Model Bankable Project on Hi-Tech Agriculture

[Document subtitle]

JULY 12, 2015

NATIONAL BANK FOR AGRICULTURE AND RURAL DEVELOPMENT

Punnen Road, Statue, Trivandrum, Kerala

Acknowledgement

We express our sincere gratitude to the various stakeholders involved in the process of finalising this document. These include the various Government Departments and farmers and Agri-entrepreneurs at the district level who have been instrumental in helping us to collect various ground level data used for estimation purposes.

Published by

National Bank for Agriculture and Rural Development
Kerala Regional Office
Punnen Road, Statue
Thiruvananthapuram – 695001

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Foreword

Poly houses are basically naturally ventilated climate controlled structures used mainly for growing of vegetables, floriculture, planting material acclimatization, fruit crop growing for export market etc. In conventional Agronomical practices, the crops are grown / cultivated in the open field under natural conditions where the crops are more susceptible to sudden changes in climate i.e. temperature, humidity, light intensity, photo period and other conditions due to which the quality and yield of a particular crop can get affected and may be decreased. By providing uniform climatic conditions and targeted application of fertilisers and pesticides we are able to realise higher and uniform yields far above normal cultivation practices.

NABARD is involved in supporting a few projects of Hi-tech Agriculture. The Government of Kerala through the line Departments of Agriculture and Horticulture and the National and State Horticulture missions are also supporting poly house construction in a big way through various subsidies.

Accordingly, it is felt that the model bankable project presented in this booklet will go a long way in helping bankers and other stakeholders in appraising and sanctioning projects under this category.

Ramesh Tenkil
Chief General Manager

Introduction

Precision farming is generally defined as information and technology based farm management system to identify, analyse and manage variability within fields for optimum profitability, sustainability and protection of the land resource. Precision farming is concerned more with managing small areas within fields rather than on the fields itself and presumes that the farmer who effectively uses information earns higher returns than those who do not. However in the Indian Context with its severe land fragmentation precision farming has to do more with the precise application of agricultural inputs based on soil, weather and crop requirement to maximise sustainable productivity, quality and profitability.

Hi tech Agriculture is one method of precision farming on a smaller scale where plant protection and fertigation are applied at the root zone and plants are grown in precise conditions of temperature and humidity for uniformity and maximisation of yield. There are two approaches viz., Greenhouse / poly house system and open air system.

Greenhouse technology

Growing of crops in green houses has proved to be the best way of utilizing the crops potential. Computerized control of irrigation, fertilization (Fertigation) and microclimate in green house enable precise monitoring of the most important production practices. In temperate regions where the climatic conditions are extremely adverse and no crops can be grown high value crops can be grown continuously by providing protection from the adverse climatic conditions such as wind, cold, precipitation, excessive radiation, extreme temperature, insects and diseases through Greenhouse Technology.

Advantages of greenhouses:

1. The yield may be 10-12 times higher than that of outdoor cultivation depending upon the type of greenhouse, type of crop, environmental control facilities.

2. The technology is ideally suited for vegetables and flower crops where uniformity in yield is very important.
3. Year round production of floricultural crops and Off-season production of vegetable and fruit crops is possible.
4. Disease-free and genetically superior transplants can be produced continuously.
5. Efficient utilisation of chemicals, pesticides to control pest and diseases and efficient use of Water.
6. Production of quality produce free of blemishes.
7. Most useful in monitoring and controlling the instability ofvarious ecological system.

Greenhouses – World Scenario

There are more than 50 countries now in the world where cultivation of crops is undertaken on a commercial scale under cover. The major countries are the USA, Spain, Canada and The Netherlands. In Asia, China and Japan are the largest users of greenhouses. The United States of America has a total area of about 4000 ha under greenhouses while Spain has been estimated to have around 25,000 ha and Italy 18,500 ha. The Netherlands is the traditional exporter of greenhouse grown flowers and vegetables all over the world. With about 89,600 ha undercover, the Dutch greenhouse industry is probably the most advanced in the world. The development of greenhouse technology in China has been faster than in any other country in the world. With a modest beginning in late seventies, the area under greenhouses in China has increased to48,000 ha in recent years. Japan also has more than 40,000 ha under greenhouse cultivation of which nearly 7500 ha is devoted to only fruit orchards.

Status in India

In India use of greenhouse technology started only during 1980's and it was mainly used for research activities. This may be because of our emphasis, so far had been on achieving self-sufficiency in food grain production. However, in recent years in view of the globalization of international market and tremendous boost and fillip that is being given for export of agricultural produce, there has been a spurt in the demand for green house technology. The National Committee on the use of Plastics in Agriculture(NCPA-1982) has recommended location specific trials of greenhouse technology for adoption in various regions of the country.

The commercial utilization of greenhouses started from 1988onwards and now with the introduction of Government's liberalization policies and developmental initiatives, several corporate houses have entered to set up 100% export oriented units. In just four years, since implementation of the new policies in 1991, 103 projects with foreign investment of more than `.80 crores have been approved to be set up in the country at an estimated cost of more than `.1000 crores around Pune, Bangalore, Hyderabad and Delhi. Thus the area under climatically controlled greenhouses of these projects is estimated to be around 300ha. Out of which many have already commenced exports and have received very encouraging results in terms of the acceptance of the quality in major markets abroad and the price obtained.

Classification of greenhouses:

Greenhouse structure of various types are used for crop production. The different types of greenhouses based on shape, utility, material and construction are briefly given below:

1.Greenhouse type based on shape:

For the purpose of classification, the uniqueness of cross section of the greenhouses can be considered as a factor. The commonly followed types of greenhouses based on shape are:

a) Lean to type greenhouse.
b) Even span type greenhouse.
c) Uneven span type greenhouse.
d) Ridge and furrow type.
e) Saw tooth type.
f) Quonset greenhouse.
g) Interlocking ridges and furrow type Quonset greenhouse.
h) Ground to ground greenhouse.

2. Greenhouse type based on Utility

a) Greenhouses for active heating.
b) Greenhouses for active cooling.

3. Greenhouse type based on construction

a) Wooden framed structure.
b) Pipe framed structure.

c) Truss framed structure.

4. Greenhouse type based on covering material

a) Glass glazing.
b) Fibre glass reinforced plastic (FRP) glazing (Plain sheet, corrugated sheet.)
c) Plastic film (UV stabilized LDPE film, Silpaulin type sheet, Net house)
d) Based on the cost of construction (High cost Green House, Medium cost Green House, Low cost Green House)

5. Computerised green houses

In general farmers prefer the manually Controlled System or Semi-Automatic Controlled System because of low investment. However, Manual systems require a lot of attention and care and are very difficult and cumbersome to maintain uniform environment inside the Green House. Ultimately this affects crop production and results in non-uniform growth and low quality of the crop.

The Computerized Control System provides a faster and more precise operation in the Green House and also stores, displays and prints the Green House information as needed. In addition, computer can perform the required operations as per a pre-scheduled programme

Components and Features of a green-house based Hi-tech Agriculture system

Polythene

Polyhouse / Green houses are made of transparent, tight, cheap and flexible polythene. This enables cultivation of vegetables and other crops in any season of the year depending upon their requirement, because temperature and humidity can easily be controlled in Polyhouses as they prevent the thermal radiation from escaping which increases the temperature and energy and thus helps in the process of photosynthesis. It is well established that for the production of energy vegetable, fruits and flower crop, the polyhouses are constructed with the help of ultraviolet plastic sheets, so that they may last for more than 5 years.

Sheets are usually of 1501-micron thick plastic sheet and draped around bamboo or iron pipes which are more durable but costlier.

Heating Systems

Heating is usually required in winter season. Generally the solar energy is sufficient to maintain inner temperature of polyhouse but when this is insufficient, via media like construction of a tunnel below the earth of polyhouse, covering the northern wall of the house by jute clothing, covering whole of the polyhouse with jute cloth during night and installing solar heating systems can be considered.

Cooling systems

In summer season when ambient temperature rises above $40^{0}C$ during daytime, the cooling of polyhouse is required. This is done by providing adequate ventilation and removing the internal air of polyhouse out of it in a natural manner or by installing high power fans which need to be switched on at regular intervals. Installation of cooler on eastern or Western Wall can also be done to keep the temperature low and maintain proper humidity. Alternatively Water-misting mechanism can be installed.

Shading systems

Certain plants are damaged due to very high light intensity during summer. Shading reduces light intensity and cools the microclimate inside the greenhouse. Shade paints (lime or Redusol or Vari clear), agro-shade nets or retractable thermal screens are generally used and operated manually or through automatic devices.

Watering systems

Water quality is very important and often overlooked. Total salt-content levels, alkalinity levels, the balance of individual ions such as boron and fluoride can all have serious bearing on crop success. The water sources should be tested before a greenhouse is established. Electrical conductivity level should be 0.75 – 1.5 dS/m and a pH of 6-7. Automatic watering system through drips or overhead foggers are generally used depending upon the crop.

Fertigation

It varies from single broad casting of fertilizers to use of soluble grade fertilizers over different operating systems. One of the most modern technologies is currently offered by Priva – Phillips Nutriflux or Van Vliet Midi Aqua Flexilene System. Both the system have nutrient plant demand of nutrients in relation to EC/pH of the media, temperature, RH, light intensity, crop growth, mineral deficiency, etc.

Photoperiod control

Several plant species flower only when they are exposed to specific light duration. Yield and quality of flower crops could be increased with artificial lighting during night hours. Cyclic lighting is most effective. Short day conditions in greenhouses can be created with fully automatic, semi-automatic or manual 'black out' system using good quality black polythene sheets, especially for chrysanthemum.

Control system

A manual or semi-automatic control system is less capital intensive but requires a lot of attention and care. Recently, computerized control systems are available which can integrate temperature, light intensity, relative humidity, CO_2, plant moisture, nutrient requirement, and plant-protection measures.

Equipment's needed

In case of permanent polyhouse structure steel and fibre made glass are galvanised hallow pipe-having glass or transparent polythene sheet structure is needed. For small farmers they can build up the polyhouse they require bamboo structure on which polythene sheet is used for cover purpose. For irrigation facility sprinkler irrigation unit is needed, while for controlling the air temperature ventilators are required.

Roof of Polyhouse

In case of construction of polyhouse plastic film, nylon, acrylic, vinyl, polycarbonate and polyethylene film can be used for the roof purpose. At present among the available polyfilm, use of film of 200 microns or 800 gauge thickness ultraviolet protective film is considered. The framework of polyhouse should be made of G.I. pipe.

Watering system

Micro irrigation system is the best for watering plants in a greenhouse. Micro sprinklers or drip irrigation equipment can be used. In micro sprinkler system, water under high pressure is forced through nozzles arranged on a supporting stand at about 1 feet height. This facilitates watering at the base level of the plants.

Equipment required for drip irrigation system include

- i) A pump unit to generate 2.8kg/cm^2 pressure
- ii) Water filtration system – sand/silica/screen filters
- iii) PVC tubing with dripper or emitters

Drippers of different types are available

i) Labyrinth drippers
ii) Turbo drippers
iii) Pressure compensating drippers – contain silicon membrane which assures uniform flow rate for years
iv) Button drippers- easy and simple to clean. These are good for pots, orchards and are available with side outlet/top outlet or micro tube out let
v) Pot drippers – cones with long tube

Water output in drippers

a. 16mm dripper at 2.8kg/cm2 pressure gives 2.65 litres/hour (LPH).

b. 15mm dripper at 1 kg/cm2 pressure gives 1 to 4 litres per hour

Filters: Depending upon the type of water, different kinds of filters can be used.

Gravel filter: Used for filtration of water obtained for open canals and reservoirs that are contaminated by organic impurities, algae etc. The filtering is done by beds of basalt or quartz**.**

Hydrocyclone: Used to filter well or river water that carries sand particles.

Disc filters: Used to remove fine particles suspended in water

Screen filters: Stainless steel screen of 120 mesh (0.13mm) size. This is used for second stage filtration of irrigation water.

Fertigation system

Fertigation systems are automatic mixing and dispensing units which consist of system pumps and a supplying device. The fertilizers are dissolved separately in tanks and are mixed in a given ratio and supplied to the plants through drippers.

Fertilizer Injectors

Fertilizer injectors are of two basic types. Those that inject concentrated fertilizer into water lines on the basis of the venturi principle and those that inject using positive displacement. The most common in use in Kerala is the Venturi Sytem. Basically these injectors work by means of a pressure difference between the irrigation line and the fertilizer stock tank. These injectors are inexpensive and are suitable for small areas. Large amounts of fertilizer application would require huge stock tanks due to its narrow ratio.

General problems of fertigation

Nitrogen tends to accumulate at the peripherous of wetted soil volume. Hence, only roots at the periphery of the wetted zone alone will have enough access to Nitrogen. Nitrogen is lost by leaching and denitrification. **Phosphorous** accumulates near emitter and P fixing capacity decides its efficiency. **Potassium** moves both laterally and downward and does not accumulate near emitter. Its distribution is more uniform than N&P. Excepting boron, all micronutrients accumulates near the emitter if supplied by fertigation. Boron is lost by leaching in a sandy soil low in organic matter. But chelated micronutrients of Fe, Zn can move away from the emitter but not far away from the rooting zone.

Media preparation

The media used in greenhouse generally have physical and chemical properties which are distinct from field soils.

- A desirable medium should be a good balance between physical properties like water holding capacity and porosity.
- The medium should be well drained.
- pH of 5.0 to 7.0 and the soluble salt (EC) level of 0.4 to 1.4 dS/m is optimum for most of the greenhouse crops
- Low pH can be raised by using amendments like lime (calcium carbonate) and dolomite (Ca-Mg carbonate) and basic, fertilizers like calcium nitrate, calcium cyanamide, sodium nitrate and potassium nitrate while high pH can be reduced by amendments like sulphur, gypsum and Epsom salts, acidic fertilizers like urea, ammonium sulphate, ammonium nitrate, mono ammonium phosphate and aqua ammonia and acids like phosphoric and sulphuric acids.
- It is essential to maintain a temperature of the plug mix between 70 to 75ºF. Irrigation through mist is a must in plug growing. Misting for 12 seconds every 12 minutes on cloudy days and 12 seconds every 6 minutes on sunny days is desirable.
- The pH of water and mix should be monitored regularly.

Desirable nutrient level in greenhouse growth media

S. No.	Category	Concentration (mg/l)			
		NO3	**N**	**P**	**K**
1.	Transplants	75	125	10-15	250-300
2.	Young pot & foliage plants	50	90	6-10	150-200
3.	Plants in beds	125	225	10-15	200-300

Pasteurization of greenhouse plant growing media

Greenhouse growing medium may contain harmful disease causing organisms, nematodes, insects and weed seeds, so it should be decontaminated by heat treatment or by treating with volatile chemicals like methyl bromide, chloropicrin etc.

Agent	Method	Recommendation
Heat	Steam	30 min at 180° F
Methyl bromide	10 ml/cu. ft. of medium	Cover with gas proof cover for 24-48 hr. Aerate for 24-28 hr before use.

Chloropicrin	(Tear gas) 3-5 ml/cu. ft. of medium	Cover for 1-3 days with gas proof cover after sprinkling with water. Aerate for 14 days or until no odour is detected before using.
Basamid	8.0 g/cu.ft. of medium	Cover for 7 days with gas proof cover and aerate for atleast a week before use.
Formalin	20 ml/l of water (37%)	Apply 2 l/cu.ft. cover for 14 to 36 hr and aerate for at least 14 days.

Disinfection of the growing media can also be achieved by fungicides or bactericides

Fungicides and their effect on a few fungi

Chemical	Rate of application	Effect against
Captan	2 g/l of water	*Pythium, Fusarium, Rhizoctonia and Phytophthora. Some extent to root and stem rot, white mold,black rot, crown rot and damping off.*
Metalaxyl + Mancozeb (Ridomil MZ 72 WP)	1 g/l of water	*Pythium, Phytophthora, Fusarium* and other soil borne pathogens

Fumigation in greenhouse

Physical propagation facilities such as the propagation room, containers, flats, knives, working surface, benches etc. can be disinfected using one part of formalin in fifty parts of water or one part sodium hypochlorite in nine parts of water. An insecticide such as dichlorvos sprayed regularly will take care of the insects present if any. Care should be taken to disinfect the seed or the planting materials before they are moved into the greenhouse with a recommended seed treatment chemical for seeds and a fungicide –insecticide combination for cuttings and plugs respectively. Disinfectant solution such as trisodium phosphate or potassium permanganate placed at the entry of the greenhouse would help to get rid of the pathogens from the personnel entering the greenhouses.

Environmental control

Temperature control

A thermostat can be coupled to water circulating pump or exhaust fan for controlling the temperature inside the greenhouse.

Relative humidity control

A humidistat coupled to water circulating pump or exhaust fan is used to control the relative humidity inside the fan and pad greenhouse. The maximum achievable relative humidity is 90% only in fan regulated (FR) greenhouse. The RH in Non ventilated (NV) GH can be increased by providing foggers.

Light intensity control

In certain areas where natural illumination is absent or very low, illumination for plants may be provided by artificial sources. Incandescent bulbs generate excessive heat and are unsatisfactory in most instances. Fluorescent tubes are useful as the sole source of light for African violets, gloxinias and many foliage plants which grow satisfactorily at low light intensities.

Problem Management in Greenhouses

The troubles which arise in the culture of crops in the greenhouse may be divided into several groups a) failure to supply the essential factors for optimum growth such as light, moisture, carbon dioxide and heat in amounts necessary for each individual crop b) fertilizer deficiencies c) fertilizer excesses d) toxic gases e) attacks by insects, animals, and allied pests and f) susceptibility to fungus, bacteria and virus troubles.

A. Fertilizer deficiencies: Symptoms of deficiencies of various fertilizers have been studied over a period of years with plants in greenhouses.

i. Chlorosis - This is a term used to denote the loss of normal green colour from the foliage whether it is on the older, more mature leaves or the younger foliage. The entire leaf may be affected or just areas between the veins, in which case the yellowing is most usually in irregular patches shading into the green colour. Sometimes only the margin of the leaf or leaflets may be yellow, while the centre of the foliage is almost a normal green.

ii. Necrosis - This refers to the death of the area severely affected by chlorosis. Necrotic spots or areas can also be caused by spray or aerosol damage, sunscald and other such factors which may have no relation of fertilizer.

iii. Nitrogen deficiency - Generally the entire plant becomes lighter green, but the effect will be most noticeable on the older foliage. Gradually the oldest leaves loose their green colour, and most plants become yellow. The flowers are smaller and may lack well-developed colour.

iv. Phosphorus deficiency - A purplish coloration developing first on the underside of the petiole, or leaf stem, which spreads to the main veins of the leaf is characteristic of this deficiency.

v. Calcium deficiency - In sand culture, a typical symptom is the development of short clubby roots followed in a matter of several weeks by their death. In many cases insufficient calcium is associated with a low pH of the soil.

vi. Iron deficiency - This is a rather common trouble although an actual lack of iron may not be the primary cause. As iron deficiency becomes more intense, necrotic areas appear on scattered portions of the yellow coloured leaves and the affected foliage may drop. Iron can become deficient in soil, but often the symptoms of this deficiency are induced by other causes from injury to the roots by over-watering or over fertilization. Nematodes or other soil pests interfering with root growth can also induce iron chlorosis symptoms.

vii. Boron deficiency - The number of cases where this is a limiting factor are few, and most of them are with certain rose and carnation varieties. The new foliage is thick or leathery and quickly becomes chlorotic. The rose flowers are usually very malformed. The stem tip dies, giving rise to growth of shoots immediately below, which in turn die at the tip, and a 'witches broom' effect is observed. Because deficiency symptoms can sometimes be confused with the effects of some other environmental factor of cultural practice, a thorough review of fertilizer application, soil testing, soil type, watering practices, and other procedures is warranted before hasty conclusions are reached.

viii. Fertilizer excesses - An unfortunate belief among many growers is that when a plant does not grow under apparently favourable conditions, the trouble can be overcome by applications of fertilizer. This practice has resulted in untold damage or loss of crops, as more often than not the original trouble could have been too much fertilizer in the soil. If additional fertilizer is applied when no more is needed, the results can be very injurious. Sometimes the difference between a high but safe nutrient level and an injurious nutrient level is not very great and the margin of safety may be extremely small. The plants exhibit heavy, rank growth, with large, dark green leaves that are often crisp and break easily. Additional nitrogen may inhibit root action, causing typical symptoms of iron chlorosis. If the root system is killed, the plants wilt excessively and never recover. This yellowing of the top foliage is very common in chrysanthemums

Linkages – Backwards and Forwards

A. **Procurement of Planting Material:** The planting material (seedlings) can be procured from approved centres managed by the Department of Agriculture or from the different campuses of the Agricultural Universities and KVKs and also from approved private nurseries.

B. **Transport:** Normally, vegetables and flowers immediately after harvest is graded, packed, and sent to market. Thus, as such there is no need of precooling or refrigerated van to transport the produce.

C. **Marketing:** Vegetables so cultivated have good and robust demand in the major cities of Kerala. However for effective price realisation branding may be necessary at a local scale and dedicated marketing channels can be thought of.

Financing Aspects

a. **Subsidy:** The State Horticulture Mission, Government of Kerala provides subsidies upto50% of the cost subject to a maximum of `. 325/$m^2$ for hi-tech and `. 125/m^2 for normal poly houses, limited to 1000 m^2/beneficiary. 50% of cost subject to a maximum of `. 3500 per 500 m^2 limited to 2 ha per beneficiary will be given as subsidy for shade nets also. The back ended subsidy will be provided to financing bank in respect to the beneficiaries immediately after the release of first instalment of loan. The subsidy admissible to the borrower under the scheme will be kept in the Subsidy Reserve Fund A/c – borrower-wise in the books of the financing banks.

Subsidy is also available for mulching at 50% of the total cost subject to a maximum of `. 7000/ha limited to 2 ha per beneficiary and for Plastic Tunnel upto 50% of cost subject to a maximum of `.5000/1000 Sq.m limited to 5 ha per beneficiary.

The national Mission on Micro irrigation offers a subsidy of 60% of system cost for small and medium farmers in the State. Farmers of Palakkad, Kasaragod, Kannur and Malappuram are eligible for a further 15% Assistance from the scheme.

b.Refinance to Banks: The 90% of the amount financed to the borrower under the scheme by banks will be eligible for the refinance from NABARD.

c. Bank Finance

i. Term Loan: The banks may finance 85-90% of the project cost as term loan. The eligible amount of subsidy would also be allowed as term loan.

ii. Margin Money: The entrepreneurs should normally meet 10-15% of the project cost out of their own resources.

iii. Interest Rate: Interest rate will be decided by financing banks from time to time. However, the repayment programme has been worked out at 14% rate of interest.

iv. Security: Banks may obtain security as per RBI norms.

v. Repayment: The principal and interest will be repayable in ten years, with moratorium of 01 year.

Income and Capital return under Greenhouse Cultivation

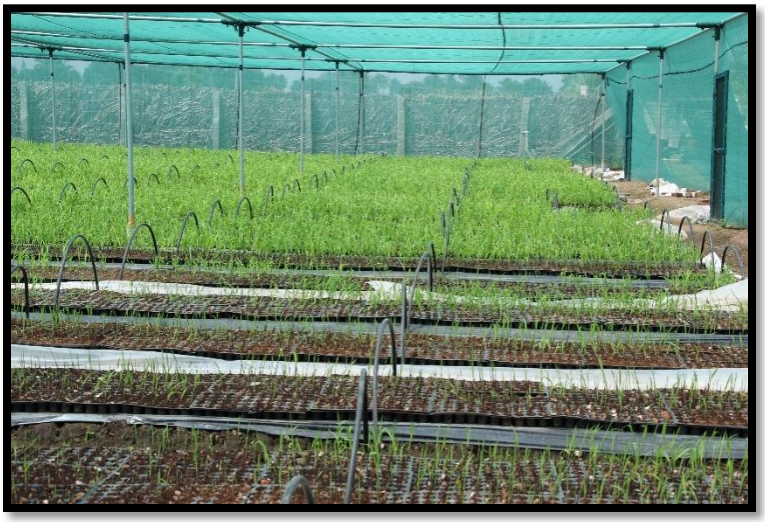
The yield under poly house cultivation can be achieved to the level of 5-8 times as compared to the open crop cultivation. Various trials conducted at agro research centres in northern India indicates that capsicum (planted in mid-September), cucumber (planting –mid October) and tomato (November planting) under poly house produced 1060kg, 1460 kg and 1530 kg per 100 square meter. The duration of these crops were 4- 9 months and more than 90% of total yield were obtained during off-season (during winter before the start of summer) which fetches significantly higher market price (2-4 times than normal season). Further, the crop duration can be extended up to the July–August with the application of micro irrigation and fertigation and yield can be achieved to the level of 20-25 kg/m2. Therefore, it is possible to harvest a single crop round year with minimum additional inputs and higher income can be generated. Further Cut Flowers like Carnations, Gerbera, Lilly, Rose, orchids, antheriumetc. can be grown under polyhouses/ net houses giving high returns and top quality produce. The potential of floriculture under protected cultivation is huge for Indian and global markets.

The cost of construction of poly house depends on location of site, size and shape of poly house, poly house structure (wooden or GI/ Steel) and types of poly house (naturally ventilated or environmental controlled). The cost of bigger naturally ventilated poly house (1000 m^2) ranges from `.900 to 1150 per square meter whereas the environmental controlled poly houses require 2 to 3 times investments over previous one depending on the automation gadgets installed. The per unit area construction cost of smaller size poly houses are more as compared to larger poly house. Similarly the cost of cultivation in larger poly house is significantly lower than smaller poly house.

It is possible to get back the investment on poly house within a period of 3 to 5 years period. If a entrepreneurs /cultivator go for poly house for nursery production of high yielding vegetable plants in an area where large scale vegetable cultivation is done, in such condition he can get back his investment within 2-3 years by providing quality planting materials to vegetable or flower growers.

The success of the Polyhouse / net house Project depends upon the scale of project. Minimum recommended project with right economic viability and long-term sustainability is around 1 -2 acres.

Economic size



1. Generally the length of the polyhouse is 25-30 feet and width 4-5 feet.
2. The direction of poly house is always East to West, so that the maximum sunshine is available.
3. The house should not be constructed in shade.
4. The size of polyhouse may differ depending on the necessity.
5. The poly houses are kept cold or hot depending upon the season.

Model Project for Naturally Ventilated Polyhouse (NVPH) - Unit size = 1000 sq.mt.

The details of estimated cost, means of finance, economics and financial viability is worked out for Naturally Ventilated Polyhouse as follows. Cucumber, Cowpea and Tomato have been taken as examples while preparing the model costs.

A.Estimated Unit Cost and Means of Finance

(Amount in `.)

Sr. No.	Items	Rate (`.)	Unit	Estimated Cost	Subsidy	Subsidy Amount	Beneficiaries' Contribution	Bank Loan
				(`)	(%)	(`.)	(`.)	(`.)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)=15% of (e)	(i)=(e)-(g+h)
1	Polyhouse and miscellaneous	1045	per sq.m	1045000	Max Amount	325000	156750	563250
2	Micro irrigation system (Drip)	150	per sq.m	150000	60%	90000	22500	37500
3	Planting Material cost	Actuals		20000		0	3000	17000
4	Land Preparation	as per table A		49500	0	0	7425	42075
5	Recurring Expenses - excluding cost of planting material (for the 1st year)	As per Table B		86855	0	0	13028	73826
	Total			**1351355**		**415000**	**202703**	**733651**

B. Economics (Year wise Income & Expenditure)

(Amount in `.)

Sr No.	Item/ Year →	1	2	3	4	5	6	7	8	9	10
1	Income from sale of produce (as per Table C)	402535	402535	402535	402535	402535	402535	402535	402535	402535	402535
2	Recurring cost (Table B)	106855	104465	102314	100378	98635	97067	95656	94386	93243	92214
3	**Gross profit (1-2)**	**295680**	**298070**	**300221**	**302157**	**303900**	**305468**	**306879**	**308149**	**309292**	**310321**
	Loan Repayment										
4	Principal	0	81517	81517	81517	81517	81517	81517	81517	81517	81517
5	Interest @ 14% p.a.	102711	102711	91299	79886	68474	57062	45649	34237	22825	11412
6	**Total Loan Repayments (4+5)**	**102711**	**184228**	**172816**	**161403**	**149991**	**138579**	**127166**	**115754**	**104342**	**92929**
7	**Income after repayment of Principal & Interest (3-6)**	**192969**	**113842**	**127405**	**140754**	**153909**	**166889**	**179713**	**192395**	**204950**	**217392**
8	Less Depreciation @10% on depreciated value of fixed assets	119500	107550	96795	87116	78404	70564	63507	57156	51441	46297
9	**Profit after Depreciation (7-8)**	**73469**	**6292**	**30610**	**53638**	**75505**	**96325**	**116206**	**135239**	**153509**	**171095**

C. NPW, BC Ratio, IRR and DSCR – As per Table D

(Amount in ` .)

i	**NPW @ 15 %**	**228980.20**
ii	BC ratio	1.13
iii	IRR	22%
iv	DSCR	1.8

D. Assumptions

a	**Rates for the items viz. Polyhouse, Micro irrigation system (drip) and land preparation are taken from Field level surveys and kept at conservative levels.**	
b	Recurring Cost	Assumptions are given in Table B
c	Production	Taken from field surveys and kept at conservative levels
d	Sale Price per Kg	Taken from field surveys and kept at conservative levels
e	Term Loan repayment Period	10 Years (including grace period of 1 year)
f	Interest on Term Loan	14% p.a.
g	Depreciation on fixed assets	@ 10% p.a. on reducing balance
h	Insurance premium for structure	@ 2% of depreciated value of structure (may vary from insurance company to company)

Capital Investment

(Amount in ` .)

SrNo	Details/Investments			Unit Rate (`)
1	**Poly House with Irrigation facility**			
1.1	Land Development	Nos		60000
1.2	Preliminary Civil works - Foundation	Nos		50000
1.3	Poly House Construction Cost of Pipes, Plastic sheets and nets)	Nos		750000

1	**Sheet(Ginger Yellow/White diffused 200 Micron)**	**160000**
2	Shade net 50%	11000
3	3/4 Self Screw	2000
4	Aluminium profile	10000
5	Coated Spring(Zig Zag)	10000
6	Insect Net 40 mesh	10000
7	Pipes	380000
8	Grouting	
	Gutter Sheet	9000
	Nut and Bolts	8000
	Labour(` 150/Sqm)	150000
	Total	**750000**

SrNo	Details/Investments			Unit Rate (`)
1.4	Water Supply Arrangements	Nos		65000
1.5	Irrigation and Fertigation System			85000
1.6	Digital Weighing Balance	Nos		20000
1.7	Fencing	Nos		40000
1.8	Store Room	Nos		35000
1.9	Creeper net and Trailing rope	Nos		30000
1.10	Miscellaneous / Contingency @ 5%	Nos		60000
	Sub Total 1			**1195000**

Variable and Recurring Costs

Table A - Land Preparation Cost

(Amount in `.)

Sr. No	Particular	Cucumber	Cowpea	Tomato	Amount
1	Compost / Neem cake / Rice Husk	4000	5000	6000	15000
2	Chemical Fertilizer / Micro Nutrients	8000	7000	7000	22000
3	Fumigation / Bed preparation cost	10000	2500	0	12500
	Total	**22000**	**14500**	**13000**	**49500**

Table B - Break Up of Recurring Cost

(Amount in `.)

Sr. No.	**Item/ Year →**	**Cucumber**	**Cowpea**	**Tomato**	**From Year 1 to 10**
1	Planting Material cost	13500	2000	4500	20000
2	Fertigation cost (Table B-I)	8364	5768	10815	24947
3	Spraying cost (Table B-II)	1339	824	1545	3708
4	Packaging cost (Table B-III)	0	0	1000	1000
5	Transportation cost (Table B-IV)	2500	1000	1000	4500
6	Electricity cost	2100	2100	2100	6300
7	Labour cost (Table B-V)	7500	7500	7500	22500
8	Insurance @ 2 % on depreciated value of Polyhouse & Micro Irrigation System *				23900
	Total recurring cost	**35303**	**19192**	**28460**	**106855**

Table B I – Fertiliser Costs

(Amount in `.)

Sr. No	**Particular**	**Cucumber**	**Cowpea**	**Tomato**	**Amount/Quantity**
1	Fertiliser dose (Kg)	58	40	75	
2	Avg. rate of fert. `/kg	140	140	140	
3	Fertigation cost	8120	5600	10500	24220
4	Contingency @ 3% of Fertigation cost	244	168	315	727
	Total Fertigation cost	**8364**	**5768**	**10815**	**24947**

Table B II a – Micronutrient Costs

(Amount in `.)

Sr. No	**Particular**	**Cucumber**	**Cowpea**	**Tomato**	**Amount/Quantity**
1	Micronutrient Dose	3	2	3	
2	Avg. Rate of micronutrient	300	300	300	
3	Spraying cost	900	600	900	2400
4	Contingency @ 3% of spraying cost	27	18	27	72
	Total Spraying cost	**927**	**618**	**927**	**2472**

Table B II b – Fungicide Costs

(Amount in `.)

Sr. No	Particular	Cucumber	Cowpea	Tomato	Amount/Quantity
1	Fungicide Dose	4	2	6	
2	Avg. Rate of Fungicide	100	100	100	
3	Spraying cost	400	200	600	1200
4	Contingency @ 3% of spraying cost	12	6	18	36
	Total Spraying cost (`.)	**412**	**206**	**618**	**1236**

Table B III – Packaging Costs

(Amount in `.)

Sr. No	Particular	Cucumber	Cowpea	Tomato	Amount/Quantity
1	No. of crates			5	5
2	Price per crate			200	200
	Total Cost for crates			**1000**	**1000**

Table B IV – Transportation Costs

(Amount in `.)

Sr. No	Particular	Cucumber	Cowpea	Tomato	Amount/Quantity
1	Transport charges	2500	1000	1000	4500

Table B V - Labour Costs *

(Amount in `.)

Sr. No	Particular	Cucumber	Cowpea	Tomato	Amount/Quantity
1	Total man-days	25	25	25	75
2	Avg. salary/day/head	300	300	300	300
3	**Total wages**	**7500**	**7500**	**7500**	**22500**

* Insurance premium may vary from insurance company to company

** Labour cost calculated only for spraying and Fertigation. Family labour assumed for day to day activities

Table C – Production and Income

(Amount in `.)

Sr. No	Particular	Cucumber	Cowpea	Tomato	Amount/Quantity
1	Plant Population	2300	2200	2500	
2	Total Production in Kg	5500	850	4500	
3	Less: Loss of produce (2%)	110	17	90	
4	Produce available for sale (kg)	5390	833	4410	
5	Rate Per Kg	35	45	40	
6	Income from sale of produce	**188650**	**37485**	**176400**	**402535**

Table D - NPW, Benefit Cost Ratio, Internal Rate of Return and DSCR

(Amount in `.)

Sr No.	Item/ Year →	1	2	3	4	5	6	7	8	9	10
1	Capital Cost	1195000									
2	Recurring Cost including land preparation cost	156355	153965	151814	149878	148135	146567	145156	143886	142743	141714
3	**Total cost (1+2)**	**1351355**	**153965**	**151814**	**149878**	**148135**	**146567**	**145156**	**143886**	**142743**	**141714**
4	Total Income from Sale of produce	402535	402535	402535	402535	402535	402535	402535	402535	402535	402535
5	**Net benefit (4-3)**	**-948820**	**248570**	**250721**	**252657**	**254400**	**255968**	**257379**	**258649**	**259792**	**260821**
	FRR	**22.37%**									
	NPW at 15% DF (` lakhs)	**228980**									
	NPW Cost at 15% DF (` lakhs)	**1791250**									
	NPW Benefit at 15% DF (` lakhs)	**2020230**									
	BCR	**1.13**									

6	**DSCR Calculation**										
I	Profit Before Interest and Tax	176180	190520	203426	215041	225496	234904	243372	250993	257851	264024
II	Total repayments towards Principal and Interest on Term Loan	102711	184228	172816	161403	149991	138579	127166	115754	104342	92929
III	DSCR (I/II)	1.72	1.03	1.18	1.33	1.50	1.70	1.91	2.17	2.47	2.84
	Average DSCR	**1.80**									

Table E - Repayment Schedule

Repayment period = 10 years

Annual repayment instalment of Principal @ `. 81,517/-

Years	Bank Loan o/s at the beginning of the year (a)	Repayment of Principal (b)	Bank Loan o/s at the end of the year (c) = (a-b)	Payment of Interest @ 14% (d)	Total Outgo (e) = (b+d)	Surplus Available for repayment (f)	Surplus available after repayment (g) = (e-f)
1	733651	0	733651	102711	102711	295680	192969
2	733651	81517	652134	102711	184228	298070	113842
3	652134	81517	570617	91299	172816	300221	127405
4	570617	81517	489100	79886	161403	302157	140754
5	489100	81517	407583	68474	149991	303900	153909
6	407583	81517	326066	57062	138579	303900	165321
7	326066	81517	244549	45649	127166	305468	178302
8	244549	81517	163032	34237	115754	305468	189714
9	163032	81517	81515	22825	104342	305468	201126
10	81515	81515	0	11412	92927	305468	212541

Annexures

Annexure I – Recommended Package of Practices

Tomato

Tomato (*Lycopersiconesculentum*) belongs to the genus Lycopersicon under Solanaceae family. Tomato is a herbaceous sprawling plant growing to 1-3 m in height with weak woody stem. It is a warm season crop and the moderate temperature ranging from 18oC to 30oC is best for its growth and flowering. The important varieties for the State include Bacterial wilt resistant varieties like Sakthi, Mukthi, Anagha and VellayaniVijai and high yielding varieties like Pusa Ruby.

Pre-Cultivation Aspects

The tomato crop can be raised in a wide variety of soil ranging from light textured sandy or sandy loam to heavy clay soils. The soil should be rich in nutrients and organic matter. The ideal soil pH is 6.00 to 7.00 for its growth. High organic matter content in soil is highly essential for higher production and quality. A raised bed is always preferred for plantation of Tomato Cultivation. After fumigation, the beds with Top width - 90cm, Path width- 50 cm, Height - 40 cm are prepared with a spacing of 40 cm between two plants and 50 cm between two rows. Seedlings of 05-06 weeks old are used for transplanting, depending on temperature and light conditions during propagation. Ideal seedling size is about 16 cm.

Manures and Fertilizers

Application of nutrients should be based on analysis of soil and plant. However, for the better crop yield 4 to 5 tonnes of well rotten FYM per unit (1008 m^2) should be mixed during soil preparation. The fertilizer doses of Nitrogen 40-45 kg, Phosphorus (P2O5) and 40-45 kg Potash (K2O5) may be applied per unit. The half of the dose of Nitrogen and potash and full dose of phosphorus are incorporated during soil preparation.

Cultural Practices

Different cultural practices followed in tomatoes are as follows

1. Suckering

Side shoots are usually not pruned until they are a few cm long, and at which time they are easier to distinguish from the main stem.

2. Crop Support & training

After transplanting as soon as possible, plant stems should be secured to nylon/plastic (high density) twine, quality of twine should be ensured. Twines are hung from horizontal wires at least 3m about the ground. Horizontal wires must be sturdy enough to support the weight of all plants in the row. Twine should be wrapped clockwise around the plant as it develops, with complete swirl every three leaves. Plastic twine should not be wrapped around fruit clusters.

4. Mulching
Straw mulch is most common, if Straw mulches are used, apply to the soil when tomatoes are about two feet high.

5. Topping
Six weeks before the anticipated crop termination date, the growing point and small fruit clusters at the top of the plant are removed this operation is called Topping.

6. Pollination
Tomatoes are self-pollinating under open field conditions. Under green house conditions, flowers need to be agitated mechanically. For pollination hand pollination method is used, in this method gently brush your hand on flower clusters. Timing is important in hand pollination for set fruit i.e. when humidity conditions are most favorable (50-70%). Pollination is done at least twice a week, inadequate pollination will lead to misshapen and lower yields.

7. De-leafing & Fruit pruning
When vines are lowered, leaves touching the ground are removed to prevent disease development. Small, undersized fruit at the end of a cluster (distal fruit) are also removed, as these will generally not grow to marketable size and are thought to reduce the size of the other fruit on the cluster.

Irrigation
Tomato needs to be irrigated at right time. In spring summer, the crop should be irrigated at the interval of 4-6 days depending upon the growth of plants. Under drip irrigation system measured quantity of water can be applied.

Harvesting, Grading & Packing
The harvesting of tomato fruits start from 90 days after transplanting. The total crop period for tomatoes is 8-9 month after planting. The harvesting is done daily or alternate day depending on market distance and customer choice. The optimum storage condition of 12oC temperature and 86 to 90 per cent relative humidity is required for tomatoes. Tomatoes should be graded to different classes according to their size and qualities. Grading is done manually by hand grading method. After grading fruits are packed in crates/CFB which is best suited for tomato packing. Depending on the market, the box is either filled with one variety, one grade, or mixed colour one grade.

Yield
Under polyhouse condition from well-maintained tomato crop average 30 kg/m^2 or 10 Kg/plant of marketable fruits are obtained.

Cucumber

Cucumber (*Cucumissativus*L.) is an important summer vegetable commonly grown throughout India. The cucumber is used as salad, as pickle and also cooked vegetable. It has a cooling effect, prevents constipation, useful in jaundice and seed have number of ayurvedic uses. Cucumber varieties such as PusaSheethal, Poinsette, PoonaKhira are exclusively used for salad purpose in the State. Cucumber is a warm season crop and grows best at a temperature between 18^0C and 24^0C.

Pre-Cultivation Aspects

It can be grown in all types of soil from sandy to heavy soils. Loam, silt loam and clay loam soils are considered best for getting higher yield. Soil pH between 5.5 and 6.7 is favorable for its cultivation. A raised bed is always preferred for plantation of Cucumber cultivation. After fumigation, the beds with a Top width of 90cm, Path width of 50cm and a height of 40cm are prepared with Plant to Plant distance of 45 cm and a Row to Row distance of 75 cm. Seeds can be sown directly in the bed as cucumber has good germination % or seedling of five to six weeks age can be used for transplanting, depending on temperature and light conditions during propagation.

Manures and Fertilizers

About 4 to 5 tonnes of farmyard manure, nitrogen in the form of ammonium sulphate or urea, phosphorus in the form of super phosphate and potash in form of K2So4 should be given depending upon the fertility status of the soil. The complete dose of farmyard manure should be applied in the soil at the time of soil preparation. Potassium and phosphate fertilizers should be mixed in the plant rows just before transplanting. The nitrogenous fertilizer is given two and half a month after transplanting.

Cultural Practices

a. **Training:** Plants can be trained on plastic twine supported from horizontal support wires running along the length of the bed (3mt above top of the bed). The base of the string can be anchored loosely to the base of the plant with non-slip noose.

b. **Pruning:** The growing point of the main stem is removed when one or two leaves have developed above the wire. Two lateral branches near the top of the plant are allowed to grow and are trained over the overhead wire, in downward direction. The growing point of each lateral is removed when they are approaching to the ground.

c. **Fruit thinning:** Fruit pruning each plant is based on plant vigour and fruit load. If too many fruits are set at once, fruit thinning is necessary to avoid malformed and non-marketable small fruit. Such fruit, as they appear, should be removed.

Irrigation
Cucumber needs to be irrigated at right time depending upon the growth of plants. Under drip irrigation system measured quantity of water can be applied.

Harvesting& Packing
Harvest may begin 50 to 65 days after planting. Once harvesting starts the fruits are generally picked at 2-4 days intervals depending upon market information. For commercial purpose, cucumber is harvested at immature stage 5-7 days after pollination depending upon the cultivars. The harvested fruits are cleaned and packed in Corrugated Fibre Box or Bamboo Box or Gunny Bags according to the availability of market and transport facility.

Yield
Average yield of capsicum is 6 to 8 kg/ plant.

Cow-Pea

Cowpea can be grown throughout the year under Kerala conditions. Important varieties include Bhagyalakshmy, Kairali, Sharika, PusaPhalguni, etc. Cowpea can be grown during any season. As a rainfed crop, sowing is done in the month of June. The most suitable time is after the first week of June. Cow pea is a leguminous crop and hence is advised as an intercrop to improve the natural fertility of the soil.

Pre-Cultivation Aspects

It can be grown in all types of soil from sandy to Sandy loam Soils are best for getting higher yield. Soil pH between 5.5 and 6.7 is favorable for its cultivation. A raised bed is always preferred for plantation of Cow pea cultivation. After fumigation, the beds with a Top width of 90cm, Path width of 50cm and a height of 40cm are prepared with Plant to Plant distance of 45 cm and a Row to Row distance of 75 cm.

Manures and Fertilizers

About 4 to 5 tonnes of farmyard manure, nitrogen in the form of ammonium sulphate or urea, phosphorus in the form of super phosphate and potash in form of K2SO4 should be given depending upon the fertility status of the soil. The complete dose of farmyard manure should be applied in the soil at the time of soil preparation. Potassium and phosphate fertilizers should be mixed in the plant rows just before transplanting. The nitrogenous fertilizer is given two and half a month after transplanting.

Cultural Practices

Training: Plants can be trained on plastic twine supported from horizontal support wires running along the length of the bed (3mt above top of the bed). The base of the string can be anchored loosely to the base of the plant with non-slip noose.

Irrigation

Cow peas need to be irrigated at right time depending upon the growth of plants. Under drip irrigation system measured quantity of water can be applied.

Harvesting& Packing

Green pods for use as vegetable can be harvested 45-90 days after sowing. Pods should be harvested while tender. For grains, the crop can be harvested in about 90-125 days after sowing.

Yield

A good crop yields about 1.2-1.5 tons of grain

Annexure II - Recommended TechnicalDesign Specifications

Specifications and Dimensions (1000 sqm):

a) Length: 32.00 m. (Spans at 4.00 m each),
b) Breadth: 31.50 m. (Spans at 5.25 m each),
c) Side / Center height: 3.20 / 4.60 +1 m top ventilation.
d) Gutter height 3.20 m,
e) Ridge height 5.60 m.

GI Pipe Specifications

a) Roll Up - (A Class) Hot galvanized ISI 1239 marked of different diameters and Galvanization as per IS-Code 4736 Size varying from 15 mm dia, 2 mm thick
b) Vent, Ties, Purlin, Front & Back Support & Insect net - 20mm dia and 2.35mm thick
c) Strut & Ties - 25 mm dia, 2.65 mm thick
d) Top Vent and wind bracing & long beam - 32mm dia, 2.65 mm thick
e) Semi Circular Arc , Ridge & Horizontal short Beam - 40mm & 2.90mm thick
f) Stanchion / Prop & King post 50 mm dia, 2.90 mm thick

Cladding Material / U.V. Poly Films

Covering with suitable U.V. stabilized poly sheet, the sheet is to be attached to the structure for quick removal and fixing and following specifications desirable

1) Poly film should have a minimum warrantee of 2 years with regard to U.V. stabilization and should have more than 70% transmittance during the first two years and not less than 65% during the entire life of the poly films.
2) The minimum thickness of the poly film will be 200 micron. The poly film should have ISO certification and conform to ISI specifications.
3) U.V. stabilized film should block U.V. Radiations below 380 nanometer of PAR light. Poly film should have good thermic effect more than 60%. Films should have properties like anti-drip, anti- fog, anti-dust, light diffusion capacity above 50% etc.

Side Ventilation

Side ventilation roll up system provided on four sides from top of side prop to 2.00 m downward and is designed to open from bottom to top using hand operated mechanism. From ground level to 1.20 m height is to be provided with a strip of U.V. Sheet in order to prevent drafts in and around the ground area. Sheet shall be buried in the ground on the lower side up to minimum depth of 40 cm to prevent migration of insects - Pest and seepage of water from outside etc.

Top Ventilation

Top ventilation roll-up system is to be provided with opening of 1.00 meter which is to be operated by hand operated mechanism and designed to be operated from bottom to top. Top open space / vent is to be covered with 20 to 40 mesh U.V. stabilized insect net. The vent hoop should be sufficiently extended so that rain water/ rain showers do not enter in the poly house.

Insect Nets

U.V stabilized insect net of 20 to 40 mesh is to be provided in the side walls and top vents , wherever applicable as per opening space/vents and tightly fitted to provide natural ventilation and to prevent entry of insects inside the poly house.

Shade Nets

Fixed type exterior/ interior U.V. shading nets are recommended which can be removed as and when required and Shade nets should be with 50% shading effect.The shade nets can also be fixed inside poly houses for better and easy workability and as per choice of farmers, with manual folding & spreading facility.

Optional:-

i) Top Ventilation up to 1.50 m height.
ii) Side Gutter for Roof Top water harvesting.
iii) Side height 4.00 m.
iv) Fan pad system for cooling.
v) Adjustment in side & top ventilation space.
vi) Height of fixed sheet from ground level can be decreased up to 0.75 mtr.
vii) Any other fixtures as per requirement of the farmer without disturbing the overall structural stability.

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