ESTIMATION OF POST-HARVEST LOSSES FOR VEGETABLES IN PALAKKAD DISTRICT

By

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(2019-11-014)

THESIS

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DECLARATION

I, **Nithya Kalpana E** (2019-11-014) hereby declare that the thesis entitled **"Estimation of post-harvest losses for vegetables in Palakkad district"** is a bonafide record of research done by me during the course of research and that it has not previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

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Nithya Kalpana E

With deepest gratitude and

Warmest affection,

I dedicate this to

My dearest Appa, Amma, Paappu and

Grandmother…

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF PLATES

ABBREVIATIONS

BCR	-	Benefit Cost Ratio
CGR	-	Compound Annual Growth Rate
CV	-	Coefficient of Variation
OLS	-	Ordinary Least Square
PHL	-	Post-Harvest Loss
SD	-	Standard Deviation
TE	-	Triennium Ending
VFPCK	-	Vegetable and Fruit Promotion Council Keralam

Introduction

Chapter 1

INTRODUCTION

Vegetables are the excellent sources of vitamins particularly niacin, riboflavin, thiamin, vitamins A and C. They also contain a wide array of potentials and help combating the under-nourishments. They provide proteins, carbohydrates and minerals like calcium and iron. They are the cheapest source of natural protective tools and are known as functional foods.

India stands second in the world, next to China with 188.91 million tonnes of vegetable production from 103 lakh hectare of area (GoI, 2020). According to APEDA (2020), India's fresh exports of vegetables are worth □4,383.41 crores, whereas the processed vegetables account for □2,760.57 crores. Inspite of, the surge in global agricultural production, 50 per cent of the world's population has been finding difficulty in obtaining their daily vegetable portions. The reason for this can be attributed to very large percentage of losses and wastages in vegetables.

Post-harvest losses could be analysed by categorizing them into both quantitative losses as well as the quality deterioration of the produce. As the harvested vegetables are subjected to a series of post-harvest management practices, the losses could be due to wide ranges of factors. Since 1977, a Special Action Programme of FAO has been working on the prevention of food losses globally. Since the year beginning from 1983, more importance has been given to fruits and vegetables due to their easy relatively low shelf-life and perishable nature.

Post-harvest losses of the agricultural commodities are observed higher in the under-developed and developing countries rather than in the developed countries. These losses can be due to pre-harvest factors at farm level and also because of post-harvest management practices such as grading, sorting, packaging, transportation, processing and distribution being performed by farmers and traders.

According to the ASSOCHAM report (2019-20), India had been losing about Rs. 2 lakh crore every year in terms of post-harvest losses. Besides, physiology of each of the vegetables plays a significant role in the post-harvest losses of vegetables. According to the data of NHB in 2011, despite urban sprawl, India had witnessed surge in area under fruits and vegetable cultivation from 9.08 million hectares (1991) to 15.64 million hectares (2012). But, along with this rise in area there has been increase in post-harvest losses to both in terms of quantity as well as in value terms.

Severe losses occur due to lack of good transportation facilities, poor management and infrastructure and improper market facilities or careless handling of the produce by farmers, market intermediaries and consumers. All these lead to high spoilage of vegetables (Gauraha and Thakur (2008); Singh *et al*. (2008)).

Post-harvest losses in vegetables

Post-harvest losses occur at any stage in the distribution of produce, right from the harvest till they reach the final consumers. The major causes of occurrence of loss can be physical handling, physiological losses and losses due to biotic factors. The physical losses are generally quantitative in nature, where the handling damages, injuries at farm level such as harvest injuries followed by transportation losses include loading and unloading of the produce. This type of losses may be found both at farmer level as well as trader level.

Physiological losses are qualitative in nature *i.e.* quality deterioration of produce, which can be of malformed fruits, uneven size of tender fruits, over-ripened fruits, shrinkage due to loss of moisture and other physiological activities in harvested fruits. Sometimes, the tight packaging during the transport may cause the produce to undergo quality and quantity and even unfit for final consumption. The simple reason behind the larger loss in the quantity of produce could be the excess production *i.e.* bumper harvest and higher production in a season, where the surplus produce is found to have no buyer/trader in the market to transact.

Losses due to the biotic factors like pests, diseases, rodents and birds are also found affecting the produce in both qualitative and quantitative aspects. These pre-harvest factors account for losses as the pest infected and diseased fruits would be sorted and graded into lower grades or sometimes, wastages as a whole and dumped into the field. Thus, the above mentioned factors cause the loss of the produce as well as the loss of all the efforts in producing them. Under this background, the present study, "Estimation of post-harvest losses for vegetables in Palakkad district" was taken up.

The objectives of the study were as follows:

1. To examine the nature and extent of post-harvest losses in vegetables and calculate the monetary loss values
2. To analyze the factors responsible for losses in vegetables
3. To study the knowledge, perception level and practices of farmers regarding the losses

Scope of the study

The findings of the study would definitely be of help to the vegetable farmers in order to understand their short-comings and practices in vegetable production. It will also be useful for both farmers and traders to understand their lacunae in post-harvest management practices and the monetary losses incurred because of improper handling at various stages of marketing. In addition to this, the various factors responsible for the losses could be analyzed in order to bring down the existing losses.

Limitations of the study

With time and resource constraints, the present study has been attempted in Palakkad district of Kerala, given the limited number of sample farmers and traders. The study was confined to the vegetable cultivation seasons of the year 2020-21. Thus the findings were found bound to the study area and to the selected vegetables. Primary data gathered from the farmers and traders were recollected from their memory as no separate field level records were found maintained by them. The survey of farmers was initially

done using personal interviews by contacting them directly, but later due to the occurrence of COVID pandemic, the data had to be collected over telephone calls. A lot of challenges were faced in during the process of contacting farmers. Despite all these limitations, the findings and conclusions of the study under-taken and the outputs of the same would be useful in-laying the foundation for further research as this is the study is first of kind in the state.

Presentation of the thesis

The study entitled "Estimation of post-harvest losses for vegetables in Palakkad district" has been presented in five chapters. The introduction chapter presents the importance of Indian vegetable scenario and post-harvest losses followed by the scope and limitations of the study. The chapter on review of literature provides the findings of related researches of the previous years. The methodology and analytical tools used for the study have been placed in the next chapter. The research findings have been presented in detail under in the subsequent chapter. The overall view of the major implications of the research work undertaken was explained in the last chapter.

Review of literature

Chapter 2

REVIEW OF LITERATURE

Review of literature is the written and systematic summary of the research which is undertaken on a particular topic. It summarizes the background and context of the research. In this chapter, an attempt has been made to review the literature of past research work in relevant to the present study. The reviews have been collected, classified and presented under the different sub-headings given below:

2.1 Growth rate analysis

2.2 Marketing channels and their efficiencies

2.3 Post-harvest losses

2.4 Nature and extent of post-harvest losses

2.5 Determinants of post-harvest losses

2.6 Monetary value of post-harvest losses

2.7 Farmers awareness regarding post-harvest losses and practices

2.1 Growth rate analysis

Raghuvanshi (2018) studied the growth rates of area, production and productivity for vegetables in Chhattisgarh. He reported that growth rates of area and production of okra were 6.9 and 9.94 per cent, also the productivity with 2.85 per cent showed positive growth and found to be significant. In brinjal, the estimated growth rates were found to be positively significant with values 8.08, 12.92 and 4.48 per cent for area, production and productivity respectively. But, Bastar district alone showed declining productivity rate by 1.71 per cent. The growth rates were also computed for tomato and potato, which reported increasing trends with 6.49 and 9.01, 12.95 and 10.93 and 6.1 and 1.76 per cent for area, output and productivity respectively.

Sonwanee (2015) analysed the growth rate in area, production and productivity for oilseeds (gingelly, linseed and soybean) in Chhattisgarh for the period 2003-04 to 2012-13. The results revealed that growth rate of area under sesamum was found significant and showed decreasing trend, whereas in production, it declined and was non-significant. Productivity was found to show an increasing trend, but it was non-significant. In case of linseed, area and production showed negative significant growth rate and productivity indicated significant and increasing trend. Area and productivity of soybean in the area was found be positive but non-significant, whereas production registered increasing and significant growth rates.

Manoj (2014) computed compounded growth rates of area, output and productivity of tomato in Jaipur, using exponential model and found that area under tomato was significant and showed increasing trend (8.32 per cent), whereas the output (-1.89 per cent) and productivity (-9.2 per cent) were found to be non-significant and declining. The overall growth rates in the state showed increasing trends with values 2.58, 2.96 and 0.37 per cent respectively.

Kumar (2005) analysed the compound growth rates of area, output and productivity of onion and potato in Karnataka. The study reported that area and production of onion was found significant with positive annual growth of 6.6 per cent and 6.36 per cent respectively whereas, productivity showed non-significance and negative rate (-0.05 per cent). In case of potato, all the three had positive and significant growth rates of 4.1 per cent, 6.8 per cent and 2.7 per cent respectively.

2.2 Marketing channels and their efficiencies

Shubhramani (2019) observed different channels adopted by farmers for Kagzi lime marketing and revealed four major chains. In the first channel identified, the producers directly sold to consumers. Second, producers marketed lime to consumers through retailers. And, the intermediaries like wholesalers and commission agents were involved in third and fourth channels. Producer's share in consumer's rupee (97.57) was

observed as maximum in the first channel and marketing cost was found highest in the fourth channel with a greater number of intermediaries.

Joshi (2019) found two major channels by which potato was routed in Indore (MP) for non-adopters of post-harvest management (PHM) practices. Channel I incurred comparatively lower routing cost (□175/qtl) than Channel II (□255/qtl).

I. Producers → Retailers→ Consumers

II. Producers → Wholesalers → Retailers → Consumers

Likewise, two major channels for PHM practices adopters were identified. □213/qtl and □313/qtl were reported as marketing cost involved for Channel I and II respectively.

I. Producers → Retailers → Consumers

II. Producers→ Wholesalers (cold storage) → Retailers → Consumers

Yadav (2018) identified the most common channels preferred and the various actors in the supply chain for marketing chilli as follows,

I. Producers → Cold storage structures → Commission agents → Wholesalers → Retailers → Consumers

II. Producers → Commission agents → Wholesalers → Consumers

III. Producers → Wholesalers → Retailers → Consumers

He analysed the price spread for channels I and II, and reported as Rs. 385/qtl and Rs. 216/qtl respectively. Hence, when intermediaries were limited, the producer's share was found to be relatively greater.

Monika (2018) identified the disposable pattern of chickpea in Prakasam district of Andhra Pradesh as (i) small farmers directly sold their produce to millers, as they wanted ready cash (ii) some farmers stored it for better price in cold storage. The estimated marketable and marketed surplus of total production was 92.01 per cent and 91.66 per cent.

Nayak *et al.* (2018) revealed four main channels for banana marketing in Durg, namely,

1. Channel 1: Producers → Consumers
2. Channel 2: Producers → Retailers → Consumers
3. Channel 3: Producers → Wholesalers → Retailers → Consumers
4. Channel 4: Producers → Commission agents → Wholesalers → Retailers → Consumers

Among the four channels, channel 3 was found to be followed widely. The channels were examined for price spread, market efficiency and producers share in final price. Channel 4 showed highest price spread of □1,796.6/qtl and channel 1 was found to be most efficient. 94.40, 51.76, 39.92 and 35.84 per cent were estimated as producers share from the four, respectively.

Khan (2016) while estimating the post-harvest losses, identified the marketing channels involved in peas and tomato of Nainital district. The produce moved in the following order from farm to consumers as, Producers → Local agents → Wholesalers → Retailers → Consumers.

Gajanana *et al.* (2015) reported on the three major disposable patterns of guava, adopted by farmers in Karnataka. They were (i) Producers → Commission agents → Retailers → Consumer, (ii) Producers → Contractors → Commission agents → Retailers → Consumers and (iii) Producers → PHCs → Commission agents → Consumers. The efficiency and the producer's share were 1.06 and 51.52 per cent, respectively and when the cost incurred in post-harvest losses were taken in to account, it decreased substantially to 0.88 and 45.8 per cent. Hence when losses are avoided, the farmers were benefited with increased share.

Mallur (2015) investigated the marketing of leafy vegetables in North Karnataka and identified the most popular marketing channel as Producers → Commission agent-

cum- wholesalers → Retailers → Consumers. He also evaluated the producer's share in final price as 72, 71.7 and 60 per cent in amaranthus, palak and methi respectively.

Sukhdev (2014) reported that majority of orange farmers in Nagpur marketed their produce through the channel, Producers →PHCs → Wholesalers → Retailers → Consumers. This channel had the highest cost incurred in marketing (□2,211.21/qtl) and relatively low producer's share in consumer's rupee (37.12 per cent).

Ramesh (2013) identified two channels through which farmers marketed banana *viz.* local market and far distance market. With increased loss per cent in banana, farmer's share in consumer's rupee decreased from 48.97 to 45.21 per cent.

Murthy *et al*. (2009) studied the marketing channels involved in mango and identified the four predominantly followed channels as,

Channel 1 - Farmers → PHCs → Wholesalers [distant] → Retailers → Consumers

Channel 2 - Farmers→PHCs→Wholesalers [local]→Wholesalers [distant] → Consumers

Channel 3 - Farmers → PHCs → Wholesalers [local] → Retailers → Consumers

Channel 4 - Farmers → Wholesalers [distant] → Retailers → Consumers

Karar (2007) while assessing the post-harvest losses of potato in Burdwan district, found five major supply chains involved as,

I. Producers → Commission agents → Wholesalers → Retailers → Consumers
II. Producers → Wholesalers 1 → Wholesalers 2 → Retailers → Consumers
III. Producers → Village level collectors → Wholesalers → Retailers → Consumers

IV. Producers → Cold storage owners → Wholesalers → Retailers → Consumers and

V. Producers → Retailers → Consumers.

Of these, the channels followed most often were identified as, Channel II and V. Channel III was considered as most efficient (180.6) whereas, channel V had lower efficiency (87.7) and it was also found to have increased producer's share in consumer's rupee as the intermediaries were less.

Gajanana *et al*. (2006) attempted to identify the channels involved in tomato marketing in Karnataka and outlined the two major channels followed by the farmers.

(i) Producers → Commission agent/Wholesalers→Retailers → Consumers (local market)

(ii) Producers → Commission agent/Wholesalers → Retailers → Consumers (distant market)

2.3 Post-harvest losses

2.3.1. Post-Harvest Loss- Definition

Post-harvest loss is characterized by not directing food to consumption due to mechanical, pathogenic or physiological injuries that alter its physical, chemical, microbiological or organoleptic properties. Quality losses include those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product. These losses are generally more common in developed countries (Kader, 2002). Quantity losses refer to those that result in the loss of the amount of a product. Loss of quantity is more common in developing countries (Kitinoja and Gorny, 1999).

A recent FAO report indicates that at global level, volumes of lost and wasted food in high income regions are higher in downstream phases of the food chain, but just the opposite in low-income regions where more food is lost and wasted in upstream phases (FAO, 2013).

Hodges *et al.* (2011) defined, "Post-harvest food loss as the measurable qualitative and quantitative food loss along the supply chain, starting at the time of harvest till its consumption or other end uses".

Troger *et al.* (2007) defined post-harvest loss as, "change in the availability, edibility, wholesomeness or quality of the food that prevents its consumption".

Post-harvest loss is that "weight of wholesome edible product with high moisture content, that is normally consumed by human and that has been separated from the medium and sites of its immediate growth and production by deliberate human action with the intention of using it for human feeding but which for any reasons fails to be consumed by human" (Alao, 2000).

According to FAO (1989), post-harvest losses in vegetables were due to the extremely perishable nature as they are composed of living tissues. Fruits, vegetables and root crops are much less hardy and are mostly perishable, and hence utmost care should be taken during harvesting, handling and transport, else they will soon decay and become unfit for human consumption.

2.3.2. Status of post-harvest losses

2.3.2a. Post-harvest losses - World scenario

World Vegetable Center (2018) explored that half of the onion produced under went post-harvest losses in Nigeria, due to improper handling and scientific storage. Farmers stored the onions in a structure called Rudu (Local straw). The main reason behind the losses was lack of grading and sorting of onions before storage and hence, the pathogens from diseased bulbs got spread easily inside the structure. The increased temperature inside the structure promoted bacterial growth and sprouting.

Acedo and Easdown (2015) reported on post-harvest losses of vegetables in South-Asian countries. Based on the crops and intermediaries, Bangladesh was found to have average losses of about 11-33 per cent. The loss percentage of vegetables in Nepal

accounted around 25-30. Pakistan with 6.1 lakh ha under vegetable cultivation faced losses of 15-40 per cent of total production. The reported losses of vegetables in Afghanistan were half of the total production and even more, due to farmer's unawareness on post-harvest practices. In Bhutan, the extent of post-harvest losses of major vegetables was estimated to be about 20-35 per cent whereas 16-40 per cent of the total vegetables in the country got wasted in Sri Lanka. In all these countries, tomato was estimated to account for the highest losses among vegetables. All of these losses were due to scarcity in post-harvest storage infrastructure facilities, transit issues, *etc.*

Ahmed *et al.* (2015) found that the total post-harvest losses of Kinnow in Pakisthan accounted for 45 per cent of total produce, of which the farm level wastage was highest (72 per cent). Also, the major factors responsible for the losses were time and method of harvests at field level and the method of loading and storage facilities at wholesale level. Experience played an important role at both the levels. The type of retailers and quantity of produce that remained unsold were the elements which resulted in post-harvest losses at retailer level.

Alavi *et al.* (2012) consolidated the various post-harvest losses studies of FAO and concluded that Southeast Asia experienced around 10-37 per cent losses in rice value chains and 8-26 per cent in China.

UNO in 2011 stated that relying on the different phases of the economic development of global nations, the extent of post-harvest spoilage of agricultural produce differs. Also, these notable losses were found to be in cradling stage of the agri-food chain and consumer levels in the developing and developed nations.

According to the report by World Bank, NRI and FAO (2011), the post-harvest losses in Sub-Saharan Africa valued to 4 billion US dollar annually, but the farmer's earnings were not more than 2 US dollars per day.

Rathore *et al.* (2010) reported that UK's annual food consumption is equivalent to the India's annual food wastage.

Nellemann and MacDevetter (2009) propounded that for the global nutrition security, post-harvest losses in the produce must be lowered to the possible extent.

2.3.2b. Post-harvest losses - Indian scenario

According to ASSOCHAM (2019), India is one of the biggest food wasters in the world, with an estimated spoilage of Rs. 900,000 million worth of fruits, vegetables and grains every year and year-on-year. It pointed-out that, Australia's annual wheat production was found equivalent to India's wheat wastage. Also, India tends to waste more fruits and vegetables than that consumed by the United Kingdom in a year.

IIHR, Bangalore in 2014 reported that, about 2 to 23 per cent of the fresh vegetable produces was wasted in India, and estimated that mean of post-harvest losses from farm to fork was around 12 per cent.

Kumar *et al.* (2004) pointed out that, minimizing the marketing losses would be the only possible means for increased vegetable production in India.

Reddy (2004) suggested that, post-harvest wastage must be reduced or even avoided, to supply the vegetables, all round the year in markets.

2.4 Nature and extent of post-harvest losses

Kumar (2020) examined post-harvest losses for mango, banana and papaya of Bilaspur (Chhattisgarh) and revealed that maximum losses occurred in mango with 11.48, 4.42 and 2.35kg/qtl at field, wholesale and retail levels, followed by 16.26kg/qtl in papaya and 17.58kg/qtl in banana. Erratic climate conditions in the study area and the varying weather parameters were the major issues causing the losses.

da Costa Ferreira *et al*. (2020) conducted the study on post-harvest losses for fruits and vegetables at trader level in Brazil. The results revealed that losses in vegetables were 16.42 per cent in bell pepper, followed by lettuce (11.8 per cent) and tomato (11.38 per cent). The maximum loss in fruits was found in plum (35.65 per cent), and papaya (17.93 per cent).

Shubhramani (2019) examined the post-harvest physical and economical losses in Kagzi lime of Akola and reported to be 7.59 and 7.76 per cent respectively.

Nayak *et al.* (2018) assessed post-harvest losses in banana of Durg (Chhattisgarh) at three levels *viz.* farm, wholesale marketing and retailer levels. The results revealed that majority of losses was reported in wholesaler stage (51 per cent), followed by farm loss (39.52 per cent) and retail level losses (37.95 per cent).

Gautam (2017) revealed that 22.65 per cent of aggregate post-harvest losses occurred in potato at various levels, which are around 9.2, 8.45, 2, 1, 2 at farm level, wholesale, retailer, cold storage and others respectively. The qualitative losses (physiological and diseases) were estimated to 21.85 per cent in Baragaon block and 23.45 per cent in Pindra block of Varanasi.

Kumar and Kalita (2017) delineated that highest portion of cereals in developing countries like India were lost in storage phase, as conventional storage structures were incapable of protecting the grains from pest and disease attack and further, resulted in poor returns to farmers. Hence, concluded that, wise post-harvest management technologies would help to cull out the losses.

Dasanayaka *et al.* (2017) identified, very less or no demand for produce (30.28%), pest injuries (19.42%), disease infestation (18.14%), mechanical damage (16.71%) and poor quality (15.42%) as the factors and its extent in causing losses in Sri Lanka.

Khan (2016) observed aggregate post-harvest losses in peas and tomato of Naintal district as 49.07 per cent and 35.51 per cent respectively. In both the crops, the highest losses were reported at trader level of 24.29 per cent and 14.1 per cent respectively.

Sharma (2016) conducted survey in Jabalpur regulated market and revealed that 856.2 qtl, 665 qtl and 491qtl per year of potato, green pea and tomato had been wasted and accounted for post-harvest losses. Transportation loss was found maximum in tomato.

Verma (2015) estimated post-harvest losses in major vegetables of Varanasi. The results reported that, 155.99 qtl of tomato was lost of the total of 1156.34 qtl production. Similarly, in brinjal, chilli, cauliflower and okra the loss per cent were examined as 1.20, 8.72, 3.63 and 2.86 respectively. The maximum losses in tomato and okra were found during harvest.

Mallur (2015) estimated post-harvest losses for leafy vegetables in North Karnataka and found that 4-8, 6-10 and 11-14 per cent losses occurred at the stages of farm, wholesale and retail levels.

Mitrannavar and Yeledalli (2014) reported the aggregate losses in potato, tomato and beans based on their study as 27.44 per cent in tomato, which is comparatively less than losses in Ethiopia (39.3 per cent), followed by potato (22.86 per cent), beans (22.36 per cent), brinjal (21.61 per cent) and onion (16.68 per cent). The maximum losses were found at trader level in all the vegetables.

Sukhdev (2014) estimated the extent of losses in Nagpur oranges and valued them in monetary terms. The results indicated that total losses accounted for about 21.5kg/qtl (□853.49/qtl). Due to unavailability of labour, the farm losses reported to be 12kg/qtl.

Kalidas and Akila (2014) investigated the post-harvest losses for tomato and reported that middlemen involved in marketing have negative impact on losses. Further, the estimated total post-harvest losses were about 26 per cent.

Ramesh (2013) conducted study for post-harvest losses estimation in banana at Shimoga and revealed that nearly 24. 12 per cent (39, 325 tonnes) of total production were led to loss in terms of inappropriate post-harvest management practices.

Begum (2012) observed 21.7 per cent of threshing losses in wheat and losses during storage as 16.25 per cent and 15.14 per cent in aman rice and boro rice, respectively. Also, 4.93kg, 4.03kg and 2.35kg per quintal were estimated as post-harvest losses at field level, in aman rice, boro rice and wheat, respectively.

Gajanana *et al.* (2007) mentioned that the key elements responsible for losses at three different stages as, the insect pests and pathogens, followed by physical handling and finally, the pressing injuries of fruits, at farm, market and retail levels respectively.

Basappa *et al.* (2007) estimated the losses in field level after the harvest of rice and wheat as 3.82kg/q and 3.28kg/q respectively. Also, the post-harvest losses for rice and wheat were recorded maximum in storage.

According to Kumar *et al*. (2006), the extent of post-harvest losses in onion and potato was found to be 7.43qtl and 5.72qtl in individual farms and around 25 per cent of total losses were reported during the harvest. Further, the onion farmers experienced losses of 6.21kg/qtl, followed by 1.85kg/qtl and 2.36kg/qtl by wholesalers and retailers. The post-harvest losses for potato was estimated to be nearly 7.34kg/qtl, 2.22kg/qtl and 3.41kg/qtl at farm, wholesale and retail levels.

Singh (2003) estimated the maximum extent of post-harvest losses in vegetables and reported in onion (6-40 per cent) during storage and transportation, followed by potato (30-40 per cent) during harvesting and storage and the least was in garlic (0.9-2.7 per cent) in storage.

Booth (1974) stated that physical, physiological and pathological agents, either individually or comprehensively paved the way for post-harvest losses in fresh produce.

2.5 Determinants of post-harvest losses

The transportation and handling injuries in the fresh fruits and vegetables could be responsible for the over-ripening *i.e.* they induces ethylene, and further, cause the development of molds in the injured portions leading to the spoilage of the entire produce. Thus, post-harvest losses are interdependent and sequential processes (FAO, 1989).

2.5.1. Losses due to abiotic factors

Nayak (2018) assessed post-harvest losses in banana of Durg (Chhattisgarh).The results revealed that major factors affecting the losses were identified as, not adhering to timely harvest at farm level, qualitative losses in transit period at wholesaler and improper handling of fruits at retailer stage.

Kumar and Kispotta (2016) examined the magnitude of post-harvest losses for major vegetables of Kaushambi (UP). The results revealed that tomato recorded the highest aggregate loss with 30.14 per cent of total produce, where 18.77 per cent and 11.37 per cent of losses were observed at farm and trader level respectively.

Ahmed *et al.* (2015) assessed that women intermediaries with primary education and those whose area middle aged were facing substantial post-harvest losses in marketing the fruits. The regression analysis revealed that post-harvest losses in the fruits studied are greatly depended on the variables viz. marketing experience, cost incurred in transport of produce, income level of trader and prices of fruits prevailing in markets.

Kumar *et al*. (2006) applied functional analysis to identify the factors that affect the post-harvest losses in onion and potato of Karnataka and pointed out that by promoting adequate storage units and proper handling of produce during the harvest can minimize the losses to a possible extent.

Rolle (2006) opined that lack of well-established maturity indices for some commodities and very less adoption of existing ones, had resulted in post-harvest losses in developing countries like India.

2.5.1a. Losses due to physical handling

Abera *et al.* (2020) estimated the extent of post-harvest losses for tomato in Ethiopia. The total losses accounted for about 39.31 per cent. Lack of grading of tomatoes, improper packing in crates and prolonged transport and marketing were identified as the prime causes for the losses.

Gardas *et al.* (2018) identified improper packaging, deficient foundation for storage and lack of modern handling practices in the field as well as markets as the three most important strands causing post-harvest losses in fruits and vegetables, using (DEMATEL) decision making and trial evaluation laboratory method.

Gajanana *et al.* (2015) in their study examined the losses and marketing efficiencies for guava in Karnataka. The results revealed that losses prior to marketing and at trader level accounted for 9.17 per cent and 4.12 per cent respectively.

Sharma and Singh (2015) concluded that the total loss was observed in tomato with 15.16 per cent in farm level due to its perishable nature. Uttarakhand vegetable farmers did not follow post-harvest practices like proper grading, packing, adequate storage and transit services. The study suggested that selling the produce through producers' cooperatives reduced the losses as well as helped farmers to yield better profit.

Ramchandra *et al.* (2015) revealed that the highest losses was reported in tomato through-out from harvest to selling, due to its perishable nature, specifically affected by physical handling during loading and unloading of the produce.

Kumar *et al.* (2015) revealed that, tomato had the highest physical post-harvest losses, followed by okra, egg plant, chilly and peas due to poorly equipped storage structures and under-developed marketing systems.

Besides, Kitinoja and Al-Hassan (2010) revealed that use of low quality crates with high holding capacities in India and Ghana for mangoes and tomatoes, respectively caused damages to low lying fruits in crates. They were removed from further marketing and accounted for post-harvest losses.

Mashau *et al.* (2012) assessed the post-harvest losses for fruits at Tshakhuma fruit market of South Africa and concluded that as a result of improper storage amenities and technologies, around half of the production had been wasted due to over-maturity.

Salami *et al.* (2010) found that more than one-fourth of the fresh strawberry is being wasted as post-harvest losses, after loading it from farm.

According to Parfitt *et al.* (2010), the storage infrastructure facilities was the major deciding factors among the developed and developing nations for the post-harvest losses in fresh vegetables and fruits.

Babalola *et al*. (2010) through his regression analysis, found that the optimum stage of harvest and quantity of the fresh produce were the major contributing factors for the post-harvest losses, as more production would lead to market glut.

Adeoye *et al.* (2009) and Rehman *et al.* (2007) reported that, bulk marketing of fresh tomatoes without sorting and grading could be the reason behind economic losses.

Karar (2007) evaluated the physical losses in potato (Burdwan) and found as 35.1 per cent (aggregate), and it was 24, 5 and 7 per cent at farm, wholesale and retail levels respectively. He pointed out that field level spoilage was the major determinant for physical losses. The economic losses were estimated to 35.5 per cent for potato.

Kumar *et al*. (2006) conducted the field survey and revealed that maximum weight loss in cereals was observed in storage period. The losses which occurred at farm level were 3.82 per cent and 3.28 per cent in rice and wheat respectively.

Gangwar *et al.* (2007) attempted to estimate the post-harvest losses in Kinnow mandarin of Punjab and concluded that harvesting methods adopted and distance to markets had the major influence on the losses. The conventional harvest resulted in 10.63 per cent of losses, whereas only 2.51 per cent losses were observed when harvest was done with clippers. Of the total produce, 5.15 per cent was lost when they were transported to market with medium transit, but in case of long transit, it was estimated to be 8.17 per cent.

2.5.1b. Physiological losses

da Costa Ferreira *et al*. (2020) reported that the major losses occurred was due to the physiological parameters in fruits and vegetables. The highest estimated losses were 17.78 per cent (vegetables) and 11.48 per cent (fruits), when transited to Coelho Neto city.

Vala and Rathod (2019) revealed maximum losses in leafy vegetables, as they are made of higher water content, followed by other major vegetables like tomato, brinjal and okra at producer level. And, at the trader level, lack of the storage facilities gave rises to post-harvest losses.

Osei-Kwarteng *et al*. (2017) collected data from vegetable amaranth farmers in Ghana to study the post-harvest losses using the Commodity Systems Assessment Methodology. The results revealed that maintaining optimum temperature after harvest is the most challenging determinant in vegetable amaranth for perishability.

Vegetables are highly perishable as they have a moisture content of 80-90 per cent. Water loss or transpiration is a major factor affecting quality of vegetables. Karim and Wee (1996) reported that in addition to lower saleable weight, loss of water can also affect quality in many ways, including wilting, shriveling, flaccidness, soft texture and loss of nutritional value. Well-managed post-harvest activities for vegetables would lead to higher yields and profits to farmers.

According to FAO (1989), the quality of the fresh produce is greatly dependent upon temperature extremes. The study indicated that fruit quality was conserved at low temperature.

2.5.1c. Farm level losses

Monika (2018) reported that delay in harvests, due to labour shortage and bad climate during drying attributed for the losses in chickpea of Andhra Pradesh at farm

level. The factors like experience, improper packing, volume of produce traded and storage were found affecting the losses at trader level.

Raghuvanshi (2018) found that there existed negative effect on losses for tomato, with inadequate labour facilities. In case of potato, the climatic factors, storage and labour availability were reported as important factors.

Buyukbay *et al.* in 2011 found that, if the time of harvests of tomato were done in-prior and delayed, against the optimum harvest time, it accounted for 5 and 12.97 per cent post-harvest losses, respectively. Also, in fresh bean, the losses were estimated to 18.44 per cent.

Babalola *et al*. (2010) through his regression analysis, found that the optimum stage of harvest and quantity of the fresh produce were the major contributing factors for the post-harvest losses, as more production would lead to market glut.

Adeoye *et al.* (2009) mentioned that local varieties of tomato are more susceptible to post-harvest damages. And, the physical injuries contributed for the losses were found to be the highest, subsequently by diseases and physiological factors in all the varieties.

The use of inappropriate tools and methods for harvesting the specific fresh produce would result in quantitative as well as the qualitative losses (Ozcan, 2007).

According to Basavaraja *et al*. (2007) education level of growers and climatic factors during threshing and drying of the grains were the important factors affecting the post-harvest losses.

Zong *et al.* (1995) stated that post-harvest losses in bitter gourd would be because of inability to sense the appropriate maturity indices for local and distant markets by the farmers. They also pointed out that due to harvest at improper time, the post-harvest qualities of gourds were degraded.

In the present study, it was found that improper time of harvest was not a problem and the major factors responsible for post-harvest losses were packaging materials used and prevailing pest and diseases at farm level.

2.5.2. Losses due to biotic factors

Gupta *et al*. (2016) estimated the average post-harvest losses for cowpea in Goa as 10.84 per cent for harvest, 6.96 per cent for threshing and 4.34 per cent for storage depicts the unawareness of post-harvest losses in different stages as they are estimated to be very low or zero losses. The major storage pest observed in storage for seeds was pulse borer.

Perry and Williams (2014) stated that the extended climacteric ripening in fruits and vegetables caused 20 per cent of the post-harvest wastage, where micro-organisms played a crucial role in almost all the crops.

Al-Hindi *et al.* (2011) revealed that majority of the post-harvest fruit spoilages were caused by fungi, and more specifically, *Aspergillus* spp.

Murthy *et al*. (2009) reported that majority of the losses (38 per cent) observed during the transit of fruits were because of pathogenic infections.

Agrios (2005) revealed that perishable fruits and vegetables were highly prone to post-harvest disease infestations and losses to around 10-30 per cent and exceeding 30 per cent of the total production in developed and developing nations respectively.

Moss (2002) stated that fungal group of pathogens mainspring the rots through mycotoxins in fruits and vegetables with lower pH and elevated moisture content.

Wilson *et al*. (1991) reported that microbial incidence and loss of quality (decay) were promoted by physiological changes in fruits and vegetables, due to improper post-harvest handling practices.

Sommer (1985) reported that economic (post-harvest) losses of the perishable produce in storage and transportation were caused mostly by the pathogenic fungi.

Stinson *et al.* (1981) described that fresh produce were easily prone to bacterial and fungal infestations, due to their reduced pH, high nutrient and water content. Thus, infected fruits are neglected by the consumers and finally, accounted for post-harvest losses.

2.6 Value of post-harvest losses

Vishwakarma *et al.* (2020) estimated an annual loss of □20,698 crores in cereals as a result of improper harvest and post-harvest management practices in India.

Joshi (2019) assessed the impact on profitability of potato cultivation through post-harvest management (Indore). The results showed that post-harvest management practices adopters received increased gross income of 8.63 per cent over the non-adopters.

Monika (2018) based on the survey of farmers and traders of chickpea in Andhra Pradesh reported around 7.36 lakh quintals was lost in terms of post-harvest losses in Prakasam district and economic losses were estimated at □441.78 crores. She also reported that farm level losses accounted for 7.26kg per quintal, which was □435.6 per quintal in monetary terms.

Kumari *et al.* (2015) proclaimed that an amount of about □10,700 crores was lost, in terms of poor post-harvest management practices in vegetables of Bhagalpur and Banka districts that accounted for 10-15 per cent of the total losses in Bihar.

Parveen *et al.* (2014) suggested that adding value to the fresh farm produce will not only enhance the exports, but also, reduce the post-harvest losses to certain extent, provided that post-harvest technologies and infrastructure facilities were properly channelized.

Negi and Anand (2014) revealed that huge amount of post-harvest losses and low income among farmers in India, were because of the inefficiency in supply chain of fruits and vegetables.

2.7 Farmers awareness regarding post-harvest losses and practices

Abera *et al.* (2020) observed 8.63 per cent and 2.93 per cent of losses in tomato marketing channels and concluded that traders were found unaware of recent post-harvest handling practices and methods.

Kibwika *et al.* (2017) revealed that rice farmers of Eastern Uganda were found conscious about the magnitude and nature of post-harvest losses, owing to their heavy requirement of capital and mismatch from growers point of view, the technologies suggested were not practiced.

According to Osei-Kwarteng *et al*. (2017) vegetable amaranth farmers in Ghana were aware of the affects of pre-harvest operations on the post-harvest losses.

Kumar and Kispotta (2016) reported that post-harvest losses at producer level resulted due to the fact that vegetable growers were less aware of post-harvest management practices.

Dohare (2014) evaluated the awareness level on post-harvest management practices of tomato farmers in Sehore district of Madhya Pradesh. The results revealed that majority of the farmers were categorized under medium-level of awareness, 31.67 and 30.83 per cent of farmers were under high-level and low-level of awareness respectively.

Sudharshan *et al.* (2013) stated that following the existing knowledge and technologies by reach the farmers would definitely help in reducing the losses, even without developing alternative new forms.

Bandole (2012) revealed that farm women in Khargone district (MP) were found to have medium range of awareness on post-harvest management practices in maize. They also followed the recommended practices to extent possible.

Sharma and Singh (2011) revealed that, losses occurred due to the fact that the farmers were found to have a lower level of perception and awareness about the maturity indices and harvesting time of the fresh produce.

Ozcan (2007) reported that one of the reasons for post-harvest losses was lack of the experience and inadequate trainings organized for the farm workers.

Methodology

Chapter 3

METHODOLOGY

Research methodology is a specific and planned outlay to solve the research problems. The objectives of the research study should be systematically gauged with well-structured and organized research methodology. It is obligatory for the researcher not only to know and understand the research methods but also to employ the tools to find out meaningful solutions to field level problems. The methodology adopted for the present study was dealt in this chapter.

3.1 SAMPLING DESIGN

In the present study, vegetable farmers were selected using multi-stage random sampling design. District followed by blocks and panchayats were selected based on the proportion of area under vegetable cultivation in the state.

3.1.1 Selection of district

During the year 2018-19, it has been reported that 41,809.11 ha was covered under vegetable cultivation, which is 4.42 per cent of total food crops area. Palakkad district contributed for 13.52 per cent (5651.78 ha) of total vegetable area. Hence, the district was chosen for the present study.

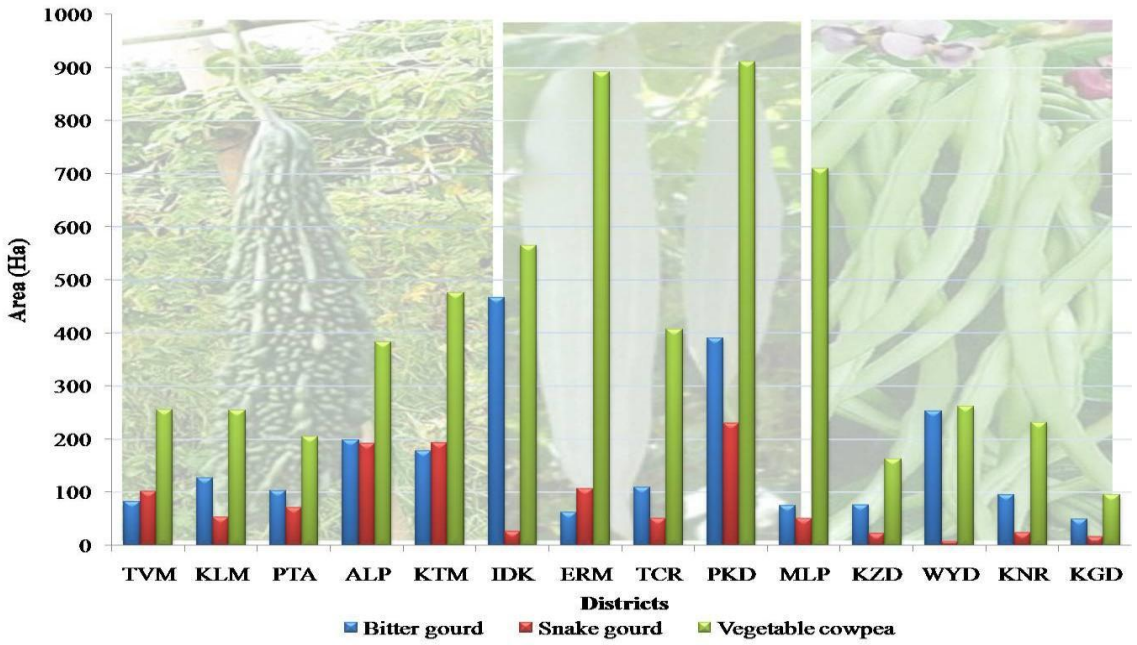
3.1.2 Selection of blocks

Palakkad district has thirteen blocks, of which two blocks i.e. Chittur and Nenmara were purposively selected, since they have maximum area under selected vegetables. Area occupied by bitter gourd, snake gourd and cowpea in Chittur block were 26.1 ha, 14.3 ha and 191.8 ha respectively and in case of Nenmara, they were 284.9 ha, 181.3 ha and 187.3 ha respectively.

3.1.3 Selection of panchayats

Four panchayats from two blocks (two of each) were purposively selected, since they have maximum area under cultivation. Nenmara and Elavanchery from Nenmara block and Perumaty and Vadakarapathy from Chittur blocks were the selected panchayats for the study.

Figure 3.1 Palakkad district's contribution towards the area under different selected vegetables for 2018-19



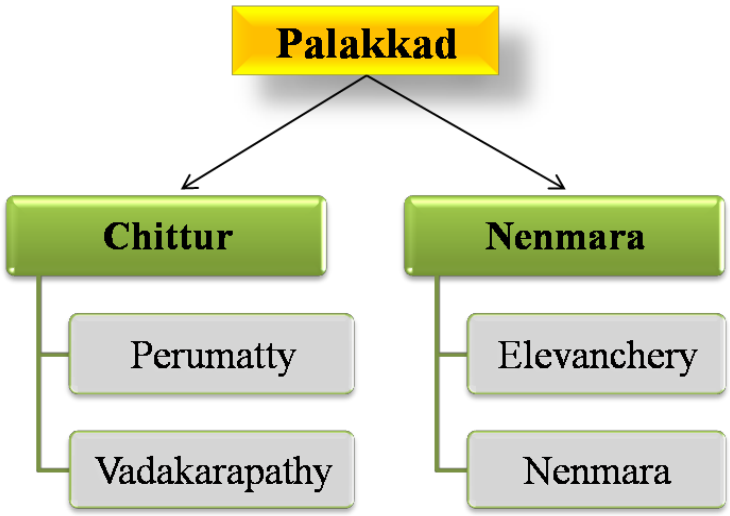
3.1.4 Selection of vegetables

The selection of vegetables was done on the basis of total annual production of different vegetables in the district. Major vegetables grown in the study area were bitter gourd, snake gourd and vegetable cowpea and their annual production accounted for 3,593 tonnes, 2,874 tonnes and 5,469 tonnes respectively. Figure 3.1 represents the Palakkad district's contribution towards the area under different selected vegetables for 2018-19.

3.1.5 Selection of respondents

Fifteen farmers from each of the panchayats, for each of the vegetables were selected randomly. Thus, the total sample size formed was 180 for farmer respondents. Post-harvest losses estimation was also done at trader level through ten wholesalers and five retailers, using pre-structured interview schedules developed for the purpose. The classification of study area has been presented in Figure 3.2.

Figure 3.2 Classification of study area



Primary respondents

4 panchayats * 3 vegetables * 15 respondents = 180 farmers
10 wholesalers + 5 retailers

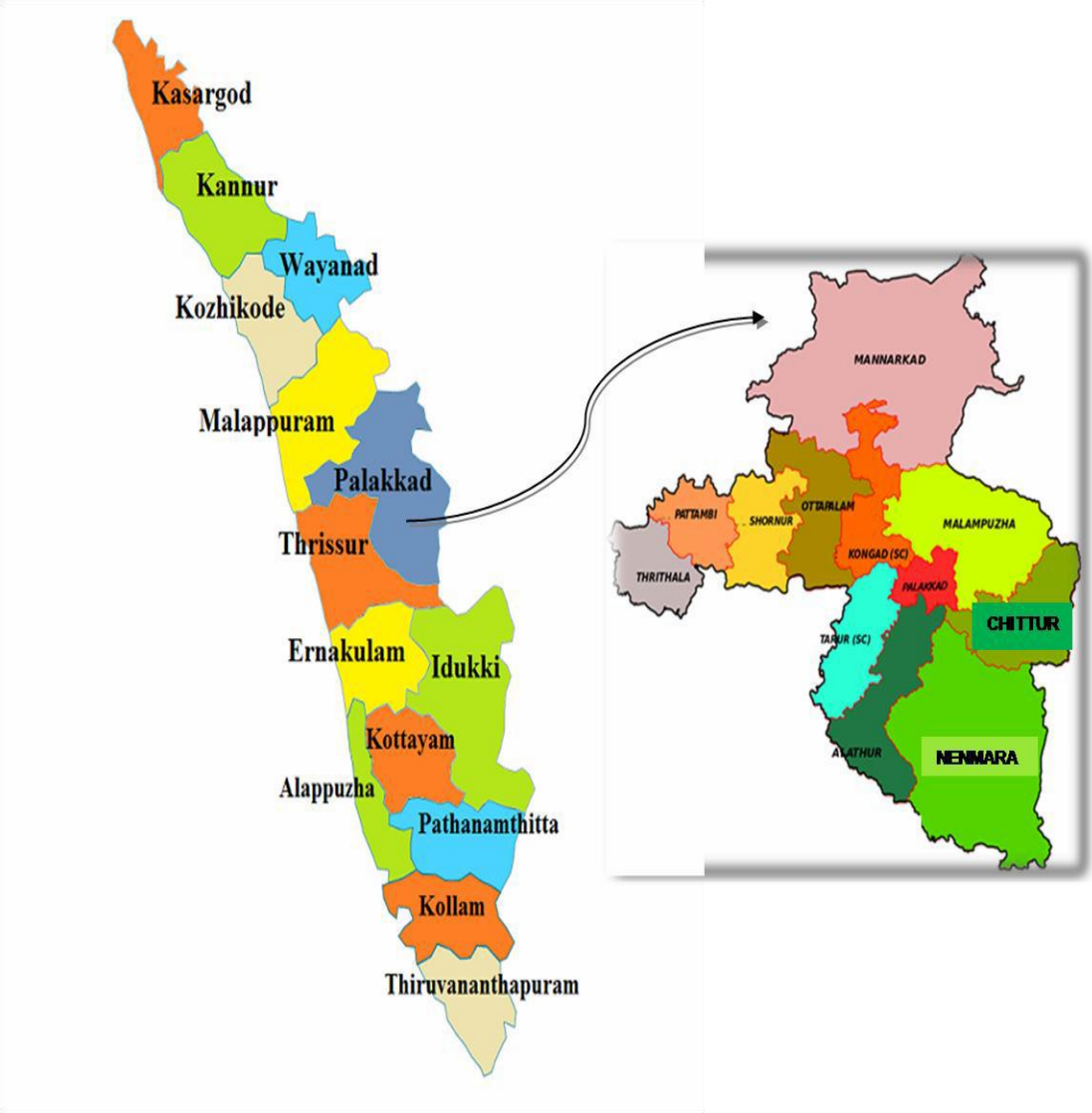
3.2 DESCRIPTION OF THE STUDY AREA

3.2.1 Palakkad district

The study was carried out in Palakkad district of Kerala. Palakkad is one of the main granaries of Kerala, also known as "The land of Palmyrahs". It is the gateway to rest of the country, through the Palakkad Gap (32-40 Km). The district is home of many tourism hotspots and unique climatic conditions with diversified development activities.

Besides, its economy is primarily agricultural and both food and cash crops are being cultivated here. In the present study, estimation of post-harvest losses for vegetables has been carried out to enable an in-depth understanding of vegetable production (bitter gourd, snake gourd and vegetable cowpea), nature and extent of losses along with their monetary values, major factors affecting post-harvest losses, farmers' knowledge and perception regarding losses and constraints prevailing in vegetable cultivation.

Figure 3.3 Map showing the study area - Palakkad district



3.2.1.1 Location

Palakkad district has a total geographical area of 4,480 square km which is around 11.55 per cent of the state's total geographical area. The district extends between 10° 24'N and 11° 14'N latitudes and 76° 20'E and 76° 54'E longitudes. It is surrounded by Malappuram district on the north and north-west, Thrissur on the south and Coimbatore district on the east. It is situated in the central region of the state, spreading over the midland plains and mountainous highlands. Palakkad is one of the four districts of state that does not have a coast line.

3.2.1.2 Demographic features

3.2.1.2.1 Population

Population statistics of the Palakkad district has been presented in Table 3.1 (2011 census). The district with a population of 28,09,934 accounted for 8.41 per cent of the total state population. Of which, females had taken lead over male population which is 51.62 per cent to the total district's population whereas male population was recorded as 48.38 per cent. According to the 2011 census, rural population with 21,33,124 which is almost 76 per cent had found dominating the urban (24 per cent) population. Although, it is well known that the rural-urban divide in Kerala is extremely narrow unlike other the states in the country.

Population density (persons per square km) of the district was found to be 627 against the state population density of 859 (persons per square km). These figures were found to have increased from 584 and 819 persons per square km respectively (Census, 2001). The sex ratio of the district (No. of females per thousand males) were recorded as 1067 against the state average of 1084 per thousand males.

Table 3.1 Population statistics of Palakkad district

S. No.	Particulars	Numbers	Percentage to total population
1	Total population	2809934	NA
2	Male population	1359478	48.38
3	Female population	1450456	51.62
4	Population density (per square km)	627	NA
5	Sex ratio (Females per thousand males)	1067	NA
6	Rural population	2133124	75.91
7	Urban population	676810	24.09

Source: Panchayat Level Statistics (2011), Palakkad; Department of Economics and Statistics, GoK

3.2.1.2.2 Literacy status

Literates in the district were reported to be 22,39,492 (88.63 per cent) relatively lesser when compared to the state 2,81,35,824 (93.91 per cent). The male literates were found higher in number than female literates in the district as well as the state. The literacy rates of the district were also relatively lower than the state literacy rates among both males and females. The status of literacy rates in the district has been presented in the Table 3.2.

3.2.1.3 Land utilization pattern

The land utilization pattern in Palakkad district (2018-19) is presented in the Table 3.3. The total cropped area in the district covered around 2,72,975 ha and the forest land extented to 1,36,200 ha which is 30.44 per cent of the total geographical area. It can be noted from the table that net sown area and land under non-agricultural uses accounted for 2,06,139 ha (46.06 per cent) and 48,460 ha (3.35 per cent) respectively.

Table 3.2 Literacy rate status in Palakkad district

S. No.	Particulars	Total
1	**Literates**	**Numbers**
	Total	2239492
	Male	1122600
	Female	1116892
2	**Literacy rates**	**Percentage (%)**
	Total	88.63
	Male	92.27
	Female	84.99

Source: Panchayat Level Statistics (2011), Palakkad; Department of Economics and Statistics, GoK

Table 3.3 Palakkad district - Land utilization pattern (2018-19)

Land use	Area (ha)	Percentage to total
Total geographical area	447584	NA
Forest	136257	30.44
Land laid to non-agricultural uses	48460	10.82
Current fallow	8838	1.97
Fallow other than current fallow	10918	2.44
Cultivable waste	19200	4.29
Net area sown	206139	46.06
Area sown more than once	67125	14.99
Social forestry	404	0.09
Total cropped area	**272975**	**60.98**

Source: Agricultural Statistics, 2018-19, Directorate of Economics and Statistics, GoK

3.2.1.4 Occupation distribution

The Table 3.4 represents Palakkad district's occupational distribution particulars for 2018-19. Number of main workers were reported as 8,75,540 *i.e.* 31.16 per cent of the district's total population. Also, cultivators and agricultural labourers were found to account for 2.11 and 6.95 per cent of the district's population. Main household industry workers were only 0.71 per cent of the district population *i.e.* 19,975 workers. The district's work participation rate was observed to be 37 per cent, which is relatively lesser than the state's work participation rate.

3.2.1.5 Agro-climatic conditions

3.2.1.5.1 Topography and climate

Palakkad is grouped into three divisions (based on the altitude) namely, the lowlands (<30m), midlands (30-300m) and highlands (>600 m). The lowland and mid-land regions of the district covered 48 per cent and 33 per cent of the total area respectively. The rest of 19 per cent of the area was under the highlands *i.e.* high mountains (Western Ghats), ravines, dense forests and also the Palakkad gap region.

The highest elevation point of the land was in the northern part of the district and sloped towards the southwest and southeastern regions. The notable peaks in the district are Anginda (2,383 m), Karimala (1,998 m), Nellikotta or Padagiri (1,585 m) and Karimala Gopuram (1,440 m).

The average day temperature in the district ranges between 25-40°C. Palakkad and Chittur blocks experience dry climate as that of Coimbatore district in Tamil Nadu, whereas the others have similarity in climate to the other districts of Kerala.

3.2.1.5.2 Rainfall

The district experiences humid climate and receives maximum rainfall during South-west monsoon. It receives an average annual rainfall of 2,348 mm. It could be

observed that July and August months bring the maximum showers to the district that has helped farmers in the cultivation of vegetables and rice, which are the major crops of the district. The distribution of rainfall during the year 2018-19 in Palakkad district is presented in the Figure 3.4.

Table 3.4 Occupational distribution of Palakkad district (2018-19)

S. No.	Particulars	Total	Percentage to total population
1	Total population	2809934	NA
2	Total population of workers	1042340	37.09
3	Main workers	875540	31.16
4	Main cultivators	59194	2.11
5	Main Agricultural labourers	195394	6.95
6	Main household industry workers	19975	0.71
7	Marginal workers	166800	5.94
8	Marginal cultivators	8611	0.31
9	Marginal Agricultural labourers	54555	1.94
10	Marginal household industry workers	5060	0.18
11	Non-workers	1767594	60.9
12	Work participation rate (%)	37	NA

Source: Department of Economics and Statistics, GoK (2018-19)

3.2.1.6 Details of land holding

The land holding distribution based on number, area and average size of the holdings in Palakkad district has been presented in the Table 3.5. Majority of the farmers (94.56 per cent) in the district owned an average land holding size of 0.23ha therefore the majority of the holdings were of marginal size. As the number of marginal farmers were found relatively more in number, the area of holdings under this category seemed to be large with 68,955 ha, followed by small, semi-medium, medium and large farmers.

Figure 3.4 Distribution of rainfall in Palakkad (2018-19)

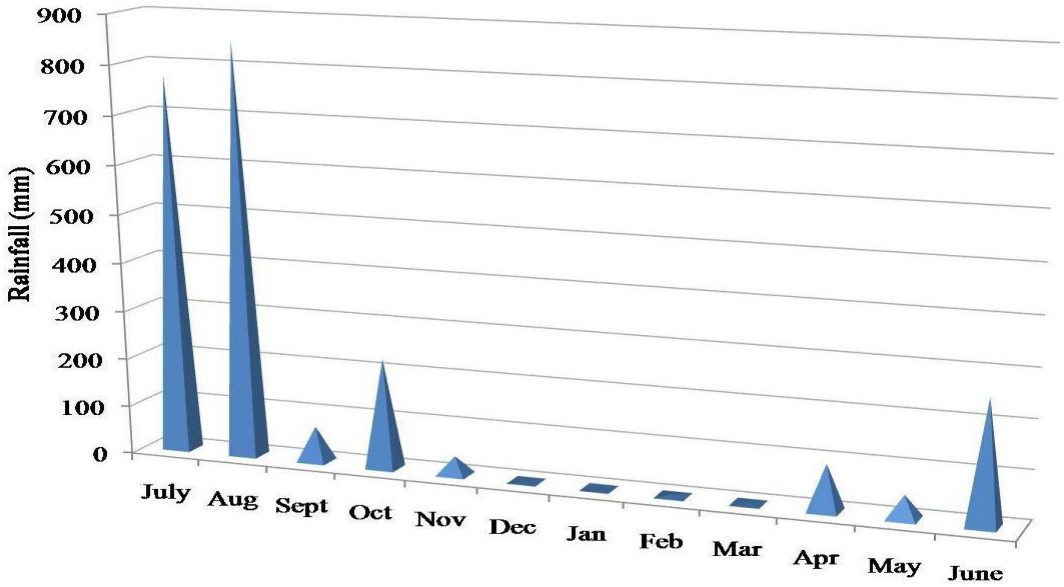


Table 3.5 Distribution of land holdings

S. No.	Size of holding	Number	Area (ha)	Average size (ha)
1	Marginal (< 1 ha)	574079 (94.56)	68954.75 (49.57)	0.12
2	Small (1-2 ha)	21500 (3.54)	29431.68 (21.16)	1.37
3	Semi-medium (2-4 ha)	9197 (1.52)	23932.34 (17.20)	2.60
4	Medium (4-10 ha)	2091 (0.34)	11169.20 (8.03)	5.34
5	Large (> 10 ha)	228 (0.04)	5621.45 (4.04)	24.66
Total		**607095 (100)**	**139109.42 (100)**	**0.23**

Source: 10th Agricultural census, 2015-16, Department of Economics and Statistics, GoK
Note: Figures in parentheses indicate percentage to total

3.2.1.7 Sources of irrigation

The various irrigation sources in Palakkad district are presented in the Table 3.6. The table shows that maximum area in the district, is being irrigated through small streams (Thodu/Canal) which covers about 38,856.67 ha (48.44 per cent of total irrigated area). Further, 15 per cent (11,963.85 ha) of the total irrigated area are watered through tube wells. And, wells contribute around 13 per cent to the total area, of which the government and private wells provide irrigation water to 5.3 ha and 10,270.43 ha respectively. Ponds, lift irrigation, rivers and lakes and others sources irrigated an area of 3,333.28 ha (4.16 per cent), 825.63 ha (1.03 per cent), 6,136.94 ha (7.65 per cent) and 8,823.22 ha (10.99 per cent) respectively.

Table 3.6 Sources of irrigation

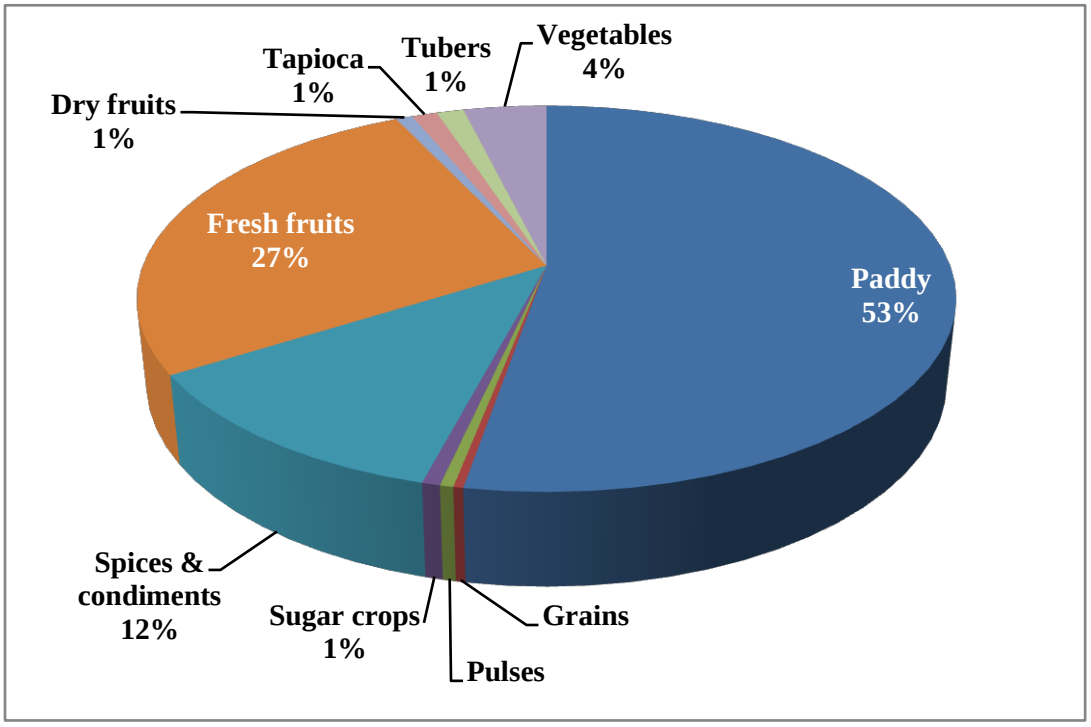
S. No.	Sources of irrigation	Area (ha)	Percentage to total
1	Small streams (Thodu/Canal)	38856.67	48.44
2	Ponds	3333.28	4.16
	a. Government	102.66	
	b. Private	3230.62	
3	Wells	10275.73	12.81
	a. Government	5.3	
	b. Private	10270.43	
4	Tube wells	11963.85	14.92
5	Lift irrigation	825.63	1.03
6	Rivers and lakes	6136.94	7.65
7	Others	8823.22	10.99
Total		**80215.32**	**100.00**

Source: Agricultural Statistics 2018-19, Department of Economics and Statistics, GoK

3.2.1.8 Area under vegetables in the district

Distribution of cultivable area under various food crops in the district during 2018-19 is presented in Figure 3.5. Among different crops, 53 per cent (77,121 ha) of the total cultivated area comes under paddy cultivation, followed by fresh fruits (39,267 ha) and spices and condiments (17,449 ha). Vegetables, with four per cent of total cultivated area in the district, contributed to the highest production in the state. Also, 5,652 ha of area had been reported under vegetable cultivation in Palakkad district during the year 2018-19. The Table 3.7 represents area-wise distribution among the vegetable crops in the district and state.

Figure 3.5 Area under various food crops in Palakkad (2018-19)



Vegetable cultivation in the district covers 5652 ha, of which drumstick occupies the majority (2124.4 ha) of area under vegetable cultivation, followed by cowpea (910.11 ha) and bitter gourd (390.6 ha). A similar trend is also reported at the state level.

Table 3.7 Area under different vegetables in Palakkad district and Kerala (2018-19)

S. No.	Crops	Area (ha)	
		Palakkad	**Kerala**
1	Drumstick	2124.4	16646.3
2	Amaranthus	138.4	1914.47
3	Bitter gourd	390.6	2258.43
4	Snake gourd	229.92	1141.93
5	Ladies finger	352.12	1324.93
6	Brinjal	158.73	1129.17
7	Green chillies	224.89	1546.28
8	Bottle gourd	21.79	213.72
9	Little gourd	89.56	1587.58
10	Ash gourd	176.89	930.62
11	Pumpkin	259.45	1297.03
12	Cucumber	105.47	1138.03
13	Cowpea	910.11	5803.05
14	Tomato	239.3	402.68
15	Beans	39.86	1065.66
16	Onion	4.28	5.21
17	Others	168.01	3404.02
Total vegetables		**5651.78**	**41809.11**
Total food crops		**146223.79**	**945017.52**

Source: Farm Guide, 2021, Department of Economics and Statistics, GoK

3.2.2 Description of selected blocks

3.2.2.1 Panchayat-wise distribution of area

The panchayat-wise distribution of study area, based on the land types is presented in the Table 3.8. Perumatty panchayat had 63 per cent of dry land, whereas

wetlands constituted for almost 37 per cent of the total area. It could be observed that in Vadakarapathy panchayat 75 per cent of the area was dry land. Elavanchery panchayat had around 64 per cent of its total area under wetland cultivation whereas, almost 60 per cent of total area in Nenmara was dry land .

Table 3.8 Panchayat-wise distribution of area

Blocks	Panchayats	Area (in cents)			
		Wetland	Dry land	Others	Total
Chittur	Perumatty	552888 (36.58)	958323 (63.41)	-	1511211 (100)
	Vadakarapathy	218830 (18.00)	905803 (74.52)	90866 (7.48)	1215499 (100)
Nenmara	Elavanchery	382281 (64.43)	211056 (35.57)	-	593287 (100)
	Nenmara	338259 (41.10)	484711 (58.90)	-	822970 (100)

Source: Panchayat Level Statistics, 2011, GoK
Note: Figures in parentheses indicate percentage to total

3.2.2.2 Cropping pattern in selected blocks

Cropping pattern followed in the selected blocks is presented in the Table 3.9. It could be observed that paddy cultivation is the pre-dominant activity in both the blocks followed by, coconut cultivation. Vegetable cultivation occupied 3 per cent and 5 per cent and five per cent to the total cropped area in Chittur and Nenmara blocks respectively.

Table 3.9 Cropping pattern in the selected blocks (2018-19)

Crop	Area in hectares	
	Chittur	**Nenmara**
Paddy	10015.2 (42.82)	10760.24 (65.65)
Coconut	8746.93 (37.39)	2764.56 (16.86)
Mango	740.55 (3.16)	389.67 (2.37)
Jack	121.18 (0.51)	226.39 (1.38)
Banana and plantain	1181.45 (5.05)	221.38 (1.36)
Tamarind	165.06 (0.7)	265.03 (1.63)
Arecanut	95.65 (0.41)	116.39 (0.72)
Tapioca	176.14 (0.83)	22.92 (0.13)
Other tubers	49.56 (0.21)	52.79 (0.32)
Vegetables	790.26 (3.38)	841.89 (5.13)
Others	1307.065 (5.58)	729.574 (4.45)
Gross Cropped Area	**23389.045 (100)**	**16390.834 (100)**

Source: Agricultural Statistics, 2018-19, GoK
Note: Figures in parentheses indicate percentage to total

3.3 DATA COLLECTION

The study was based on both primary and secondary data. In order to estimate the nature and extent of post-harvest losses in vegetables and to delineate the major determinants for post-harvest losses, primary data were obtained from the vegetable farmers of Palakkad district on various socio-economic aspects. Apart from this, data was also collected from wholesalers and retailers to determine the costs and losses incurred at various levels of marketing.

Primary data was collected from the farmers of the selected vegetable crops using separate pre-structured interview schedules. A total of 180 farmers and ten wholesalers and five retailers were surveyed. Secondary data were collected from various authorized sources. Details of secondary data along with the source and period are presented in Appendix II.

3.4 PERIOD OF STUDY

Time series data was confined to area, production and productivity of vegetables in India as well as for Kerala for the period from 1991 to 2019. Survey of vegetable farmers, wholesalers and retailers was undertaken during the months of February to June, 2021.

3.5 ANALYTICAL FRAMEWORK

3.5.1 Growth rate analysis

The growth rates for area, production and productivity of vegetables in India and Kerala were calculated using compound annual growth rate analysis. The analysis was carried out using the functional form,

$$Y_t = ab^t$$

Where,

Y_t : Area/ production/productivity of vegetables (in the year t)

a : Intercept
b : Regression coefficient
t : Number of years

Taking logarithms on both the sides,

$$\ln Y_t = \ln a + t \ln b$$

$$\mathbf{Y_t' = A + B}$$

Where,

$Y_t' = \ln Y_t$,

$A = \ln a$

$B = \ln b$

The rate of change of area, production and productivity in unit time (yearly) is the compound annual growth rate. The value of the co-efficient (b) was estimated by the method of Ordinary Least Squares (OLS). The formula used to estimate CAGR in percentage is as follows:

Compound Annual Growth Rate (CAGR) = (Antilog B-1) × 100

Coefficient of variation

Co-efficient of variation (CV) was used to measure the variation over the years for the area, production and productivity using the formula,

CV = [Standard deviation / Mean] × 100

Standard Deviation (SD) $= \sqrt{\frac{1}{n}} \quad \mathbf{X} - \boldsymbol{X}^{\,2}$

Mean $= \frac{1}{n}[\ \mathbf{Xi}]$

Where, Xi - Sum of observations and

n - Total number of observations

3.5.2 Economics of vegetable production and marketing

3.5.2.1 ABC cost concepts

The ABC cost concepts recommended by the Commission on Agriculture Cost and Prices (CACP) of Government of India were used for the analysis of costs and returns in vegetable production. The costs involved for the analyses in the present study are as follows:

i. Cost A_1 includes:

1. Hired human labour
2. Hired machine power
3. Cost of seeds
4. Cost of manures
5. Cost of fertilizers
6. Cost of plant protection chemicals
7. Land revenue/ tax
8. Depreciation on farm implements and farm buildings
9. Interest on working capital
10. Miscellaneous expenses

ii. Cost A_2 = Cost A_1 + Rent paid for leased in land

iii. Cost B_1 = Cost A_1 + Interest on the value of owned fixed capital assets (excluding land)

iv. Cost B_2 = Cost B_1 + Rental value of owned land (less land revenue) and rent paid for leased in land

v. Cost C_1 = Cost B_1 + Imputed value of family labour

vi. Cost C_2 = Cost B_2 + Imputed value of family labour

vii. Cost C_3 = Cost C_2 + 10 per cent of Cost C_2 (Managerial cost of the farmer)

Benefit-Cost ratio

Benefit-cost ratio is a profitability concept, which indicates the returns obtained per unit of cost incurred. If B:C ratio calculated is more than one, it indicates that the enterprise is profitable. It is computed using the following formula,

Benefit-cost ratio (BCR) = (Gross returns) / (Total cost)

3.5.2.2 Marketing of vegetables

Marketing Channel

It is defined as the route/path by which agricultural commodities flow from producers to consumers by means of a chain of intermediaries (Kohl and Uhl, 1980).

Marketing Cost

It is the cost incurred in the marketing channels by the producers and other intermediaries to perform various marketing functions.

Marketing Margin

It is the profit earned by the middlemen in the marketing channel, as various marketing functions are performed while the commodity is channeled from producers to consumers. Mathematically, it is the ratio of producers' price to consumers' price. It was obtained by differencing the farm and retail prices of the selected vegetables.

Price spread

Farm-retail spread or price spread has been estimated by finding the difference between price paid by the consumer and price received by the producer for an equivalent quantity of agricultural commodity.

Producer's share in consumer's rupee (P_s)

It is the expression of per cent of price received by the farmer (P_f) to the final retail price (P_r) paid by the consumer. It is computed using the following formula:

$$P_s = (\mathbf{P_f} / \mathbf{P_r}) \mathbf{X\ 100}$$

Marketing efficiency

Marketing efficiency is the ratio of output to input. It was measured using the Acharya and Agarwal formula, where marketing efficiency was determined by taking final price of commodity and the costs incurred in marketing them (usually per kg). A produce is said to be efficiently marketed, if it has higher rate of marketing efficiency and vice versa.

$$\mathbf{E = CP / (MC+MM)}$$

Where, E - Marketing efficiency

CP - Consumer's price

MC - Total marketing costs

MM - Total marketing margins

3.5.3 Post-harvest losses

The nature and extent of post-harvest losses in selected vegetables were assessed at different stages (farmer, wholesaler and retailer) using simple average, percentage and tabular analyses. The physical losses and monetary values for the same were also estimated. The losses were estimated in both qualitative and quantitative terms, where the physical losses incurred was based on decrease in product values (second/third grade) due to deteriorations and damages and monetary losses was assessed based on the quantity of discarded vegetable produce.

3.5.4 Functional analysis

Multiple-linear regression model was fitted to delineate the determinants of post-harvest losses in the selected vegetables. The function was hypothesized by taking socio-economic aspects of farmers, favourable weather conditions, timely availability of labour, packing materials used and biotic factors (pests and disease infestations). The specified functional form is as follows:

$$\mathbf{Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7}$$

Where, Y - Post-harvest losses (Kg per quintal)

$\mathbf{a_0}$ is the intercept and

$\mathbf{a_2, a_3, a_4, a_5, a_6, a_7}$ are the regression coefficients

X_1 - Age (yrs)

X_2 - Area under vegetable production (acre)

X_3 - Experience in farming (years)

X_4 - Favourable weather conditions (if, favourable = 0 or if not =1)

X_5 - Timely availability of labour (if, available = 0 or if not =1)

X_6 - Materials used for packing (if, wooden baskets or jute sacks =1 or if not =0)

X_7 - Biotic factors - pests and diseases (if present = 1 or if not =0)

Age and experience of vegetable growers in farming could help them in reducing the post-harvest losses and thus, they were included in the analyses. In addition to this, practices like harvesting the produce at proper stage using appropriate method and the crop protection measures undertaken would be considered as the adaptive measures followed by the farmers against the losses. While the determinants like favourable weather conditions, availability of labour at the required time and better packing materials used for the harvested produce would also help the farmers to minimize the qualitative losses to a considerable extent.

3.5.5 Knowledge, perception level and practices of farmers regarding the losses

In order to understand the farmer's knowledge, perception level and practices regarding the post-harvest losses, five-point Likert-type scale was adopted. The responses from the farmers were recorded using the score which ranges from five to one, indicating the knowledge and awareness regarding the losses as follows:

5 - Strongly agree
4 - Agree
3 - Neutral
2 - Disagree
1 - Strongly disagree

A set of seven statements were put-forth and respondents were asked to give their opinion based on the five-point scale. The maximum score expected would be 35 and minimum of 7. The perception scores were converted to percentage for each of the respondents. Based on the mean and standard deviation values, the respondents were categorized into three groups, *i.e.* high, medium and low level of perception.

3.5.6 Garret ranking technique

In order to analyse the constraints faced by the vegetable growers in the study area, Garret ranking technique was used. A set of observations, were obtained as the major problems faced by the farmers at the field level were recorded in the pilot survey of the study. Further, the ranks were converted into scores based on the prioritization by the farmers' using the Garret and Woodworth (1969) table. The following formula is used in score conversion:

$$\textbf{Per cent position} = 100 \times (R_{ij} - 0.5) / N_j$$

Where, the rank assigned for i^{th} item by j^{th} farmer and the total number of items taken for ranking would be R_{ij} and N_j respectively.

Results and discussion

Chapter 4

RESULTS AND DISCUSSION

The present chapter deals with presentation of results of the collected data. In order to reach the research objectives, the data were analysed and deduced into valid and significant inferences using the analytical tools. The presentation of the results is headed under the sub-sections as follows:

4.1 Growth rate analysis
4.2 Nature and extent of post-harvest losses
4.3 Economics of vegetable cultivation and marketing
4.4 Estimation of monetary loss
4.5 Determinants of post-harvest losses at farm level
4.6 Socio-economic profile of vegetable growers
4.7 Perception of farmers on losses
4.8 Major constraints faced by vegetable growers

4.1 GROWTH RATE ANALYSIS

4.1.1 Growth rate of area, production and productivity of vegetables in India

Area and production of vegetables in India has shown a two-fold increase from TE 1993 to TE 2020. With the help of time series data (1991-2020) of vegetables in India, growth rate analyses were carried out for area, production and productivity. Descriptive statistical tools and compound growth rates were used for showcasing their values in a meaningful manner. Table 4.1 and Figure 4.1 depict the data on area, production and productivity for TE 1993 TE 2020. During the period of TE 1996 area, production and productivity of vegetables had an increased trend of 2.15, 13.73 and 10.66 per cent respectively. This period marks the drastic increase in productivity, which could be made possible with favourable weather conditions for vegetable production in India.

Table 4.1 Area, production and productivity of vegetables in India (1991-2020)

S. No.	Period	Area ('000' ha)	Production ('000' MT)	Productivity (ton $ha^{-1)}$
1	TE 1993	5174.3 (NA)	62708 (NA)	12.19 (NA)
2	TE 1996	5285.3 (+2.15%)	71318 (+13.73%)	13.49 (+10.66%)
3	TE 1999	5862 (+10.91%)	82851 (+16.17%)	14.11 (+4.6%)
4	TE 2002	6134.7 (+4.65%)	86084 (+3.9%)	13.95 (-1.11%)
5	TE 2005	6306 (+2.79%)	101937 (+18.42%)	15.07 (+8.03%)
6	TE 2008	7547.3 (+19.68%)	122456 (+20.13%)	15.77 (+4.6%)
7	TE 2011	8489.7 (+12.49%)	145660 (+18.95%)	17.13 (+8.63%)
8	TE 2014	9381 (+10.5%)	166602 (+14.38%)	17.76 (+3.68%)
9	TE 2017	10201 (+8.74%)	174794 (+4.92%)	17.13 (-3.53%)
10	TE 2020	10362 (+1.58%)	188562 (+7.88%)	18.32 (+6.93%)

Note: Figures in parentheses indicate the growth rates w.r.t. previous TE

Also, during the period of TE 1999, area under vegetables was observed to have increased by 10.91 per cent, and production and productivity rose by 16.17 and 4.6 per cent respectively. During the period of TE 2002, area and production had shown increasing trend of 4.65 and 3.9 per cent, but productivity showed a slight decline by 1.11

per cent. Beginning from TE 2005 to TE 2017, all the three parameters depicted an increasing trend. This may be due to the implementation of the schemes under National Horticulture Mission which thereby also led to increase in production and supply of vegetables. There has been an area expansion of 5.18 per cent rise in production of 7.88 per cent and 6.93 per cent increase in productivity during the period of TE 2020. Vegetable cultivation is considered to be relatively more remunerative than food grains. West Bengal with 15.3 per cent share in Indian vegetable production leads among the states in the country, which is followed by Uttar Pradesh with 14.2 per cent.

Table 4.2 depicts the compound growth rates of area, production and productivity of vegetables in India. It could be observed that growth rates for area, production and productivity were 2.94, 4.44 and 1.48 respectively. It can thus, be concluded that India has shown positive and significant growth rates in vegetables over the years in area, production and productivity.

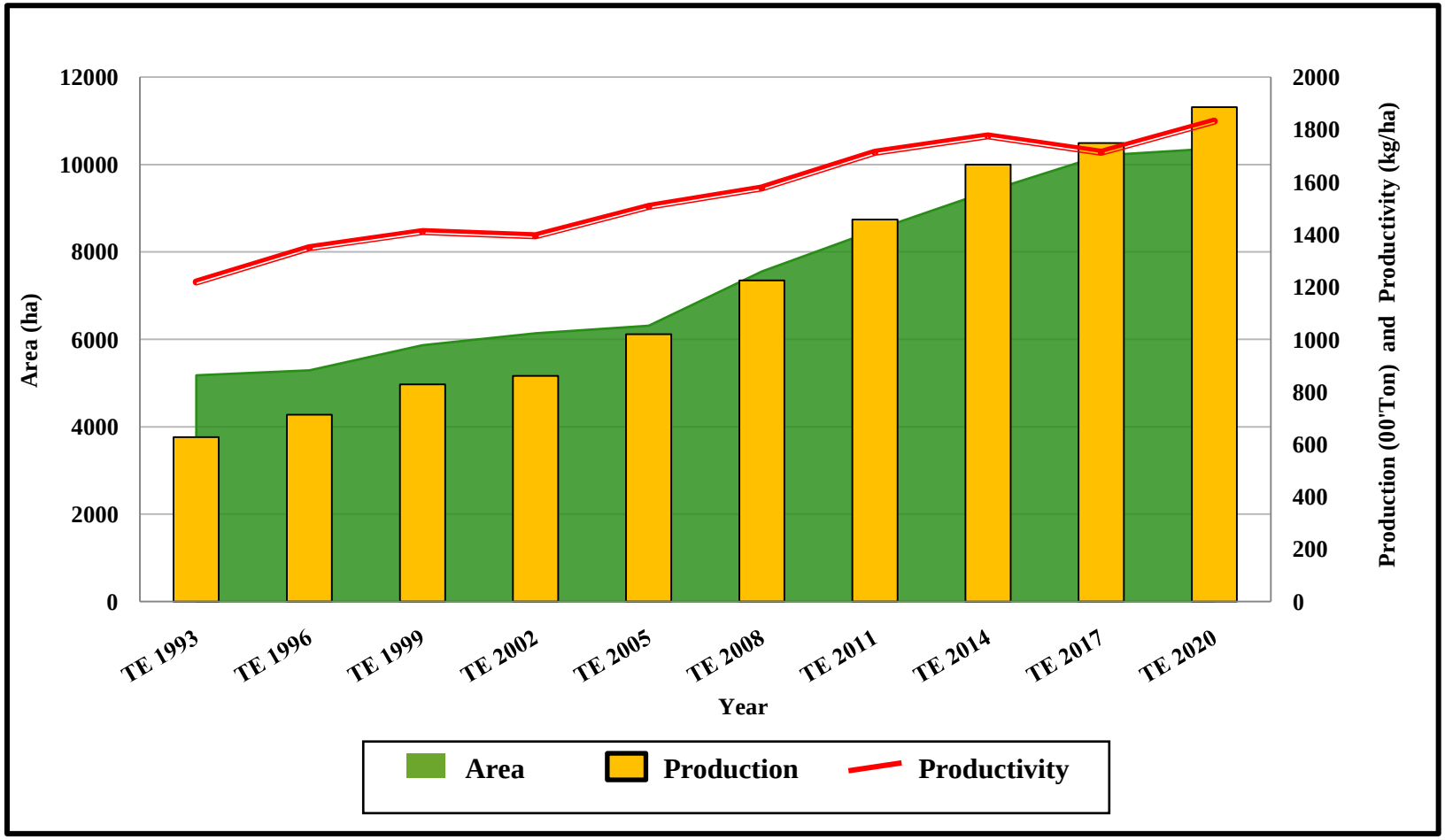
Kondal (2014) studied the trends in area and production in Indian horticulture sector and reported that the compound annual growth rates of area and production of vegetables in India from 2001-02 to 2010-2011 were 3.64 and 5.75 per cent respectively.

Table 4.2 Compound growth rates of area, production and productivity of vegetables in India (1991-2020)

Particulars	Area	Production	Productivity
Growth rate (%)	2.94	4.44	1.48
R^2	0.95	0.97	0.87

Coefficient of variation (CV) of area, production and productivity of vegetables in India are presented in the Table 4.3. It can be observed that CV was higher for production followed by area and productivity. These variations may be due to the factors like fragmentation of land, cultivation practices and technology adoption by vegetable growers and also, variations in climate.

Figure 4.1 Area, production and productivity of vegetables in India (1991-2020)



Source: Horticultural Statistics at a Glance, Ministry of Agriculture

Table 4.3 Coefficient of variation (CV) of area, production and productivity of vegetables in India (1991-2020)

Variable	Coefficient of variation (CV)
Area	26.13
Production	37.18
Productivity	13.28

4.1.2 Growth rate of area for vegetables in Kerala

Area under vegetable cultivation in Kerala had shown a declining trend till TE 2012, thereafter, it gained momentum and the area under vegetable increased. Vegetable and Fruit Promotion Council Keralam (VFPCK) was setup in 2001, to empower the vegetable and fruit farmers through quality production, value addition and marketing the produce for better prices without the interventions of intermediaries. Using time series data (2004-2020) of vegetables in Kerala, growth rate analysis for area was calculated.

Triennium endings (TE) estimated for the period 2004-2020, are represented in the Table 4.4 and Figure 4.2. During the period of TE 2006, the area under vegetable cultivation was 50,185 ha, and it contracted by 10.33 per cent during the period of TE 2009. From the TE 2012 till TE 2020, it was found there was a sharp increase in the area under vegetable cultivation. In particular, the area expansion during TE 2018 was higher with 54.44 per cent. With the efforts put-forth by the institutions like VFPCK and the state department of Agriculture through various schemes that were implemented might have been main reason behind the expansion of vegetable area in the state. The vegetable area in the TE 2020 was 82,508 ha, which accounted for 21.31 per cent increase.

The compound growth rate for vegetable area in Kerala state is presented in the Table 4.5. It is clear from the table that area under vegetable cultivation in the state has shown positive growth rate, which indicated increasing trend over the years. The Table 4.6 depicts the coefficient of variation of area for vegetables in the state. It can be

interpreted that there existed variation to the extent of 30.7 per cent in the vegetable cultivation area, and this can be attributable to change in cropping pattern followed in the vegetable growing tracts of Kerala.

Table 4.4 Area under vegetable cultivation in Kerala (2004-2020)

S. No.	Period	Area (ha)
1	TE 2006	50185 (NA)
2	TE 2009	45001 (-10.33%)
3	TE 2012	41369.3 (-8.07%)
4	TE 2015	44040.7 (+6.46%)
5	TE 2018	68014.3 (+54.44%)
6	TE 2020	82508.7 (+21.31%)

Note: Figures in parentheses indicate the growth rates w.r.t. previous TE

Table 4.5 Compound growth rates in Kerala (2004-2020)

Particulars	Area
Growth rate (%)	+3.11
R^2	0.27

Table 4.6 Coefficient of variation (CV) in Kerala (2004-2020)

Variable	Coefficient of variation (CV)
Area	30.67

Doddamani and Jagrati (2014) studied the growth dynamics of vegetable sector in Karnataka state during the period of 1991-2012 and reported that the area and production of vegetables had shown positive trend while the productivity was found declining.

4.1.3 Growth rate of area for vegetables in Palakkad district

Palakkad district solely accounted for 13.52 per cent of area under vegetable cultivation in Kerala. Vegetable and Fruit Promotion Council Keralam (VFPCK) (setup in 2001) helps famers in production and marketing of the vegetables. Majority of the vegetable growers in the district were registered farmers. Using time series data (2004-2020) on vegetables, growth rate analysis for area was calculated.

Table 4.7 Area under vegetable cultivation in Palakkad (2004-2021)

S. No.	Period	Area (ha)
1	TE 2006	8458.67 (NA)
2	TE 2009	7754.67 (-8.32%)
3	TE 2012	7387.67 (-4.73%)
4	TE 2015	6909.33 (-6.47%)
5	TE 2018	6229 (-9.85%)
6	TE 2020	5340.33 (-14.27%)

Note: Figures in parentheses indicate the growth rates w.r.t. previous TE

Triennium endings (TE) estimated for the years, 2004-2020 are represented in the Table 4.7 and Figure 4.3. During the period of TE 2009, the area under vegetable cultivation fell by 8.32 per cent, and during the period of TE 2012, the area contracted by 4.73 per cent. From TE 2015 till TE 2020, a significant decline in area has been observed. A marked decrease of 14.27 per cent has been observed in TE 2020. As same as that of

state, vegetable growers face constraints like extreme climatic conditions and high demand of labours for vegetable production, which might have led to contraction in area.

The compound growth rate for vegetable area in Palakkad district is presented in the Table 4.8. It is clear from the table that area under vegetable cultivation in the state has shown negative growth rate, which indicates decreasing trend over the years.

Table 4.8 Compound growth rates in Palakkad (2004-2021)

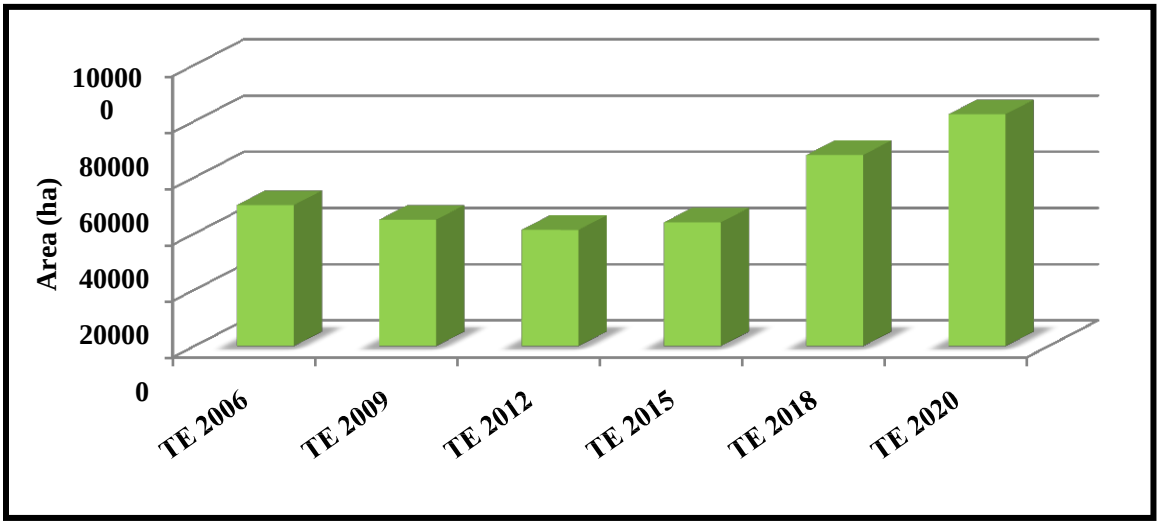
Particulars	Area
Growth rate (%)	-2.98
R^2	0.79

Table 4.9 Coefficient of variation (CV) in Palakkad (2004-2021)

Variable	Coefficient of variation (CV)
Area	16.63

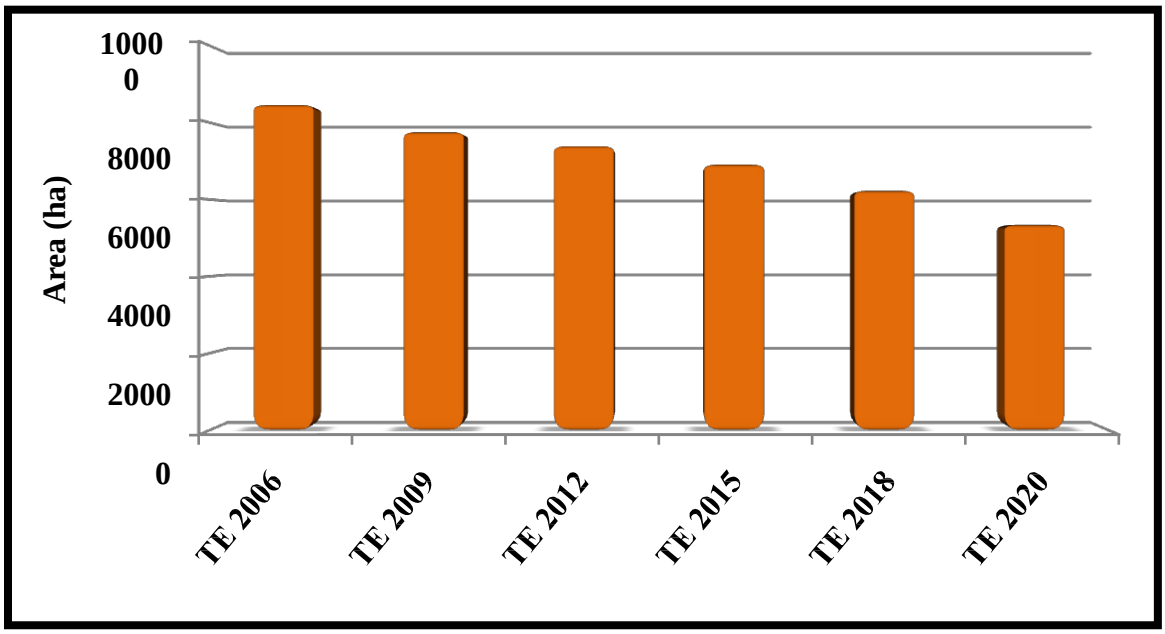
Table 4.9 depicts the coefficient of variation of area for vegetables in the state. It can be interpreted that there existed much variation in the vegetable cultivation area, and this can be attributed to change in cropping patterns followed in the vegetable growing tracts of the district.

Figure 4.2 Area under vegetable cultivation in Kerala (2004-2020)



Source: Agricultural Statistics, DES, GoK

Figure 4.3 Area under vegetable cultivation in Palakkad district (2004-2021)



Source: Agricultural Statistics, DES, GoK

4.2 NATURE AND EXTENT OF POST-HARVEST LOSSES IN VEGETABLES

Vegetables are perishable in nature and are prone to losses. Pre-harvest factors like nutritional deficiencies, changing weather conditions, pests and disease incidences, *etc.* cause post-harvest losses. The present study deals with three main categories of losses *i.e.* physical losses, physiological losses and losses due to biotic factors like pests, diseases, birds, *etc.* Physical losses mainly include the damages which take place due to handling at the farm level and during transportation and marketing of the produce.

Physiological losses are those like malformed fruits, due to deficiencies, uneven shaped fruits and over-ripened fruits, which make the produce unfit for consumption. Biotic elements like pests and disease causing organisms and birds which cause tender fruit damages were also found contributing to the losses. All these categories of losses were analysed in the series of post-harvest management practices in vegetables *i.e.* grading, sorting, packaging, transportation and marketing.

The nature and extent of losses are based on the qualitative characteristics during both pre-harvest and post-harvest periods of vegetables. If the fruits were hardy in nature, losses due to physical handling would be relatively less in comparison to found in soft tender vegetables. At times, physical handling damages might give rise to physiological losses and losses due to biotic factors as well through the development of lesions, moulds, *etc.* around the wounds caused. The following sub-sections deal with nature and magnitude of losses in the selected vegetables at farm and trader level.

4.2.1 Nature and extent of losses in bitter gourd

The total losses in bitter gourd were found to be 12.46 per cent of the production, which in physical terms was around 34.53qtl/ha. Pest and disease incidence was observed more common in the bitter gourd and therefore, 53.61 per cent of total losses (18.51 qtl/ha) were found caused by these factors. Table 4.10 shows the nature and extent of losses in bitter gourd at farm level. The physical losses were found as spine damages in


Plate 1: Post-harvest practices in bitter gourd at farm level


the tender fruits while handling during the different stages of marketing. The loss per cent attributed by physical and physiological factors were 3.68 (10.2 qtl/ha) and 2.1 (5.82 qtl/ha) per cent respectively. It was also observed that uneven fruit size led to increase in the quantity of second grades, which were sold for half of the first grade prices.

Table 4.11 represents the trader level losses in bitter gourd. The highest percentage of loss was found caused by physiological (4.2 per cent) nature due to quality deterioration, followed by physical damages (4.12 per cent). The total losses observed was almost 9.42 per cent of the total produce handled by the traders. The losses at the trader level were found relatively lower than at farm level, because primary stage grading and packaging of produce were done at farmer's field. Besides, as the traders marketing their produce without any lag (maximum a day) to the next intermediaries in the marketing channel, it would help in minimization of loss at their end.

Table 4.10 Nature and extent of losses in bitter gourd at farm level

S. No.	Nature and stage of losses	Extent of losses	
		Losses (kg/qtl)	**Losses (qtl/ha)**
1	Physical losses	**3.68**	**10.20** (29.53)
	a. Harvesting	*1.75*	*4.85*
	b. Grading & packaging	*1.12*	*3.11*
	c. Transportation and marketing	*0.81*	*2.24*
2	Physiological losses	**2.1**	**5.82** (16.85)
	a. Harvesting	*1.4*	*3.88*
	b. Grading & packaging	*0.7*	*1.94*
3	Losses due to biotic factors	**6.68**	**18.51** (53.61)
	Total	**12.46**	**34.53** (100.0)

Note: Figures in parentheses indicate percentage to total

Table 4.12 represents the total post-harvest losses in bitter gourd. It is very clear from the table that losses were found higher in grower's field (12.46 per cent) than at

trader level (9.42 per cent). It could also be seen that the major contributing factor for the losses in bitter gourd was physical damages of produce (7.8 per cent), followed by biotic factors (7.78 per cent). Hence, the total estimated loss in the study area for bitter gourd was estimated for 21.88 per cent of the total produce.

Table 4.11 Nature and extent of losses in bitter gourd at trader level

S. No.	Nature of losses	Extent of losses	
		Losses (kg/qtl)	Per cent to total
1	Physical losses	4.12	43.74
2	Physiological losses	4.2	44.58
3	Losses due to biotic factors	1.1	11.68
	Total	**9.42**	**100.0**

Zong *et al.* (1995) stated that post-harvest loss in bitter gourd was due to inability to sense the appropriate maturity indices for local and distant markets by the farmers. They also pointed out that due to harvest at improper time, the post-harvest quality of the fruits was degraded.

But, in the present study, the farmers were well-aware of maturity indices of bitter gourd as vegetable cultivation in the area is being under taken from times in memorial and it is the "hub of vegetable cultivation in the state".

Table 4.12 Total post-harvest losses in bitter gourd

S. No.	Nature of losses	Extent of losses (kg/qtl)			Per cent to total
		Farm level	Trader level	Total	
1	Physical losses	3.68	4.12	7.8	35.65
2	Physiological losses	2.1	4.2	6.3	28.79
3	Losses due to biotic factors	6.68	1.1	7.78	35.56
	Total	**12.46**	**9.42**	**21.88**	**100.0**

4.2.2 Nature and extent of losses in snake gourd

The total loss in snake gourd was found to be 9 per cent of the production, which in physical terms accounted for 26.10 qtl/ha. The pests and disease incidences which were prevalent in snake gourd accounted for 52.66 per cent of total losses (13.74 qtl/ha). Table 4.13 presents the nature and extent of losses in snake gourd at farm level. Physiological losses were found to the extent of 6.96 qtl/ha, which was due to deformed tender fruits. The loss per cent which could be attributed to physical and physiological factors were 1.86 (5.39 qtl/ha) and 2.4 (6.96 qtl/ha) respectively. Table 4.14 represents the trader level losses in snake gourd. The highest percentage of losses was found in quantity (2.2 per cent) terms due to improper handling, followed by physiological damages (1.99 per cent). The total loss observed was almost 4.89 per cent of the total produce handled by the traders. Besides in snake gourd, it was observed that losses at the trader level were relatively less compared to farm level, because of its semi-hardy nature. Losses due to biotic factors were found to be 0.7 per cent at trader level.

Table 4.13 Nature and extent of losses in snake gourd at farm level

S. No.	Nature and stage of losses	Extent of losses	
		Losses (kg/qtl)	Losses (qtl/ha)
1	Physical losses	**1.86**	**5.39** (20.67)
	a. Harvesting	*1.08*	*3.13*
	b. Grading & packaging	*0.56*	*1.62*
	c. Transportation and marketing	*0.22*	*0.64*
2	Physiological losses	**2.40**	**6.96** (26.67)
	a. Harvesting	*1.50*	*4.35*
	b. Grading & packaging	*0.90*	*2.61*
3	Losses due to biotic factors	**4.74**	**13.74** (52.66)
	Total	**9.00**	**26.10** (100.0)

Note: Figures in parentheses indicate percentage to total

Table 4.14 Nature and extent of losses in snake gourd at trader level

S. No.	Nature of losses	Extent of losses	
		Losses (kg/qtl)	Per cent to total
1	Physical losses	2.2	44.99
2	Physiological losses	1.99	40.69
3	Losses due to biotic factors	0.7	14.32
	Total	**4.89**	**100.0**

Table 4.15 represents the total post-harvest losses in snake gourd. It is evident from the table that losses were found relatively higher in grower's field (9 per cent) when compared to trader level (4.89 per cent). The highest loss in snake gourd was due to losses by biotic factors especially due to the fruit rot at the tips (5.44 per cent), followed by physiological losses (4.39 per cent). Hence, the total computed losses in the study area for snake gourd accounted for 13.89 per cent of the total produce.

Table 4.15 Total post-harvest losses in snake gourd

S. No.	Nature of losses	Extent of losses (kg/qtl)			Per cent to total
		Farm level	Trader level	Total	
1	Physical losses	1.86	2.2	4.06	29.23
2	Physiological losses	2.4	1.99	4.39	31.61
3	Losses due to biotic factors	4.74	0.7	5.44	39.16
	Total	**9.00**	**4.89**	**13.89**	**100.0**

Gautam (2017) reported that 22.65 per cent of aggregate post-harvest losses occurred in potato at various levels, which was around 9.2, 8.45, 2, 1, 2 per cent at farm level, wholesale, retailer, cold storage and others respectively. The qualitative losses (physiological and diseases) were estimated to 21.85 per cent in Baragaon block and 23.45 per cent in Pindra block of Varanasi.

Plate *2*: Post-harvest practices at farm level (snake gourd and vegetable cowpea)

4.2.3 Nature and extent of losses in vegetable cowpea

The total loss in vegetable cowpea was found to be 11.53 per cent of the total production, which in physical terms was around 9.15 qtl/ha. Pests and disease incidence were observed to be the dominating factor which accounted for 65.74 per cent of total losses (6.02 qtl/ha). Table 4.16 represents the nature and extent of losses in vegetable cowpea at farm level.

The loss per cent attributed to physical and physiological factors were 2 (1.59 qtl/ha) and 1.95 (1.54 qtl/ha) respectively. In vegetable cowpea, harvesting at the right stage of maturity was observed to be one of the laborious activities among the growers. Table 4.17 represents the trader level losses in vegetable cowpea. As the tender pods were tied into small bundles, they under-went physical losses during handling and transportation.

Table 4.16 Nature and extent of losses in vegetable cowpea at farm level

S. No.	Nature and stage of losses	Extent of losses	
		Losses (kg/qtl)	**Losses (qtl/ha)**
1	Physical losses	**2.00**	**1.59** (17.35)
	d. Harvesting	*0.94*	*0.75*
	e. Grading & packaging	*0.81*	*0.64*
	f. Transportation and marketing	*0.25*	*0.20*
2	Physiological losses	**1.95**	**1.54** (16.91)
	c. Harvesting	*1.10*	*0.87*
	d. Grading & packaging	*0.85*	*0.67*
3	Losses due to biotic factors	**7.58**	**6.02** (65.74)
	Total	**11.53**	**9.15** (100.0)

Note: Figures in parentheses indicate percentage to total

So, the highest per cent of loss was found have occurred due to physical handling (4.77 per cent), followed by physiological damages (3.1 per cent). The total loss was almost 8.67 per cent of total produce handled at the traders. Loss due to biotic factors was found to be 0.8 per cent at trader level.

Table 4.17 Nature and extent of losses in vegetable cowpea at trader level

S. No.	Nature of losses	Extent of losses	
		Losses (kg/qtl)	Per cent to total
1	Physical losses	4.77	55.02
2	Physiological losses	3.1	35.75
3	Losses due to biotic factors	0.8	9.23
	Total	**8.67**	**100.0**

Table 4.18 represents the aggregate post-harvest losses in vegetable cowpea. It is clear from the table that losses were found higher in grower's field (11.53 per cent) than at trader level (8.67 per cent). Highest loss in vegetable cowpea was due to losses by biotic factors (8.38 per cent), followed by physical losses (6.77 per cent). Physiological deterioration accounted for 5.05 per cent. Hence, the total loss in vegetable cowpea was estimated to be around 20.2 per cent of the total produce.

Table 4.18 Total post-harvest losses in vegetable cowpea

S. No.	Nature of losses	Extent of losses (kg/qtl)			Per cent to total
		Farm level	Trader level	Total	
1	Physical losses	2	4.77	6.77	33.51
2	Physiological losses	1.95	3.1	5.05	25.0
3	Losses due to biotic factors	7.58	0.8	8.38	41.49
	Total	**11.53**	**8.67**	**20.2**	**100.0**

Agrios (2005) revealed that perishable fruits and vegetables are highly prone to post-harvest disease infestation losses to around 10-30 per cent and exceeding 30 per cent of the total production in developed and developing nations respectively.

4.2.4 Total post-harvest losses in vegetables

Table 4.19 and Figure 4.4 represent the total post-harvest losses in vegetables at farm level. Highest losses were observed in bitter gourd with 12.46 per cent, followed by vegetable cowpea (11.53 per cent) and snake gourd (9.0 per cent). Loss due to biotic factors was the highest among different factors in all the three study vegetables.

It was also observed that all the vegetables were harvested based on the harvest indices and the consumers preferences. As these products were preferred in farm fresh quality, they were marketed and channelized to reach consumers at the earliest possible time. Figure 4.5 depicts the total post-harvest losses in vegetables at farm and trader level.

Table 4.19 Total post-harvest losses in vegetables at farm level

Vegetable	Loss per cent		
	Bitter gourd	**Snake gourd**	**Vegetable cowpea**
Physical losses	3.68	1.86	2.0
Physiological losses	2.1	2.4	1.95
Losses due to biotic factors	6.68	4.74	7.58
Total	**12.46**	**9.0**	**11.53**

Sommer (1985) reported that economical (post-harvest) losses of the fruits and vegetables in storage and transportation were caused mostly by the pathogenic fungal complex. This has also been confirmed in the present study, since the losses due to biotic factors were observed to be relatively higher in the study vegetables.

Figure 4.4 Total losses in study vegetables at farm level

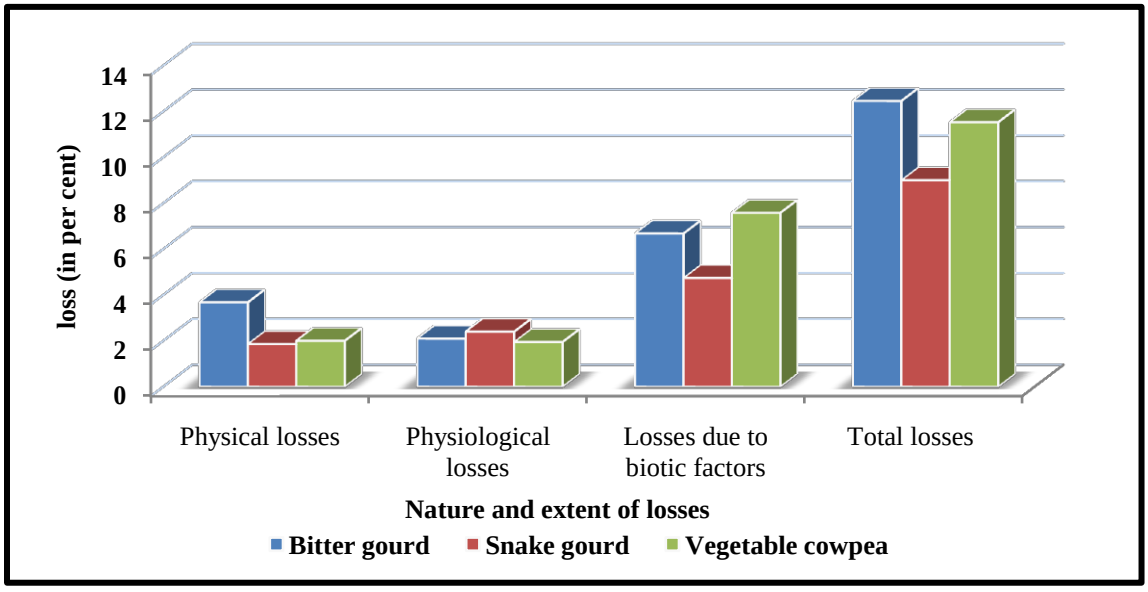
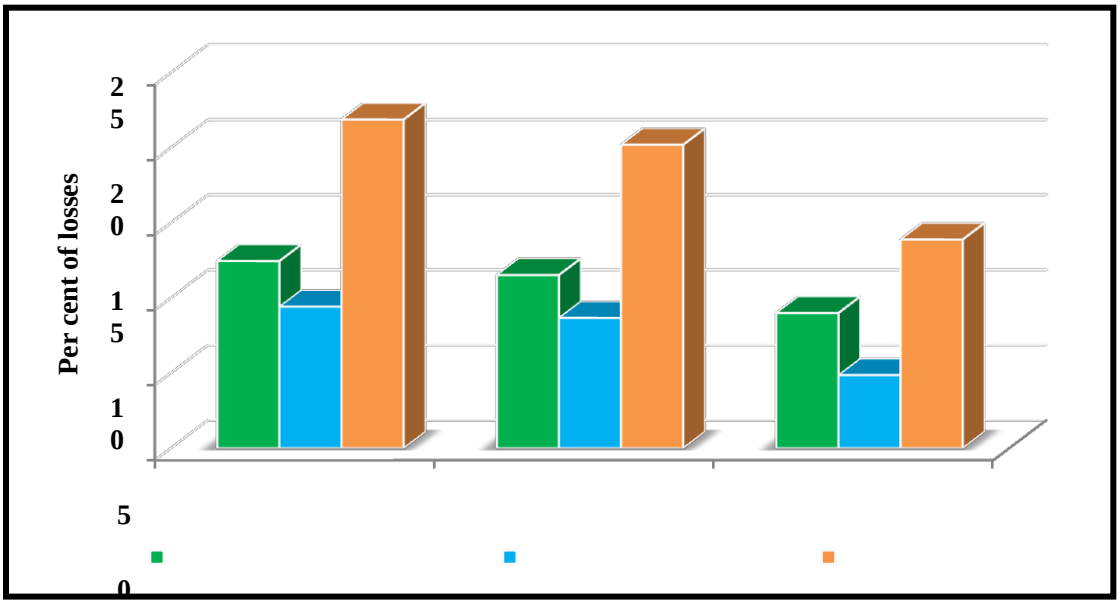


Figure 4.5 Total post-harvest losses in vegetables at farm and trader level



4.3 ECONOMICS OF VEGETABLE CULTIVATION AND MARKETING IN PALAKKAD DISTRICT

4.3.1 Cost of cultivation of vegetables

Total expenditure incurred in each of the vegetables cultivation with their respective yields and returns and the benefit-cost ratio were worked-out using the primary data from the vegetable farmers.

4.3.1.1 Cost of cultivation of Bitter gourd

Cost of cultivation refers to overall expenditure incurred by the farmer in the cultivation of vegetables. It was calculated by input-wise cost in together with percentage to the overall cost. A detailed cost of cultivation using ABC cost concepts were also worked out.

4.3.1.1.1 ABC cost concepts

Various prime costs such as human labour, machine labour, seeds, manures and fertilizers, plant protection chemicals were included under cost A1. The costs of pandhal materials like bamboo sticks, strings, wires, *etc*. were obtained by dividing total cost by the frequency of use. Apart from these, depreciation, interest on working capital (@ 7 per cent) and other miscellaneous expenses were also taken into account for computing cost A1.

The cost of cultivation of bitter gourd (□/ha) under ABC cost concepts is presented in the Table 4.20. It is evident from the table that 29.14 per cent of cost A1 was spent on labour charges (intercultural operations and harvesting of produce). Hence, cost A1 accounted for □1,57,723ha^{-1}. The difference of 18.8 per cent between the cost A1 and

cost A2 is attributed to the fact that bitter gourd cultivation as undertaken in both owned as well as leased-in lands in the study area.

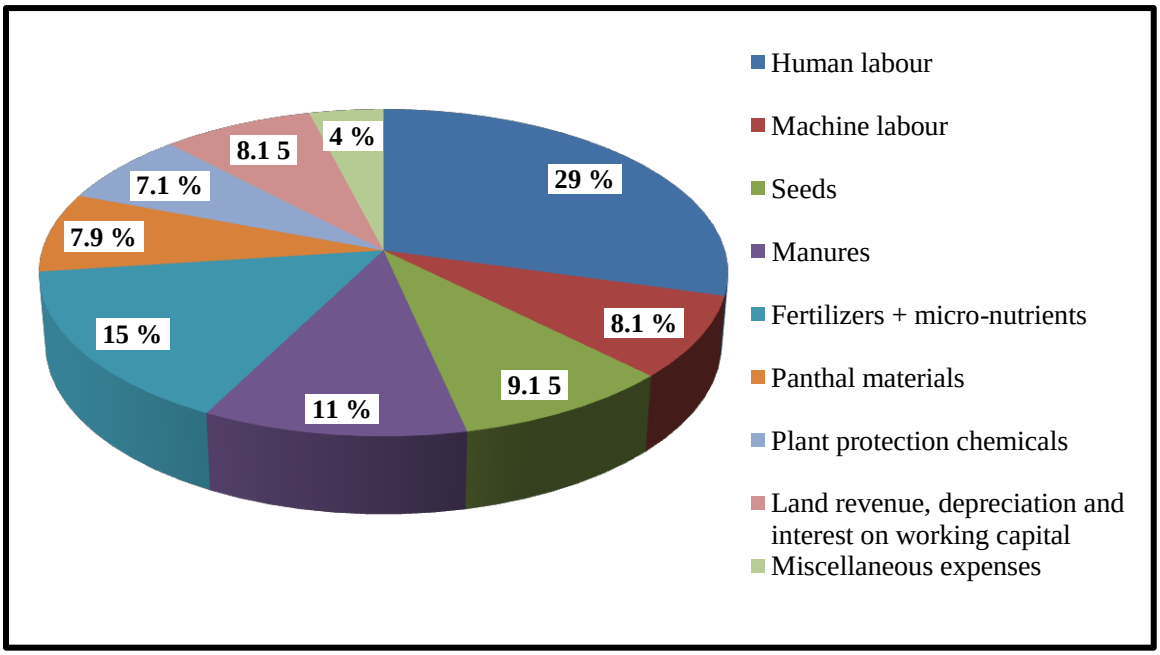
Table 4.20: Input-wise cost of bitter gourd under ABC cost measures (□/ha)

S. No.	Particulars	Cost (□/ha)	Per cent
1	Human labour	46366	29.41
2	Machine labour	12750	8.08
3	Seeds	14375	9.11
4	Manures	17247	10.9
5	Fertilizers and micro-nutrients	24285	15.4
6	Pandhal materials	12409	7.87
7	Plant protection chemicals	11248	7.15
8	Land revenue	313	0.19
9	Depreciation	2324	1.47
10	Interest on working capital @ 7 per cent	10146	6.44
11	Miscellaneous expenses	6260	3.98
12	**Cost A1**	**157723**	**100**
13	Rent paid for leased in land	63750	
14	**Cost A2**	**221473**	
15	Interest on fixed capital (excluding land)	52119	
16	**Cost B**	**273592**	
17	Imputed value of family labour	65348	
18	**Cost C**	**338940**	

Source: Computed from field survey data

Also, the difference of 19.2 per cent among cost B and cost C clearly indicated the fact regarding utilization of family labour to a great extent in the bitter gourd cultivation. Hence, the cost C incurred in a hectare of bitter gourd cultivation was estimated to □3,38,940. Figure 4.6 represents the percentage share of variable costs in bitter gourd cultivation per hectare.

Figure 4.6: Per cent share of variable costs in bitter gourd cultivation (ha^{-1})



Sreela (2005) studied the production and marketing of vegetables in Palakkad district and reported that 43.49 per cent of total expense was incurred for human labour charges in bitter gourd cultivation. She also revealed that there was a hike in agricultural wages and the utilization of family labour in vegetable cultivation practices was to a marked extent.

GoK (2020) reported that cost of cultivation of bitter gourd in Kerala accounted for □4,61,689 ha^{-1}, which included 31.2 per cent of total cost for hired human labour.

4.3.1.1.3 Yield and returns from bitter gourd cultivation

Based on the market demand, the fruits are harvested in fresh forms and pre-cooled. They are subjected to grading, sorting and packing with the materials available with the growers like sacks, wooden baskets, plastic crates, *etc.* and are transported to the markets. Sometimes, the traders or commission agents or VFPCK agents come to the field and collect the produce directly from the growers.

Table 4.21 depicts the details on yield and returns from bitter gourd cultivation. The total aggregate average yield was observed as 277.15 qtl/ha. It is clear from the table that gross returns from bitter gourd cultivation amounted to □9,42,310 ha^{-1}. The net returns per hectare at cost A1, cost A2, cost B and cost C were computed as □7,84,588, □7,20,838, □6,68,719 and □6,03,371 respectively.

Table 4.21: Yield and returns from bitter gourd cultivation (□/ha)

S. No.	Particulars	Amount (ha^{-1})
1	Total yield (Quintals/ha)	277.15
2	Gross returns (□/ha)	9,42,310
3	Net returns at Cost A1 (□/ha)	7,84,588
4	Net returns at Cost A2 (□/ha)	7,20,838
5	Net returns at Cost B (□/ha)	6,68,719
6	Net returns at Cost C (□/ha)	6,03,371

Sreela (2005) reported that the yield of bitter gourd in Palakkad district was 23,721 kg ha^{-1} and the value of output was estimated as □1,86,195 ha^{-1}.

4.3.1.1.4 Benefit-cost ratio for bitter gourd cultivation

The benefit-cost ratio for bitter gourd cultivation in the study area was given in the Table 4.22. It is a profitability concept, which indicates the returns obtained for the cost (say per rupee) incurred. It is evident from the table that bitter gourd cultivation in the study area was remunerative, as the ratios were found to be more than one as 5.97, 4.25, 3.44 and 2.78 for cost A1, cost A2, cost B and cost C respectively.

Table 4.22: Benefit-cost ratio for bitter gourd cultivation

S. No.	Costs	Benefit-cost ratio
1	Cost A1	5.97
2	Cost A2	4.25
3	Cost B	3.44
4	Cost C	2.78

4.3.1.2 Cost of cultivation of Snake gourd

Cost of cultivation of snake gourd was calculated by taking cost incurred in the input wise and the percentage to the total cost. A cost of cultivation using ABC cost concepts was also worked out.

4.3.1.2.1 ABC cost concepts

Various prime costs such as human labour, machine labour, seeds, manures and fertilizers, plant protection chemicals were included in the cost A1. The costs of pandhal materials like bamboo sticks, wires, strings, *etc.* were computed by dividing total cost by the frequency of use. Apart from these, depreciation, interest on working capital (@ 7 per cent) and other miscellaneous expenses were also taken into account for computing cost A1.

The cost of cultivation of snake gourd (□/ha) under ABC cost concepts is presented in the Table 4.23. It is evident from the table that 29.17 per cent of cost A1 was spent on labour charges (intercultural operations and harvesting of produce). Hence, the cost A1 accounted for □1,35,805 ha^{-1}. The difference of 23 per cent between the cost A1 and cost A2 revealed that snake gourd cultivation was taken up in both owned as well as leased-in lands in the study area. It was also observed that snake gourd cultivation in the study area involved relatively less laborious compared to bitter gourd.

Besides, from the difference of 11.15 per cent between cost B and cost C we can infer that there was a significant utilization of family labour in the snake gourd cultivation. Cost C incurred in snake gourd cultivation was estimated as □2,76,745 ha^{-1}. Pie-chart (Figure 4.7) represents the per cent share of variable costs in snake gourd cultivation per hectare.

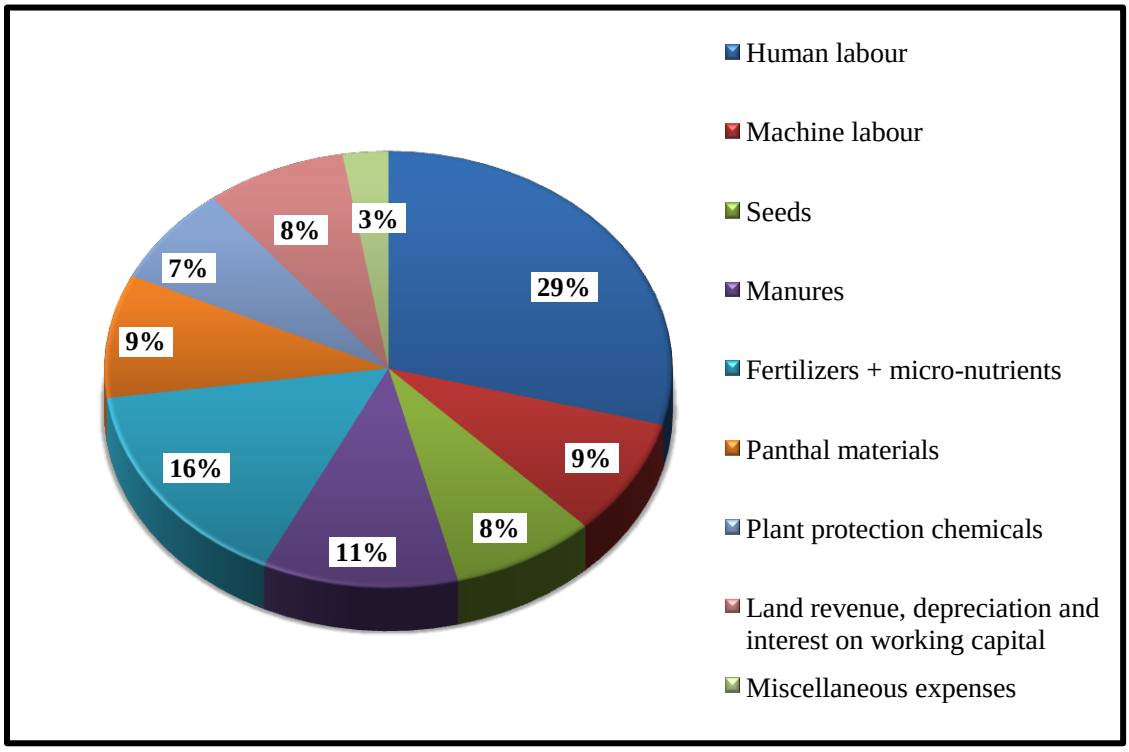
Table 4.23: Input-wise cost of snake gourd under ABC cost measures (□/ha)

S. No.	Particulars	Cost (□/ha)	Per cent
1	Human labour	39615	29.17
2	Machine labour	11750	8.65
3	Seeds	11204	8.25
4	Manures	15115	11.13
5	Fertilizers and micro-nutrients	21215	15.62
6	Pandhal materials	12409	9.14
7	Plant protection chemicals	10009	7.37
8	Land revenue	313	0.23
9	Depreciation	1889	1.39
10	Interest on working capital @ 7 per cent	8740.4	6.44
11	Miscellaneous expenses	3546	2.61
12	**Cost A1**	**135805.4**	**100**
13	Rent paid for leased in land	63750	
14	**Cost A2**	**199555.4**	
15	Interest on fixed capital (excluding land)	46333	
16	**Cost B**	**245888.4**	
17	Imputed value of family labour	30857	
18	**Cost C**	**276745.4**	

Source: Computed from field survey data

Sreela (2005) studied the production and marketing of vegetables in Palakkad district and reported that 41 per cent of total expense was incurred for human labour charges in snake gourd cultivation and revealed that due to hike in the agricultural wages, family labour was found engaged in the cultivation practices as in bitter gourd.

Figure 4.7: Per cent share of variable costs in snake gourd cultivation (ha^{-1})



4.3.1.2.3 Yield and returns from snake gourd cultivation

Based on the market demand, the fruits are harvested in fresh forms and pre-cooled. They are subjected to grading, sorting and packing with the materials available with the growers like sacks, wooden baskets, plastic crates, *etc.* and are transported to the markets. Sometimes, the traders or commission agents or VFPCK agents come to the field and collect the produce directly from the growers.

Table 4.24 depicts the details on yield and returns from snake gourd cultivation. The aggregate average yield was observed as 290.05 qtl/ha. It is clear from the table that

gross returns from snake gourd cultivation amounted to □6,67,115 ha^{-1}. The net returns per hectare at cost A1, cost A2, cost B and cost C were computed as □5,31,310, □4,67,560, □4,21,227 and □3,90,370 respectively.

Table 4.24: Yield and returns from snake gourd cultivation (□/ha)

S. No.	Particulars	Amount (ha^{-1})
1	Total yield (Quintals/ha)	290.05
2	Gross returns (□/ha)	6,67,115
3	Net returns at Cost A1 (□/ha)	5,31,310
4	Net returns at Cost A2 (□/ha)	4,67,560
5	Net returns at Cost B (□/ha)	4,21,227
6	Net returns at Cost C (□/ha)	3,90,370

Sreela (2005) reported that the yield of snake gourd in Palakkad district was 23,999 kg/ha and value of output was estimated as □1,16,565 ha^{-1}.

4.3.1.2.4 Benefit-cost ratio for snake gourd

The benefit-cost ratio for snake gourd cultivation in the study area was given in the Table 4.25. It is a profitability concept, which indicates the returns obtained for the cost (say per rupee) incurred. It is evident from the table that snake gourd cultivation in the study area was a remunerative, as the ratios were found to be more than one as 4.91, 3.34, 2.71 and 2.41 for cost A1, cost A2, cost B and cost C respectively.

Table 4.25: Benefit-cost ratio for snake gourd

S. No.	Costs	Benefit-cost ratio
1	Cost A1	4.91
2	Cost A2	3.34
3	Cost B	2.71
4	Cost C	2.41

4.3.1.3 Cost of cultivation of Vegetable cowpea

Cost of cultivation of vegetable cowpea was calculated by taking cost incurred in the input wise and the percentage to the total cost. A cost of cultivation using ABC cost concepts was also worked out.

4.3.1.3.1 ABC cost concepts

Various prime costs such as human labour, machine power, seeds, manures and fertilizers, plant protection chemicals were included in the cost A1. The costs of pandhal materials like bamboo sticks, wires, strings, *etc.* were arrived by dividing total cost by the number of times used. Apart from these, depreciation value, interest on working capital (@ 7 per cent) and other miscellaneous expenses were also been taken into account for computing cost A1.

The cost of cultivation of vegetable cowpea (□/ha) under ABC cost concepts is presented in the Table 4.26. It is evident from the table that 49.44 per cent of cost A1 was spent on labour charges (intercultural operations and harvesting of produce). Hence, the cost A1 accounted for □1,04,916 ha^{-1}. No difference between the cost A1 and cost A2 revealed is attributed to the fact that vegetable cowpea cultivation as undertaken only in owned lands in the study area.

Also, the difference of 9.49 per cent among the cost B and cost C showed that fact regarding utilization of family labour to a marked extent in the vegetable cowpea cultivation. Hence, the cost C incurred in a hectare of vegetable cowpea cultivation was estimated to □1,32,236. Figure 4.8 represents the percentage share of variable costs in vegetable cowpea cultivation per hectare.

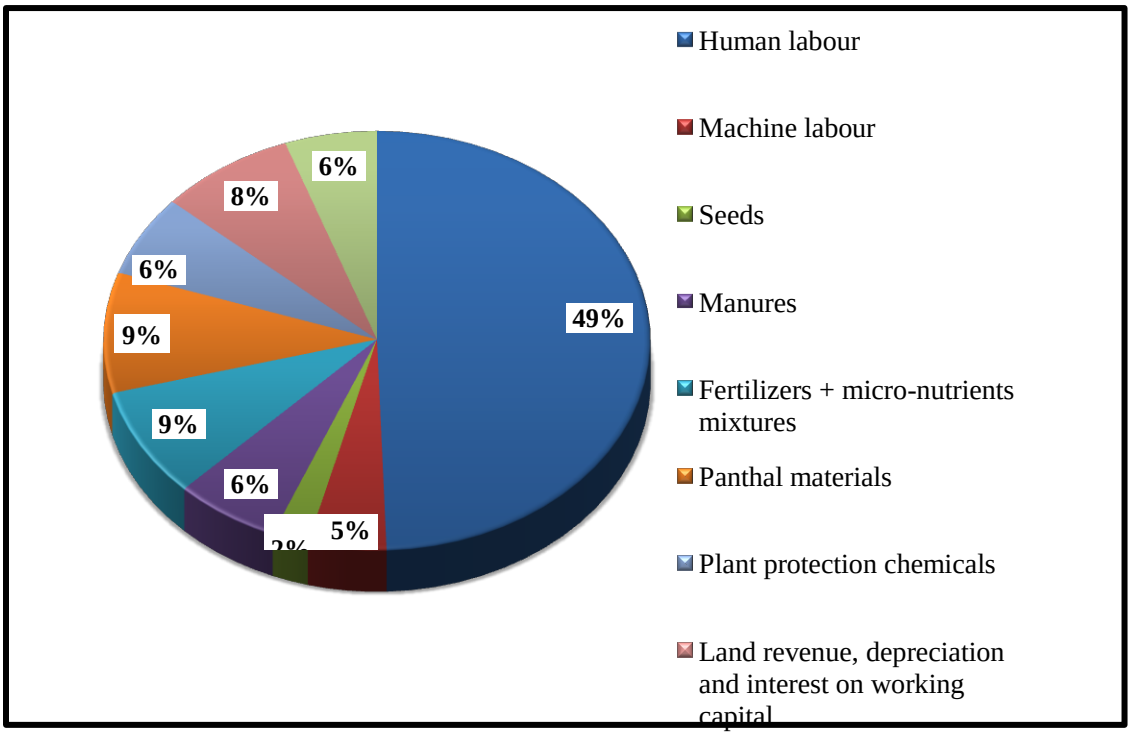
Table 4.26: Input-wise cost of vegetable cowpea under ABC cost measures (□/ha)

S. No.	Particulars	Cost (□/ha)	Per cent
1	Human labour	51874	49.44
2	Machine labour	4850	4.62
3	Seeds	2250	2.14
4	Manures	6512	6.21
5	Fertilizers and micro-nutrients	8879	8.46
6	Pandhal materials	9752	9.29
7	Plant protection chemicals	6594	6.28
8	Land revenue	313	0.3
9	Depreciation	1389	1.32
10	Interest on working capital @ 7 per cent	6753	6.44
11	Miscellaneous expenses	5750	5.48
12	**Cost A1**	**104916**	**100**
13	Rent paid for leased in land	0	
14	**Cost A2**	**104916**	
15	Interest on fixed capital (excluding land)	12532	
16	**Cost B**	**117448**	
17	Imputed value of family labour	14788	
18	**Cost C**	**132236**	

Source: Computed from field survey data

GoK (2020) reported that cost of cultivation of cowpea in Kerala accounted for □4,84,456 ha^{-1}, which included 47.66 per cent of cost A1 for hired human labour.

Figure 4.8: Per cent share of variable cost in vegetable cowpea cultivation (ha^{-1})



4.3.1.3.3 Yield and returns from vegetable cowpea cultivation

Based on the market demand, the tender fruits are harvested in fresh forms and pre-cooled. They are subjected to grading, sorting, bundling and packing with the materials available with the growers like sacks, wooden baskets, plastic crates, *etc.* and were transported to the markets. Table 4.27 depicts the details on yield and returns from vegetable cowpea cultivation.

The total aggregate average yield was observed as 79.4 qtl/ha. It is clear from the table that gross returns from vegetable cowpea cultivation amounted to □2,54,080 ha^{-1}. The net returns per hectare at cost A1, cost B and cost C were computed as □1,49,155, □1,36,623 and □1,21,835 respectively.

Table 4.27: Yield and returns from vegetable cowpea cultivation (□/ha)

S. No.	Particulars	Amount (per ha)
1	Total yield (Quintals/ha)	79.4
2	Gross returns (□/ha)	2,54,080
3	Net returns at Cost A1 (□/ha)	1,49,155
4	Net returns at Cost A2 (□/ha)	1,49,155
5	Net returns at Cost B (□/ha)	1,36,623
6	Net returns at Cost C (□/ha)	1,21,835

4.3.1.3.4 Benefit-cost ratio for vegetable cowpea

The benefit-cost ratio for vegetable cowpea cultivation in the study area was given in the Table 4.28. It is a profitability concept, which indicates the returns obtained for the cost (say per rupee) incurred. It is evident from the table that vegetable cowpea cultivation in the study area was a remunerative, as the ratios were found to be more than one as 2.42, 2.16 and 1.92 for cost A1, cost B and cost C respectively.

Table 4.28: Benefit-cost ratio for vegetable cowpea

S. No.	Costs	Benefit-cost ratio
1	Cost A1	2.42
2	Cost A2	2.42
3	Cost B	2.16
4	Cost C	1.92

4.3.1.4 Overall cost and returns of selected vegetables

Table 4.29 depicts the cost and returns of selected vegetables in the study area. It is evident from the table that vegetable cultivation is remunerative for farmers in the study area, where the benefit-cost ratios were found to be 2.78, 2.41 and 1.92 for bitter

gourd, snake gourd and vegetable cowpea respectively. The net return values obtained show that prices of these vegetables were almost stable during the study period.

Table 4.29: Overall cost and returns of vegetables (□/ha)

S. No.	Particulars	Bitter gourd	Snake gourd	Vegetable cowpea
1	Yield (Kg/ha)	27,715	29,005	794
2	Price (□/Kg)	34	23	32
3	Gross returns (□)	9,42,310	6,67,115	2,54,080
4	Total cost (□)	3,38,940	2,76,745	1,32,236
5	Net returns (□)	6,03,371	3,90,370	1,21,835
6	B:C ratio	2.78	2.41	1.92

4.3.2 Marketing of vegetables

According to Acharya and Agarwal (2004), "Marketing is as critical to better performance in agriculture as farming itself". So, it is not only concerned with good production practices of produce, but also to market them in an efficient way, as the growers should benefit over the risks taken in cultivation with better prices and reduced costs involved in marketing". This study had attempted to identify the marketing channels and their efficiencies for the vegetables such as bitter gourd, snake gourd and vegetables cowpea in the study area.

VFPCK plays a major role in vegetable marketing in Kerala. Majority of vegetable growers in the study area were observed to market their produce through VFPCK, since, there was no marketing charges and also charges for loading and unloading the vegetables. But, five per cent of the value of produce was charged by the VFPCK market for the member farmers.

4.3.2.1 Marketing channels

Kohl and Uhl (1980) defined as, "Marketing channels are the route/path by which the agricultural commodities flow from producers to consumers by means of chain of intermediaries". The following were the marketing channels identified in the study area for bitter gourd, snake gourd and vegetable cowpea. Figure 4.9 depicts the identified marketing channels for selected districts.

Among the identified channels, channel 1 and channel 4 were found to be most commonly followed in the study area, where farmers were found to sell their produce to primary wholesalers through VFPCK and commission agents. The longest channel identified was channel 3, which constituted five intermediaries between producer and consumers *i.e.* VFPCK, commission agent, primary and secondary wholesalers and retailers. Channel 6 was followed by the vegetable growers, because during final harvests, second grade and poor quality produce constitute the major share. Thus, retailers and local shopkeepers procure the produce directly from the farm and channelize to consumers. The other channels had been observed to be followed by very few growers in the area.

Sreela (2005) studied the marketing of vegetables in Palakkad district of Kerala and reported that most commonly followed marketing channel by the growers was through VFPCK to wholesaler, retailers and consumers.

4.3.2.2 Marketing costs and margins involved

Costs incurred in the marketing channels by the producers and other intermediaries to perform various marketing functions are marketing costs. Marketing margins are the profit earned by the middlemen in marketing channel, as various marketing functions are performed while the commodity is channeled from producers to consumers. It was obtained by deducting the retail price from farm prices of particular vegetable.

Table 4.30 depicts the marketing costs and margins of bitter gourd for kg of produce. It can be inferred from the table that channel 3 with more intermediaries, was found to incur the highest marketing costs of □24.4 per kg. The marketing costs involved in the channel 1, channel 2, channel 4 and channel 5 per kg, were noticed as □23.7, □21.7,
□21.9 and □21.1 respectively.

Table 4.30 Marketing costs and margins of bitter gourd (□/kg)

Market functionaries	Particulars	Channels				
		1	**2**	**3**	**4**	**5**
VFPCK (@ 5%)		1.7	1.7	1.7	1.7	-
Commission agent	Commission	-	-	0.66	0.66	1.13
Primary wholesaler	Transportation	6.5	6.5	6.5	6.5	6.5
	Loading & unloading	2	2	2	2	2
	Margin	3.5	4	3.5	4	4
Secondary wholesaler	Marketing cost & margin	2.5	-	2.5	-	-
Retailer	Marketing cost & margin	7.5	7.5	7.5	7.5	7.5
	Total cost (□)	**23.7**	**21.7**	**24.4**	**21.9**	**21.1**

The VFPCK charges □1.7 per kg for bitter gourd while, the commission charged by commission agents was □0.66 per kg. The marketing costs borne by primary wholesaler was observed to be transportation cost of □6.5 per kg, followed by loading and unloading charges of □2 per kg and the margin fixed ranges from □3.5-4 per kg and the marketing costs and margins of secondary wholesalers and retailers were noticed to be
□2.5 and □7.5 per kg respectively.

Table 4.31 depicts the marketing costs and margins of snake gourd for per kg produce. It was clear from the table that channel 3 with more intermediaries, was found to incur the highest marketing costs of □18.6/kg. The marketing costs involved in the channel 1, channel 2, channel 4 and channel 5 per kg, were obtained as □17.9, □16.15,
□16.8 and □16.2 respectively.

Figure 4.9: Identified marketing channels for selected vegetables

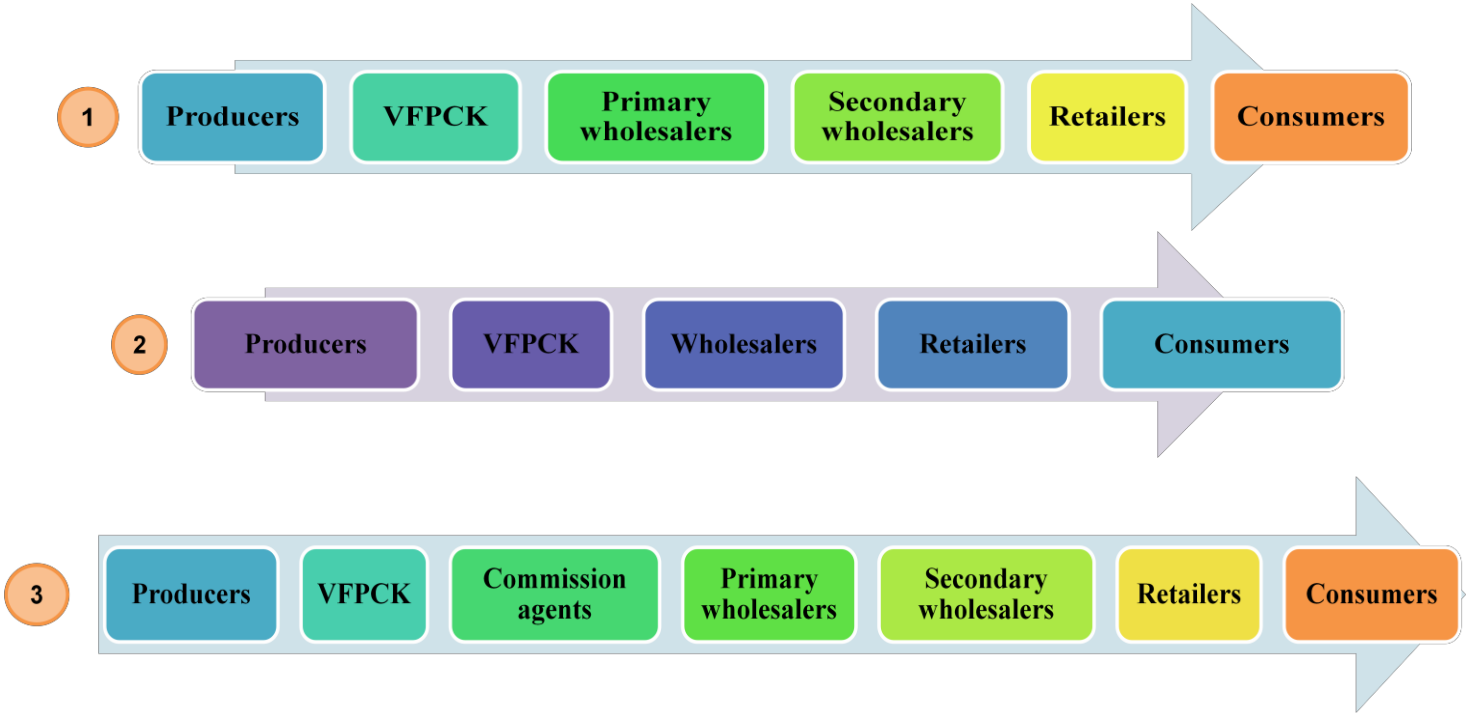
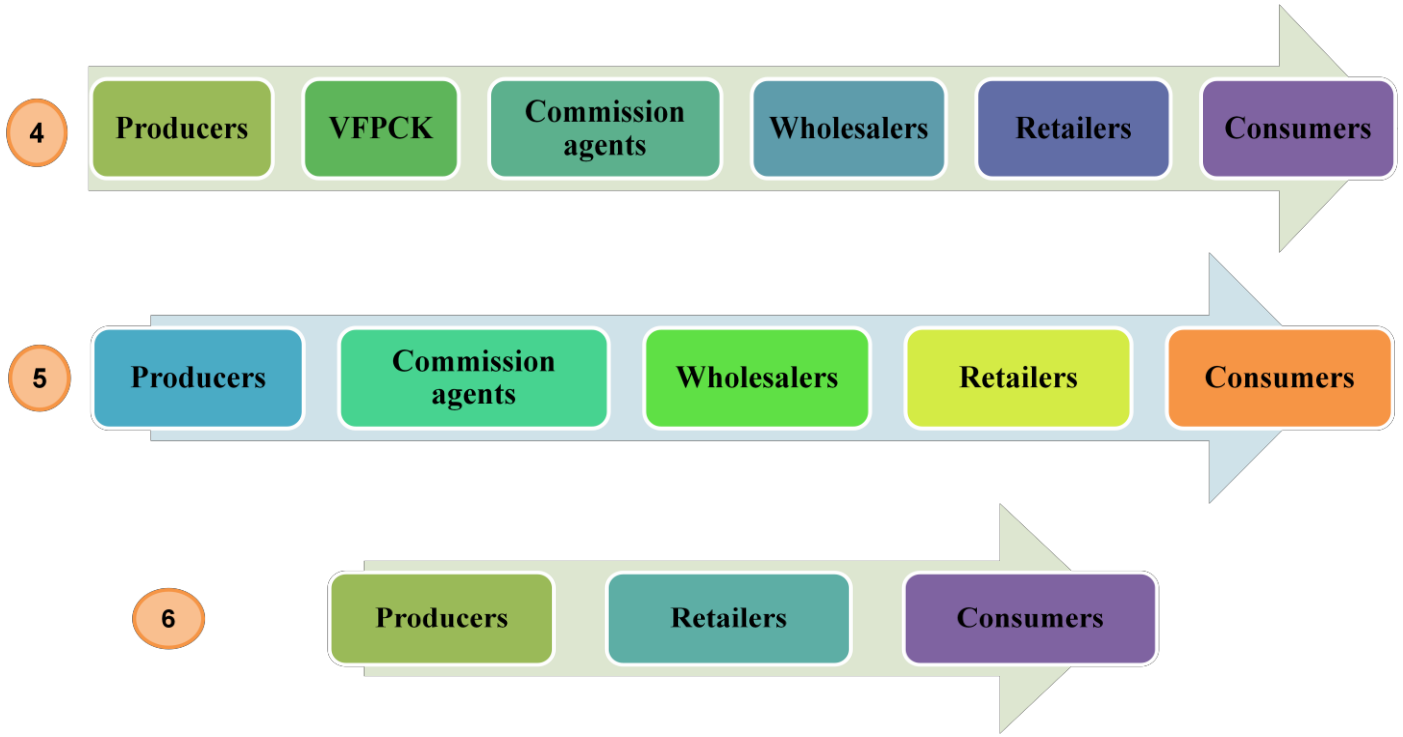


Figure 4.9: Identified marketing channels for selected vegetables



The VFPCK charges □1.15 per kg for snake gourd while, the commission charged by commission agents was □0.66 per kg. The marketing costs borne by primary wholesaler was observed to be transportation cost of □6 per kg, followed by loading and unloading fees of □1.5 per Kg and the margin fixed was □2.5 per kg and the marketing costs and margins of secondary wholesalers and retailers were noticed to be 1.75 and 5 per kg respectively.

Table 4.31 Marketing costs and margins of snake gourd (□/kg)

Market functionaries	**Particulars**	**Channels**				
		1	**2**	**3**	**4**	**5**
VFPCK (@ 5%)		1.15	1.15	1.15	1.15	-
Commission agent	Commission	-	-	0.66	0.66	1.13
Primary wholesaler	Transportation	6	6	6	6	6
	Loading & unloading	1.5	1.5	1.5	1.5	1.5
	Margin	2.5	2.75	2.5	2.75	2.75
Secondary wholesaler	Marketing cost & margin	1.75	-	1.75	-	-
Retailer	Marketing cost & margin	5	5	5	5	5
	Total cost (□)	**17.9**	**16.15**	**18.6**	**16.8**	**16.2**

Table 4.32 depicts the marketing costs and margins of vegetable cowpea for unit produce (Kg). It is clear from the table that channel 3 with more intermediaries, had found to incur the highest marketing costs of □20.8/kg. The marketing costs involved in the channel 1, channel 2, channel 4 and channel 5 per kg, were noticed as □20.1, □19.1,
□19.8 and □18.7 respectively.

The VFPCK charges □1.6 per kg for vegetable cowpea while, the commission charged by commission agents was □0.66 per kg. The marketing costs beared by primary wholesaler was observed to be transportation cost of □4.5 per kg, followed by loading and unloading fees of □1 per kg and the margin fixed ranged between □4-5 per kg and the

marketing costs and margins of secondary wholesalers and retailers were noticed to be 3 and 7 per kg respectively.

Table 4.32 Marketing costs and margins of vegetable cowpea (□/kg)

Market functionaries	Particulars	Channels				
		1	**2**	**3**	**4**	**5**
VFPCK (@ 5%)		1.6	1.6	1.6	1.6	-
Commission agent	Commission	-	-	0.66	0.66	1.13
Primary wholesaler	Transportation	4.5	4.5	4.5	4.5	4.5
	Loading & unloading	1	1	1	1	1
	Margin	4	5	4	5	5
Secondary wholesaler	Marketing cost & margin	3	-	3	-	-
Retailer	Marketing cost & margin	6	7	6	7	7
Total cost (□)		**20.1**	**19.1**	**20.8**	**19.8**	**18.7**

4.3.2.3 Marketing efficiencies in vegetable marketing

Farm-retail spread or price spread has been estimated by finding the difference between price paid by the consumer and price received by the producer for an equivalent quantity of agricultural commodity. Producer's share in consumer's rupee (P_s) is the expression of percent of price received by the farmer (P_f) to the final retail price (Pr).

Marketing efficiency is the measure of output to input ratio. It was measured using the Acharya and Agarwal formula, where marketing efficiency was determined by taking final price of commodity and costs incurred in marketing them (usually per kg). The produce is said to be efficiently marketed, if it measures higher rates and vice versa.

Table 4.33 gives the channel-wise marketing efficiencies for the bitter gourd. It is evident from the table that the marketing efficiency was found highest for channel 5 with 2.7. The price spread for channel 1, 2, 3, 4 and 5 were estimated to be □23.7 per kg, □21.7 per kg, □24.36 per kg, □21.86 per kg and □21.13 per kg respectively. The price spread was observed maximum in channel 3 and the producer's share in consumer price was relatively higher in channel 5 (63.01 per cent).

Table 4.33 Marketing efficiency in bitter gourd (□/kg)

S. No.	Particulars	Channels				
		1	**2**	**3**	**4**	**5**
1	Total marketing margin	9.5	8.5	9.5	8.0	8.5
2	Total marketing cost	14.2	13.2	14.86	13.86	12.63
3	Producer price	34	34	34	34	36
4	Consumer price	57.7	55.7	58.36	55.86	57.13
5	Price spread	23.7	21.7	24.36	21.86	21.13
6	Producer's share in consumer price (%)	58.92	61.04	58.25	60.87	63.01
	Marketing efficiency	**2.43**	**2.57**	**2.39**	**2.55**	**2.7**

The marketing efficiency of bitter gourd (1.03) was found relatively higher than snake gourd (0.91) in Palakkad district (Sreela, 2005).

Table 4.34 gives the channel-wise marketing efficiencies for the snake gourd. It is clear from the table that the marketing efficiency was found highest for channel 5 which is 2.57. The price spread for channel 1, 2, 3, 4 and 5 were estimated to be □17.9 per kg,
□16.35 per kg, □18.6 per kg, □17.05 per kg and □16.35 per kg respectively.

The price spread was observed maximum (□18.6 per kg) in channel 3 and producer's share in consumer's price was observed relatively higher (60.93 per cent) in channel 5.

Table 4.34 Marketing efficiency in snake gourd (□/kg)

S. No.	Particulars	Channels				
		1	**2**	**3**	**4**	**5**
1	Total marketing margin	6.5	5.75	6.5	5.75	5.75
2	Total marketing cost	11.4	10.6	12.1	11.3	10.6
3	Producer price	23	23	23	23	25.5
4	Consumer price	40.9	39.35	41.6	40.05	41.85
5	Price spread	17.9	16.35	18.6	17.05	16.35
6	Producer's share in consumer price (%)	56.23	58.45	55.29	57.43	60.93
	Marketing efficiency	**2.29**	**2.42**	**2.26**	**2.35**	**2.57**

Table 4.35 gives the channel-wise marketing efficiencies for the vegetable cowpea. It is evident from the table that the marketing efficiency was found highest for channel 5 with 2.79. The price spread for channel 1, 2, 3, 4 and 5 were estimated to be □21 per kg, □19.1 per kg, □21 per kg, □19.7 per kg and □19 per kg respectively. The price spread and producer's share in consumer price was observed maximum in channel 1 (65.6 per cent) and 3 (65.5 per cent).

Table 4.35 Marketing efficiency in vegetable cowpea (□/kg)

S. No.	Particulars	Channels				
		1	**2**	**3**	**4**	**5**
1	Total marketing margin	10	10	10	9.5	10
2	Total marketing cost	10.1	9.1	10.76	10.26	8.63
3	Producer price	32	32	32	32	33
4	Consumer price	52.1	51.1	52.76	51.76	51.63
5	Price spread	20.1	19.1	20.76	19.76	18.63
6	Producer's share in consumer price (%)	61.42	62.62	60.65	61.82	63.92
	Marketing efficiency	**2.59**	**2.67**	**2.55**	**2.62**	**2.77**

4.4 ESTIMATION OF MONETARY LOSS VALUES

After the harvest, the produce was subjected to post-harvest management practices such as grading, sorting, packaging and transportation before it finally reaches the consumers. So, the grading of produce at the field level helps to reduce the losses in the marketing chain by culling out the diseased, pests infected and quality deteriorated tender fruits from the good ones. The loss per cent of vegetables at the farm level was used for the estimation of monetary loss values in each of the selected vegetable. The losses were valued in monetary terms at the prevailing price in the market during the study period. Hence, deducting the economic income from gross income gave the value of economic loss, which included the monetary loss incurred by the farmers in terms of post-harvest losses.

4.4.1 Monetary loss values of bitter gourd at farm level

The average yield of bitter gourd was estimated as 277.15 qtl/ha, in which the first or premium quality grade and second graded produce were observed to be 132 qtl/ha and 110.62 qtl/ha respectively. The farm level wastage/loss was observed to 34.53 qtl/ha (12.46 per cent). The values was estimated with prevailing market price for the first grade, second grade and wastage/loss per hectare were □4,48,800, □1,88,054 and
□1,17,402.

Table 4.36 shows the loss values of bitter gourd at farm level. Of the total losses, the values were estimated for physical, physiological and losses due to biotic factors distinctly. Losses due to biotic factors at farm level were found the highest among the three categories of losses (6.68 per cent), valued at □62,900 ha^{-1}. The physical and physiological losses were estimated to be □34,680 ha^{-1} and □19,720 ha^{-1} respectively.

From the table, it is clear that gross income estimated as □9,42,310 ha^{-1}, in which the growers were able to earn the economic profits of only 67.59 per cent and rest of the 32.41 per cent were lost in terms of post-harvest losses. Thus, the total economic loss value estimated for bitter gourd at farm level was □3,05,439 ha^{-1}.

4.4.2 Monetary loss values of snake gourd at farm level

The average yield of snake gourd was estimated as 290.05 qtl/ha, in which the first or premium quality grade and second graded produce were found to 236.53 qtl/ha and 27.41 qtl/ha respectively. Unlike, snake gourd the second grade in snake gourd (9.45 per cent) was found to be relatively less. The farm level wastage/loss was observed to 26.11 qtl/ha (9.0 per cent). The values was estimated with prevailing market price for the first grade, second grade and wastage per hectare were □5,91,325, □34,263 and □60,040.

Table 4.37 shows the loss values of snake gourd at farm level. Of the total losses, the values were estimated for physical, physiological and losses due to biotic factors separately. Alike, bitter gourd losses due to biotic factors at farm level were found the highest among the three categories of losses (4.74 per cent), valued at □31,621 ha^{-1}. The physical and physiological losses were estimated to be □12,408 and □16,011 per hectare respectively. From the table, it is evident that gross income estimated as □7,25,125 ha^{-1}, in which the famers were able to earn economic profits of 86.4 per cent and rest of the 13.6 per cent were lost in terms of post-harvest losses. Hence, the total economic loss value estimated for snake gourd at farm level was □94,316 ha^{-1}.

4.4.3 Monetary loss values of vegetable cowpea at farm level

The average yield of vegetable cowpea was estimated as 79.4 qtl/ha, in which the first or premium quality grade were found to be 70.25 qtl/ha. Unlike, bitter gourd and snake gourd the second grade in vegetable cowpea was not preferred for marketing. The farm level wastage/loss was observed to 9.15 qtl/ha (11.53 per cent). The values was estimated with prevailing market price for the first grade and wastage were □2,24,800 ha^{-1} and □29,280 ha^{-1}.

Table 4.38 shows the loss values of vegetable cowpea at farm level. Of the total losses, the values were estimated for physical, physiological and biotic factors losses distinctly. Alike, bitter gourd and snake gourd losses due to biotic factors at farm level were found the highest among the three categories of losses (7.58 per cent), valued at

observed □19,264 ha^{-1}. The physical and physiological losses were estimated to be □5,056 ha^{-1} and □4,960 ha^{-1} respectively.

From the table, it is clear that gross income estimated to □2,54,080 ha^{-1}, in which the famers were able to earn economic profits of 88.48 per cent and rest of the 11.52 per cent were lost in terms of post-harvest losses. Thus, the total economic loss value estimated for vegetable cowpea at farm level was □29,280 ha^{-1}.

4.4.4 Estimated loss values in study vegetables

Figure 4.10 depicts the monetary loss values in study vegetables at farm level. Bitter gourd farmers were observed to incur the highest loss (□3,05,439) in terms of post-harvest losses per hectare, followed by snake gourd (□94,316) and vegetable cowpea (□29,280). Figure 4.11 represents the economic profit and losses with respect to post-harvest losses in study vegetables. Since the loss percentage in bitter gourd was found the highest, the economic loss incurred by bitter gourd growers were also observed to be highest at 32.41 per cent, followed by snake gourd (13.6 per cent) and vegetable cowpea (11.52 per cent).

Table 4.36 Monetary loss values of bitter gourd at farm level (□/ha)

Particulars	Gross production	First grade	Second grade	Wastage/loss
Quantity (Qtl/ha)	277.15 **(100)**	132 **(47.63)**	110.62 **(39.91)**	34.53 **(12.46)**
Values (□/ha)	9,42,310	4,48,800	1,88,054	1,17,402

Note: Figures in parentheses indicate percentage to total

Nature of loss	Losses in monetary terms			
	Kg/qtl (%)	□/qtl	Loss (Qtl/ha)	□/ha
Physical loss	3.68	12,512	10.2	34,680
Physiological loss	2.1	7,140	5.8	19,720
Losses due to biotic factors	6.68	22,712	18.5	62,900
Total	**12.46**	**42,364**	**34.53**	**1,17,402**

Gross income (□/ha)	Economic income (□/ha)	Economic loss (□/ha)
9,42,310 **(100)**	6,36,871 **(67.59)**	3,05,439 **(32.41)**

Note: Figures in parenthesis indicate percentage to gross income

Gross income = Yield x price
Economic income = Standard grade value + second grade value
Economic loss = second grade value + wastage/loss value

Source: Computed from survey data

Table 4.37 Monetary loss values of snake gourd at farm level (□/ha)

Particulars	Gross production	First grade	Second grade	Wastage/loss
Quantity (Qtl/ha)	290.05 **(100)**	236.53 **(81.55)**	27.41 **(9.45)**	26.11 **(9.0)**
Values (□/ha)	7,25,125	5,91,325	34,262.5	60,040

Note: Figures in parenthesis indicate percentage to gross production

Nature of loss	Losses in monetary terms			
	Kg/qtl (%)	□/qtl	Loss (Qtl/ha)	□/ha
Physical loss	1.86	4,278	5.39	12,408
Physiological loss	2.4	5,520	6.96	16,011
Losses due to biotic factors	4.74	10,902	13.75	31,621
Total	**9**	**20,700**	**26.1045**	**60,040**

Gross income (□/ha)	Economic income (□/ha)	Economic loss (□/ha)
7,25,125 **(100)**	6,25,587.5 **(86.4)**	94,315.5 **(13.6)**

Note: Figures in parenthesis indicate percentage to gross income

Gross income = Yield x price
Economic income = Standard grade value + second grade value
Economic loss = Second grade value + wastage/loss value

Source: Computed from survey data

Table 4.38 Monetary loss values of vegetable cowpea at farm level (□/ha)

Particulars	Gross production	Standard grade	Wastage/loss
Quantity (Qtl/ha)	79.4 **(100)**	70.25 **(88.74)**	9.15 **(11.53)**
Values (□/ha)	2,54,080	2,24,800	29,280

Note: Figures in parenthesis indicate percentage to gross production

Nature of loss	Losses in monetary terms			
	Kg/qtl (%)	**□/qtl**	**Loss (Qtl/ha)**	**□/ha**
Physical loss	2	6,400	1.59	5,056
Physiological loss	1.95	6,240	1.55	4,960
Losses due to biotic factors	7.58	24,256	6.02	19,264
Total	**11.53**	**36,896**	**9.15**	**29,280**

Gross income (□/ha)	Economic income (□/ha)	Economic loss (□/ha)
2,54,080 **(100)**	2,24,800 **(88.48)**	29,280 **(11.52)**

Note: Figures in parenthesis indicate percentage to gross income

Gross income = Yield x price
Economic income = Standard grade value
Economic loss = Wastage/loss values

Source: Computed from survey data

Figure 4.10 Estimated monetary loss values in study vegetables

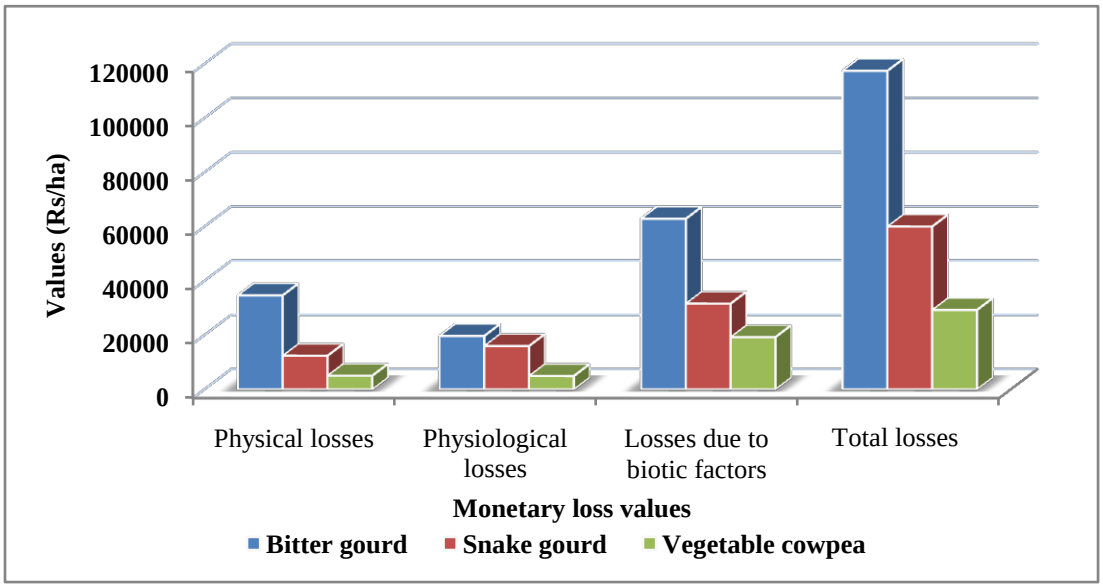
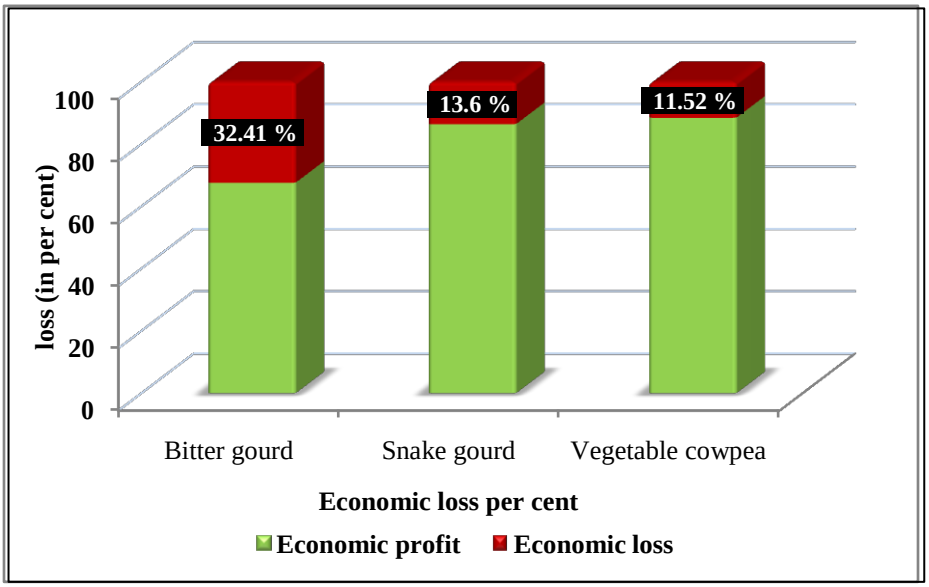


Figure 4.11 Estimated monetary loss in study vegetables



4.4.5 Estimated loss values in study vegetables at block and district level

With the average loss per cent observed from the farm level, an attempt to estimate the loss values at study block and district with respect to post-harvest losses was made. Annual production details of bitter gourd and vegetable cowpea for the Chittur and Nenmara blocks were collected and loss values were estimated. Monetary loss values of vegetables at farm level in study blocks are presented in the Table 4.39. The total quantity lost was computed at 318.37 qtl, 192.69 qtl and 1830 qtl and are estimated loss values at Chittur block level were □10.82 lakh, □4.43 lakh and □58.56 lakh for bitter gourd, snake gourd and vegetable cowpea respectively.

Also, the total quantity lost was estimated as 3596.18 qtl, 2448 qtl and 1827.16 qtl and estimated loss values at Nenmara block level were □122.27 lakh, □56.31 and □58.47 lakh for bitter gourd, snake gourd and vegetable cowpea respectively. Since, the Nenmara block accounted for maximum production, the loss values were also found to be relatively higher than that of Chittur block.

Annual production details of bitter gourd and vegetable cowpea for the Palakkad district were collected from secondary sources and loss values were estimated. Monetary loss values of vegetables at farm level in Palakkad district is presented in the table 4.40. The total quantity lost was extrapolated to 4477 qtl, 2586.6 qtl and 6306 qtl and the estimated loss values at district level were □152.22 lakh, □59.49 lakh and □210.78 lakh for bitter gourd, snake gourd and vegetable cowpea respectively.

Parveen *et al.* (2014) suggested that adding value to the fresh farm produce will not only enhance the exports, but also, reduce the post-harvest losses to significant extent, provided that the post-harvest technologies and infrastructure facilities are properly channelized.

Table 4.39 Monetary loss values of vegetables (farm level) in the study area (□/ha)

CHITTUR BLOCK				
Vegetable	**Production (Qtl)**	**Average loss %**	**Total loss (Qtl)**	**Loss value (lakh □)**
Bitter gourd	2555.14	12.46	318.37	10.82
Snake gourd	2141	9.0	192.69	4.43
Vegetable cowpea	15872	11.53	1830.04	58.56
NENMARA BLOCK				
Bitter gourd	28861.84	12.46	3596.18	122.27
Snake gourd	27200	9.0	2448	56.31
Vegetable cowpea	15847	11.53	1827.16	58.47

Table 4.40 Monetary loss values of vegetables (farm level) in Palakkad district (□/ha)

Vegetable	**Production (Qtl)**	**Average loss %**	**Total loss (Qtl)**	**Loss value (lakh □)**
Bitter gourd	35931.66	12.46	4477.085	152.22
Snake gourd	28740	9.0	2586.6	59.49
Vegetable cowpea	54690	11.53	6305.76	210.78

Source: Computed from primary and secondary data

4.5 MAJOR DETERMINANTS OF POST-HARVEST LOSSES AT FARM LEVEL

4.5.1 Factors responsible for losses in bitter gourd

Table 4.41 depicts the major factors affecting the post-harvest losses at farm level in bitter gourd. Area under cultivation, unfavourable weather conditions, usage of packing materials like sacks, wooden baskets, *etc.* and incidence of pests and diseases were the major factors which were found to be positively significant. Labour power was found to be non-significant and subsequently helped in reducing the losses. Majority of the farmers were found following the post-harvest management practices like pre-cooling, grading and sorting, *etc.* Hence, educating the farmers with cost-effective crop protection practices and crop-specific strategic plans to combat the poor weather conditions would definitely solve the post-harvest loss problems.

Table 4.41 Factors responsible for losses in bitter gourd at farm level

S. No.	Variable	Coefficient	Std. error	*p* value
1	Intercept	10.206	1.35	-
2	Age (years)	-0.040	0.03	0.30
3	Area under bitter gourd cultivation (ha)	2.663*	0.57	0.00
4	Experience in bitter gourd farming (years)	0.067	0.03	0.10
5	Influence of bad weather	1.092*	0.41	0.01
6	Inadequate labour power	-0.445	0.40	0.28
7	Packing materials used	1.008**	0.28	0.00
8	Incidence of pests and diseases	0.852*	0.40	0.04
9	R-square	**71.75**		
10	Adjusted R-square	**67.95**		

*Level of significance p<0.05
**Level of significance p<0.01

The bitter gourd farmers were found practicing the conventional way of packing. But, by the use of improved packing materials like plastic crates with cushioning materials rather than the jute sakes, bamboo baskets would help farmers in reducing the damages and wastage of produce.

Kumar *et al*. (2006) applied functional analysis to identify the factors that affect the post-harvest losses in onion and potato of Karnataka and pointed out that by promoting the adequate storage units and proper handling of produce during the harvest it is possible to minimize the losses to possible extent.

4.5.2 Factors responsible for losses in snake gourd

Table 4.42 depicts the major factors affecting the post-harvest losses at farm level in snake gourd. Area under cultivation and incidence of pests and diseases were the factors found positively significant, while farming experience was negatively significant. Similar to bitter gourd, labour power was found to be non-significant and subsequently helped in reducing the losses. Majority of the farmers were found to be following the post-harvest management practices like pre-cooling, grading and sorting, *etc.* Hence, educating the farmers with cost-effective crop protection practices and crop-specific strategic plan to combat the poor weather conditions would definitely solve the post-harvest loss problems.

Moss (2002) stated that fungal group of pathogens mainspring the rots through mycotoxins in fruits and vegetables with lower pH and elevated moisture content.

Table 4.42 Factors responsible for losses in snake gourd at farm level

S. No.	Variable	Coefficient	Std. error	*p* value
1	Intercept	9.014	0.28	-
2	Age (years)	0.001	0.004	0.78
3	Area under snake gourd cultivation (ha)	1.745**	0.533	0.00
4	Experience in snake gourd farming (years)	-0.050**	0.008	0.00
5	Influence of bad weather	0.032	0.127	0.80
6	Inadequate labour power	-0.047	0.168	0.78
7	Packing materials used	0.051	0.121	0.67
8	Incidence of pests and diseases	0.386**	0.141	0.01
9	R-square	**74.30**		
10	Adjusted R-square	**70.84**		

*Level of significance p<0.05

**Level of significance p<0.01

4.5.3 Factors responsible for losses in vegetable cowpea

Table 4.43 depicts the major factors affecting the post-harvest losses at farm level in vegetable cowpea. Area under cultivation and incidence of pests and diseases were the factors found positively significant. Unlike other crops, vegetable cowpea is a labour-intense crop and thus timely labour inadequacy contributes to the losses, which was found to be positive and significant, while experience showed negative significance. Hence, with adequate labour power and better crop-protection methods, losses could be reduced to the minimum possible extent.

Babalola *et al*. (2010) through his regression analysis, found that the optimum stage of harvest and quantity of the fresh produce were the major contributing factors for the post-harvest losses, as more production during a particular would lead to market glut.

Table 4.43 Factors responsible for losses in vegetable cowpea at farm level

S. No.	Variable	Coefficient	Std. error	*p* value
1	Intercept	13.061	0.715	-
2	Age (years)	-0.030	0.019	0.12
3	Area under vegetable cowpea cultivation (ha)	1.951**	0.584	0.00
4	Experience in vegetable cowpea farming (years)	-0.054*	0.022	0.02
5	Influence of bad weather	-0.295	0.192	0.13
6	Inadequate labour power	0.672**	0.204	0.00
7	Packing materials used	-0.071	0.209	0.73
8	Incidence of pests and diseases	0.457*	0.221	0.04
9	R-square	**74.04**		
10	Adjusted R-square	**70.55**		

*Level of significance p<0.05

**Level of significance p<0.01

4.6 SOCIO-ECONOMIC PROFILE OF VEGETABLE GROWERS

The current study was based on the primary data collected from the survey of 180 vegetable growers. Chittur and Nenmara blocks from Palakkad district were selected for the study, as they had the maximum area and total annual production in the state. Based on the total annual production bitter gourd, snake gourd and vegetable cowpea were selected for the study.

Sixty farmers from each of the vegetables were surveyed and the data collected constitute information on socio-economic characteristics *i.e.* age, education status, annual income, income sources, sources of farming credits, land holding pattern, area under vegetable cultivation, farming experience, organizational membership and land ownership status. The data analyses of the characteristics are as below:

4.6.1 Age

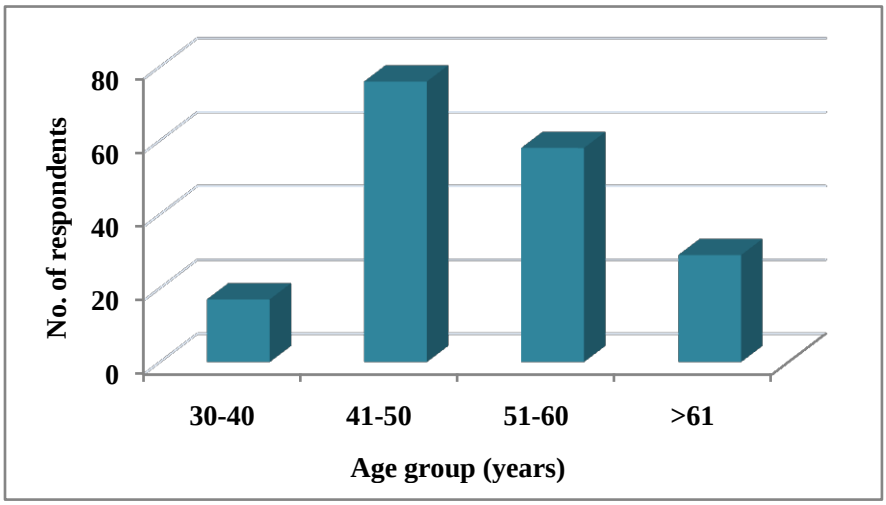
Table 4.44 and Figure 4.12 represent the distribution of respondents based on age. It could be observed that majority of the respondents (42.22 per cent) fall under the age group of 41 to 50 years. Thirty-two per cent of respondents belong to age category of 51 to 60 years, about sixteen per cent belong to group of above 60 years and only 9.44 per cent of respondents belong to 30 to 40 years age group. These indicate that all categories of age group were engaged in vegetable cultivation in the study area.

Table 4.44 Age-wise distribution of respondents

Age group (years)	No. of respondents
30-40	17 (9.44)
41-50	76 (42.22)
51-60	58 (32.22)
>61	29 (16.11)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

Figure 4.12 Age-wise distribution of respondents



4.6.2 Education

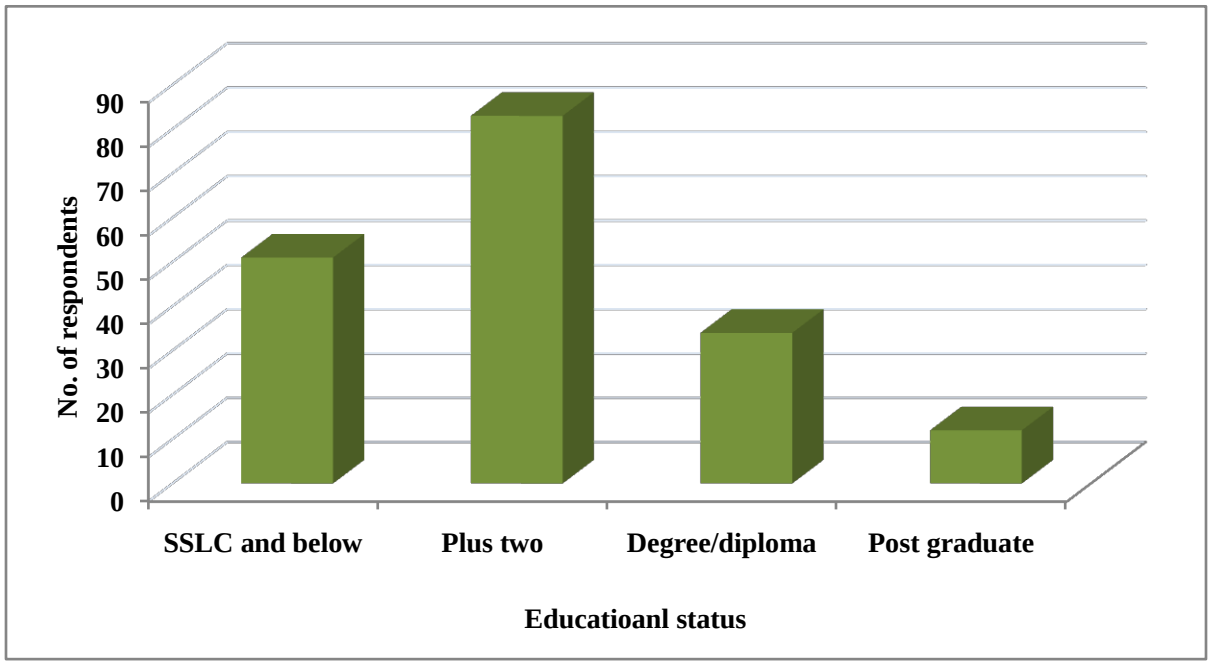
The education status of the farmers was grouped into four strata and are presented in the Table 4.45 and Figure 4.13. It is evident from the table that 46.11 per cent of respondents were found having their education at plus two level, followed by SSLC and below with 28.33 per cent. And 18.9 per cent of respondents had found to be a degree/ diploma holders. It was also noted that 6.67 per cent of farmers were post-graduates.

Table 4.45 Distribution of respondents based on education status

Status categories	No. of respondents
SSLC and below	51 (28.33)
Plus two	83 (46.11)
Degree/diploma	34 (18.89)
Post-graduate	12 (6.67)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

Figure 4.13 Distribution of respondents based on education status



4.6.3 Annual income

The distribution of farmers on the basis of annual income levels were categorized into five groups and had been presented in the Table 4.46. It could be observed from the table that majority (31.11 per cent) of sample farmers earned an income between □1 to 1.5 Lakh. Also, 26.11 per cent of growers earned an income between □50,000 to □1 Lakh, followed by □1.5 to 2 Lakh as annual income was found received by 21.67 per cent of respondents in the study area. It could also be observed that 7.22 and 13.89 per cent of sample farmers earned an income around less than □50,000 and above □2 Lakh annually respectively. Hence, it is very clear that vegetable cultivation in the study area was highly remunerative.

Table 4.46 Distribution of respondents based on income level

Income group (□)	No. of respondents
<50,000	13 (7.22)
50,000 - 1lakh	47 (26.11)
1 - 1.5lakh	56 (31.11)
1.5 - 2lakh	39 (21.67)
>2lakh	25 (13.89)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

4.6.4 Income sources

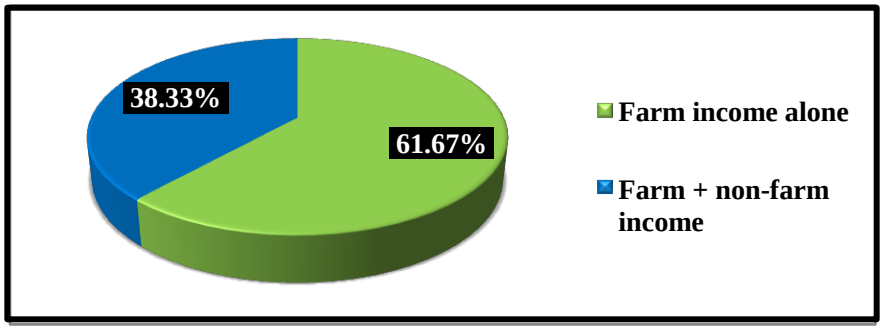
Table 4.47 and Figure 4.14 depict the classification of sample respondents on the basis of their income sources (occupation). Among the total, more than half (61.67 per cent) of the respondents were found to be dependent on farm income alone. Besides farming, 38.33 per cent of respondents were engaged with other income generating activities.

Table 4.47 Income sources of respondents

Occupation	No. of respondents
Farm income alone	111 (61.67)
Farm + non-farm income	69 (38.33)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

Figure 4.14 Income sources of respondents



4.6.5 Land holding pattern

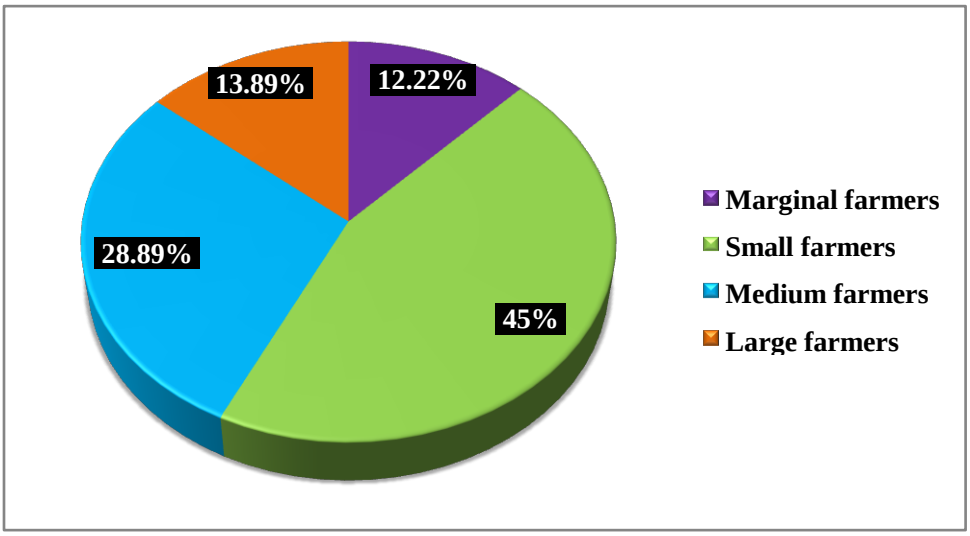
The sample respondents were grouped into four different categories based on their land holding patterns as presented in the table 4.48 and Figure 4.15. It could be observed that majority (45 per cent) of the farmers were grouped under the small size of holding 1 to 2 hectares of land. Around twenty-nine per cent of farmers fell under medium category, followed by 13.89 per cent of large farmers and 12.22 per cent of marginal farmers.

Table 4.48 Distribution of respondents on land holding size

Size of holding (ha)	No. of respondents
Marginal (<1)	22 (12.22)
Small (1 - 2)	81 (45)
Medium (2 - 4)	52 (28.89)
Large (>4)	25 (13.89)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

Figure 4.15 Distribution of respondents on land holding size



4.6.6 Distribution of area under vegetable cultivation

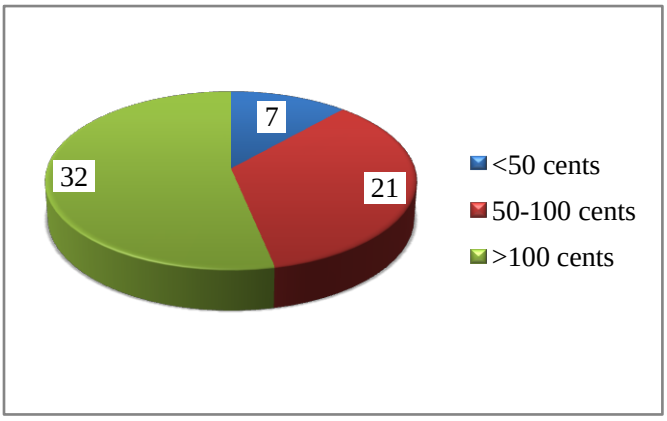
Table 4.49 and Figure 4.16 give the distribution of sample respondents based on the area under vegetable cultivation *i.e.* bitter gourd, snake gourd and vegetable cowpea. The classification was made with three categories of land holding size (cents) under vegetable cultivation. It is evident from the table that 53.33 per cent of bitter gourd famers fell under the group of holding one acre and above, whereas snake gourd and vegetable cowpea farmers fell under the group of holding 50 to 100 cents with 56.67 per cent and 50 per cent respectively.

Table 4.49 Distribution of respondents based on area under vegetable cultivation

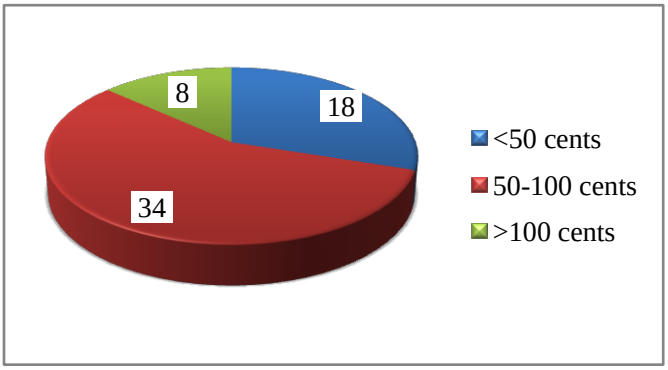
Size of holding (cents)	No. of respondents		
	Bitter gourd	**Snake gourd**	**Vegetable cowpea**
<50	7 (11.67)	18 (30)	22 (36.67)
50 - 100	21 (35)	34 (56.67)	30 (50)
>100	32 (53.33)	8 (13.33)	8 (13.33)
Total	**60 (100)**	**60 (100)**	**60 (100)**

(Figures in parentheses indicate percentage to total)

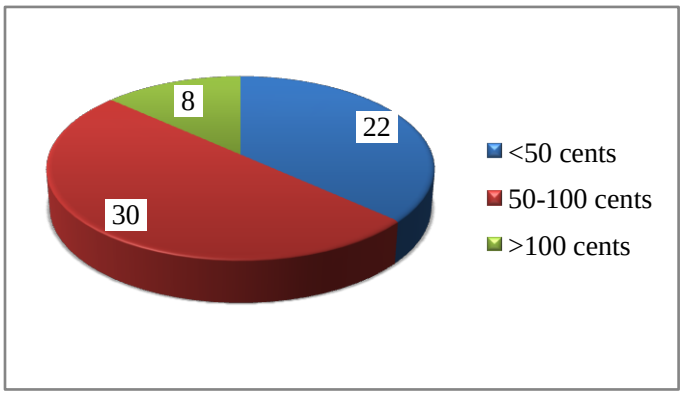
Figure 4.16 Distribution of respondents based on area under vegetable cultivation



a. Bitter gourd



b. Snake gourd



c. Vegetable cowpea

4.6.7 Land ownership status under vegetable cultivation

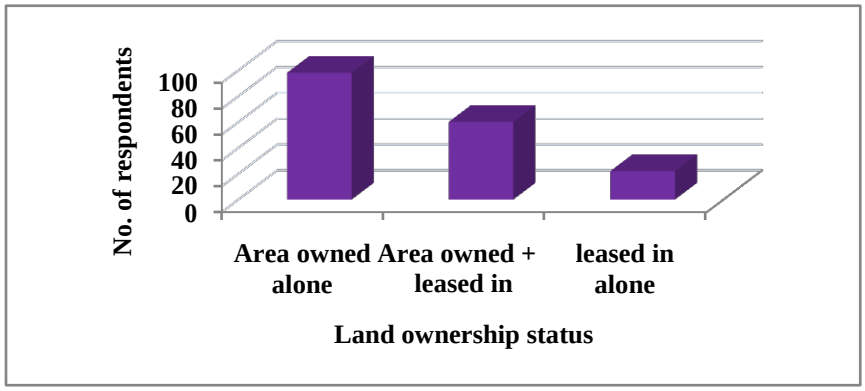
Vegetable cultivation in the study area was found done in both owned as well as leased land and the respondents were categorized into three groups as given in the Table 4.50 and Figure 4.17. Around 54.44 per cent of respondents were found cultivating in their own land and 33.33 per cent and 12.22 per cent of farmers were observed cultivating in owned plus leased-in land and leased-in land only respectively. The average lease amount paid was □1,00,000 $ha^{-1}yr^{-1}$.

Table 4.50 Ownership status of sample respondents

Land categories	No. of respondents
Owned alone	98 (54.44)
Owned + leased-in	60 (33.33)
Leased-in only	22 (12.22)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

Figure 4.17 Ownership status of respondents



4.6.8 Vegetable farming experience

According to the experience (in years) in vegetable farming, sample respondents were grouped into four categories as given in the Table 4.51. As the highest, 43.89 per cent of farmers were found to have an experience between 11 to 20 years, followed by

28.89 per cent of farmers with 21 to 30 years of experience and 17.22 per cent of farmers in the initial stage of vegetable cultivation with less than ten years of experience. Also, 10 per cent of sample farmers were found well experienced with more than 30 years.

Table 4.51: Farming experience of respondents

Categories (years)	No. of respondents
<10	31 (17.22)
11 - 20	79 (43.89)
21 - 30	52 (28.89)
>30	18 (10)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

4.6.9 Organizational membership

The sample respondents were classified based on their membership status in different organizations as given in the Table 4.52. About 70.56 per cent of the respondents were members in VFPCK and 23.89 per cent of farmers hold membership with other small farmers groups and associations and also, there found 5.55 per cent of respondents do not possess any membership with organizations.

Table 4.52 Distribution of respondents based on membership status

Membership organization	No. of respondents
VFPCK	127 (70.56)
Others	43 (23.89)
No membership	10 (5.55)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

Plate 3: Field survey

4.6.10 Sources of credit

Table 4.53 represents the distribution of sample respondents, who avail credits from various sources. Around 31.67 per cent and 30 per cent of respondents depend on cooperative societies and commercial banks as their credit sources. Also, 17.22 per cent of farmers tend to source credits from their traders, to whom they market their produce. 16.11 per cent of respondents were found dependent on their friends, relatives, *etc.* for their credit needs. Around 5 per cent of the respondents were observed to have not participated in credit activities.

Table 4.53 Credit sources of respondents

Sources	No. of respondents
Commercial banks	54 (30)
Co-operatives	57 (31.67)
Traders	31 (17.22)
Others	29 (16.11)
No credits	9 (5)
Total	**180 (100)**

(Figures in parentheses indicate percentage to total)

4.7 STUDY ON PERCEPTION LEVEL OF FARMERS ON LOSSES

In order to understand the farmer's knowledge, perception level and practices regarding the post-harvest losses, five-point Likert-type scale was adopted. The responses from the farmers were recorded using the score scale which ranges from five to one, indicating the knowledge and awareness regarding the losses. The statements in the Table 4.54 were used for perception analysis regarding the losses.

A set of seven statements were put-forth and respondents were asked to respond based on the five-point scale. The maximum score expected would be 35 and minimum of 7. The perception scores were made to percentage analysis for each of the respondents.

Based on the mean and standard deviation values, the respondents were categorized into three groups, *i.e.* high, medium and low level perception as shown in the Table 4.55 and Figure 4.18.

Table 4.54 Perception level statements regarding the post-harvest losses

S. No.	Particulars
1	Losses during harvests
2	Losses in marketing
3	Insect pests and diseases
4	Aware of existence of cold storage units
5	Proper grading of produce helps in reducing the losses
6	Usage of packaging materials that keeps the produce undamaged during transportation
7	Carrying-out the farm operations in a proper manner

Table 4.55 Perception level of vegetable farmers regarding the post-harvest losses

Perception categories	Mean perception index	No. of respondents
Low level of perception	Mean - SD	20 **(11.11)**
Medium level of perception	Mean $\pm$SD	136 **(75.56)**
High level of perception	Mean + SD	24 **(13.33)**

It could be inferred from the table that majority of the farmers in the study area had good knowledge regarding the post-harvest losses like practicing the post-harvest management practices. But, due to the external factors like climate, natural disasters, sometimes, hike in lead wage rate, *etc.* were stated as major issues regarding the reasons for losses.

Only a few of the vegetable growers were found aware of existence of cold storage unit in the study area. So, training and practicing of modernized use of cold

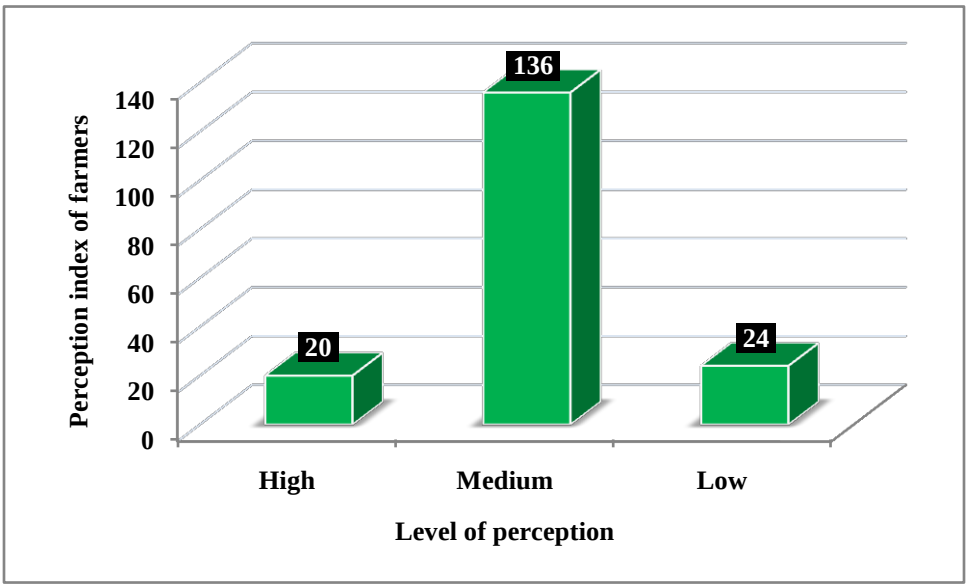
structures for vegetable storage during the period of high production would also help in reducing the losses to maximum possible extent.

According to Kwarteng *et al*. (2017) vegetable amaranth farmers in Ghana were aware of affect of pre-harvest operations on the post-harvest losses.

4.7 MAJOR CONSTRAINTS FACED BY VEGETABLE GROWERS

Post-harvest losses in vegetables were estimated and found that farmers were experiencing constraints in cultivation aspects. In order to find out the constraints faced by the vegetable growers in the study area, Garret ranking technique was used. The major constraints were figured out from the pilot survey and they were represented to farmers for the ranking. Based on the ranks given for each of the constraints, they were converted to scores and are presented in the Table 4.56.

Figure 4.18 Perception levels of vegetable farmers regarding the post-harvest losses



It could be observed from the table that unfavourable weather conditions with score of 65.72 was ranked first, followed by high input costs (56.37), incidence of pests and diseases (53.35) and timely labour inadequacy (50.51). It was noted that prevailing

climatic factors were found to invite pests and disease infestations in the study area. Apart from these, lower prices for the produce and difficulties in availing the high yielding variety seeds were ranked the least constraints with score of 37.86 and 37.04 respectively.

Table 4.56 Constraints faced by vegetable growers

S. No.	Constraints	Garret score	Rank
1	Unfavourable weather conditions	65.72	1
2	High cost of inputs	56.37	2
3	Incidence of pests and diseases	53.35	3
4	Timely labour inadequacy	50.51	4
5	Low price for produce	37.86	5
6	Difficulties in sourcing HYV seeds	37.04	6

Sreela (2005) reported that the three most important constraints faced by the vegetables farmers in Palakkad district were pests and diseases, high input costs and inadequacy of labour and their demand for higher wages.

Summary and conclusions

Chapter 5

SUMMARY AND CONCLUSION

The study entitled "Estimation of post-harvest losses for vegetables in Palakkad district" aimed at estimating the nature and extent along with monetary losses in the selected vegetables. The losses were studied under three major categories based on their nature at both farm level and trader level. The major determinants affecting the losses at farm level were also studied using regression analysis. Farmers' perception level regarding the losses were also studied using the five-point Likert type scale.

The compound annual growth rates of area (2.94 per cent), production (4.44 per cent) and productivity (1.48 per cent) of vegetables in India has been calculated and found that they are positive and significant. In Kerala, the area under vegetable cultivation has shown a positive growth rate with 3.12 per cent. Unlike India and Kerala, Palakkad district has experienced negative growth rate of 2.98 per cent.

In order to assess the economics of vegetable cultivation and marketing for the selected vegetables, the sample farmers of 60 for each of the vegetables, 10 wholesalers and 5 retailers were selected randomly. Thus, the total sample size was 180 vegetable growers and 15 market intermediaries. The results depicted that the cost of cultivation of bitter gourd per hectare was found highest, followed by snake gourd and vegetable cowpea. In addition to this, human labour accounted for maximum costs in all the three vegetables taken for study. The benefit-cost ratios of bitter gourd, snake gourd and vegetable cowpea were found to be stable, indicating that vegetable cultivation is remunerative in the study area. The vegetables were marketed through VFPCK as well as commission agents, but majority of the farmers preferred marketing through VFPCK, because of the price stability and also ease of procedures without marketing charges.

Various marketing concepts like marketing channels, marketing costs and margins, price spread, producer's share in consumer's rupee and marketing efficiencies

were also studied. A total of 6 marketing channels were observed among the vegetable farmers in the study area. The marketing channel 3 with commission agents was observed to incur the higher marketing costs and margins by intermediaries and thus, found to have low marketing efficiencies for all the three study vegetables. In contrast to this, the channel 2 and 4 with VFPCK had observed to show relatively lesser marketing costs and margins. Therefore, the marketing efficiency as well as the producer's share in consumer's rupee has been found to be relatively higher.

The nature and extent of post-harvest losses in study vegetables were analysed. The results obtained showed that about 21.88 per cent of losses in bitter gourd, 13.89 per cent in snake gourd and 20.2 per cent in vegetable cowpea. Of the total loss, the farm level losses were observed to be higher than the trader level losses in all the three selected vegetables. The losses associated with the physical damages were more in bitter gourd whereas the physiological deteriorations were found to be higher in snake gourd. But, the incidence of biotic factors (pest and diseases) in vegetable cowpea accounted for the losses.

The monetary losses estimated for the farm level losses has been found to be highest in bitter gourd with □1,17,402 ha^{-1}, followed by snake gourd with □60,040 ha^{-1} and vegetable cowpea with □29,280 ha^{-1} as the economic loss per cent has been observed with the similar trend. Using the regression analysis, the major determinants affecting the losses at farm level were delineated. In bitter gourd, the factors like area under cultivation, poor weather conditions, packing materials used and biotic factors contributed for the losses. In snake gourd, area under cultivation, experience and prevailing pest and diseases were the determinants responsible for causing the losses. The losses in vegetable cowpea, have been observed to be affected by area under cultivation, experience, inadequate labour and presence of biotic factors.

Using five-point Likert type scale, the perception level of farmers regarding the losses have been recorded and the results revealed that the majority of the farmers in the study area were found to be categorized under medium-level perception. The constraints

in vegetable cultivation and marketing faced by the farmers were analysed and the major constraints recorded were unfavourable climatic conditions, high input costs and incidence of pest and diseases in the study area.

Policy implications

- The farmers need to be trained for adopting improved packaging practices to minimize the losses, as the vegetable growers in the study area had been observed using the conventional packaging practices like wooden baskets, jute sacks, *etc.*
- Since, majority of the farmers were found to have medium-level perception regarding the post-harvest losses, they should be given awareness on ways and means to reduce the losses at farm level.
- Through the trainings with cost-effective post-harvest management practices offered to farmers, the losses could be reduced to marked extent.
- Effective utilization of existing cold storage structures in the study area during the period of bumper production would help to reduce the losses due to glut in the markets.
- Transportation losses could be minimized to some extent by providing better logistics support to the farmers.
- Through encouragement to farmers by promoting new government schemes to take up the value addition activities, the post-harvest losses in vegetables could be minimized to some possible extent.

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Appendices

APPENDIX - I (1)

Kerala Agricultural University
Estimation of post-harvest losses for vegetables in Palakkad district

Survey questionnaire for vegetable farmers

Block :	**Panchayat :**	**Date :**

1. <u>Socio-economic details of the farmer:</u>

A. Name of the respondent :
B. Age :
C. Gender : Male / Female
D. Address :

E. Contact number :

F. Educational qualification

a. Below SSLC ☐
b. SSLC ☐
c. Plus Two ☐
d. Degree ☐
e. Diploma ☐
f. Post graduation ☐

Specify (If any other)……

G. **Number of members in a family :**

S. No	Name	M/F	Relationship	Education	Age	Occupation		Annual income	
						1°	2°	1°	2°

H. Experience in vegetable farming :
I. Year of establishment of pandal :

2. <u>Income details:</u>

A. Annual income

<50,000	**50000-1 lakh**	**1 lakh- 2 lakh**	**2 lakh- 4 lakh**	**>4 lakh**
☐	☐	☐	☐	☐

B. Source of income:

a. Farming alone
b. Farming+ Business
c. Farming + Government job
d. Farming + Self employed

Specify, if any other : _____

3. <u>Land details:</u>

Particulars	**Owned (ha)**	**Leased in (ha)** (from which yr)	**Leased out (ha)** (from which yr)	**Total (ha)** (from which yr)
Wet land				
Garden				
Permanent fallow				
Total (ha)				

Rental value of own land (leased out) :

Rental value of leased-in land :

Specify, if any other : _____

4. Cropping pattern followed

_____

5. <u>Crop details:</u>

Vegetable as: a) Main crop ☐ b) Intercrop ☐

Other intercrop: if any, _____

6. Details of non-crop activities

S. No.	Variety	Area (acres)	Quantity produced (Kg)	Price realized Rs /Kg	
				Current year	Previous year
1					
2					
3					

S. No	Activities	Area	Annual maintenance expenses	Gross returns
Live stock				
Poultry				
Fisheries				
Others				
Total				

7. Details on contact with developmental agencies

S. No	Agencies	Type of assistance			
		Seeds	Technology	Subsidy	Marketing
1	Agrl. department				
2	VFPCK				
3	KAU				
4	Cooperative				
5	NGO				
6	Others				

Specify, if any other : _____

8. Method of vegetable cultivation:

a) Organic ☐ b) By using chemicals ☐ c) Organic + Chemical ☐
d) Others

9. Input requirement details:

A. **Sources of irrigation:**

I. a) Owned well b) Canal c) Bore well d) Others (specify)
e) Drip (fertigation)

II. Availability of irrigation facility?
a) Adequate b) Not adequate

10. Details of credit, if any:

S. No	Sources of finance	Loan amount	
		Taken	Outstanding
1	Centralized Bank		
2	Co-operative Bank		
3	Gold Loan		
4	Money Lender		
5	Friends and Relatives		
6	Others		

Are you a loan-defaulter? Yes/No

11. Production details:

S. No.	Activities	Quantity	Unit cost (Rs.)	Labour hours		Cost of labour/ Day
				Manual	Machine	
1	Land preparation					
2	Sowing					
3	Manuring + Liming					
4	Intercultural operations (agronomic practices like					

	weeding, *etc*., pest & disease management)					
5	Harvesting					
6	Grading					
7	Transportation					

Maintenance cost/ plant :

12. <u>Details of labour employed:</u>

A. **Number of man days**:
   A type:
   B type:
B. **Rate/ day:**
   A type:
   B type:
C. **Rate/ day** (skilled labour):
D. Availability of labour: a) More than adequate ☐ b) Adequate ☐
   c) Less than adequate ☐
E. Skilled labour problem: Yes ☐ No ☐
F. Did you experienced any kind of loss due to:
   a) Climate ☐
   b) Pest and diseases ☐
   c) Physiological losses ☐
   d) Government policy on pricing ☐
   e) Labour shortage ☐
   f) Wild animals (attack) ☐
G. In case of pest and disease, specify the kind and nature of attack:

_____

_____

_____

H. In case of climate, specify the nature of losses:

_____

_____

_____

13. <u>Yield obtained (per acre):</u>

A. When will you start harvesting the vegetable from sowing (DAS)?

B. Number of harvests /season : _____

Phase - I 45 - 70 days (7-10 weeks)	**Phase - II** 71 - 95 days (11-13 weeks)	**Phase - III** 96 - 120 days (14-17 weeks)

C. Yield and price

Previous year		**Current year**	
Quantity	Price/kg	Quantity	Price/kg

14. <u>Post harvest details:</u>

A. After the harvest, do you undertake any value addition to the produce?

Cleaning ☐ b) Sorting ☐ c) Grading ☐ d) All of the above ☐
e) Others ☐

B. Is that beneficial? How? What is the difference in price?

_____

C. Are you applying any pre-treatment to vegetable? Yes ☐ / No ☐
If yes, mention the chemical used for pre-treatment:_____
Quantity:_____ Price: _____

D. Problems faced : a) Lack of infrastructure facility ☐
b) transportation facilities ☐
c) Lack of technical knowledge ☐ d) Others ☐

E. What are the difficulties encountered in growing and selling the produce?

_____

_____

_____

15. <u>Specify the maturity indices apt for marketing</u>

16. <u>Details of marketing:</u>

I. Marketing channels involved :
II. Who are the intermediaries? :
III. Are there any govt. institutions to conduct auctions?
Yes ☐ No ☐
If so, specify (in detail) :

_____

17. <u>How are the grading and packaging of vegetables done for marketing?</u>

18. Details of marketing

Level Details		
Marketing		
1	Total Marketed Quantity	
2	Where do you sell the produce?	
3	To Whom do you sell the produce? (Code)	
4	Reason for sale to local dealer (Code)	
5	Distance to the market	
6	Any market charges	
7	Mode of Transport	
8	Price received (per kg)	
9	Mode of Payment	
Storage		
10	Time period of storage	
11	Mode of storage	
12	Cost of Storage	
13	Other remarks	
Additional charges		
14	Loading and unloading charges	
15	Transport charges	
16	Commission / brokerage	
17	Other charges, if any	
18	Source of information on price	

S. No	Code for 3		
	Method of sale	**Quantity**	**Price/ Unit**
1	Local dealer		
2	Primary market		
3	Secondary Whole sale market		
4	Co-operative Marketing Society		
5	Other modes (Specify)		

Code for 4
1. Advance taken 2. Loan marketable surplus 3. To obtain high price for the produced 4. No transport facility 5. Transportation cost 6. Immediate cash payment 7. Traditional practice 8. Minimal procedures in selling the produce 9. Lack of awareness about other opportunities 10. Other reasons (specify)

19. **<u>Storage infrastructure facilities :</u>**

I. Are there any needs for cold storage units in your area? Yes ☐ No ☐

II. If so, then suggest some measures for the usage,

_____

20. **<u>Price details:</u>**

A. How do they fix the price for the quality produce you sell?

B. a) Market price ☐ b) Supply ☐ c) Demand ☐ d) Considering all ☐ e) Cost incurred ☐

C. Unit price of vegetable / per slot (in Rs.):

D. Whether the payment is made on spot: Yes ☐ No ☐

21. Whether the entire produce produced during the season is marketed?

Yes ☐ No ☐

22. Whether you are getting the reasonable prices at all the levels?

Yes ☐ / No ☐

23. What are all the exclusive institutional supports (VFPCK) available in marketing of produce?

_____

24. Who will meet the cost of transportation to marketing?

	Producer	**Trader**	**Processors**	**Others**
Met by				

25. Details on intermediaries

a) Reasons for sales to the local dealer /wholesaler /consumer /commission agents/agencies?
b) Do you know the price at which final intermediary sells the produce to ultimate consumers?
c) Sources of information on price data?
d) Are you a member of any producer organization/ Cooperative / SHG (PDS)
e) Any contractual agreement of selling of the produce
f) If yes, since which year?
g) How the price is determined
h) Is there any incentive/bonus

26. Are you satisfied while marketing the produce? Yes ☐ No ☐ If not, why?

27. Rank the constraints faced in vegetable cultivation and marketing:

S. No	Problems	Occurrence of problem (Yes / No)	Extent of problem (5 point scale)	Ranks
1	Low yield			
2	High labour charge			
3	Scarcity of labour			
4	Climate change			
5	Unavailability of inputs			
6	Increasing price of inputs			
7	Post and disease attack			
8	Decreasing demand			
9	High transportation cost			
10	Price fluctuations			

11	Value addition			
12	Post-harvest losses			

28. <u>Details on post-harvest losses:</u>

S. No.	Stages of PHL in vegetable	Losses / ton	Losses (in %)	Monetary losses (in Rs.)
1	Field level losses			
	a. Pests			
	b. Diseases			
	c. Pre-mature harvests			
	d. Climatic parameters			
	1. High / low temperature			
	2. High / low humidity			
	3. Rainfall			
	4. Drought			
2	Transportation losses			
	a. Handling			
	b. Storage			

29. What are the other physiological parameters causing PHL in vegetables?

30. Total losses in monetary terms (in Rupees/ha) :

31. Suggestions to improve vegetable productivity and reduce the losses:

a) At your farm:

b) In your region:

32. Farmer's perception levels - regarding PHL [Scoring (5-point scale)]

S. No.	Stages of PHL in vegetables	Awareness level (score 1-5)
1	**Field level losses**	
	1. Pests	
	2. Diseases	
	3. Pre-mature harvests	
	4. Climatic parameters	
	a. High / low temperature	
	b. High / low humidity	
	c. Rainfall	
	d. Drought	
2	**Transportation losses**	
	a. Handling	
	b. Storage	

APPENDIX - I (2)

Kerala Agricultural University
Estimation of post-harvest losses for vegetables in Palakkad district

Survey questionnaire for vegetable traders

Block :	**Panchayat :**	**Date :**

I. General details

1. Name :
2. Gender :
3. Age :
4. Type of Market intermediary : Village trader / Wholesalers / Retailer
5. Address :

6. No. of years of experience in vegetable trading :
7. Main product(s) dealt with :

8. Quantity (volume) of transaction/year (apprx.) :
9. Transactions made
   I. Purchase of produce : Time :
   II. Sale of produce : Time :
10. **Vegetables transacted during the year**

S. No.	**Season**	**Place**		**Distance**	**Total quantity transacted**	**Purchase price**	**Remarks**
		From	**To**				
1							
2							
3							

11. **Expenditure:**

S. No.	Particulars	Amount (Rs.)	Remarks
1	Transport cost		
2	Loading and unloading charges		
3	Weighing and watching charges (if any)		
4	Other processing expenses (if any)		
5	Storage Cost		
6	Brokerage		
7	Taxes		
8	Other expenses		
9	Selling Price (Rs./Quintal)		

12. Do you have any shop or stall for marketing the produce?

13. If Yes, mention the location, size and number of stalls:
    Location :
    Area :
    No. of stalls :

14. From whom you mostly purchase?

15. To whom the products are sold?

16. Constraints faced in buying it from producers/traders:

17. Problems faced in marketing of vegetables:

18. Give suggestions to overcome the problems:

19. Marketing channel involved in vegetables:

20. Post harvest losses of different vegetables

S. No.	Stages of PHL in vegetable trading	Losses / ton	Losses (%)
1	Transportation losses		
	a. Handling		
	b. Storage		

21. **Reasons for Losses:**

APPENDIX - II

Details of secondary data and duration

Particulars	Period	Sources
Area, Production and Productivity of vegetables in India	1991-92 to 2019-20	National Horticulture Board (www.nhb.gov.in/) Data Book Agricultural statistics at a glance Horticulture Statistics
Area, Production and Productivity of vegetables in Kerala	2004-2020	Farm Guide (2012 to 2021) Agricultural Statistics Agricultural Census (2015-16)
Area, Production and Productivity of vegetables in Palakkad	2004-2020	Farm Guide (2012 to 2021) Agricultural Statistics Agricultural Census (2015-16)

Abstract

ESTIMATION OF POST-HARVEST LOSSES FOR VEGETABLES IN PALAKKAD DISTRICT

By

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ABSTRACT OF THE THESIS

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ABSTRACT

Over the last two decades, India's food system with population surge has been undergoing a transformation with increase in demand for high value fruits and vegetables. However, farmers are unable to receive higher benefits from these transitions which are due to poorly developed value chain systems in the various post-harvest management practices of perishable crops like vegetables. The study entitled "Estimation of post-harvest losses for vegetables in Palakkad district" was aimed to examine and estimate the nature and extent of post-harvest losses for vegetables.

Using time series data on the area, production and productivity of vegetables in India and area under vegetable cultivation in Kerala and Palakkad district, compound annual growth rates were calculated. The major vegetables like bitter gourd, snake gourd and vegetable cowpea were selected for the study in proportion to their production to the total vegetables. The respondents were selected using multi-stage random sampling technique. Thus, a sample of 180 farmers (60 for each vegetable) and fifteen vegetable traders from two blocks *i.e.* Chittur and Nenmara were selected for the study.

The cost of cultivation for the three vegetables were worked-out using ABC cost concepts, where in, human labour accounted for the highest percentage (29 percent each for bitter gourd and snake gourd and nearly 49 per cent for vegetable cowpea) to total cost, in all the selected vegetables. The total cost of cultivation (cost A1) was found to be the highest in bitter gourd with □1,57,723 ha^{-1}, followed by snake gourd (□1,35,805 ha^{-1}) and vegetable cowpea (□1,04,916 ha^{-1}). The benefit-cost ratios at cost C were found to be stable with 2.78 for bitter gourd, 2.41 for snake gourd and 1.92 for vegetable cowpea. Also, the major marketing channels for vegetables in the study area were identified and majority of the farmers were found marketing their produce through VFPCK.

The nature and extent of post-harvest losses in vegetables were determined by classifying them into three major categories *viz*. physical loss, physiological loss and loss due to biotic factors. In bitter gourd, the losses were found to be 3.68 (10.2 qtl/ha), 2.1

(5.82 qtl/ha) and 6.68 (18.51 qtl/ha) percent to the total production (per hectare) in terms of physical damages, physiological deterioration and loss due to biotic factors respectively at farm level. Thus, the total loss observed in bitter gourd at farm level was about 12.46 percent (34.53 qtl/ha). At trader level, the physiological loss contributed to almost 45 percent of the total losses. Hence, the total loss in bitter gourd was observed to be 21.88 per cent. Likewise in snake gourd, the extent of losses at farm level was found to be 9 percent (26.1 qtl/ha), where the highest losses (4.74 percent) were due to biotic factors like pests and diseases prevailing in the study area. Therefore, the total loss estimated in snake gourd was 13.89 percent which included 4.89 percent of loss at trader level.

In vegetable cowpea, the total loss accounted for 20.2 percent to the total production per hectare *i.e.* 11.53 percent at farm level and 9.15 percent at trader level. Hence, based on the nature of produce the loss due to physical damage was highest in bitter gourd whereas the loss due to physiological factors was found highest in snake gourd and loss with respect to biotic factors was found to be maximum in vegetable cowpea. And, the post-harvest losses were observed as maximum in bitter gourd followed by vegetable cowpea and snake gourd.

Economic loss is obtained by addition of post-harvest loss values and value of second grade produce. The monetary loss of vegetables at farm level were also estimated by taking into consideration the prevailing prices of ₹34 (bitter gourd), ₹23 (snake gourd) and ₹32 (vegetable cowpea) (per kg). The vegetables were graded by the shape and size of the produce into standard and second grades, and it was observed that the second grade fetched only half the price of the standard grade. The post-harvest monetary losses
accounted for ₹1,17,402 ha^{-1} in bitter gourd. Farmers tend to lose the value of their
produce for second grades. Thus, the economic losses were estimated at ₹3,05,439 ha^{-1}. Similarly, the monetary loss for snake gourd was computed as ₹60,040 ha^{-1}, whereas the economic loss valued at ₹94,316 ha^{-1}. In vegetable cowpea, the monetary losses and economic losses were estimated to be the same at ₹29,280 ha^{-1}, due to undesirable second

grade produce by the traders and consumers. Therefore, the monetary losses were observed to be highest in bitter gourd (32.41 percent to total value of production per hectare) followed by snake gourd and vegetable cowpea. Using the values of the farm level losses, the monetary losses were extrapolated to block and district levels. The estimated loss values for Chittur block were □10.82 lakh, □4.43 lakh and □58.56 lakh in bitter gourd, snake gourd and vegetable cowpea respectively, taking the production data into consideration. In Nenmara, the losses were estimated to □122.27 lakh for bitter gourd, □56.31 lakh for snake gourd and □58.47 lakh for vegetable cowpea. Similarly, for Palakkad district the estimated losses were □152.22 lakh, □59.49 lakh and □210.78 lakh respectively.

Regression analyses were used to delineate the factors responsible for losses at farm level. In bitter gourd, area under cultivation, unfavourable weather conditions, pests and diseases and use of packing materials like jute sacks and wooden baskets were found as major determinants for losses. Area under cultivation, experience in farming and prevailing pests and diseases in snake gourd were found to affect the volume of post-harvest losses at farm level. Besides these, the variable, timely labour availability was also found to contribute to the losses in vegetable cowpea.

The socio-economic profile of the farmers was also analysed for the study. The knowledge, perception level and practices of the farmers regarding the losses were studied using the five-point Likert type scale and it was found that majority (76 percent) of the farmers were categorized under medium level of perception. Garrett ranking technique was used to find the major constraints faced by farmers in vegetable production and marketing. The unfavourable weather conditions, followed by high input cost and pest and disease incidence were found to be the major constraints in the study area.

Thus, it can be concluded that with improvement in the awareness level among farmers regarding the post-harvest losses and by training them in the area of post-harvest operations and handling, we can reduce the losses occurring in the vegetables to a remarkable extent in the area studied.