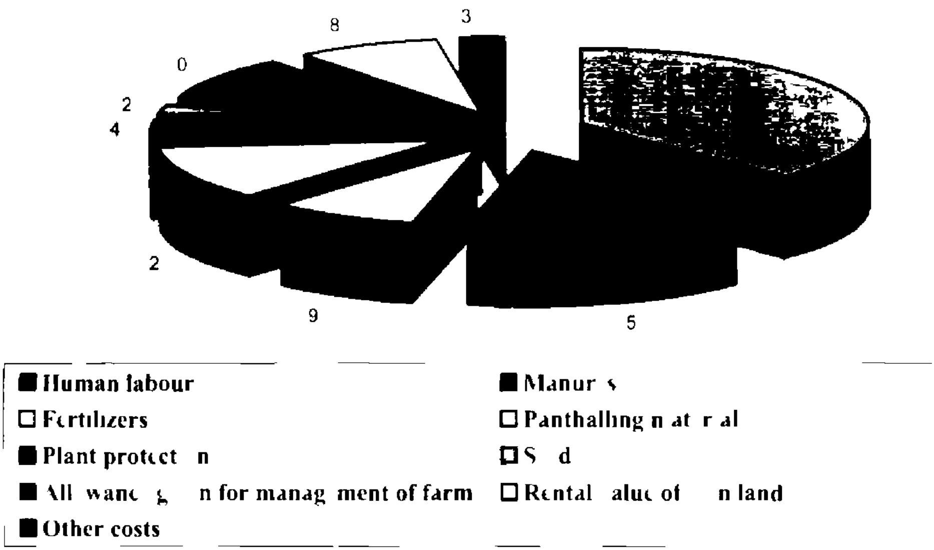
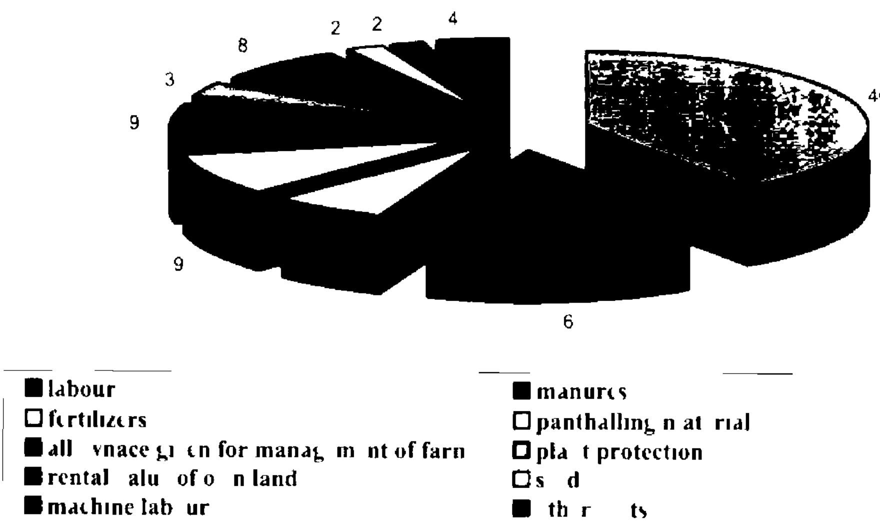


Fig 3 Input wise cost of cultivation of bittergourd in Pazhavannur



while rental value of own and took up a share of 7 80 per cent followed by fert lizer (6 80 per cent) plant protection chemicals (3 21 per cent) seeds (2 33 per cent) and machine labour (1 77 per cent)

The class wise analys s revealed that for Class I human labour vas the largest item of expenditure contributing 42 82 per cent to the total cost followed by manures (14 06 per cent) allowance given for management of farm (9 09 per cent) fertilizers (8 54 per cent) rental value of own land (7 86 per cent) panthalling material (7 81 per cent) and plant protect on chemicals (1 96 per cent) In the case of Class II also human labour was the largest item of input cost accounting for 41 11 per cent of the total cost Manures occupied the second position with 14 31 per cent followed by cost incurred for the purchase of panthalling material w th a share of 8 87 per cent to the total cost Allowance given for management of farm contribi ted 9 09 per cent follo ved by rental alue of own land (7 60 per cent) fertilizers (6 96 per cent) and plant protection chemicals (3 21 per cent) Regarding Class III a similar pattern was obser ed With human labour contributing the highest share in the total cost (40 53 per cent) As observed in Class I and Class II here also manures was the second largest item occupying 15 03 per cent of the total cost Allowance given for management of farm took the th rd place with a share of 9 09 per cent Panthalling material (9 03 per cent) came next followed by rental value of land (7 81 per cent) fertilizers (6 52 per cent) and plant protect on chemicals (3 56 per cent)

Based on the above analys s of input wise cost of cultivat on it could be concluded that human labour was the most important nput in both the study areas and the contribution of family labour was higher compared to hired labour The contr bution of hired labour was found to show an ncreas ng trend from Class I to Class III The above results on the highest share of human labour was s milar o the findings of Madalia and Kukadia (1978) Brahmaiah and Naidu (1993) Ramachandran (1997) Karthikeyan (2001) and Thomas *et al* (2006) Moreover the importance of family labour as observed in the present study was n line with the results obtained by Sandhya (1992) Sreela (2005) and Thomas et al (2006) The percentage share of fertilizers to the total cost (8 16 per cent) was on par with the findings of Thomas *et al* (2006) The present study was however in contrast to the results reported by Nagesh (2001) who opined that cost of panthalling and staking occupied the highest share of the total input costs in case of bittergourd cultivation in Thiruvananthapuram. This may be attributed to the difference in area of study where panthalling materials used were found to be comparatively costly The expense on plant protection chemicals at the aggregate level was found to be higher in Nemmara compared to Pazhayannur and an increasing trend was observed from Class I to Class III This could be due to the fact that the usage of plant protection chemicals was found to increase when the cultivation is taken up on a large scale on commercial basis However it differed from the findings of Sreela (2005) who reported that the expenditure on plant protection chemicals of Class II farmers was highest compared to Class I and Class III

4 3 2 Operation wise cost of cultivation

The operation wise cost of cultivation of bittergourd was also worked out for both Nemmara and Pazhayannur and the results are presented in the following sections The different operations included land preparation sowing manuring and fertilizer application panthalling irrigation application of plant protection chemicals and harvesting

4 3 2 1 Operation wise cost of cultivation Nemmara

The analysis of the operation wise cost of cultivation in Nemmara as presented in Table 4 11 and Fig 3 revealed that at the aggregate level manuring and fertilizer application contributed the highest share of 27 89 per cent in the total cost incurring an expense of Rs 32995 per hectare Panthall making was the next important item accounting for 17 35 per cent of the total cost with an expense of Rs 17970 per hectare The cost incurred for the other operations were irrigation

Table 4 11 Operation wise cost of cultivation of bittergourd in Nemmara (Rs per hectare)

Particulars	class I	per cent	class II	per cent	class III	per cent	Aggregate	per cent
Land preparation	8972	8 44	8778	8 12	7067	6 50	7524	6 89
Sowing	2619	2 46	2715	2 51	2647	2 43	2666	2 44
Manuring and fertiliser appl cation	28378	26 70	32356	29 95	32920	30 26	32995	30 20
Panthal making	17063	16 05	17334	16 04	18030	16 57	17970	16 45
Plant protection	5889	5 54	6447	5 97	6062	5 57	6159	5 64
Irrigation	12111	11 40	10086	9 33	10130	9 31	10135	9 28
Harvesting	9556	8 99	8270	7 65	9886	9 09	9468	8 67
Miscellaneous cost	1256	1 18	1084	1 00	844	0 78	1124	1 03
Depreciation	184	0 17	196	0 18	226	0 21	207	0 19
Land revenue	100	0 09	100	0 09	100	0 09	100	0 09
Interest on farm loan	1426	1 34	1672	1 55	1811	1 66	1783	1 63
Interest on working capital	587	0 55	688	0 64	746	0 69	734	0 67
Interest on fixed capital	147	0 14	166	0 15	94	0 09	112	0 10
Rent on own land	8333	7 84	8333	7 71	8333	7 66	8333	7 63
Rent on leased in land	0	0 00	0	0 00	0	0 00	0	0 00
Allowance g ven for management of farm	9662	9 09	9822	9 09	9890	9 09	9931	9 09
Total cost	106283	100 00	108047	100 00	108786	100 00	109240	100

(Rs 10135) harvesting (Rs 9468) land preparation (Rs 7524) plant protection (Rs 6159) and sowing (Rs 2666)

The class wise analysis revealed that cost ncurred per hectare for manuring and fertilizer application were Rs 28378 Rs 32356 and Rs 32920 for Class I Class II and Class III respectively and for panthall making it was found to be Rs 17063 Rs 17334 Rs 18030 For irrigation cost incurred per hectare by Class I II and III farmers were Rs 12111 Rs 10086 and Rs 10130 respectively a major share of which was contributed by family labour Expense incurred on harvesting operation was Rs 9566 Rs 8270 and Rs 9886 per hectare for Class I II farmers and III respectively It was also noted that harvesting operation of Class I farmers was exclusively accomplished by family labour while t was observed to have prominence over hired labour in the other classes The expense on land preparation per hectare was Rs 8972 for Class I Rs 8778 for Class II and Rs 7067 for Class III Expenses meted out towards plant protect on by Class I Class II and Class III were Rs 5889 Rs 6447 and Rs 6062 per hectare respectively in which input cost occupied the major share Th s operation was carried out entirely by family labour The expense for sowing operation was found to be Rs 2619 Rs 2715 and Rs 2647 per hectare for Class I Class II and Class III farmers respectively of which major share was contributed by seeds

4 3 2 2 Operation wise cost of cultivation Pazhayannur

The operation wise cost of cultivat on of bittergourd n Pazhayannur is given in Table 4 12 and Fig 4 The analysis revealed that manuring and fertilizer application contributed the largest share n the to al cost at aggregate level incurr ng a cost of Rs 29812 per hectare Panthall making was the next important item incurring a cost of Rs 16440 per hectare followed by harvesting with Rs 11238 (10 51 per cent) and a major share of the cost was contributed by family labour Irrigation was the next important item contributing a share of Rs 11107 per hectare followed by land preparation (Rs 7679) plant protection (Rs 5342) and sowing (Rs 3128)

Class wise analysis revealed that costs incurred at Class I II and III for manuring and fertil zer application were Rs 29861 Rs 29293 and Rs 29500 per hectare respectively and for panthall making it was found to be Rs 17779 Rs 15836 and Rs 16727 Cost incurred per hectare for harvest ng operation by Class I II and III were Rs 11435 Rs 11589 and Rs 11019 respectively and for irrigation it was Rs 10833 Rs 12881 and Rs 10940 and family labour was observed to have prominence over hired labour in all the classes The class wise expenses on land preparation was Rs 7528 Rs 8482 and Rs 7208 per hectare for Class I Class II and Class III respectively and that for application of plant protection chemicals were Rs 3879 Rs 5403 and Rs 5 69 The application of plant protect on chemicals was carried out entirely by family labour For sowing the expenses incurred by Class I Class II and Class III farmers were found to be Rs 2869 Rs 3570 and Rs 2885 per hectare respectively and cost of seeds was the single largest item of expenditure in this operation

To sum up the operation wise cost manuring and fertilizer application was found to occupy the highest share in the operation wise expense in both the areas Th s was on par with the f ndings of Sreela (2005) and Brahmaiah and Naidu (1993) It was also supported by the results of the study conducted by Madan *et al* (1999) who reported that farmyard manure constituted 30 53 per cent of the total cost of cauliflower cultivation Sowing operation received the lowest share in the present study which were in contrast to the findings of Karth keyan (2001) who opined that seeds and sowing was the single largest item that occupied a major share of the total cost in the case of cool season vegetables

The expenditure on plant protection chemicals was found to be lower in Pazhayannur when compared to Nemmara The majority of the farmers

Table 4 12 Operation wise cost of cultivation of bittergourd in Pazhayannur (Rs per hectare)

Particulars	class I	per cent	class II	per cent	class III	per cent	Aggregate	per cent
Land preparation	7528	7 10	8482	7 74	7208	6 76	7679	7 18
Sowing	2869	2 71	3570	3 26	2885	2 71	3128	2 93
Manuring and fertiliser application	29861	28 17	29293	26 72	29500	27 67	29812	27 89
Panthal making	17779	16 77	15836	14 45	16727	15 69	16440	15 38
Plant protection	3879	3 66	5403	4 93	5769	5 41	5342	5 00
Irrigation	10833	10 22	12881	11 75	10940	10 26	11107	10 39
Harvesting	11435	10 79	11589	10 57	11019	10 34	11238	10 51
Miscellaneous cost	1342	1 27	1259	1 15	1512	1 42	1182	1 11
Depreciation	173	0 16	216	0 20	210	0 20	211	0 20
Land revenue	100	0 09	100	0 09	100	0 09	100	0 09
Interest on farm loan	1453	1 37	1716	1 57	1729	1 62	1652	1 55
Interest on working capital	599	0 57	707	0 65	712	0 67	697	0 65
Interest on fixed cap tal	186	0 18	260	0 24	263	259 00	259	0 24
Rent on own land	8333	7 86	8333	7 60	8333	7 82	8333	7 80
Rent on leased in land	0	0 00	0	0 00	0	0 00	0	0 00
Allowance given for management of farm	9637	9 09	9965	9 09	9690	9 09	9718	9 09
Total cost	106008	100 00	109610	100 00	106595	100 00	106901	100 00

Fig 3 Operation wise cost of cultivation of bittergourd in Nemmara

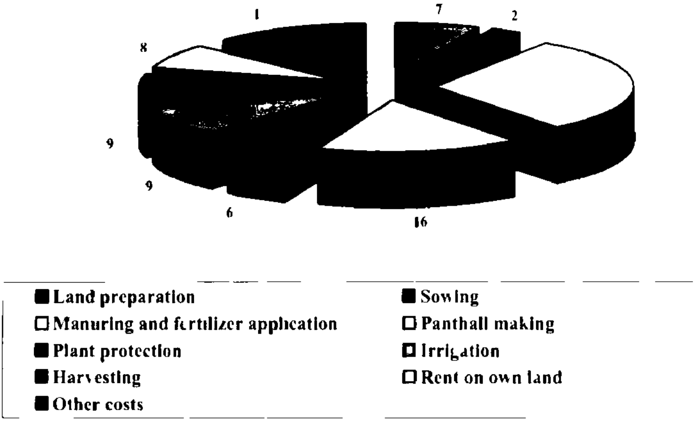
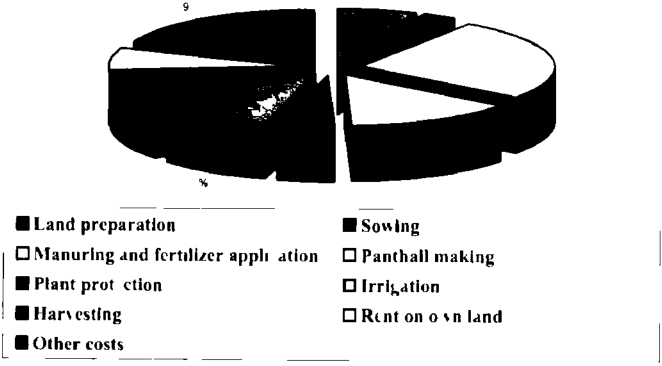


Fig 4 Operation wise cost of cultivation of bittergourd in Pazhayannur



in Pazhayannur were found to use less chemicals and were using non chemical methods of pest control like banana fruit trap and pheromone trap

4 4 Yield and returns of bittergourd

The average yield and returns per hectare for different classes and the two areas Nemmara and Pazhayannur were analysed and is presented in the Table 4 13

For Nemmara, the average output at the aggregate level was 22190 kg per hectare and the total returns obtained was Rs 177520 per hectare The total value of bittergourd was highest for Class II (Rs 181848) followed by Class III (Rs 175752) and Class I (Rs 166224) In the case of Pazhayannur output at the aggregate level was found to be 21551 kg per hectare and the total returns was Rs 172408 per hectare The total value of bittergourd was highest for Class II (Rs 180896) followed by Class III (Rs 167904) and Class I (Rs 161488)

Table 4 13 Yield and returns of bittergourd

Area	Nemmara		Pazhayannur	
	Yield (Kg per hectare)	Returns (Rs per hectare)	Yield (Kg per hectare)	Returns (Rs per hectare)
Class I	20778	166224	20186	161488
Class II	22731	181848	22612	180896
Class III	21969	175752	20988	167904
Aggregat	22190	177520	21551	172408

Comparative analysis of yield and returns of bittergourd in the two areas revealed that yield and returns were slightly higher in Nemmara as compared to Pazhayannur This is in line with the trend observed for cost of cultivation The above results on output and returns was similar to the findings of Thomas et al (2006) who reported the average output to be 22490 kilogram per hectare

However it differed from the f ndings of Nagesh (2001) who reported that the yield from bittergourd was 17213 8 kg per hectare The trend observed in the class wise analysis on realized returns was similar to the results obta ned in the study conducted by Sreela (2005) who reported .hat Class II realized the highest returns compared to Class I and Class III

4 5 Cost of production of bittei gourd

Cost of production was worked out in terms of the cost involved in producing one quintal of bittergourd It was worked out for three classes in both the areas based on cost concepts The results of the analysis are discussed below

4 5 1 Cost of production of b ttergourd Nemmara

Cost of production of b ttergourd in Nemmara as given in Table 4 14 showed that at aggregate level the costs were Rs 301 Rs 302 Rs 340 Rs 410 Rs 448 and Rs 492 per quintal in the respect ve order for Cost A1 Cost B Cost B_2 Cost C Cost C_2 and Cost C_3 Class w se analysis showed that an increasing trend was observed in the case of cost of product on at A B and B_2 from Class I to Class III and the cost of production at C_1 C_2 and C_3 was found to be highest for Class I followed by Class III and II

Table 4 14 Cost of production of bittei goui d in Nemmai a

(Rupees pei quint'l)

Particulars	Class I	Class II	Class III	Aggregate
Cost A1/A2	259	276	308	301
Cost B1	260	277	308	302
Cost B2	300	314	346	340
Cost C1	425	395	412	410
Cost C2	465	432	450	448
Cost C3	512	475	495	492

4 5 2 Cost of production o bittergourd Pazhayannur

Cost of product on per quintal of bittergourd in Pazhayannur is given in Table 4 15 Cost of production for the sample as a whole were Rs 296 Rs 297 Rs 336 Rs 412 Rs 451 and Rs 496 per quintal in the respective order for Cost A1 cost B cost B_2 cost C Cost C_2 and cost C_3 Class wise analys s showed that an increasing trend was observed in the case of cost of production at A B B_2 and C from Class I to Class III In the case of costs at C_2 and C_3 the cost of production was found to be highest for Class I followed by Class III and II Cost of production per quintal at cost C_3 basis for Class I Class II and Class III and at aggregate levels were Rs 525 Rs 485 Rs 508 and Rs 496 respectively

Table 4 15 Cost of production of bittergourd in Pazhayannur

(Rs per quintal)

Particulars	class I	class II	class III	Aggregate
Cost A1/A2	270	274	312	296
Cost B1	271	275	313	297
Cost B2	312	312	353	336
Cost C1	436	404	422	412
Cost C2	477	441	462	451
Cost C3	525	485	508	496

On comparison of the cost of production of the two areas it was found to be sim lar in both areas Class wise analysis also showed a s m lar trend in both the areas This was found to be n line with Gupta (1987) who observed that the cost of production per unit area was lower on large sizes farms making them economically more effic ent The results indicate the same trend with respect to the costs A_1 B_1 B_2 and B_3 The results of the cost of production at aggregate level gave comparable results with the findings of Sreela (2005)

4 6 Farm efficiency measures

The profitability of the crop production can be judged better from the income measures namely farm business income own farm business income family labour income net income and farm investment income Income measures in relation to various cost concepts were worked out for bittergourd in both the areas and are presented and discussed below It may be noted that the farm business income and the own farm business income were the same as the Cost A1 and Cost A2 were same The benefit cost ratio (B C ratio) in relation to the different cost concepts was also worked out to examine the profitability in the cultivation of bittergourd

4 6 1 Income measures

The different income measures were analyzed for both Nemmara and Pazhayannur

The income measures for Nemmara as given in Table 4 16 and Fig 5 showed that the farm business income family labour income net income and farm investment income at the aggregate level for bittergourd were Rs 110630 Rs 102185 Rs 68279 and Rs 86655 per hectare respectively Class wise analysis indicated that farm business income and family labour income was the largest for Class II farmers followed by Class I farmers and Class III farmers In the case of net income and farm investment income also Class II farmers occupied the first position but Class III came next and Class I had the lowest Net income at Class I Class II and Class III levels were Rs 59941 Rs 73801 and Rs 66966 per hectare in the respective order

Table 4 16 Farm ıncome measures of bıttergouı d ın Nemmara

(Rupees per hectare)

Farm efficıency measures	Income			
	Class I	Class II	Class III	Aggregate
Farm busıness ıncome	112334	119085	108093	110630
Famıly labour ıncome	103854	110586	99666	102185
Net ıncome	59941	73801	66966	68279
Farm ınvestment ıncome	78083	92122	85283	86655

In Pazhayannur the farm busıness ıncome famıly labour ıncome net ıncome and farm ınvestment ıncome per hectare at the aggregate level as presented ın Table 4 17 and Fıg 6 were Rs 108696 Rs 100104 Rs 65507 and Rs 83817 respectıvely Class wıse analysıs showed that farm busıness ıncome and famıly labour ıncome were the hıghest for Class II farmers followed by Class I farmers and Class III farmers But ın the case of net ıncome and farm ınvestment ıncome Class II farmers occupıed the fırst posıtıon followed by Class III and Class I Net ıncome per hectare at Class I Class II and Class III levels were Rs 55480 Rs 71286 and Rs 61309 ın the respectıve order

Table 4 17 Faım ıncome measures of bıttergouı d ın Pazhayannur

(Rupees per hectare)

Farm efficıency measures	Income			
	Class I	Class II	Class III	Aggregate
Farm busıness ıncome	107052	118897	102446	108696
Famıly labour ıncome	98533	110304	93850	100104
Net ıncome	55480	71286	61309	65507
Farm ınvestment ıncome	73636	89844	79595	83817

Fig 6 Farm income measures of bittergoud in Nemmara

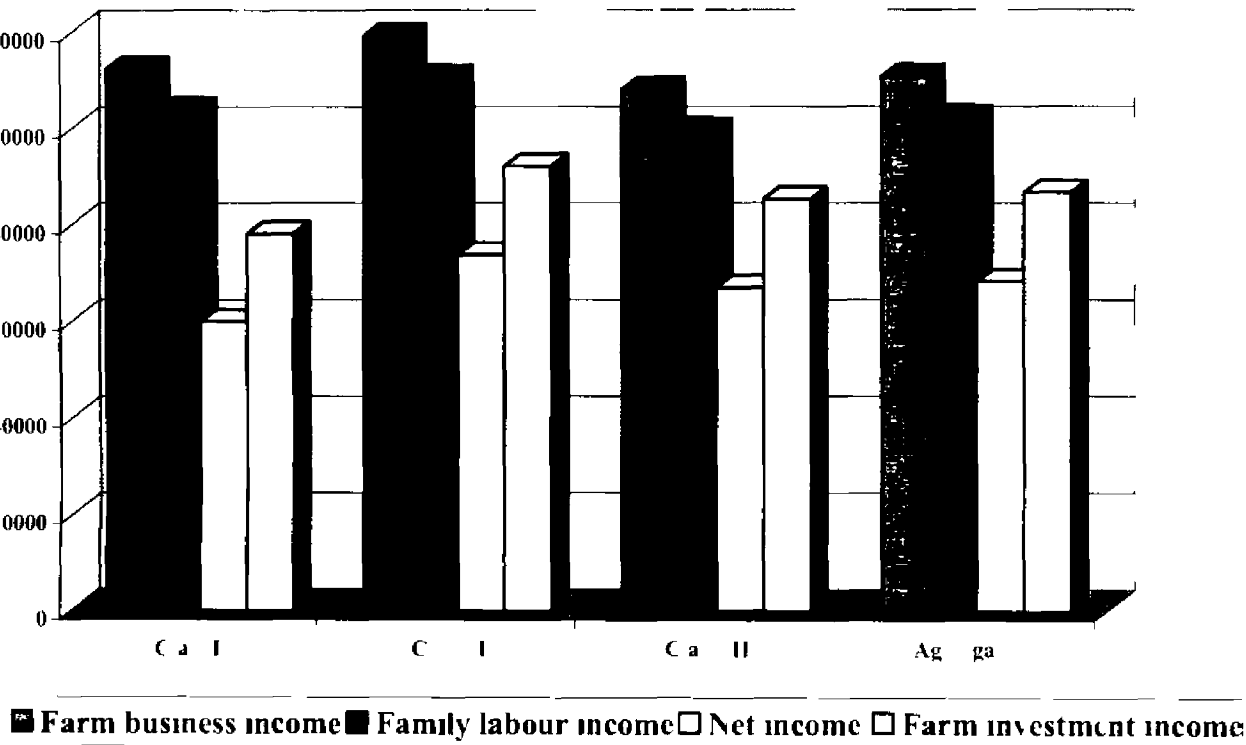
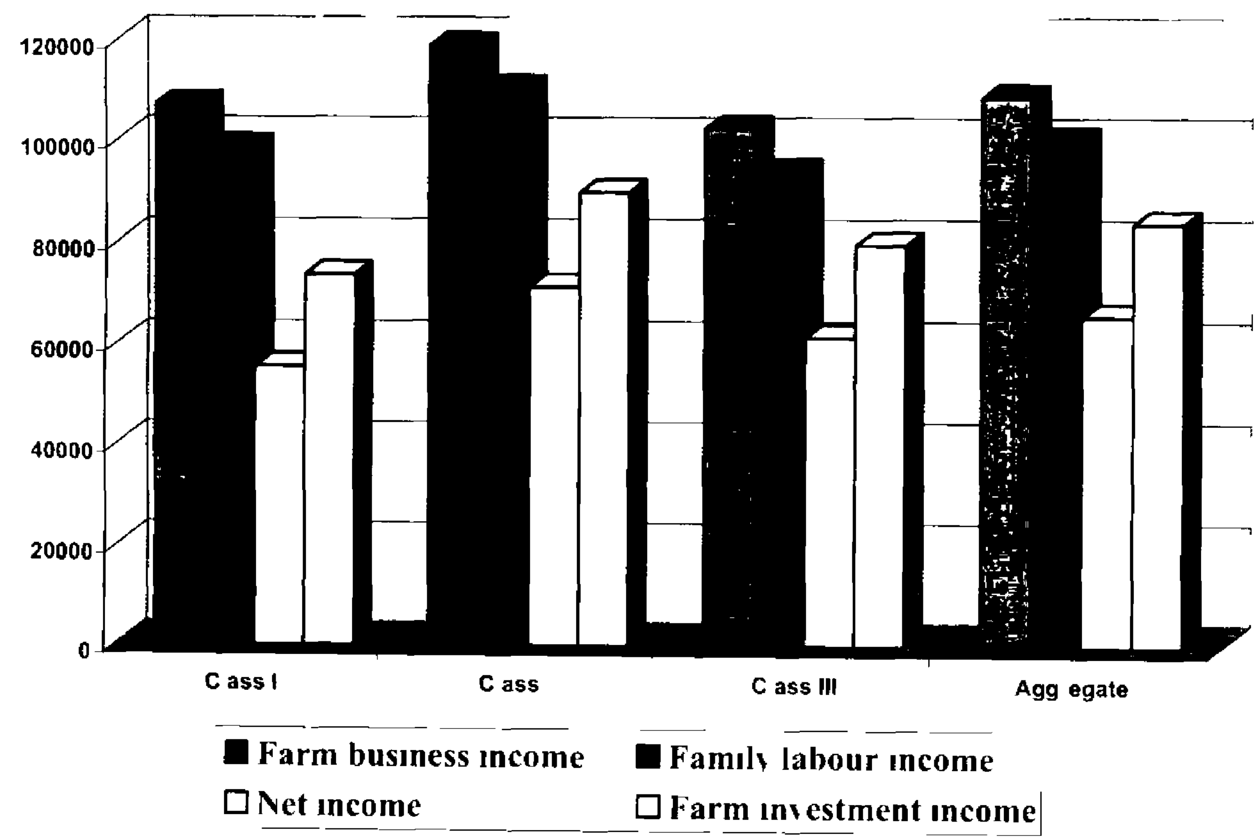


Fig 7 Farm income measures of bittergourd in Pazhayannur



The income measures showed a similar trend in both the areas However at the aggregate level the net income was found to be higher in Nemmara as compared to Pazhayannur In both the areas the net income was found to be highest for Class II as compared to Class I and Class III This was found to be in line with the findings of Sreela (2005) who reported that Class II farmers realized the highest net income and it was found to be around Rs 78044 per hectare

4 6 2 Benefit cost ratio of bittergourd

The benefit cost ratio indicates value of output per rupee of the cost incurred This ratio will serve as a measure which would indicate whether the cost incurred is commensurate with the returns obtained Benefit cost ratio of bittergourd was estimated with respect to various cost concepts for the two areas and the results are presented below

An analysis of benefit cost ratio of bittergourd in Nemmara revealed that B C ratio was more than one at the various cost concepts for all the classes At the aggregate level bittergourd sustained a benefit cost ratio of 1 63 at cost C_3 level and for Class I Class II and Class III farmers it was 1 56 1 68 and 1 62 respectively B C ratio at Cost A1 B_1 and B_2 were highest for Class I followed by Class II and Class III

Table 4 18 Benefit cost ratio of bittergourd in Nemmara

Cost	Benefit cost ratio			
	Class I	Class II	Class III	Aggregate
Cost A1/ A_2	3 08	2 90	2 60	2 65
Cost B_1	3 08	2 89	2 59	2 65
Cost B_2	2 67	2 55	2 31	2 36
Cost C_1	1 88	2 02	1 94	1 95
Cost C_2	1 72	1 85	1 78	1 79
Cost C_3	1 56	1 68	1 62	1 63

The analysis of the B C ratio of Pazhayannur as given in Table 4 19 revealed that the benefit cost ratio at aggregate level was 1 61 at cost C_3 while it was 1 65 for Class II followed by Class III (1 58) and Class I (1 52) B C ratio at Cost A1 B_1 and B_2 were highest for Class I followed by Class II and Class III

Table 4 19 Benefit cost ratio of bittergourd in Pazhayannur

Cost	Benefit cost ratio			
	Class I	Class II	Class III	Aggregate
Cost A1/A_2	2 97	2 92	2 57	2 71
Cost B_1	2 96	2 91	2 55	2 70
Cost B_2	2 57	2 56	2 27	2 38
Cost C	1 83	1 98	1 90	1 94
Cost C_2	1 68	1 82	1 73	1 77
Cost C_3	1 52	1 65	1 58	1 61

The analysis of the benefit cost ratios revealed a similar trend in both the areas with a B C ratio of around 1 6 The high profitability of bittergourd cultivation is evident from the above results has been substantiated by the findings of Sandhya (1992) Nagesh (2001) Sreela (2005) and Thomas *et al* (2006)

4 7 Pattern of pesticide use in bittergourd

Pesticide is an important input in the cultivation of bittergourd Different pests and diseases were found to prevail in the study area The major pests on bittergourd are fruit fly beetles jassids etc and the major diseases are mildews and mosaic

The pest management practices as per recommendation of Kerala Agricultural University are given in Table 4 20 It was observed that jassids were a major problem in the study areas but no recommendations vere made as pointed out by Sreela (2005)

Table 4 20 Recommended pest management practices

Pests/ Diseases	Management practices
Fru t fly	Application of Carbaryl 0 2% Banana fruit trap
Epilachna beetle	0 2 % Carbaryl
Red pumpkin beetle	Carbaryl 10% DP
Downy mildew	Mancozeb 0 2%
Powdery mildew	Nitrophenol 0 05%
Mosaic	Dimethoate 0 05%

The pest management pract ces followed by the farmers varied in both the areas A good proport on of respondents n Pazhayannur used more of non chemical methods of pest control while the respondents in Nemmara were relying mostly on chemical pesticides The farmers in Nemmara were mostly at the mercy of the traders who sold them the most costly chemicals as reported by Sreela (2005) However the farmers who did not approach the Agricultural officers or the University for consultation were resorting to chemical methods of pest control as directed by the pesticide dealers

The pest management practices followed by the farmers in the study area as given in Table 4 21 showed that the farmers did not follow the recommendations Since fruit fly was the major problem in the study areas they used both chemical and non chemical methods to control them Non chemical methods like pheromone trap banana fruit trap and Thulsi trap were used by the sample farmers For the control of Jassids Confidor was used Diseases like yellowing and downy mildew was tackled by using Saff and Mancozeb respectively

Table 4 21 Pest management practices followed by sample farmers

Pests/ Diseases	Management practices of sample farmers
Fruit fly	Malathion, Tatafuran Banana fruit trap Pheromone trap Thulsi trap
Epilachna beetle	Ekalux
Red Pumpkin beetle	Ekalux
Jassids	Confidor
Yellowing	Saff
Downy mildew	Mancozeb

Most of the respondents in the study area were aware of the toxicity level of the pesticides The awareness of the respondents with regard to toxicity level of pesticides as presented in Table 4 22 showed that in Nemmara, about 87 5 per cent of respondents were aware about the toxicity level and it was found to be 92 5 per cent in Pazhayannur However the survey revealed that even though they were aware most of them were not willing to follow safety measures during the application It may be noted that the application of the plant protection chemicals were done entirely by the family members All the above aspects intensify the risk associated with the use of these hazardous chemicals

Table 4 22 Awareness of farmers with respect to toxicity level

Area	Awareness of farmers with respect to toxicity level	
	Number	Percentage to total
Nemmara	35	87 5
Pazhayannur	37	92 5
Total	72	90 0

The respondents however tried to maintain at least three days gap between the application of the pesticides and the next harvest of the vegetable The harvesting of the produce was done once in 3 to 4 days and they usually g ve a 3 4 days break between the application of pesticides and the next harvest

4 9 Socio economic issues in pesticide use

Based on the results obtained in the previous section the issues related to pesticide use was found to be important and inorder to analyse the importance of pesticide in bittergourd production the following functions were fitted which are explained in the sections below

4 9 1 Gross income function

The contribution of pesticides to the gross income was analysed by fitting a log linear gross income function. The variables chosen were area, plant protection chemicals (PPC) human labour fertilizers and organic manure The results of the log linear function of Nemmara and Pazhayannur are presented in Table 4 23

Table 4 23 Regression coefficients of gross income function analysis

Variables	Regression Coefficients	
	Nemmara	Pazhayannur
Constant	0 7824	0 8927
Area (acres) (X_1)	0 4523**	0 5682**
PPCs (Rs) (X_2)	0 2548*	0 2352**
Human labour (mandays) (X_3)	0 3323	0 5571
Fertilizers (Rs) (X_4)	0 1316	0 1873
Organic manure (Rs) (X_5)	0 2982*	0 2467**
R^2	0 6325	0 7837

** Significant at 1 per cent level
* Significant at 5 per cent level

The results revealed that in Nemmara, R^2 was found to be 0 63 indicating that 63 per cent of the variations was attributed to the var ables included in the model Area was s gnif cant at 1 per cent level nd cating that the gross returns increased with the area Plant protection chemicals and organic manure was found to be significant at 5 per cent level The significant relationsh p between plant protection chemicals and gross returns indicates that the farmers used more chemicals to obtain better returns The regression coefficients of all the variables vere positive indicating that these variables influence the gross income positively though only three variables were found to be s gnificant viz area plant protection chemicals and organic manure An increase in the use of these inputs significantly increased the gross returns

For Pazhayannur R^2 was found to be 0 78 indicating that 78 per cent of the variations were attr buted to the variables included in the model Area plant protection chemicals and organic manure were found to be highly sign ficant As in the case of Nemmara, in Pazhayannur also the plant protect on chemicals were found to significantly influence the gross returns

The above results showing the importance of plant protection chem cals n determ ning the gross income of bittergourd was in conformity with the findings of Arunkumara (1995) who reported that plant protection chem cals were h ghly significant in determining the gross ncome of cole crop

4 9 2 Plant protection chemical (PPC) expenditure function

A log linear function was fitted to analyse the factors influencing the expenditure on pesticides The different independent variables selected were area n acres gross mcome per farm in rupees quantity of organic manure and fertilizer used in kilograms The dependent variable was the expenditure on PPCs The results of the expenditure function for Nemmara and Pazhayannur are presented in Table 4 24

Table 4 24 Regression coefficients of PPC expenditure function analysis

Variables	Regression Coefficients	
	Nemmara	Pazhayannur
Constant	8 2213	7 1715
Area (acres) (X_1)	0 1073**	0 0982**
Family Income (Rs) (X_2)	1 0944	0 3479*
Fertilizers (X_3)	0 0944*	1 2534
Organic manure (Rs) (X_4)	0 1175	0 5540
R^2	0 7157	0 7395

** Significant at 1 per cent level
* Significant at 5 per cent level

It was found that in the case of Nemmara R^2 was 0 71 per cent indicating that 71 per cent of the variations was attributed to the selected variables All the coefficients except organic manure and family income were found to be significant Area was found to be significant at 1 per cent level indicating that the expenditure on PPCs increased with an increase in the size of holding Fertilizer use was significant at 5 per cent level of probability It shows that the application of more amounts of fertilizers resulted in an increase in the expenditure of plant protection chemicals This is due to the fact that fertilizers induce luxurious growth of the plants which in turn lead to high pest incidence The other variables were not found to be significant

In Pazhayannur R^2 was found 0 73 per cent indicating that 73 per cent of the variations was attributed to the selected variables The regression coefficient for area was found to be significant at 1 per cent level and income at 5 per cent level The coefficients of fertilizers were however not found to be significant at 1 or 5 per cent levels However it was found to be the next important variable influencing the expenditure on PPCs The regression coefficient of income was significant indicating that the expenditure on PPCs increased with an increase in the family income

It may be noted that the regression coefficient for organ c manure was negative indicating an inverse relationship with the expenditure on PPCs This is due to the fact that organ c manures favour biological protection of plant However the regression coeff cients of organic manure were found to be s gnificant at 10 per cent level and was fo nd to influence the expend ture on pesticides

The above results were found to be in conformity with the findings of Arunkumara (1995) who reported that family income s gnificantly influenced the pesticide expenditure The significant relationship between PPC expend ture and the size of holding as ev ident from the expend ture function confirms the results obtained in the cost of cultivation which has been discussed earlier It is n l ne with the findings of Meenaksh (1984) who reported that in large land holdings farmers spend more on pesticides

4 10 Technical efficiency of bitter gourd

Efficiency is a very important concept in production economics where resources are meagre and opportunities for developing and adopt ng better technologies are competitive Effic ency of a farm refers to its performance in the utilization of resources at its disposal It is also mportant to know ho v well the resources are being ut lized and what possibilit es ex st for improving the operational efficiency in the phase of overall resource scarcity

Efficiency studies would show whether t is still possible to raise productivity by improving the level of efficiency wi hout actually increasing the resource base Estimates on the extent of inefficiency would also help to decide whether to improve efficiency (or) to develop technologies to raise agricultural productiv ty

In the present study to understand the technical eff c ency among the vegetable farmers the stochastic frontier function of Cobb Douglas form was estimated using Maximum L kelihood Estimator (MLE) method The techn cal efficiency of bittergourd farmers in Nemmara and Pazhayannur was est mated through a frontier production function The variables were expenditure on manures and fertilizers expenditure on PPC and labour expenses and the dependent variable was y eld of bittergourd in kilograms The Ordinary Least Square (OLS) in Nemmara and Pazhayannur is given in Table 4 25

Table 4 25 OLS estimates of frontier function for bitteigourd

Explar atory variables	Nemmara	Pazhayannur
Constant	0 9777	1 8963
Manures	0 2359*	0 1677
Human Labor	0 6047**	0 4747**
Fertilizer	0 6070	0 228
Plant protection	0 1650**	0 3151**
R^2	0 9189	0 9358

** Significant at 1 per cent level
* Significant at 5 per cent level

The results revealed that R^2 was found to be above 0 91 in both the areas indicating the importance of variables chosen The variables PPC and labour was found to be significant at 1 per cent level in both the areas while manures were found to be significant at 5 per cent level in Nemmara and insignificant in Pazhayannur As already explained in earlier sections on the cost of cultivation labour expenditure was the most important item in the cultivation of b ttergourd which is in conformity with the above results In the case of PPC also significantly influence the yield of bittergourd

The Maximum Likelihood Estimates of bittergourd in Nemmara and Pazhayannur as presented in Table 4 26 gave similar results as OLS estimates In Nemmara, plant protection and labour was found to be significant at 1 per cent level indicat ng their influence on y eld Thus labour and PPC were found to be the major contributing factors in determining bittergourd yield Labour was found to be more significant than PPC indicating that bittergourd cultivation is labour intensive The value of γ indicated that 61 42 per cent of the variation between the actual output and the maximum possible output was due to the technical inefficiency at the farmers level Mean technical efficiency (MTE) was found to be 0 79 Thus the farmers were 21 per cent less efficient in utilizing the inputs and hence they had the potential to increase the yield

Table 4 26 Maximum Likelihood Estimates of bittergourd

Explanatory variables	Nemmara	Pazhayannur
Constant	1 9334	1 1939
Manures	0 1402	0 2391
Human Labor	0 5178**	0 6038**
Fertilizer	0 2376	0 6584
Plant protection	0 2825**	0 1655**
σ^2_u	0 09091	0 1342
σ^2_v	0 05710	0 0680
γ	0 6142	0 6636
MTE	0 79	0 84

** Significant at 1 per cent level
* Significant at 5 per cent level

In Pazhayannur also plant protection and labour was found to be significant at 1 per cent level indicating their influence on the yield of bittergourd The value of γ indicated that 66 36 per cent of the variation between the actual output and the maximum possible output was due to the technical inefficiency at the farmer s level Mean technical efficiency (MTE) was found to be 0 84 Thus the farmers were 16 per cent less efficient in utilizing the inputs and hence they had the potential to increase the yield

The above results on the importance of labour and PPC significantly influencing the yield is in conformity with the findings of Sreela (2005) It was observed by her that when land was included as one of the variables the parameter of the model namely land labour plant protect on fertil /er and manure plant protection was found to be most significantly influencing the yield However the mean technical efficiency (MTE) of bittergourd obtained in the study area was not in line with the findings of Sreela (2005) and was found to be lower But it was in line with the results obtained in the study by Nagesh (2001) who estimated the MTE of the bittergourd growers as 80 per cent

The technical efficiency of the individual farms was also worked out as the ratio between the actual output to the frontier output The frequency d stribution of the farmers according to the farm specific technical efficiency s presented in Table 4 27

Table 4 27 Fi equency disti ibution of farm specific technical efficiency

Efficiency level	Nemmara	Pazhayannur
Below 0 70	4 (10 0)	1 (2 5)
0 70 0 80	13 (32 5)	16 (40 0)
0 80 0 90	23 (57 5)	21 (52 5)
Above 0 90	0 (0 0)	2 (5 0)
Total	40 (100)	40 (100)

* Figures in parenthes s show percentage to total

The results revealed that there is wide variation in the level of efficiency across farms It varied between 0 61 to 0 87 in Nemmara while for Pazhayannur it varied between 0 69 to 0 91 In Nemmara 57 5 percent of farmers had an efficiency level between 0 80 and 0 90 while it was 52 5 per cent in Pazhayannur Only 5 0 per cent of farmers he above an effic ency level of 0 90 in Pazhayannur while none of the farmers had eff ciency level above 90 per cent in Nemmara The mean techn cal effic ency was found to be higher n

Pazhayannur when compared to Nemmara which means farmers in Pazhayannur was more efficient than the farmers in Nemmara

4 10 Factors influencing the overuse of pesticides

In analysing the technical efficiency it was found that there is overuse of chemicals in both the areas The overuse of chemicals results in many environmental and health problems which is not accounted in the cost Such an effect is termed as externality

According to Bromley (1993) externality refers to instances where the action of one person result in the unwanted costs being vested on another person for which no accounting is done The major externalities conceptualized are technological externality and negative externality The additional costs each farmer is incurring through excess use of plant protection chemicals compared to the frontier levels is measured and is used as a way to estimate the technological externality by comparing each farmer with an efficient level Interspatial or negative externality is the externality on others in productive process Consumer Willingness To Pay is considered as a proxy for negative welfare effect which includes the health hazards due to pesticide on consumers due to its consumption

Here an attempt is made to identify the factors influencing the overuse of plant protection chemicals The percentage overuse of PPC was assumed to be a linear function of age of the farmer number of years of schooling experience in the use of PPC (years) gross income (Rs) organic manures (Rs) fertilizers (Rs) and characteristics of farmers like consultation services availed from the specialists and awareness of toxicity levels of pesticides

Qualitative characteristics of farmers were included because farmers were overusing the plant protection chemicals due to both socio economic reasons and extensıon factors ınfluencıng theır decısıon to use the chemıcals The results are presented ın Table 4 28

Table 4 28 Factors ınfluencıng the overuse of plant protectıon chemıcals ın bıttergourd

Sl No	Independent varıables	Regressıon coefficıents	
		Nemmara	Pazhayannur
1	Constant	76 1554	108 62
2	Age (years)	0 7346E-02	1 9325
3	No of years of schoolıng	0 5758	8 1841
4	No of years of applıcatıon of agro chemıcals	0 22098	2 602
5	Gross ıncome	0 1043E 05**	0 1050**
6	Expendıture on organıc manure (Rs)	0 76512E-03*	0 1468*
7	Expendıture on fertılızers (Rs)	0 6141E 02	0 1959
8	Consultatıon wıth specıalısts	82 17884	52 5412*
9	Awareness of toxıcıty levels	8 4547	72 7627
10	R^2	0 4867	0 5214

** Sıgnıficant at 1 per cent level
* Sıgnıficant at 5 per cent level

The results showed that R^2 was 0 49 ın Nemmara and 0 52 ın Pazhayannur ındıcatıng that 49 and 52 per cent of the varıatıons ın the overuse of pestıcıdes were explaıned by the varıables chosen In Nemmara, gross ıncome of farmers was sıgnıficant at 1 per cent level and the varıables educatıon and expendıture on organıc manure was found to be sıgnıficant at 5 per cent level It was found that ın both the areas the coefficıents of gross ıncome and expendıture on organıc manure were negatıve ındıcatıng that they are ınversely related to pestıcıde use The sıgnıficant negatıve regressıon coefficıent for consultatıon wıth specıalıst ın Pazhayannur ındıcates that varıable ıs ınversely related wıth the pestıcıde overuse Thıs ındıcates that the farmers havıng hıgher gross ıncome those applyıng more organıc manure and those who consulted specıalısts dısplayed a tendency to use pestıcıdes efficıently

The study conducted by Poornıma (1999) gave sımılar results whereın the farmers who were aged havıng hıgher gross ıncome those applyıng more

FYM those who consulted specialists and those who applied prophylactic dose of chemicals were found to use pesticides optimally

4 12 Consumer awareness with respect to pesticide residues

A consumer survey was conducted in order to analyse the awareness among the consumers with regard to the pesticide residue in bittergourd The survey was based on 75 consumers who were interviewed to elucidate their awareness on pesticide residues and their Willingness To Pay Premium (WTPP) for pesticide free bittergourd A higher premium indicates the scope for markets in selling pesticide free bittergourd The results of the analysis of the WTPP are presented below

4 12 1 Willingness to pay premium for pesticide free bittergourd

The Willingness To Pay Premium (WTPP) for pesticide residue free bittergourd was elucidated from the consumers It was hypothesized that consumer would pay a premium for pesticide free bittergourd The difference between the WTPP and market price can be considered as externality cost to the consumer

It was found that about 82 5 per cent of the consumers were aware of the pesticide residues On an average the consumers were willing to pay Rs 12 21 per kg as price for pesticide free bittergourd The price premium formed 52 63 per cent above the market price of Rs 8 per kg This can be addressed in the framework of negative externality

The consumers were grouped into high, medium and low according to their monthly income level and the WTPP was separately analysed in each group 25 consumers each were surveyed in these income groups and the average WTPP in each group is given in Table 4 29

Table 4 29 Consumei s WTPP according to income group

Income group	WTPP (Rs /kg)
High	7
Medium	4
Low	2
Average	4 21

The results reveal the fact that the WTPP increased as the income of the consumers increased and average WTPP was found to be Rs 4 21per kilogram

A logistic regression was estimated to analyse the factors influencing the consumer WTPP for pesticide residue free bittergourd and the results are presented in Table 4 30 The independent variables chosen were the income of the consumers awareness of the consumer with regard to the pesticide residues and the education level of the consumers

Table 4 30 Results of logistic regression of WTPP of consumers

Sl No	Independent variables	Estimated coefficient
1	Income (X)	0 95150E 05**
2	Awareness of pesticide residues (X_2)	0 19649**
3	Education level (scores) (X_3)	0 32069E 03

** Significant at 1 per cent level
* Significant at 5 per cent level

Using the model the probability of WTPP> Rs 2/kg of the prevailing market price was worked out considering the independent variables as explained above Both awareness with respect to pesticide residues and income were found to be significant at 1 per cent level ind cating that the WTPP was directly related to these variables This means that the consumers who were aware of the pesticide residues and who had higher income level were willing to pay more as the price premium for pesticide free bittergourd However the education level did not show any significant influence on WTPP

The results obtained on the WTPP as explained above are in conformity with the findings of past studies on other crops Poornima (1999) got similar results while analyzing the results of consumer awareness regarding pesticide residue free grapes On an average the consumers were willing to pay a premium of Rs 11 42 per kg for pesticide free grapes and the income of the consumer and awareness of pesticide residues were found to be significant and positive An analysis of the willingness to pay premium for pesticide free cabbage by Arunkumara (1995) indicated that the average WTPP was Rs 1 60 per kg of pesticide free cabbage and it was 50 per cent higher than the market price

The WTPP is a measure of the negative externality The WTPP of more than Rs 4 per kilogram of bittergourd obtained in the present study shows the scope of markets for pesticide free bittergourd and organic cultivation Few farmers in the study area had tried the organic cultivation of bittergourd and were faced with certain constraints

The main constraint was that the produce fails to find market when sold along with the inorganically cultivated bittergourd as the size of the bittergourd was small when compared to the bittergourd obtained from the inorganic cultivation The farmers opined that unless and until the whole area practiced organic pest management there would not be good results of the same The yield obtained was low when compared to inorganic cultivation and the price received was lower than expected The lack of separate markets for selling organically produced bittergourd was another constraint identified by them

Summary and conclusion

5 SUMMARY AND CONCLUSION

India is the second largest producer of vegetables in the world next only to China. In 2004 India produced 84 8 million tonnes of vegetables from 5 9 million hectares of land India shares about 13 per cent of the world output of vegetables from about 2 8 per cent of the cropped area in the country Fruits and vegetable crops receive considerably high quantity of pestic des and w th a cropped area of 3 per cent they consume 13 per cent of total pest c des in the country In Kerala, vegetable cultivat on is taken on a commerc al basis and the common vegetables cultivated are bittergourd snakegourd ivygourd amaranthus tomato chillies cucumber etc Bitter gourd is an important vegetable crop cultivated in the state mainly because of its excellent nutritional values Bitter gourd is cultivated in the state on a commercial basis in an area of 2162 hectare of which Palakkad and Thrissur distr cts contribute 11 65 percent and 12 16 per cent respectively to the total area The usage of pesticides in the crop is found to be more when compared to other vegetables as the pest attack is severe in the crop In this context the present study was undertaken with the objective of analysing the costs and returns pest cide use pattern socio econom c issues in pest cide use and the consumer awareness regarding pesticide use in bittergourd

The study was undertaken in Palakkad and Thrissur districts and from these districts Nemmara and Pazhayannur panchayats were selected purposively From the list of farmers cultivating bittergourd a sample of 40 farmers were selected from each panchayat which were categorized into three groups based on the area under bittergourd as Class I (<50 cents) Class II (50 100 cents) and Class III (>100 cents) The data was collected from the farmers through personal interview method using well structured and pre tested interview schedule A separate schedule for consumer survey was prepared and the data on the consumer awareness regarding pesticide use in bittergourd and the r will ngness to pay for pesticide free bittergourd from 75 consumers belonging to d fferent income groups in Thrissur was collected The cost of cult vat on was worked out using operation wise approach and input wise approach by employing the ABC cost concepts of farm management The issues related to pesticide use was analysed using the gross income function and pesticide expenditure function The technical efficiency of the farmers was analysed for both the areas using frontier production function and the factors influencing the overuse of chemicals was assessed by fitting a linear function The consumer awareness regarding the pesticide use in bittergourd was analysed by assessing the Willingness To Pay Premium (WTPP) for pesticide free bittergourd using logistic regression

Bittergourd is an important vegetable crop and the common varieties cultivated in the study area were Preethi Priya and Priyanka The different inputs and operations in bittergourd cultivation were identified and the input wise and operation wise costs were worked out for both Nemmara and Pazhayannur At the aggregate level the input wise cost of cultivation at cost C_3 was found to be Rs 109241 in Nemmara and Rs 106901 in Pazhayannur Class wise analysis revealed that in Pazhayannur the cost was highest in Class II followed by Class III and Class I and in Nemmara the cost of cultivation showed an increasing trend from Class I to Class III Human labour accounted for the highest share among the inputs in both the areas The contribution of plant protection chemicals was found to be higher in Nemmara as compared to Pazhayannur At the aggregate level the contribution of plant protection chemicals was found to be 4 01per cent in Nemmara and 3 21 per cent in Pazhayannur

The analysis of operation wise cost of cultivation revealed that manuring and fertilizer application contributed the highest share in all the three classes and at the aggregate level The results showed a similar trend in both the areas The application of plant protection chemicals which includes both the cost of chemicals and labour charges contributed a share of 5 64 per cent in Nemmara and 5 00 per cent in Pazhayannur In both the areas only family labour was engaged in this operation

At the aggregate level the yield and returns per hectare was found to be 22190 kg per hectare and Rs 177520 per hectare in Nemmara and 21551 kg per hectare and Rs 172408 per hectare in Pazhayannur The cost of production was found to be Rs 492 per quintal at cost C_3 for Nemmara and Rs 496 per quintal in Pazhayannur

The socioeconomic issues in pesticide use was analysed by fitting function for identifying the factors influencing the overuse of plant protection chemicals and the consumer willingness to pay for pesticide residue free bittergourd The gross income function was fitted to assess the contribution of pesticides to gross income The results showed that in Nemmara, area was found to be significant at 1 per cent level and plant protection chemicals and organic manure at 5 per cent level In Pazhayannur area, plant protection chemicals and organic manure were significant at 1 per cent level The analysis revealed that plant protection chemicals play a significant role in the gross income of the farmer

The factors influencing the pesticide expenditure was analysed using a log linear function with expenditure on plant protection chemicals as dependent variable It was found that area was significant at 1 per cent level in both Nemmara and Pazhayannur Fertilizers and income were found to be significant at 5 per cent level in Nemmara and Pazhayannur respectively The significant relationship between PPC expenditure and size of holding indicates that the usage of plant protection chemicals increases with the size of holding So also in the case of fertilizers and income which exhibited a positive relationship with plant protection chemicals expenditure

Technical efficiency of bittergourd was estimated using the stochastic frontier production function. The analysis of efficiency revealed the mean technical efficiency of Nemmara and Pazhayannur as 0 79 and 0 84 respectively The OLS estimates showed that human labour and PPC was significant at 1 per cent level in both the areas and manures at 5 per cent level in Nemmara The

Maximum Likelihood estimates gave similar results γ was found to be 0 6142 for Nemmara and 0 6636 for Pazhayannur The frequency distribution of sample farmers according to the farm specific technical efficiency showed that 50 60 per cent of the farmers in both the areas lie in an efficiency level of 80 90 per cent However farmers of Pazhayannur were found to be more technically effic ent than Nemmara

On the analysis of stochastic production frontier it has been found that the farmers overused the chemicals and hence an attempt was made to analyse the factors influencing the overuse of PPCs it was found that in Nemmara and Pazhayannur gross income was significant at 1 per cent level However the coefficient was negative indicating a negative relationship with the overuse of chemicals The farmers having higher gross income those applying more organic manure and those who consulted specialists displayed a tendency to use pesticides conservatively

A consumer survey was conducted in order to analyse the awareness among them with regard to the pesticide residue in b ttergourd and their willingness to pay premium (WTPP) for pesticide free bittergourd On an average the consumers were will ng to pay Rs 4 21 per kg more as price for pesticide free bittergourd The price premium formed 52 63 per cent above the market price A logistic regression was estimated to analyse the factors influencing the consumer WTPP for pesticide residue free bittergourd and the results showed that awareness with respect to pesticide residues and income were found to be highly significant indicating that the WTPP was directly related to these variables This means that the consumers who were aware of the pesticide residues and who had higher income level were willing to pay more as the price premium for pesticide free bittergourd

The analysis of the WTPP revealed the scope of organic product on of bittergourd However some constraints were identified in the organic production The main constraint was that the produce fails to find market when sold along with the inorganically cultivated bittergourd as the size of the bittergourd was small when compared to the bittergourd obtained from the inorganic cultivation The farmers were also of the opinion that until the whole area practices organic pest management there would not be good results of the same The yield obtained was low when compared to inorganic cultivation and the price received is lower than expected The lack of separate markets for selling organically produced bittergourd at attractive prices was another constraint

The major findings of the study are summarized as follows

- The total cost of cultivation of bittergourd at aggregate level was Rs 109241 and Rs 106901 per hectare in Nemmara and Pazhayannur respectively
- Among the inputs labour charges constituted the major share followed by manures
- Among the different operations manuring and fertilizer application occupied the lion s share
- The pesticide usage in the study area was found to be indiscriminate and the usage of plant protection chemicals was found to increase with an increase in holding size
- The yield and returns per hectare was found to be 22190 kg and Rs 177520 in Nemmara and 21551 kg and Rs 172408 in Pazhayannur
- The B C ratio was found to be 1 63 in Nemmara and 1 61 in Pazhayannur
- In the analysis of gross income function, area, PPC and organic manure was found to be significantly influencing the gross income
- The analysis of factors influencing the pesticide expenditure showed that area, fertilizer and income were found to be the significant determinants

- Technical effic ency studies indicated th overuse of chemicals and the mean technical efficiency was found to be 0 79 for Nemmara and 0 84 for Pazhayannur
- The factor significantly influencing the overuse of chemicals in both the areas was found to be gross income with a negative coefficient
- The consumer survey revealed that the average WTPP was Rs 4 21 per kilogram and it was 52 63 per cent above market price

Based on the above findings the following suggestions are put forth

- The indiscriminate use of hazardous chemicals should be regulated by su table policy measures

  There is vast scope for organic markets in bittergourd and hence the production on an organic basis should be taken up
- Extension activities to popularize the importance of non chemica methods of pest control like pheromone trap to be intensified
- Price differentiation for organically produced b ttergourd to ensure better production and incentive to farmers
- Appropriate extension activities tc give training support to farmers regarding safe appl cation of pesticides

  Regulation of indiscrim nate supply of pest c des by the dealers to the farmers through suitable measures

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SOCIO-ECONOMIC ISSUES IN PESTICIDE USE: AN ANALYSIS IN BITTERGOURD

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ABSTRACT OF THE THESIS

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ABSTRACT

The present study on the Socio economic issues on pesticide use An analysis in bittergourd was conducted to study the economics analyse pattern of pesticide use and examine the socio economic issues in use of pesticides in bitter gourd The study was taken up in Palakkad and Thrissur districts where bittergourd cultivation is taken up on a commercial scale From the districts Nemmara and Pazhayannur panchayats were selected for the study

The total cost of cultivation per hectare at C_3 level in bittergourd cultivation was found to be Rs 109240 in Nemmara and Rs 106901 in Pazhayannur The benefit cost ratio was found to be 1 63 in Nemmara and 1 61 in Pazhayannur Among the inputs labour charges constituted the major share followed by manures Among the different operations manuring and fertilizer application occupied the lion s share

The pesticide usage in the study area was found to be indiscriminate and the usage of plant protection chemicals was found to increase with an increase in holding size The respondents in Pazhayannur were resorting more on non chemical methods of pest control The yield and returns per hectare was found to be 22190 kg and Rs 177520 in Nemmara and 21551 kg and Rs 172408 in Pazhayannur

In the analysis of gross income function area PPC and organic manure was found to be significantly influencing the gross income The factors influencing the pesticide expenditure were analyzed and the study showed that area fertilizer and income was found to have significant influence on pesticide expenditure In the estimation of technical efficiency using maximum likelihood estimates plant protection chemicals and human labour were found to be significant The mean technical efficiency in bittergourd production was found to be higher in Pazhayannur (0 84) as compared to Nemmara (0 79)

In the analysis of the factors influencing the overuse of pesticides the gross income was found to have significant influence on the overuse of pesticides Consumer survey revealed that 82 5 per cent of consumers were aware of the pesticide residues and the Willingness To Pay Premium (WTPP) was found to be Rs 4 21 per kilogram of bittergourd

The major constraints in the organic production of bittergourd was the lack of proper markets for selling organically produced bittergourd non uniformity in the cultivation practices in an area and small size of the produce obtained though organic cultivation