

Study of Value Chain of Coloured Capsicum



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Disclaimer

This Study Report has been prepared by C V Reddy, Faculty Member, National Bank Staff College (NBSC), Luck now based on the field study conducted by him from 21 to 25 January 2019 in Karnataka. The views expressed in the report are that of the author. It does not necessarily represent or reflect the policy or view of National Bank Staff College (NBSC) or National Bank for Agriculture & Rural Development (NABARD). NBSC and NABARD accept no financial liability or any other liability whatsoever to anyone using this report as also for the accuracy of facts and figures quoted in the report.

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Summary

Capsicum (sweet pepper or bell pepper) is the most popular salad vegetable grown in the country. Two types of capsicum are grown commercially, first type is green capsicum cultivated in open condition mainly used as a vegetable and in fast food preparations. Second type is coloured capsicum grown under protected cultivation (poly houses/net houses) and is in good demand in urban markets mostly driven by high end consumers, hotel and catering industry as a salad and in fast food preparations.

The total area under capsicum in the country was 45850 ha during the year 2016-17 with total production of 327020 MT. The top five states Karnataka, Himachal Pradesh, Madhya Pradesh, Haryana and Maharashtra accounts for about 45 % of the area and 73% of production under capsicum. Karnataka is the leading state with production of about 81670 MT with 25% share. Out of the total production of capsicum, about 20% is coloured capsicum with main production units being in Karnataka, Himachal Pradesh, Haryana and Maharashtra.

The open cultivated green capsicum yields about 20 to 40 tonnes per hectare in about 4 to 5 months of growing period depending upon variety and season. Poly house cultivated coloured capsicum yields about 80 to 100 tonnes per hectare in about 10 to 12 months crop duration in southern states and part of Maharashtra.

Due to growing domestic as well as export demand for coloured capsicum, many farmers and entrepreneurs have adopted the protected cultivation of coloured capsicum in poly houses on commercial scale.

The study of coloured capsicum value chain was undertaken with following objectives;

Stage		Objectives
A	Pre-production value chain – starting from seedling production to harvesting.	<ol style="list-style-type: none">1. Study the cost of production and value chain of seedling and suggest alternatives for reduction of costs2. Estimate the cost of production and scale of finance3. Identify the issues in production systems and suggest remedial measures to improve the value of the produce.
B	Post production value chain from farm to fork.	<ol style="list-style-type: none">1. Study the existing marketing systems2. Study the value chain and players' role and share in the market value3. Study the feasibility of promoting coloured capsicum Producers Company4. Policy suggestions for improving the value chain of coloured capsicum

The study was undertaken in Bangalore rural and Bangalore urban districts of Karnataka covering following players in the value chain of capsicum.

- a. Seed production and marketing companies
- b. Seedling supplying nurseries
- c. Capsicum growers
- d. Research and extension services providers
- e. Capsicum Aggregators and marketers
- f. Retail units

The quality seedlings is most important contributor of value chain of capsicum. There is a wide variation in retail price of seed depending upon the variety. All the varieties used for protected cultivation of coloured capsicum are F1 hybrids and produced by multinational companies or imported. There are no domestic F1 hybrids of coloured capsicum matching with imported varieties in terms of productivity and produce quality.

The major inputs for raising seedlings are F1 hybrid seeds, pro-trays, growing media, plant protection chemicals, nutrients and labour apart from capital cost on poly house, irrigation systems and growing stands.

The abstract of the value chain of coloured capsicum seedling production and share of various stake holders in the value chain of seedlings is given in the chart below;



The major benefit of value chain of about 85.70 % realised by the seed companies is due to monopoly of a few seed companies.

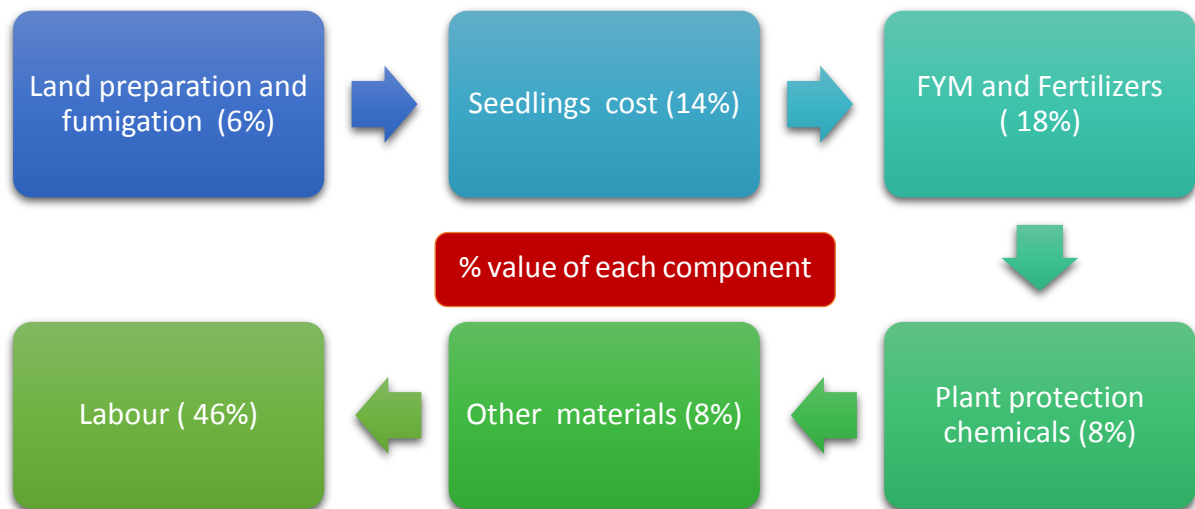
The following suggestions emerged from the study to reduce the cost of seedlings to the farmers:

- a. Developing simple cost effective nursery technology for raising quality seedlings with minimal cost by the growers
- b. Breeding of suitable F1 hybrids by ICAR Research Institutions
- c. Encouraging domestic companies to produce F1 hybrids
- d. A few state governments have set up centre of excellence for protected cultivation and production and supply vegetable seedlings at minimal cost. Farmers can be linked to these units wherever feasible.

The coloured capsicum is largely grown in poly house. Naturally ventilated poly house is ideal for production of quality capsicum and for achieving high productivity. With Average cost of Rs 850 per sq. m, the capital investment for construction of poly house is Rs 34 lakh per acre. The poly house is eligible for capital subsidy under NHB/MIDH schemes of GOI and State Government schemes. Majority of the growers have availed the eligible capital subsidy. With capital subsidy the cultivation capsicum in poly house is more remunerative as the capital cost

incurred by the growers can be recovered in 8 to 10 years without capital subsidy and 4 to 5 years with capital subsidy.

The estimated production cost for protected cultivation of coloured capsicum in one acre area is Rs 600000. The component wise value of the production cost is given in the chart below



The major component of production cost is labour consisting of 46% of cost of production. The scale of finance required is about 180000 per acre of poly house.

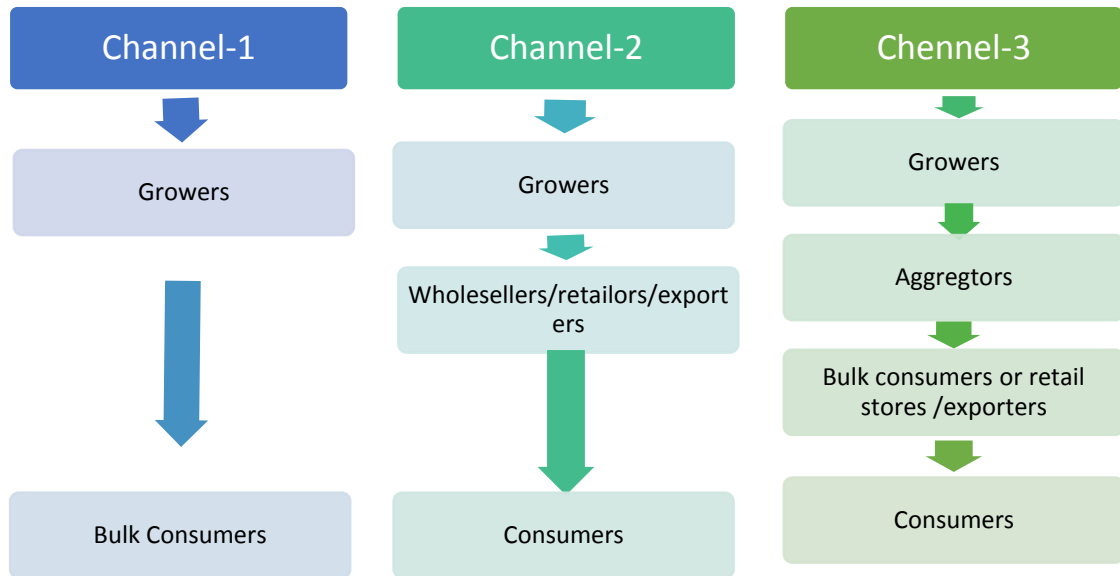
The majority of small growers are not following market oriented production plan as there is no information of market demand and demand forecast for coloured capsicum as the market is mainly operated by the aggregators. There is a need for providing access to market information on daily demand, price, location of demand, buyers contact details etc. so that the price realisation by the growers is higher.

Knowledge on harvesting standards is very important to produce quality fruits with longer shelf life. It was observed that many small growers are not aware of the right stage of harvesting and are not using garden secateurs for harvesting. Fruits are harvested by plucking resulting in damage to fruit stalk, also not retaining adequate stalk with the fruit resulting in lower price realisation.

The fruits with 3 to 4 lobes harvested at right stage of maturity weighing >150 gms are graded as A grade fruits. By adopting good package of practices, about 90 to 95% of grade A fruits can be harvested. It was observed that on account of non-adoption of complete recommended package of practices, majority of small farmers are getting higher ratio of grade B fruits resulting in loss of income due to lower price realisation. There average price realisation for Grade A is about Rs 40/kg against Rs 25 to 30 per kg of grade B fruits.

The coloured capsicum at present is targeted at elite consumers and hotels. The production of coloured capsicum is also very limited to meet the market demand of about 50000 to 60000 tonnes per annum. The entire production is being consumed in the domestic market, very limited production is being exported to Asian countries. Due to targeted market demand and

limited production, the majority of the produce is being marketed through private channels. The existing marketing channels are as under;



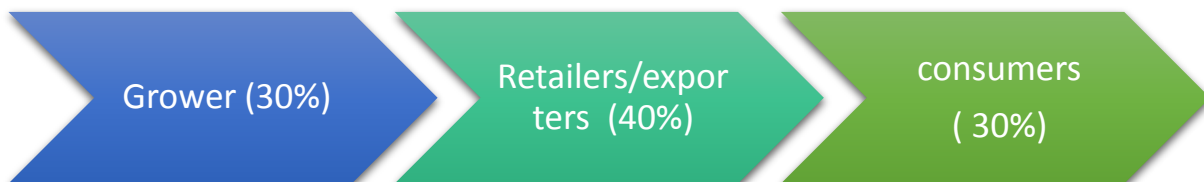
Channel-1: This channel is being followed by large growers having staggered production for meeting assured supply for meeting the regular demand. These growers are directly supplying to the chain of hotels and bulk consumers.



The present average price realisation by the growers marketing directly to bulk consumers is about Rs 60 per kg. The average consumer price is about Rs 100 per kg.

The major issues with this channel is that the purchase price from farmers is linked to market price and fluctuation of prices is very high.

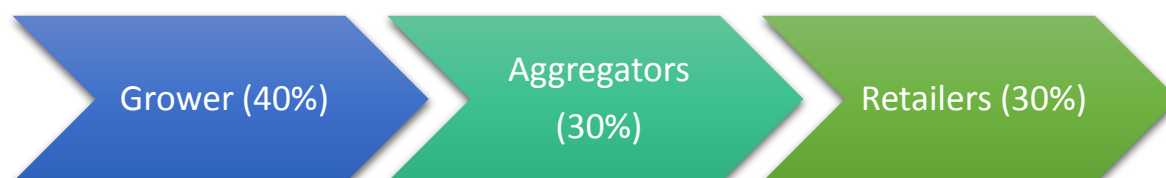
Channel-2: This channel is being followed by small growers. This is a loose value chain wherein the buyers are not pre-determined and growers deal with multiple buyers, either procured at farm gate or supplied to the buyer. The sale price is linked to market prices.



The grower's realisation is about 30% if marketed through this channel. The present average price realisation by the growers is Rs 30 per kg when marketed through retailers / exporters. The middle player realises about 40% of value. The average consumer price is about Rs 100

per kg. The major issues with this channel is also the purchase price from farmers is linked to market price and fluctuation of prices is very high.

Channel-3: This channel is being followed by both large and small growers. The aggregators play an important role in networking between growers and bulk consumers /retailers/exporters. Aggregators buy graded fruits with differential pricing for grades. The present average price realisation by the growers under this model for grade A is Rs 40 per kg, aggregators price is Rs 70 per kg, retailers price is Rs 100 per kg.



On an average the grower realises 40% of consumer price, aggregators and retailers realise 30% each.

At present there is no institutional arrangement for publishing the price movement of coloured capsicum. Due to lack of information on spot price or future price, the growers mainly depend upon the price indicated by the aggregators. The pricing is linked to the following factors;

- Demand and supply
- Movement of price in the local markets
- Fixed price with contract farming arrangement

Only a few growers prefer the fixed price for entire crop season through contract arrangement

At present no FPOs' or growers' collectives of coloured capsicum has been formed. There is a good potential for promoting capsicum growers' FPOs' involving small growers. The advantages of promoting FPO's would be:

- i. FPO's can have their own nurseries and supply seedlings to the members at reduced cost
- ii. Collective input supply for assured quality and cost effectiveness
- iii. Ensuring adequate and timely availability of credit/ finance to the members
- iv. Provide technical support to their members for construction of poly houses and crop production
- v. Direct marketing of produce eliminating aggregators and better price realisation
- vi. Promote value addition and exports

Majority of the small growers suffer huge crop and income losses during production and post-production marketing stages due to lack of data and forecasting mechanism on pest and diseases, market demand, market price etc. Since the coloured capsicum is very high value crop, crop losses and poor price realisation severely affect the financial loss to the growers.

There is a good scope for application of Internet of Things (IOT) technologies in production and post-production and marketing stages and improve the value chain.

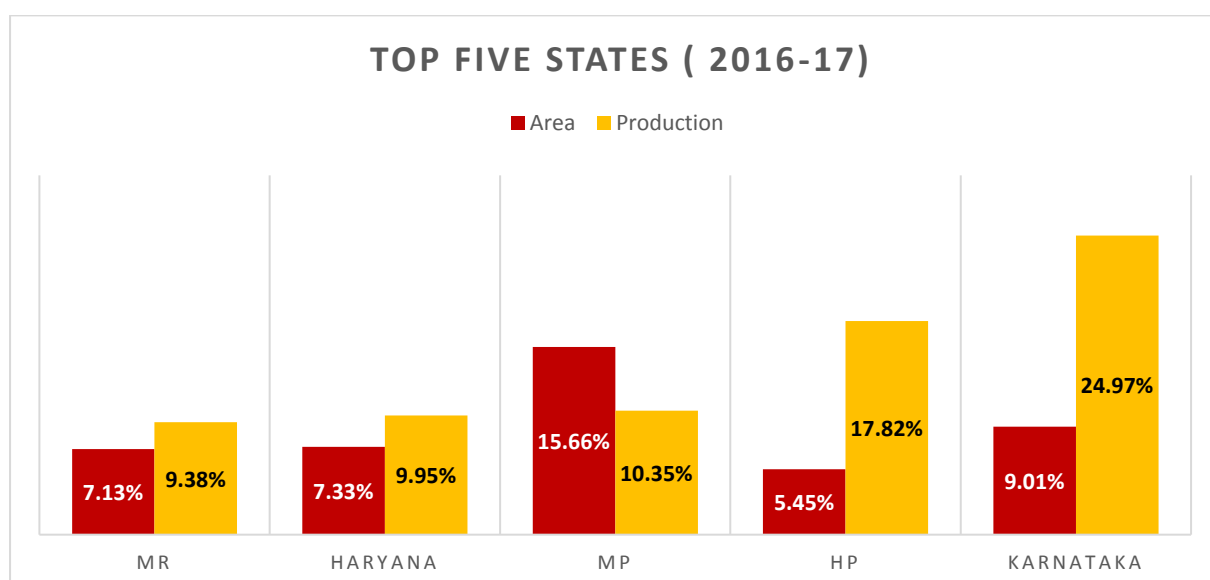
The following recommendations are made form study for implementation

- i. The entire F1 hybrid varieties' seed requirement is being met from imported varieties. The seed cost is one of the major costs of production. There is need for developing F1 hybrids by domestic seed companies in association with IIHR and other Research institutes.
- ii. Need for developing low cost protected cultivation structures without affecting the production and quality of produce. ICAR institutions may be funded for developing and standardisation of low cost poly house structures.
- iii. There is gap in technology adopted by the growers and there is need for strengthening extension services, through either ICAR or universities and use of mobile APPs and other IOT applications in providing extension services. A few Agri. start-ups may be supported for developing the IOT applications for coloured capsicum and protected cultivation of other crops.
- iv. Development of dedicated mobile APP for coloured capsicum to disseminate information of production technologies, pest and disease management and market information will be useful. NABARD may support development of APP
- v. There is need for developing export market for coloured capsicum as domestic market may get saturated with growing area and production. APEDA and ICAR may support the growers in production of exportable quality produce and export.
- vi. In order to promote protected cultivation with bank loan, collateral security norms may be relaxed and rationalised. NABARD may take up the issue with RBI.
- vii. At present there is no scale of finance for protected cultivation of coloured capsicum. Major ROs like Karnataka, Tamil Nadu, Telangana , Maharashtra, Haryana, HP, etc. may take up the issue with SLTCs /DLTC and fix a separate scale of finance for all protected cultivation of crops including coloured capsicum.
- viii. There is good potential for promoting FPOs. NABARD may promote coloured capsicum growers or protected cultivation grower's organisations.
- ix. There is a need to expedite adoption of Model Contract Farming Act by all the states to make contract farming sustainable and beneficial for all the stake holders
- x. National Horticulture Board may publish daily price data on coloured capsicum, so that growers will have access to market prices of major markets and that would help them in price discovery.

1. Introduction

Capsicum (sweet pepper or bell pepper) is the most popular salad vegetable grown in the country. Two types of capsicum are grown commercially, first type is green capsicum cultivated in open condition mainly used as a vegetable and in fast food preparations. Second type is coloured capsicum grown under protected cultivation (poly houses/net houses) and is in good demand in urban markets mostly driven by high end consumers, hotel and catering industry as a salad vegetable and in fast foods preparations.

The total area under capsicum in the country was 45850 ha during the year 2016-17 with total production of 327020 MT¹ State wise area and production are given in the Annexure -I. The top five states Karnataka, Himachal Pradesh, Madhya Pradesh, Haryana and Maharashtra account for about 45 % of the area and 73% of production under capsicum as given in the chart below;



Karnataka is the leading state with production of about 81670 MT with 25% share. The productivity in Karnataka is very high as major production of capsicum is under protected cultivation with year round production. Out of the total production of capsicum, about 20% is coloured capsicum and majority of the production units are located in Karnataka, Himachal Pradesh, Haryana and Maharashtra.

The open cultivated green capsicum yields about 20 to 40 tonnes per hectare in about 4 to 5 months growing period depending upon variety and season. Poly house, cultivated coloured capsicum yields about 80 to 100 tonnes per hectare² in about 10 to 12 months crop duration in southern states and part of Maharashtra. The advantages of protected cultivation are;

- Provides better growing environment to plants

¹ NHB

² IIHR capsicum technical bulletin

- Protects from rain, wind, high temperatures and minimizes the damage of insect pests and diseases thereby improving the quality and yield
- Higher productivity resulting in increased yield
- Facilitates year round production coupled with yield enhancement by 2-3 times as compared to open cultivation.

Due to growing domestic as well as export demand for coloured capsicum, many farmers and entrepreneurs have adopted the protected cultivation of coloured capsicum on commercial scale. There are various sizes of growing units with various levels of technology adoption ranging from shade net house to hi-tech poly house.

The majority of the coloured capsicum growers are small with poly house size ranging from 0.5 acre to 1 acre. The major issues in pre and post production value chain faced by the growers are as under;

- Lack of knowledge on varieties in demand
- High cost of seeds
- Capital intensive
- High recurring cost as compared to open cultivation
- Lack of approved scale of finance for meeting production cost for protected cultivation of capsicum
- Gap in knowledge in planting and training of plants
- Gap in knowledge on control of diseases and Integrated Pest Management
- Lack of knowledge on pesticides residues and banned chemicals
- Lack of knowledge on harvesting standards and export standards
- Lack of direct access to market
- High dependency on aggregators
- High fluctuations in market prices
- Lack of price discovery mechanism
- Lack of information on value chain

2. Study Objectives

The study of coloured capsicum value chain was under taken with following objectives;

Stage		Objectives
A	Pre-production value chain – starting from seedling production to harvesting.	<ol style="list-style-type: none"> 1. Study the cost of production and value chain of seedling and suggest alternatives for reduction of costs 2. Estimate the cost of production and scale of finance 3. Identify the issues in production systems and suggest remedial

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B	Post production value chain from farm to fork.	<ol style="list-style-type: none"> 5. Study the existing marketing systems 6. Study the value chain and players' role and share in the market value 7. Study the feasibility of promoting coloured capsicum Producers Company 8. Policy suggestions for improving the value chain of coloured capsicum

The study was undertaken in Bangalore rural and Bangalore urban districts of Karnataka covering the following players in the value chain of capsicum.

- a. Seed production and marketing companies
- b. Seedling supplying nurseries
- c. Capsicum growers
- d. Research and extension services providers
- e. Capsicum aggregators and marketers
- f. Retail units

List of various stake holders including growers met during the study is given in the Annexure-II

3. Production technology of coloured capsicum under protected cultivation

3.1. Agro climatic conditions

Capsicum is a cool season crop, but it can be grown round the year using protected structures where temperature and relative humidity (RH) can be manipulated. This crop requires day temperature of 25-30°C and night temperature of 18-20°C with relative humidity of 50-60%. If temperature exceeds 35°C or falls below 12°C, fruit setting is affected. Places having high rainfall and humidity are not suitable for its cultivation, since this encourages many foliar diseases.

3.2. Selection of Site

Selection of site for taking up of protected cultivation is a critical step. Places having high rainfall and humidity are not suitable for its cultivation since this encourages many foliar diseases. Also the areas with high wind velocity are not suitable since they are likely to damage the structure and the polyethylene sheet frequently, thereby enhancing the maintenance cost of the structure. It is essential to avoid location or area where heavy rains accompanied with gusty winds are prevalent to avoid damage to the protected structure. Well drained sandy loam soils having good percolation is most suitable to grow capsicum. The soil pH of 6 to 7 and EC < 1 mm hos/cm is ideal for growing capsicums.

3.3. Poly house structures

The poly house is designed depending on the prevailing local climatic conditions and different types of structures are built for protected cultivation. However, cost effective poly house and net house structures are most commonly used to grow coloured capsicum in the country.

3.3.1. Net house (Shade net house):

Growing of vegetables in net house is the cost effective method in many parts of southern states particularly in and around Bangalore, due to easy availability of granite pillars which can give good strength to structure and are highly durable. Net houses are constructed using granite stone pillars of 12 feet height, 8 inch X 4 inch thickness. These pillars are placed 2 feet deep inside the soil with concrete cement grouting. Uneven and sharp edge of stone pillars on the top need to be covered with smooth materials like rubber tubes to avoid tearing of net. A GI wire grid is provided on the top of granite pillar to support the shade net. Over the GI wire grid, 50% HDPE white shade net is fixed to support another layer of shade net (green or black with 35% shade), which is movable or retractable. This additional shade net is used during hot summer mid days (Feb-June), sparingly during winter season and whenever the sunlight is more between 11.00 am to 3.00 pm. UV stabilized 40 mesh nylon net is provided on all sides of the net house.

3.3.2. Poly house

Poly house gives better protection compared to net house due to total avoidance of rain water entry into poly house; hence leaf diseases can be easily controlled. Yield is normally 15-20 per cent more in poly house compared to net house. GI pipes are used to construct poly house and in some cases farmers use wooden or stone pillars which require less initial investment. Transparent UV stabilized polyethylene film, 200 micron thickness is used for covering the poly house roof. It is provided with retractable or movable shade nets at about 11 feet height just below the structures from ground level. The sides of the poly house are covered with 200 micron thick polyethylene film to a height of 3 feet from the ground level, to have better protection from rain splash. Remaining height of side wall is covered with 40 micron white coloured insect proof net from all the four sides.

4. Cultural and Nursery practices

4.1. Selection of cultivars

Growing of capsicum hybrids in green house is useful to obtain continuous and regular flower and fruit setting relatively longer period of 8 to 10 months. Most of the capsicum hybrids produce green fruits that mature to red, orange or yellow depending on the hybrid. The fruits should have characters such as uniform size and shape preferably four lobes, fruit weight of >150g, uniform colouring after attaining complete maturity, with a better shelf life of more than 5 days under ambient conditions. Selected hybrid should be high yielding, with potential annual yield of >40 tonnes /acre. Hybrids should have shorter inter nodal lengths (7 to 10 cm),

attaining maximum height of 10 feet in a crop period of 10 months. Popularly grown commercial hybrids in India include Indra, Yamuna (Green); Bombay, Triple star, Natasha, Inspiration, Pasarella (Red); Sunnycz, Swarna, Orobelle, Bachata (Yellow).

4.2. Nursery raising

Good quality seeds are required for producing better seedlings. The seedlings are raised in pro-trays. About 10000 to 12000 seedlings are required per acre. The pro-trays are filled with sterilized coco peat and seeds are sown, one seed per cell to a depth of ½ cm and covered with the same media. The filled trays are staked one above the other and covered with plastic sheets till germination of seeds.

4.3. Land preparation

The land should be thoroughly ploughed and soil should be brought to fine tilth. Well decomposed organic manure at the rate of 20-25 kgs per sq.mt is mixed with soil. Raised beds are formed after bringing soil to fine tilth. The bed size should be 90-100 cms wide and 15-22 cms height. Between the beds walking space of 45 cm to 50 cm need to be provided.

4.4. Fumigation

The crop beds are drenched using 4 per cent formaldehyde (@4 L/ m² of bed) and covered with black polyethylene mulch sheet. While treating with formalin, care should be taken to wear mask, gloves and apron. Four days after formalin treatment, the polyethylene cover is removed. The beds are raked repeatedly every day to remove the trapped formalin fumes completely, prior to transplanting. Fumigation with formaldehyde helps to minimize the soil borne diseases. Basamid can also be used for soil sterilization.

4.5. Fertilizer application

A basal fertilizer dose of 20:25:20 NPK is required per acre and is applied to the beds uniformly before transplanting in the form of 80 kg calcium ammonium nitrate, 125 kg super phosphate and 32 kg murate of potash or 40 kg sulphate of potash.

4.6. Application of neem cake and Microbial Bio-control Agents

Fifteen days before transplanting, neem cake has to be enriched with bio agents like Trichoderma harzianam and Pseudomonas lilacinous. Neem cake of about 200 Kg is powdered and slightly moistened. Trichoderma harzianam, Pseudomonas lilacinous and Paecilomyces chilmosporea each of two kg are mixed thoroughly to the neem cake. The mixture is covered with wet gunny bags or dry grass and left for 8-10 days. Direct exposure to sunlight and rainfall is avoided. After 10 days, this enriched mixture of neem cake and bio-agent along with 600

kg of neem cake has to be applied uniformly to the beds for an area of one acre. This is highly useful to reduce the problem of soil borne pathogens and nematodes. Azospirillum or Azotobacter or VAM which is a nitrogen fixing bacteria can also be applied to the growing bed.

4.7. Laying of drip line

One 16mm inline drip lateral needs to be placed at the center of the bed having emitting points at every 30 cm in travels with discharges rate of 2ltr/hr or 4 ltr/hr. The drip system to be checked at each emitting point for uniform discharges before covering the beds with polythene mulch.

4.8. Mulching and Spacing

Black polyethylene non-recycled mulch film of 30-100 micron thick, 1.2 m wide, is used to cover the planting beds. Holes of 5 cm diameter are made on the polyethylene film as per recommended spacing (45 cm X 30cm). The planting beds are covered with the film by securing the edges of sheet firmly in the soil. Mulching practice conserves water, controls weeds, and reduces infestation of pests and diseases and results in higher yield and good quality produce.

4.9. Transplanting

Planting beds are watered to field capacity before transplanting. Seedlings of 30-35 days old are used for transplanting. Care should be taken to see that no damage is occurred to roots, while taking out the seedlings from individual cells of pro-trays. Seedlings are transplanted into holes made in polyethylene mulch film at a depth of 5 cm. After transplanting, seedlings are drenched with 3 g/L copper oxy chloride or 3 g/L captan or 2 g/L copper hydroxide solution to the base of seedlings at the rate of 25-30 ml per plant. Watering the mulched beds daily during afternoon by using hose pipe for a week continuously is essential to avoid mortality due to heat trapped by mulch sheet.

4.10. Pruning

Capsicum plants are pruned to retain four stems. The tip of the plant splits into two at 5th or 6th node and are left to grow. These two branches again split into two giving rise to four branches. At every node the tip splits into two giving rise to one strong branch and one weak branch. The pruning is done after 30 days of transplanting at an interval of 8 to 10 days, resulting in bigger fruits with better quality and high productivity. The capsicum plants can also be pruned to two stems and same level of yield can be maintained.

4.11. Training

The main stem of plant is tied with four plastic twine to train along and tied to GI wire grid provided on the top of the plants. This is practiced after four weeks of transplanting. The new branches and plants are trained along the plastic twines.

4.12. Drip irrigation and Fertigation

Drip irrigation is given to provide 2-4 litres of water per square meter per day depending on the season. Water soluble fertilizers are given through fertigation for entire crop growth period, starting from third week after transplanting. Fertigation is to be given twice a week as recommended in the table below:

Sloe	Required fertilizer	Fertilizer dosage per fertigation (kg/ac)
1	19:19:19	4
2	Potassium Nitrate	1.5
3	Calcium Nitrate	1.5

Capsicum crop is sprayed with water soluble fertilizers like potassium nitrate and calcium nitrate at every 3 week interval after 2 months of transplanting @3gms/ltr as foliar application. Apart from these sprays, vegetables special (a micronutrients formulation) @ 5g/ltr are also sprayed.

4.13. Integrated Pests and Diseases Management

Capsicum being relatively long duration (9-10 months) crop in poly house, the management of pest and disease is very important to reduce the adverse effect on the yield, quality and market value of the produce. Hence their identification and management at right stage of the crop should be given importance. The major pests and diseases, their symptoms and their management in capsicum are given below. The major focus has been given on adoption of integrated approach in managing pests and diseases, that helps to reduce the pesticide load, cost of chemicals and avoids the resurgence of pests and diseases.

4.14. Harvesting and yield

Early morning hours are best suited for capsicum harvest. Green capsicum can be harvested at 55 to 60 days after transplanting, yellow capsicum at 70-75 days whereas red capsicum at 80-90 days. Fruits can be harvested once in 3 to 4 days. Yellow and red fruits can be harvested when they have gained 50 -80% of the colour development. After harvest fruits should be kept in cool places and avoid direct exposure to sunlight. The fruits should be handled carefully by adopting clip harvest technique and scuffling should be minimised. Average yield of capsicum is about 30 to 40 tonne/acre.

4.15. Post-Harvest Management

4.15.1 Grading

Capsicums are highly perishable in nature and lose water very rapidly due to shrivelling, drying and softening of the fruit which accelerates deterioration. Good quality fruits are selected and are wiped with clean dry and soft cloth to remove water drops or wetness or powdery residues of pesticides/ fungicides, if any, found on the fruits. Good quality fruits with 2-3 lobes weighing < 150 gram are graded as B grade fruits. Fruits with uniform maturity, colour, shape, size and free from defects spots, bruises or decay and pesticide residues should be used for packing while fruits showing signs of sunscald, mechanical or insect damage, or diseased misshaped and damaged fruits should be discarded. Generally fruits with 3-4 lobes weighing 150 gram and more are grouped as grade A fruits. Only the graded fruits are packed in the cartoon boxes.

4.15.2. Packing and storage

Graded fruits should be packed in CFB cartons (5/7 ply thick) in long distance transport. The optimum conditions for storage of capsicum is 7 to 8°C temperature with high RH (90-95%). The shelf life of capsicum can be increased by single or in multiple layers with paper shreds as cushioning material for 2 to 3 weeks. Capsicums are sensitive to chilling injury below 5° C which leads to softening, pitting, and decay of fruits. Capsicum fruits should not be stored with other ripening fruits especially mangoes, papayas and tomatoes to prevent faster ripening and spoilage.

4.15.3. Shrink wrapping technology of capsicum

Capsicum fruits are shrink wrapped individually. Freshly harvested capsicum fruits are sorted/ graded, washed thoroughly with water or disinfectants, surface dried stalk are trimmed and individual fruits are packed loosely in flexible fill before passing through shrink tunnel (150 to 170°C) for 8 to 10 seconds. Thus shrink wrapped fruits are collected, packed and stored at room temperature or at optimum storage conditions. Film gets shrink wrapped tightly around each fruit and acts as another layer of protective cover. This technology helps in extending the shelf life of fruits, which can be used to transport for long distance market and also for export.

Shrink wrapping technology is useful only when it is coupled with low temperature storage, as otherwise it aggravates spoiling of fruits. It is advantageous over normal storage as it reduces weight loss, maintains firmness and reduces chilling injury, blemishes and secondary infection of fruits. Under low temperature storage (8-12°C), the shelf life of shrink wrapped fruits can be extended up to 6 weeks. It also delays ripening & senescence and thereby

extends storage life of fruits. It provides improved sanitation where spoiled ones can be discarded easily and also facilitates for consumer appeal variety and brand identification.

4.16. Best Practices to Achieve Higher and Quality Yield

- The organic manure/compost applied to the soil should be enriched with Microbial Bio-control Agents like *Pseudomonas fluorescens*, *Paecilomyces lilacinus*, *Trichoderma harzianum* etc. and biofertilizers like, PSB, *Azospirillum Azotobacter*, etc. to enhance soil health.
- Any damage of net or poly sheet in the structure should be immediately repaired to prevent entry of pests and diseases.
- The poly house/ net house should have double door system which is the safest way to prevent the entry of pests and diseases. The doors should be constructed preferably away from roadside.
- Seedlings raised in pro-trays have to be transplanted within 30-35 days after sowing on the main raised planting beds (1/2 ft. above the ground level).
- Regular pruning has to be followed to retain two-third healthy branches and retain one fruit with good shape and size in each branch and remove deformed fruits, if any, at a very early stage.
- Branches are properly tied with plastic twine and other end tied to the supporting GI grid to give strong support and to avoid breakage of branches/ fruits.
- Drip irrigation and fertigation schedules should be followed regularly.
- Pests and disease incidence has to be avoided for adopting prophylactic measures. Proper and recommended quantity and dosage of pesticides and insecticides to be used to control the incidence.
- It is important to maintain hygiene condition in green house and dispose off the rotten, fallen and infected plant debris/ fruits and regularly, preferably every day during evening hours, after completing all the operations of the day.
- Care should be taken not to pinch the apical bud and protect it from the mite infestation.
- Botanicals, Microbial Bio-control Agents, biological agents and biofertilizers should be used as an integrated pest, disease and nutrient management practice.
- Yield should constitute about 90-95% percent of A grade fruits (3-4 lobes, 150-180 gms). Deformed and irregular shaped fruits are to be pinched out at younger stage and fruits with 50-70 per cent colour should be harvested, graded and packed properly.

5. Value chain analysis of coloured capsicum

5.1 Cost of production and value chain of seedlings

The quality seedlings is most important contributor of value chain of capsicum. There is a wide variation in retail price of seed depending upon the variety. All the varieties used for protected cultivation of coloured capsicum are F1 hybrids and produced by multinational

companies or imported. There are no domestic F1 hybrids of coloured capsicum matching with imported varieties in terms of productivity and produce quality. The selection of varieties by the growers depends upon the targeted market and consumers.

The major companies supplying coloured capsicum seeds are Rijkzwaan and Syngenta seed companies and major ruling varieties in the market are Sympathy (Yellow), Bachata (Yellow) and Inspiration (Red) from Rijkzwaan seeds Ltd.

The cost of major ruling varieties of coloured capsicum ranges from Rs 6 to 7 per seed. The price is generally linked to quality of produce, productivity and diseases resistance. The seed cost is very high and raising seedlings requires special skills and structures like poly houses or shade nets. Many decentralised nurseries for production of vegetable seedlings have emerged in the major vegetables including coloured capsicum growing clusters and these units are running successfully as mother units to vegetable production units and have become very important players in supplying assured quality seedlings to the growers.

The advantages of buying seedlings by the growers from the decentralised nurseries are as under

- Assured quality seedlings of desired varieties
- Savings in time and cost for raising nurseries (30 days)
- Option to decide crop and varieties in the last minute
- Avoidance of losses due to poor seed germination , nurseries disease etc.,

The major inputs for raising seedlings are F1 hybrid seeds, pro-trays, growing media, plant protection chemicals, nutrients and labour apart from capital cost on poly house, irrigation systems and growing stands.

Value chain analysis considering only recurring cost for production of 10000 seedlings is given in the Annexure-III.

The abstract of the value chain of coloured capsicum seedling production and share of various stake holders in the value chain of seedlings is given in the chart below;



The major benefit of value chain of about 85.70% realised by the seed companies due to monopoly of a few seed companies which are in the production of F1 hybrid coloured capsicum seeds. The average cost of seedling distributed to farmers is about Rs 8. Of which the average cost of seed is Rs 7 and cost raising seedling is about Rs 0.75 and the nursery retain net margin of Rs 0.25 per seedling.

The following suggestions emerged from the study to reduce the cost of seedlings to the farmers.

- a. Developing simple cost effective nursery technology for raising quality seedlings with minimal cost by the growers
- b. Breeding of suitable F1 hybrids by ICAR Research Institutions
- c. Encouraging domestic companies to produce F1 hybrids
- d. A few state governments like Karnataka, Telangana, Karnataka etc., have set up centre of excellence for protected cultivation and production and supply of vegetable seedlings at minimal cost. Farmers can be linked with these units wherever feasible.

State Horticulture Departments, ICAR and State Agriculture Research and Extension units may be roped in for promoting low cost seedlings as suggested above.

5.2. Capital cost and production cost

5.2.1. Capital cost

The coloured capsicum is mainly grown in poly house. Naturally ventilated poly house is ideal for production of quality capsicum and for achieving high productivity. The capital investment for pucca poly house with GI frame and UV resistance 200 micro polyethylene sheet cover and fertigation and fogging system works to Rs 800 to 900 per sq. m depending upon the location. With Average cost of Rs 850 per sq. m, the capital investment for construction of poly house is Rs 34 lakh per acre.

Majority of the capsicum growers covered under study have gone for cultivation of capsicum in poly house. The average size of poly house is about one acre (4000 sq. m). The poly house is eligible for capital subsidy under NHB/MIDH schemes of GOI and under State Government schemes. Majority of the growers have availed the eligible capital subsidy. With capital subsidy the cultivation of capsicum in poly house is more remunerative as the capital cost incurred by the growers can be recovered in 8 to 10 years without capital subsidy and in 4 to 5 years with capital subsidy.

5.2.2. Cost of production of coloured capsicum and scale of finance

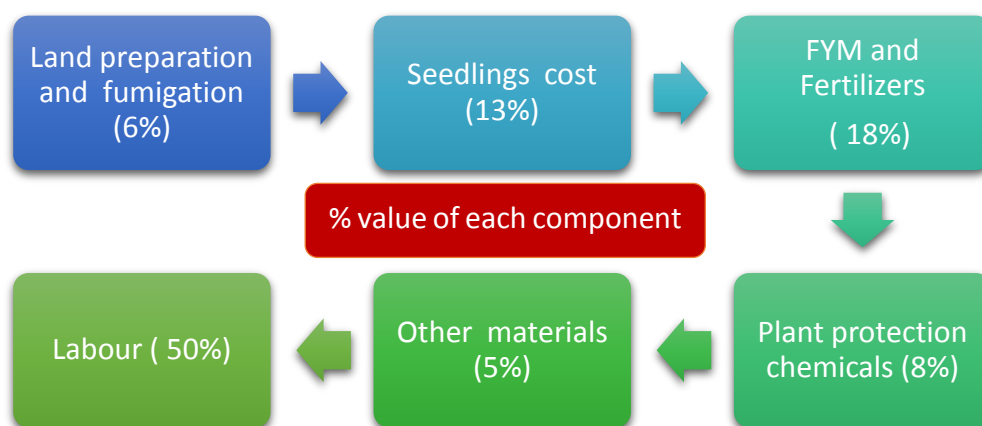
Traditionally green capsicum is cultivated in open field for shorter duration of 4-5 months. The production cost is comparable with any other vegetable crops like tomato, brinjal, chillies etc. The scale of finance for cultivation of green capsicum in open field is fixed by the DLTC and banks are financing for green capsicum cultivation in open field. The scale of finance adopted by the banks is reported to be adequate by green capsicum growers. The scale of finance approved in Bangalore rural district is Rs 60500 per acre and Karnataka State average approved scale of finance is Rs 51341 per acre. District wise approved scales of finance for Karnataka for the year 2018-19 for cultivation of capsicum is given in the Annexure-IV.

The cultivation of coloured capsicum under poly houses and shade nets is highly intensive cultivation with production more than 2 to 3 times as compared to open cultivation and also

crop duration is 10 to 12 months depending upon the crop management. The production cost for coloured capsicum under poly house is high due to the following reasons;

- High cost seedlings
- Additional cost for fumigation of soils
- High incidence of pest and diseases necessitating more number of sprays
- Use of liquid fertilizers
- High number of labour for training, spraying harvesting and grading etc.
- Duration of the crop is also twice that of open cultivation
- Handling of high production

The estimated production cost for protected cultivation of coloured capsicum in one acre area is Rs 600000. Detailed break-up of the cost is given in the Annexure-V and VI The component wise % of value of the production cost is given in the chart below



The major component of production cost is labour consisting of 50% of cost of production. The estimated scale of finance for coloured capsicum for production in poly house is as under:

Total cost of production per crop/acre	Rs 600000
The cost of production for first four months (40% of production cost) as farmers get adequate cash flows from sale of produce and don't need any finance from 5 th month onwards .	Rs 240000
Margin by the growers (25% of the first four months cost)	Rs 60000
Scale of finance required	Rs 180000

The scale finance required is about 180000 per acre of poly house

It was also observed that majority of the farmers have not been given KCC cards and also not getting interest subvention. There is a need for creating awareness among banks about

the need for sanction of KCC card limits and considering ST limits sanctioned to capsicum growers and extend interest subvention scheme benefit.

The production cost can be reduced by adopting the following measures

- Raising of own seedlings
- Periodical fumigation of soil
- Crop rotation
- Following recommended prophylactic measures
- Involvement of family labour

5.2.3. Production issues

The protected cultivation of coloured capsicum requires good skill and knowledge in production management. The incidence of pest and diseases are very high under poly houses as compared to open cultivation, if neglected. Adoption of regular recommended package of practices and prophylactic measures are critical in achieving high production with minimal grade B fruits and with no residuals of plant protection chemicals. Major gaps in production technology adopted by the growers are as under;

- Poor selection of site without linkages and infrastructure
- Poor quality construction of poly houses
- Wrong choice of varieties
- Unscientific training and maintenance of the plants
- Lack of knowledge on symptoms and control measures of the pest and diseases
- Application of over dosages of fertilizers and plant protection chemicals resulting in high cost of production and poor quality of produce
- Lack of knowledge on harvesting standards and harvesting methods
- Lack of knowledge on markets and market prices

5.3. Production planning, harvesting standards and grading of coloured capsicum

5.3.1. Production Planning

With recommended spacing, about 10000 plants can be planted in the poly house of one acre size (4000 Sq. m). The production per plant will be about 4 kg under good management. With this productivity one acre well managed crop can produce about 40 tonnes of fruits per annum. The crop period varies from 10 -12 months depending upon the management of the crop. With average harvesting period of about 8 months with monthly production from one acre of poly house is about 5 tonnes.

The majority of small growers are not following market oriented production plan as there is no information of market demand and demand forecast for coloured capsicum as the market is mainly operated by the aggregators. There is a need for providing access to market

information on daily demand, price, location of demand, buyers contact details etc. so that the price realisation by the growers will be higher. Market information could be provided through mobile APP and there is a need for developing dedicated APP for coloured capsicum.

5.3.2. Harvesting Standards

Knowledge on harvesting standards is very important to produce quality fruits with longer shelf life. The stage of harvesting depends upon the targeted market, mode of transportation, storage method and period of storage. The right stage of harvesting is when fruits develop 50 to 80% of their colour either red or yellow. For distant markets involving transportation and storage, the fruits are recommended for harvesting at 50% colour development and for local market at 80% colour development.



The recommend method of harvesting of fruits is using garden secateurs leaving adequate stalk of the fruit intact without damage.

It was observed that many small growers are not aware of the right stage of harvesting and are not using garden secateurs for harvesting. Fruits are harvested by plucking resulting in damage to fruit stalk or no stalk is retained with the fruit resulting in lower price realisation.

5.3.3. Grading

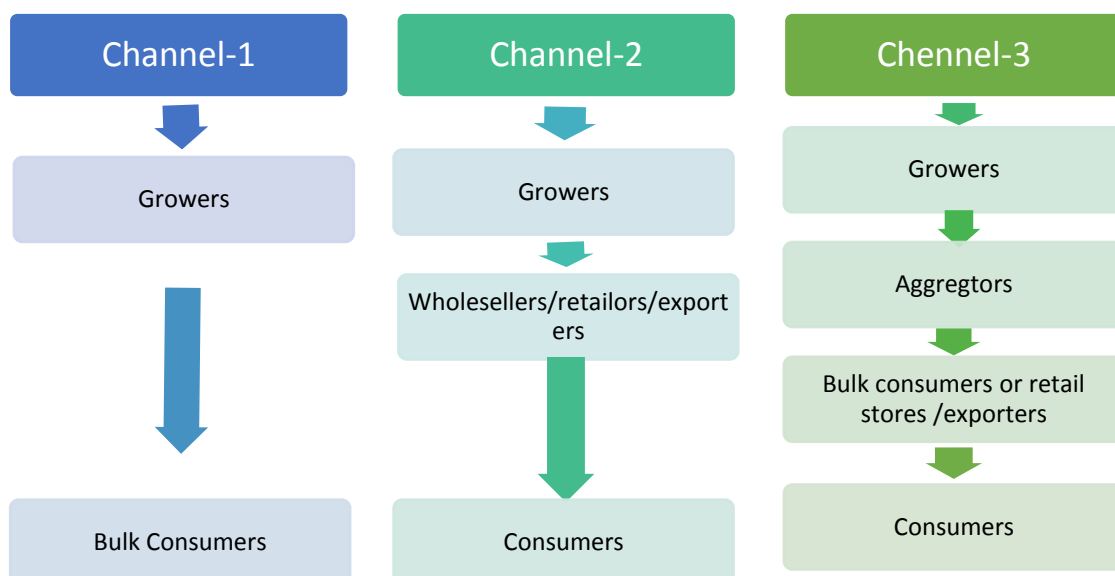
The fruits with 3 to 4 lobes harvested at right stage of maturity weighing >150 gms are graded as A grade fruits. By adopting good package of practices about 90 to 95% of grade A fruits can be harvested and remaining will be grade B.



It was observed that non-adoption of complete recommended package of practices, majority of small farmers are getting higher ratio of grade B fruits resulting in loss of income due to lower price realisation. The average price realisation for Grade A is about Rs 40/kg against Rs 25 to 30 per kg of grade B fruits.

5.4. Existing marketing systems of coloured capsicum

The marketing of coloured capsicum at present is targeted at elite consumers and hotels. The production of coloured capsicum is also very limited to meet the market demand of about 50000 to 60000 tonnes per annum. The entire production is being consumed in the domestic market, very limited production is being exported to Asian countries. Due to targeted market demand and limited production, the majority of the produce is being marketed through private channels. The existing marketing channels are as under;



Channel-1: This channel is being followed by large growers having staggered production for meeting assured supply for meeting the regular demand. These growers are directly supplying to the chain of hotels and bulk consumers. The sale price is linked to market prices. Only quality produce of grade A fruits are preferred by the buyers. The produce is supplied in bulk or retail packing as per the arrangement between the grower and buyer. The merits and demerits of marketing through this channel are;

For growers	<ul style="list-style-type: none"> • No assured price • higher price realisation • Market driven • No technical support
For bulk consumers	<ul style="list-style-type: none"> • Assured quality supply • Low price due to direct supply

The value chain analysis of channel-1 is given in the chart



The present average price realisation by the growers marketing directly to bulk consumers is about Rs 60 per kg. The average consumer's price is about Rs 100 per kg.

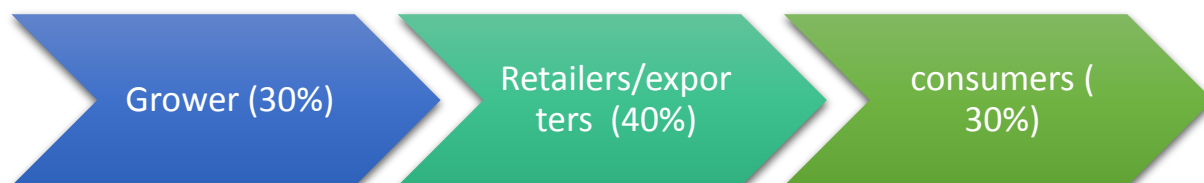
The major issue with this channel is the purchase price from farmers is linked to market price and fluctuation of prices is very high.

The gross income, net income and IRR for poly house under this channel of marketing is given in the Annexure VII. The IRR for poly house investment of about Rs 34 lakh per acre for cultivation of coloured capsicum works out to 109% under this channel.

Channel-2: This channel is being followed by small growers. This is a loose value chain wherein the buyers are not pre-determined and growers deal with multiple buyers either procured at farm gate or supplied to the buyer. The sale price is linked to market prices. Buyer undertakes grading etc. after buying entire produce from the growers. The merits and demerits of marketing through this channel are;

For growers	<ul style="list-style-type: none"> • No assured price • low average price realisation • Market driven • No technical support
-------------	--

For retail stores /exporters	<ul style="list-style-type: none"> • Assured supply • Supply of preferred varieties • Regular supply • Higher margin
For bulk consumers	<ul style="list-style-type: none"> • Assured quality supply • Low price due to direct supply



The grower’s realisation is about 30% if marketed through this channel .The present average price realisation by the growers is Rs 30 per kg when marketed through retailers / exporters. The middle player realises about 40% of value. The average consumer’s price is about Rs 100 per kg.

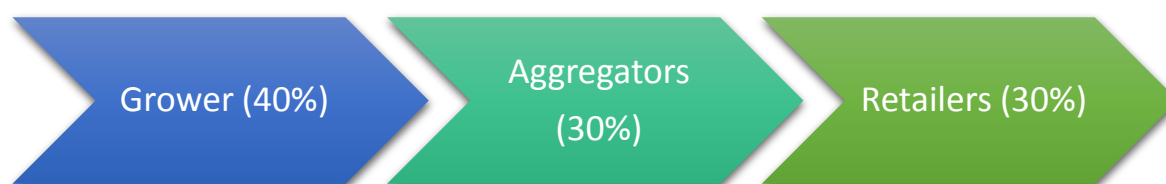
The major issue with this channel is the purchase price from farmers is linked to market price and fluctuation of prices is very high as under channel -1

The gross income, net income and IRR for poly house under this channel of marketing is given in the Annexure VIII. The IRR for poly house investment of about Rs 34 lakh per acre for cultivation of coloured capsicum works out to 11.34% under this channel.

Channel-3: This channel is being followed by both large and small growers. The aggregators play an important role in networking between growers and bulk consumers /retailers/exporters. Aggregators buy graded fruits with differential pricing for grades. The advantages and disadvantages of marketing through this channel for growers are;

Advantages	<ul style="list-style-type: none"> • Assured predetermined price • Procurement at farm gate • Assured long term market • Technical support • Input supply
Disadvantages	<ul style="list-style-type: none"> • High fluctuation in price if not pre contracted • Lack of knowledge on spot and future price leading to exploitation by aggregators • Value addition in the hands of aggregators

The present average price realisation by the growers under this model for grade A is Rs 40 per kg, aggregators price is Rs 70 per kg, retailers price is Rs 100 per kg .The value chain analysis of this channel is given in the chart



An average the grower realises 40% of consumer price, aggregators and retailers realise 30% each.

The gross income, net income and IRR for poly house under this channel of marketing is given in the Annexure IX. The IRR for poly house investment of about Rs 34 lakh per acre for cultivation of coloured capsicum works out to 35.96% under this channel.

5.5. Pricing mechanism

At present there is no institutional arrangement for publishing the price movement of coloured capsicum. Due to lack of information on spot price or future price, the growers mainly depend upon the price indicated by the aggregators. The pricing is linked to the following factors;

- Demand and supply
- Movement of price in the local markets
- Fixed price with contract farming arrangement

Only a few growers are having fixed price for entire crop season through contract arrangement. Majority of the aggregators prefer flexible pricing depending upon the market price movement.

5.6. Scope for promoting capsicum producers companies

At present no FPO's or grower's collectives of coloured capsicum has been formed. There is a good potential for promoting capsicum grower's FPO's involving small growers. The advantages of promoting FPO's would be:

- i. FPO's can have their own nurseries and supply seedlings to the members at reduced cost
- ii. Collective input supply for assured quality and cost effectiveness
- iii. Ensuring adequate and timely availability of credit/ finance to the members
- iv. Provide technical support to their members for construction of poly houses and crop production

- v. Direct marketing of produce eliminating aggregators and better price realisation
- vi. Promote value addition and exports

5.7. Application of IOT

Majority of the small growers are suffering huge crop and income loss during production and post-production and marketing stages due to lack of data and forecasting mechanism. The coloured capsicum is very high value crop and crop losses and poor price realisation severely affect the growers. There is a good scope for application of Internet of Things (IOT) technologies in production and post-production and marketing stages and improve the value chain;

Stage	IOT Application
Production stage	<ul style="list-style-type: none"> • Water efficiency • Efficient nutrient management • Pest and disease forecast • Pest and disease diagnosis • Soil health diagnosis • Crop yield forecast • Forecast of harvesting calendar
Post production and marketing	<ul style="list-style-type: none"> • Residual analysis • Source Trace • Price forecast • Forecast of market demand • Buyers and seller network.

There are lot of start-ups in the country providing various solutions. Linking these start-ups with coloured capsicum growers will help the growers in increased production, productivity, quality of produce and better price realisation.

6. Conclusion

- i. The quality seedlings is most important contributor of value chain of capsicum. All the varieties used for protected cultivation of coloured capsicum are F1 hybrids and produced by multinational companies or imported. There are no domestic F1 hybrids of coloured capsicum matching with imported varieties in terms of productivity and produce quality resulting in very high cost of seeds and seedlings.
- ii. With average cost of Rs 850 per sq. m, the capital investment for construction of poly house is Rs 34 lakh per acre. The poly house is eligible for capital subsidy under NHB/MIDH schemes of GOI and State government subsidy schemes .Majority of the growers have availed the eligible capital subsidy. With capital subsidy, the cultivation of capsicum in poly house is more remunerative as the capital cost incurred by the

growers can be recovered in 5 to 6 years. The units without capital subsidy may require very long period for repayment of loan.

- iii. Since the capital cost is very high, banks are seeking collateral of urban properties and other liquid assets as the value of agriculture land is low and primary security is not covering the loan component of poly house. There is a need for rationalisation of security norms for financing poly houses.
- iv. The production of coloured capsicum is very limited to meet the market demand of about 50000 to 60000 tonnes per annum. Due to targeted market demand and limited production, the majority of the produce is being marketed through private channels. Unlike in other agricultural commodities, the market players are limited as produce is not being marketed through APMCs.
- v. The scale of finance for open field cultivation of green capsicum is being adopted by the banks for financing production credit for cultivation of coloured capsicum. The production of coloured capsicum in poly houses and shade nets is highly intensive with production more than 2 to 3 times as compared to open cultivation and also crop duration is 10 to 12 months depending upon the crop management. The recommended scale of finance for coloured capsicum is Rs 180000. The average scale of finance for cultivation of green capsicum in open field in Karnataka is Rs 51000.
- vi. Majority of the coloured capsicum growers are not getting Agricultural production credit and have not been given KCC and also not covered under interest subvention scheme. There is need for creating awareness among banks about the need for sanction of KCC limits / ST limits to capsicum growers with interest subvention benefit.
- vii. Lack of knowledge on construction of poly houses and production technology of capsicum under poly houses is major issue affecting cost of production , quality of produce and price realisation .
- viii. At present three channels of marketing are existing. Channel-1, direct market linkage with the bulk consumers and retail units found to be more beneficial for the growers against the channel -2 system of marketing involving middle man which is not beneficial for the growers, as the traders are exploiting the growers. The third channel through aggregators with pre contracted price and contract farming arrangement is providing stable market and income to the farmers.
- ix. There is no institutional arrangement for price discovery mechanism of coloured capsicum, it mainly depended on the price quoted by the aggregators. The majority of small growers are not following market oriented production plan as there is no information of market demand and demand forecast for coloured capsicum as the market is mainly operated by the aggregators. There is a need for providing access to market information on daily demand, price, location of demand, buyers contact

details etc. so that the price realisation by the growers will be higher. All the market information could be provided through mobile APP and there is a need for developing a dedicated APP for coloured capsicum.

- x. There is a good potential for promoting coloured capsicum Producers Company / grower collectives to empower the growers in direct marketing of produce and sourcing of inputs and seeds and improve the margin by reducing production cost and higher price realisation.
- xi. There is very good scope for IOT application in coloured capsicum value chain of both Production and marketing. Appropriate applications can reduce the cost of production, help in production planning, and improve the quality of produce and networking of all growers with markets.
- xii. There is a good scope for exporting coloured capsicum .However due to high residuals of plant protection chemicals and poor quality, exports are limited to Asian markets. There is a need for developing protocol for production of coloured capsicum meeting importing standards of major colour capsicum consuming countries.
- xiii. Lack of cold chain such as pre cooling units, refrigerated vans and cold storages is affecting the storage life, quality of fruits and supply chain of coloured capsicum. There is a need for developing cold chain by either capsicum growers as common service centre or by the aggregators as a service providers.

7. Recommendations

- xi. The entire F1 hybrid varieties seed requirement is being met from imported varieties. The seed cost is one of the major costs of production. There is need for developing F1 hybrids by domestic seed companies in association with IIHR and other Research institutes.
- xii. There is need for developing low cost protected cultivation structures without affecting the production and quality of produce. ICAR institutions may be funded for developing and standardisation of low cost poly house structures.
- xiii. There is gap in technology adopted by the growers and there is need for strengthening extension services, through either ICAR or universities and use of mobile APPs and other IOT applications in providing extension services. A few Agri. start-ups may be supported for developing the IOT applications for coloured capsicum and protected cultivation of other crops.
- xiv. Development of dedicated mobile APP for coloured capsicum to disseminate information of production technologies, pest and disease management and market information will be useful. NABARD may support for development of APP

- xv. There is need for developing export market for coloured capsicum as domestic market may likely get saturated with growing area and production. APEDA and ICAR may support the growers in production of exportable quality produce and export.
- xvi. In order to promote protected cultivation with bank loan, collateral security norms may be relaxed and rationalised. NABARD may take up the issue with RBI.
- xvii. At present there is no scale of finance for protected cultivation of coloured capsicum. Major ROs like Karnataka, Tamil Nadu, Telangana, Maharashtra, Haryana, HP, etc. may take up the issue with SLTCs /DLTC and fix separate scale of finance for protected cultivation of all crops including coloured capsicum.
- xviii. There is good potential for promoting FPOs. NABARD may promote coloured capsicum growers or protected cultivation grower's organisations.
- xix. There is need to expedite adoption of Model Contract Farming Act by all the states to make contract farming sustainable and beneficial for all the stake holders
- xx. National Horticulture Board may publish daily price data on coloured capsicum, so that growers will have access to market prices of major markets and that would help them in price discovery.

Annexure-I: Area and production of Capsicum

Area 000 ha

Production 000 MT

Sloe	State	2014-15		2015-16		2016-17 (provisional)	
		Area	Production	Area	Production	Area	Production
1	Karnataka	3.62	49.24	3.43	56.70	4.13	81.67
2	Himachal Pradesh	2.07	34.13	2.47	57.41	2.50	58.29
3	Madhya Pradesh			7.19	33.84	7.18	33.84
4	Haryana			3.28	25.89	3.36	32.53
5	Maharashtra	1.60	18.68	3.80	29.33	3.27	30.67
6	J&K	1.05	23.16	1.05	23.16	1.05	23.16
7	Jharkhand	18.63	17.35	18.63	17.35	18.82	17.52
8	Uttarakhand	2.74	14.61	2.47	13.77	2.48	13.78
9	Odisha	0.40	5.83	0.46	6.77	0.46	6.79
10	Telangana	0.50	5.65	0.37	4.70	0.52	6.63
11	Punjab			0.31	4.81	0.33	4.96
12	Meghalaya	0.50	4.40	0.55	4.32	0.61	4.94
13	Mizoram	0.32	3.59	0.33	3.68	0.34	3.67
14	Andhra Pradesh	0.10	1.45	0.13	2.18	0.11	3.64
15	Assam	0.38	2.64	0.38	2.64	0.38	2.64
16	Tripura	0.14	1.06	0.14	1.10	0.14	1.09
17	Others#	0.10	0.71	0.96	0.81	0.17	1.2
	Total	32.15	182.50	45.95	288.46	45.85	327.02

Source: Horticulture at glance 2017, NHB

Other States: TN, WB, Kerala, Arunachal Pradesh, Sikkim, Manipur

Annexure-II: List of stake holder met during the study

1. Nurseries
 - a. Mr Vasanth
 - b. Mr Prakash
 - c. Mr Mohan
2. Capsicum growers
 - a. Mr. Vasanth
 - b. Mr Nikil Srivastava
 - c. Mr Ananad
 - d. Mr Srinivasula Naidu
 - e. Mr Rajanna
 - f. Mr Baskar
 - g. Mr Nagesh
 - h. Mr Shivarajanna
 - i. Mr Babu
 - j. Mr Ravikumar
3. Marketing
 - d. Mr Sudhindra
 - e. Mr Radha Krishna
 - f. Big market store
 - g. Reliance fresh store
 - h. Natures Basket store
4. R&D and Extension Services
 - i. Dr Dinesh , Director IIHR
 - j. Dr Balakrisna , Scientist , IIHR
 - k. Dr Hebbar , Scientist , IIHR
 - l. Dr Sudhakar Rao Scientist , IIHR
 - m. Mr Subbanna SADH , Dept. of Horticulture
5. Seed producers
 - n. Mr Venugopal Reddy, RIJKZWAAN Seeds ltd.

Annexure-III: Value chain analysis of coloured capsicum seedlings

Batch size: 10000 seedlings

Sl. No	Details	Amt (Rs)
1	Cost of 10000 seeds @ Rs 6 per seed	60000
2	Cost of pro-trays 100 @ Rs 15	1500
4	Cost coco peat @Rs 4 kg @1.25 kg per pro-tray	500
5	Cost of plat protection chemicals (LS)	1500
6	Cost plant nutrients (LS)	1500
7	Labour cost (45 days) 10 labour @ Rs 250/man-day	2500
	Total cost from 1 to 7	67500
8	Cost of production per seedling (Rs)	6.75
9	Selling price at nursery gate per seedling	7
10	Net income per seedling	0.25

Nurseries also raise the seedlings as a custom service provider and charge Rs 1 as a seedling raising cost. Seeds are supplied by the farmers

Annexure-IV: District-wise scales of finance for cultivation of green capsicum in open field in Karnataka.

Sloe	Name of the district	Approved scale of finance 2018-19 (Rs /acre)
1	Bagalkot	100000
2	Bengaluru Urban	60500
3	Bengaluru Rural	60500
4	Ramanagar	60500
5	Belgaum	30000
6	Bellary	NA
7	Bidar	NA
8	Bijapur	20000
9	Chickmagalur	30000
10	Chitradurga	30000
11	Davangere	33000
12	Dharwad	30000
13	Gadag	30000
14	Haveri	30000
15	Gulburga	80000
16	Yadgiri	80000
17	Hassan	NA
18	N.Kanara	NA
19	Kodagu	NA
20	Kolar	100000
21	Chickballapur	100000
22	Mandya	30000
23	Mysore	30000
24	Chamarajnagar	30000
25	Raichur	55000
26	Koppal	55000
27	S.Canara	NA
28	Udupi	NA
29	Shivamogga	NA
30	Tumkur	55000
Average for Karnataka		51341

Source: SLBC

Annexure-V: Cost of production of coloured capsicum (Rs /acre)

Sloe	Details	Amt (Rs)
1	Land preparation (LS)	25000
2	Fumigation (average cost /crop)	10000
3	Farm Yard Manure 30 tonnes @3000 Rs/MT	90000
4	Mulching cost (average cost/crop)	16000
5	Cost seedlings including 10% extra Rs 7 per seedlings for 11000	77000
6	Cost training material (average /crop) (LS)	2000
7	Cost of plant protection chemicals (LS)	50000
8	Cost of water soluble chemical fertilizers	20000
9	Cost of labour for planting , training, pruning, spaying , harvesting and other cultural practices (1500 man days @ Rs 300)	300000
10	Cost of maintenance of poly house and other structures (average /crop)	10000
11	Total production cost	600000
12	Average cost per kg of production of 40 tonnes per acre	15

Annexure-VI: Yield and income coloured capsicum (Rs /acre)

Sloe	Details	Amt (Rs)
1	Average yield (tonnes/acre)	40
2	Yield of Grade A fruits (tonnes /acre)	36
3	Average sale price of Grade A fruits (Rs /tonne)	40000
4	Gross income from sale of Grade A fruits	1440000
5	Yield of Grade B fruits (tonnes /acre)	4
6	Average sale price of Grade B fruits (Rs/tonne)	25000
7	Gross income from sale of Grade A fruits	100000
8	Total gross income	1540000
9	Total cost of production	600000
10	Total net income	940000
11	Average gross income per kg	38.5
12	Average cost of production per kg	15
13	Average net income per kg for farmers	23.5
14	Average price realised by aggregators/whole sellers	70
15	Net income after meeting expenses like storage. packaging and transport	15
16	Retail consumers price	100
17	Net income by the retailers after meeting storage loss , unsold stocks etc.	20

Annexure-VII: Direct marketing under Channel -I -Internal Rate of Return (IRR) Unit size : one acre poly house

		Rs lakhs									
Details		Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8	Year-9	Year-10
Costs											
1.Investment cost		34.00	0.00	0.00	4.00	0.00	0.00	0.00	4.00	0.00	0.00
2.Recurring costs		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
3.Total Cost		40.00	6.00	6.00	10.00	6.00	6.00	6.00	10.00	6.00	6.00
Benefits											
4 Gross Income		24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
5.Total Benefits		24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
6. Net Income		16.00	18.00	18.00	14.00	18.00	18.00	18.00	14.00	18.00	18.00
IRR	109.22%	<p>Assumptions for cultivation capsicum in Bangalore cluster</p> <ol style="list-style-type: none"> 1. Average capital cost Rs 34 lakhs per acre @ Rs 850 per sq. m 2. Average cost of production Rs 6 lakhs per acre per crop 3. Poly sheet replacement at every four years in travels @ Rs 4 lakh per acre 4. Average production of 40 MT /annum/acre and sale prices Rs 60 per kg 									
NPW at 15 % DF (Rs lakh)	84.20										
NPW Cost at 15% DF (Rs lakh)	76.84										
NPW Benefit at 15 % DF (Rs lakh)	161.04										
BCR	2.10										

Annexure-VIII : Marketing through middle man under Channel 2 -Internal Rate of Return (IRR) Unit size : one acre poly house

Rs lakhs											
Details		Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8	Year-9	Year-10
Costs											
1.Investment cost		34.00	0.00	0.00	4.00	0.00	0.00	0.00	4.00	0.00	0.00
2.Recurring costs		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
3.Total Cost		40.00	6.00	6.00	10.00	6.00	6.00	6.00	10.00	6.00	6.00
Benefits											
4 Gross Income		12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
5.Total Benefits		12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
6. Net Income		28.00	6.00	6.00	2.00	6.00	6.00	6.00	2.00	6.00	6.00
IRR	11.34%	<p>Assumptions for cultivation capsicum in Bangalore cluster</p> <ol style="list-style-type: none"> 1. Average capital cost Rs 34 lakhs per acre @ Rs 850 per sq. m 2. Average cost of production Rs 6 lakhs per acre per crop 3. Poly sheet replacement at every four years in travels @ Rs 4 lakh per acre 4. Average production of 40 MT /annum/acre and sale prices Rs 30 per kg 									
NPW at 15 % DF (Rs lakh)	3.68										
NPW Cost at 15% DF (Rs lakh)	76.84										
NPW Benefit at 15 % DF (Rs lakh)	80.52										
BCR	1.05										

Annexure-IX :Marketing through aggregators under Channel -3 -Internal Rate of Return (IRR) Unit size : one acre poly house

		Rs lakhs									
Details		Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8	Year-9	Year-10
Costs											
1.Investment cost		34.00	0.00	0.00	4.00	0.00	0.00	0.00	4.00	0.00	0.00
2.Recurring costs		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
3.Total Cost		40.00	6.00	6.00	10.00	6.00	6.00	6.00	10.00	6.00	6.00
Benefits											
4 Gross Income		16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
5.Total Benefits		16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
6. Net Income		24.00	10.00	10.00	6.00	10.00	10.00	10.00	6.00	10.00	10.00
IRR	35.96%	<p>Assumptions for cultivation capsicum in Bangalore cluster</p> <ol style="list-style-type: none"> 1. Average capital cost Rs 34 lakhs per acre @ Rs 850 per sq. m 2. Average cost of production Rs 6 lakhs per acre per crop 3. Poly sheet replacement at every four years in travels @ Rs 4 lakh per acre 4. Average production of 40 MT /annum/acre and sale prices Rs 40 per kg 									
NPW at 15 % DF (Rs lakh)	30.52										
NPW Cost at 15% DF (Rs lakh)	76.84										
NPW Benefit at 15 % DF (Rs lakh)	107.36										
BCR	1.40										