

Model Bankable Scheme for Organic Cultivation of Chilli in Uttarakhand



1. Introduction

Chilli (*Capsicum annuum*) belongs to the genus *Capsicum* under Solanaceae family. The Chilli plant is a white flowered, dark green or purple leaved plant that grows upto 1.5 m in height. It is also called as hot pepper, cayenne pepper, sweet pepper etc. Five species of *Capsicum* are under cultivation, though a number of wild species have been identified recently. In India, only two species viz. *Capsicum annuum* and *Capsicum frutescens* are known and most of the cultivated varieties belong to the species *Capsicum annuum*. The native home of chilli is considered to be Mexico with secondary origin of Guatemala. Chilli was introduced in India by the Portuguese in Goa in the middle of 17th century and since then it had rapidly spread throughout the country.

Chilli besides imparting pungency and red colour to the dishes, is a rich source of vitamin A, C and E and assists in digestion. Recently, Russian scientists have identified Vitamin P in green chilli which is considered to be important as it protects from secondary irradiation injury. The pungency in chilli is due to an alkaloid capsaicin which has high medicinal value. Capsaicin has many medicinal properties, especially as an anti-cancerous agent and instant pain reliever. It also prevents heart diseases by dilating blood vessels. Capsicum pigment is incorporated in poultry feed. In Mexico, pigments are concentrated and blended in feed mix for chicken. This gives a reddish tint to the chicken meat, which is more valued. It is believed that yolks of eggs of such chicken are also more coloured and healthy looking. Almost 80 percent of the capsaicin in chilli is in its seeds and membranes.

Chilli is an important ingredient in day to day curries, pickles and chutnies. Oleoresin, sauce and essence are prepared from chilli. Chilli is used in various forms; as raw fresh green chopped chilli ; or ground to a paste, broken split or whole form. To preserve chilli for longer time it is pickled or sun-dried to get a "red" coat chilli which when powdered is used in pinch to get the desired level of pungency.

2. International Scenario :

The world area and production of chilli is around 15 lakh ha and 70 lakh tonne respectively. Major chilli growing countries are India, China, Pakistan, Indonesia, Korea, Turkey and Sri Lanka in Asia; Nigeria, Ghana, Tunisia and Egypt in Africa; Mexico, United States of America in North & Central America; Yugoslavia, Spain, Romania, Bulgaria, Italy and Hungary in Europe and Argentina, Peru and Brazil in South America. India is the world leader in chilli production followed by China & Pakistan. The bulk share of chilli production is held by Asian countries. The major consumers of chilli in the world are India, China, Mexico, Thailand, United States of America, United Kingdom, Germany and Sweden. The major chilli exporting countries with their percentage share in world total exports are India (25 %), China (24 %), Spain (17 %), Mexico (8 %), Pakistan (7.2 %), Morocco (7 %) and Turkey (4.5 %). The world trade in chilli account for 16 % of the total spice trade in the world, occupying second position after black pepper. The major chilli importing countries are United Arab Emirates, European Union, Sri Lanka, Malaysia, Japan and Korea.

3. National Scenario :

India is a major producer, exporter and consumer of chilli. The area and production of chilli in the country is 6.81 lakh ha and 10.09 lakh tonne. The major states growing chilli in the country are Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamilnadu, Uttar Pradesh, West Bengal etc. The productivity is high in the States of Andhra Pradesh, Tamil Nadu etc., where chilli is grown under irrigation than in Maharashtra and Karnataka, where the crop is raised mainly under rainfed situations. The major chilli growing districts of the country are Dharwad in Karnataka, Nagpur in Maharashtra and Prakasam, Khammam, Guntur and Warangal in Andhra Pradesh. Andhra Pradesh ranks first both in area and production.

The state wise area (ha) and production (t) of chilli during 2005-06 (provisional) and major chilli growing tracts in the country are given in Table 1 and 2 respectively.

Table 1. State wise Area and Production of chilli in India

Name of the State	Area (ha)	Production (t)
Andhra Pradesh	171450	537710
Andaman & Nicobar	388	878
Arunachal Pradesh	2168	2646
Assam	14690	9490
Bihar	3093	3089
Chattisgarh	6510	3600
Gujarat	31650	37840
Himachal Pradesh	740	200
Jammu & Kashmir	996	1006
Karnataka	69880	94500
Kerala	-	1192
Madhya Pradesh	46660	42480

Maharashtra	99300	51214
Manipur	6490	3890
Meghalaya	600	3000
Mizoram	1400	1190
Nagaland	600	3000
Orissa	75120	63290
Punjab	9882	15888
Rajasthan	17720	17530
Tamilnadu	49033	31830
Tripura	1940	2910
Uttar Pradesh	17340	16119
Uttarakhand	2006	4262
West Bengal	51957	60727
Total	681613	1009481

Source : Spices Board, Kochi

Table 2. Major chilli growing tracts of the country

State	Major chilli growing tracts
Andhra Pradesh	Guntur, Warangal, Khammam, Prakasam, Krishna, Hyderabad, Nizamabad, Cuddapah, Rajamundry and Nellore
Karnataka	Dharwad, Mysore, Hassan, Bangalore, Bellary, Ranibennur, Hubli, Gadag and Byadgi
Maharashtra	Nagpur, Nasik, Ahmednagar, Solapur, Aurangabad, Nanded, Amravati
Punjab	Amristar, Nabha, Patiala
Uttar Pradesh	Bareilly and Khurja
Tamilnadu	Coimbatore, Ramanathapuram, Tuticorin, Tirunelveli, Virudunagar, Kanayakumari, Madurai, Salem, Tiruchi, Villupuram and Cuddalore districts
West Bengal	Murshidabad, South & North 24 Parganas, Nadia, Coochbehar, Jalpaiguri, East & West Midnapore districts

Indian Chilli is mainly exported to Bangladesh, Bahrain, Israel, Japan, Malaysia, USA and UAE.

Even though exact area and production details on organic chilli in the country is not available, it is known that organic chilli is cultivated in some areas of tribal region of Khandamal Orissa, hills of Uttarakhand and in some parts of Tamilnadu as well as Maharashtra. In Uttarakhand, organic chilli is being grown in the bio villages identified by the Directorate of Agriculture in various districts. Even though the area under certified organic chilli at present is small, the same is likely to go up due to preference by the farmers.

4. Status of Chilli in Uttarakhand :

The area and production of chilli in Uttarakhand as on 31 March 2005 is to the tune of 2005 ha and 4262 t. In terms of area and production, Uttarakhand may not be in the top of the chilli growing states in the country, but chilli of Uttarakhand has a special place owing to their colour and pungency. The district wise area and production under chilli is given in Table 3.

Table 3. District wise area and production of chilli in Uttarakhand

Sl. No.	District	Area (ha)	Production (t)
1	Nainital	129	690
2	Udhamsingh Nagar	215	1207
3	Almora	367	821
4	Bageshwar	126	143
5	Pithoragarh	29	41
6	Champawat	145	156
7	Dehradun	99	100
8	Pauri Garhwal	172	192
9	Tehri Garhwal	130	135
10	Chamoli	120	124
11	Rudraprayag	182	217
12	Uttarkashi	175	316
13	Haridwar	116	120
	TOTAL	2005	4262

Areas in Betalghat block of Nainital district, Sult and Syaldeh blocks of Almora district, Beironkhal block of Pauri Garhwal district and Lohaghat of Champawat district are the major chilli growing pockets of the State. Chilli of Betalghat and Lohaghat command premium price in the market for their very high levels of pungency which is evidenced by high values of Scoville Heat Units, a method to express the capsaicin content in chilli.

5. Organic Farming :

Organic farming is a crop production method respecting the rules of the nature. It maximises the use of onfarm resources and minimises the use of off-farm resources. It is a farming system that seeks to avoid the use of chemical fertilisers and pesticides. In organic farming, entire system i.e. plant, animal, soil, water and micro-organisms are to be protected. The guidelines for organic farming is enclosed in **Annexure 1**.

6. Organic production of Chilli :

6.1 Climate

Chilli requires a warm and humid climate for its best growth and dry weather during the maturation of fruits. Chilli crop comes up well in tropical and sub-tropical regions, but it has a wide range of adaptability and can withstand heat and moderate cold to some extent. The crop can be grown over a wide range of altitudes from sea level upto nearly 2100 m above MSL. It can be grown throughout the year under irrigation. It can be grown successfully as a rain-fed crop in areas receiving an annual rainfall of 850-1200 mm. Heavy rainfall leads to poor fruit set and in association with high humidity leads to rotting of fruits. Pungent chilli are susceptible to frost. A temperature ranging from 20-25°C is ideal for chilli. In chilli fruit development was found to be adversely affected at temperatures of 37°C or more. High temperature associated with low relative humidity at flowering increases the transpiration resulting in shedding of buds, flowers and small fruits.

6.2 Soil

Chilli can be grown in a range of soils, but black soils which retain moisture for long periods are suitable for rainfed crop whereas well drained soils, deltaic soils and sandy loams are good under irrigated condition. However, in hills of Uttarakhand, chilli are grown in a wide range of soils ranging from sandy to clay loam mixed with gravel and coarse sand.

6.3 Maintenance of buffer zone

For organic cultivation of chilli, a buffer zone of 7.5 - 15 m is to be left all around the conventional farm, depending upon the location of the farm. The produce from this buffer zone shall not be treated as organic.

6.4 Land Preparation

Land is prepared to a fine tilth by thorough ploughing / digging. Two to three ploughings are done to bring the soil to fine tilth. Stones and gravel are to be removed. In case of direct sowing, three to four ploughings are undertaken and sowing is done along with the last ploughing. The soil can be treated with azatobacter or azospirillum @ 1-1.25 kg mixed with 50 kg of farm yard manure and the same may be broadcast in the field. Farm Yard manure @ 4-6 t and 1-2 t of vermicompost can be added per acre.

6.5 Planting material

Chilli is propagated by seeds. For raising nurseries, seeds of high yielding varieties with tolerance to pests and diseases may be used. They should be carefully selected from certified organic farms or from own seed plot which is raised organically. To start with, chemically

untreated seeds from local high yielding varieties could also be used, in the absence of organically produced seeds.

6.6 Varieties

Pusa Sadabahar, Pusa Jwala and Pant C-1 are the chilli varieties for cultivation in Uttarakhand. However, many of the farmers are growing varieties procured from Pantnagar for long and even using their own seeds.

6.7 Seed Treatment

Seeds should not be treated with any chemical fungicides or pesticides. However, it is always beneficial to adopt indigenous practices for seed treatment, wherever possible. The seeds may be treated with *Trichoderma* and *Psuedomonas sp.* @ 10 g per kg of seed to prevent incidence of seedling rot in the nursery. The ideal time for raising nursery is February - March in the hills of Uttarakhand. Transplanting would be done during the months of April - May. 400 g of seeds would be sufficient for raising nursery for transplantation in an area of acre.

6.8 Nursery Raising

Fresh seeds are sown in well prepared nursery beds. Although it can be sown by broadcast method in the main field, transplanting method is preferred for better quality and survival. The nursery bed is usually raised from ground level and is prepared by thorough mixing with compost and sand. Seeds treated with *Trichoderma* are sown and covered thinly using sand. The seeds germinate in 5 to 7 days. About 40 - 45 days old seedlings are transplanted in the main field.

6.9 Transplanting

40-45 days old seedlings are used for transplantation. Transplanting is generally done during the April-May in the hills of Uttarakhand. Seedlings are transplanted in shallow trenches / pits or on ridges / level lands. In some places, 60 cm x 60 cm or 45 cm x 30 cm or 30 cm x 30 cm spacing is also followed. However, a spacing of 60 cm x 30 cm with a plant population of about 22200 seedlings per acre or 45 cm x 45 cm with a plant population of 19750 per acre are considered optimum.

6.10 Direct Sowing

Direct sowing is practiced under rainfed conditions. For direct sown crop, the seeds are drilled by the end of March or first week of April. Seed rate is 2.5-3.0 kg per acre. After 30-40 days of sowing, thinning and gap filling is done on a cloudy day.

6.11 Irrigation

Chilli cannot withstand heavy moisture. Hence irrigation should be given only when necessary. Frequent and heavy irrigation induces lanky vegetative growth and cause flower shedding. Plant growth, branching and dry matter accumulation are adversely affected by excess irrigation. The

number of irrigation and interval between irrigation depends on soil and climatic conditions. If the plants show drooping of leaves at 4 p.m., it is an indication that irrigation is needed. Flowering and fruit development in chilli are the most critical stages of water requirement. Normally chilli is grown under rain-fed condition. However, under irrigated condition, care should be taken to avoid using water contaminated with fertilizers, pesticides and fungicides. Irrigation should be done judiciously. Stagnation of water should not be allowed in nursery beds and fields in order to avoid fungal infection.

6.12 Inter culture operations

Grown up seedlings raised by sowing through broadcasting method or in line in ridges should be thinned out by hand 25 to 30 days after sowing the seeds to maintain a plant population of about 30 to 60 plants/m². The plant density to be maintained finally may depend on the nature and fertility of the soil. On marginal soil, the population is maintained high. Generally two weedings/hoeings are required to keep the field free from weeds, the first within 20-25 days of sowing and the other after 20-25 days of the first weeding/hoeing. Wherever needed, depending on the weed growth one or two more weedings may be taken up. Weeds which attract pests should be allowed to grow in the field to act as trap and removed before flowering. Earthing up is carried out as and when necessary. Chilli can be cultivated organically as an inter or mixed crop provided all the other crops are grown under organic methods. It is desirable to include a leguminous crop in rotation with chilli.

6.13 Manuring

Organic manures such as farmyard manure is applied @ 4 t/acre. However, it is always advisable to use compost/farmyard manure from own farm rather than from outside the farm. Restricted use of permitted mineral fertilizers under organic system can be done depending on requirement, on the basis of soil analysis. Use of bio-fertilizers can also be resorted to in combination with organic inputs.

6.14 Plant protection

6.14.1 Pests

Thrips, mites, aphids, root grubs and pod borers are the major pests in chilli. To avoid infestation of root grub, only well rotten farmyard manure should be applied in the field. Application of neem cake @ 100 kg/acre is advisable for control of root grubs. Change in the agronomic practices to disturb the life cycle of the grub is also found useful. To control the infestation of root grub, light traps can be laid out from March. Grass can be heaped at different places in the field and the grubs which accumulate in these heaps may be collected in the early morning and destroyed. 400 g/acre of *Beauveria bassiana* may be broadcast in the field. Transplanting before first fortnight of April also helps in reducing the incidence of root grub.

Application of neem seed kernel extract (NSKE) can be done for control of thrips, aphids and mites. 10 kg of neem seed kernels may be boiled in 15 l of water. 200 ml of this extract may be mixed in 15 l of water and four to five sprays may be given to control sucking pests. Farmers also use seed extracts of Bakaine (*Melia azadirach*) along with Bichoo Grass (*Urtica dioica*) for control of pests. Release of larvae

of *Chrysoperla cornea*, a bio control agent, once in 15 days is also helpful in controlling thrips and mites. Fruit (pod) borers are the major pests which cause considerable damage to the crop. They can be managed to a certain extent by adoption of bio control measures. Restricted installation of pheromone traps in the field @ 5 no. per acre helps to monitor the adult moths. Ten days after spotting the moths in the traps, 4-5 spraying with Nuclear Polyhedrosis Virus (NPV) @ 200 LE (larval equivalent)/acre is beneficial to control the early larval stage of the pod borers. The egg masses of Spodoptera borer can be mechanically collected and destroyed. Trichogramma, an egg parasite, may be released two days after appearance of moths. Spraying of neem products like neem oil, neem seed kernel extract and restricted use of *Bacillus thuringiensis* @ 0.4 kg/acre are beneficial. All the shed fruits and part of inflorescence should be collected and destroyed at regular intervals.

6.14.2 Diseases

Fruit rot & Die back caused by *Colletotrichum capsici* and bacterial wilt are the two major diseases of chilli. Bacterial leaf spot, powdery mildew and mosaic disease (caused by virus) are the major diseases of chilli. Careful seed selection and adoption of phytosanitary measures will check the diseases of chilli. Early removal of affected plants will control the spread of the diseases. Seed treatment with Trichoderma takes care of seedling rot in nursery. Varieties tolerant to diseases should be used wherever the disease is severe. Rouging and destruction of affected plants help in checking the mosaic virus. For effective disease control, 10 g of Trichoderma or Pseudomonas sp. per litre of water should be used for spraying.

6.15 Harvesting

Chilli is highly perishable in nature. It requires more attention during harvest, storage and transportation. Harvesting should be done at the right stage of maturity. Dark green fruit should be plucked for preparing chilli pickle. For dry chilli and for making chilli powder, picking should be done when the fruit is dark red. Ripe fruits are to be harvested at frequent intervals. Retaining fruits for a long period on the plants causes wrinkles and colour fading. Crop is ready for harvesting in about 90 days after transplanting. About 5-6 pickings are made for dry chilli and 8-10 pickings for green chilli.

6.16 Growth Phases in Chilli

The crop duration of chilli is about 150-180 days depending on variety, season and climate, fertility and water management. The growth of chilli comprises of vegetative and reproductive phases. In general, the vegetative phase in chilli extends to 75-85 days followed by 75-95 days of reproductive phase. The vegetative phase is characterised by increase in plant height with profuse branching. Heavy branching is preferred for better aeration and sunlight infiltration into the canopy over compact varieties. This also helps in preventing fruit rot. Flowering starts from 80-85 days of the crop or 40-45 days after transplanting. Chilli plant is an often cross pollinated

crop with 50% of natural crossing. For fruit development and maturity about 40 days time is required after anthesis and pollination.

6.17 Yield

The yield of fresh chilli varies from 30-40 q/acre depending on variety and growing conditions. Out of 100 kg of fresh fruits 25-35 kg of dried fruits may be obtained. The yield of dry chilli is expected to be in the range of 7.5 to 10 q/acre. However, in the present model, yield of 8 q/acre has been assumed.

7. Post Harvest Management :

7.1 Drying

Chilli on harvesting have a moisture content of 65-80% depending on whether partially dried on the plant or harvested while still succulent. This must be reduced to 8-10% to avoid microbial activity and aflatoxin production. Traditionally, this has been achieved by sun - drying of fruits immediately after harvesting, the most common practice in India, without any special form of treatment. Soon after harvest, the produce is to heaped or kept in clean gunnies for one day for uniform colour development of the pods. The best temperature for ripening is 22-25°C and direct sun light is to be avoided since this can result in the development of white patches. The preparation of drying floor differs from tract to tract. Heaped fruits are spread out in thin layers in the sun on hard dry ground or on concrete floors or even on the flat roofs of houses, frequent stirrings are given during day time in order to get uniform drying and thereby avoid discolouration or mould growth. Levelled and compacted floor is to be made for drying. From the fifth day onwards, the produce is inverted on alternate days so that the pods in the lower layers are brought up to ensure quick and uniform drying. While drying, the produce can be covered with polythene sheets during night time to avoid dew deposition and resultant colour fading.

Since the produce is exposed to sun for 10-15 days in the open yards, it is likely to get contaminated with foreign matter like dust and dirt, damaged by rainfall, animals, birds and insects. Traditional method of harvesting and sun drying involves poor handling of fruits resulting in bruising and splitting. Bruises shows up as discoloured spots on pods, splitting leads to an excessive amount of loose seeds in a consignment and there is a considerable loss in weight and then in price. If the harvested fruits are not properly dried and protected from rain and pests, it will loose the colour, glossiness and pungency. The losses due to this method may range from 30-40 % of the total quantity.

The produce can be dried within a period of 18 hours using air blown drier keeping the temperature at 44o - 46o C. This method not only saves time, avoids the drying operations for 10-15 days but also imparts deep red colour and glossy texture to the fruits. Solar drier and tray drier can be used. RRL (Jammu) has devised a Solar Drier for drying chilli which effects complete drying of the commodity in 4-5 days with a marked improvement in colour and storage characteristics. The gadget is very simple and is made of mud, stone pebbles and glass panes and

is specially suited for rural areas. It can be conveniently constructed by village artisans. With the extensive use of such solar driers, sizeable quantities of red chilli can be produced in rural areas.

7.2 Grading & Packing

Grading is to be done to remove defective and discoloured pods. All diseased, deformed and discoloured fruits should be removed before marketing and storage. Well dried pods after removing the extraneous matters like plant parts, etc. should be packed in clean, dry gunny bags and stored ensuring protection from dampness.

7.3 Storage

Chilli should be properly stored to avoid infestation of pests. Storage is a must for off-season consumption and marketing. While dry chilli powder can be stored at home, green fruit has to be kept in cold storage. It is preferable to store dried chilli in refrigerated condition (cold storage) to retain colour. Dunnage has to be provided to stack the packed bags to prevent moisture ingress from the floor. Care should be taken to stack the bags at 50 –60 cm away from the wall. Storing chilli for longer periods may lead to deterioration. However, if cold storage facilities are used, the product may be stored for 8-10 months. Insects, rodents and other animals should be effectively prevented from getting access to the premises where chilli is stored.

7.4 Processing

Processed products such as dehydrated chilli, pickle, powder, paste, sauce, etc., can be prepared for higher returns. Almost all chilli growers sell it directly. The farmers will be in a position to get better returns by value addition in the form of processed products. Hence, farmers must be educated in the processing of chilli.

8. Linkages :

8.1. Technical guidance

Technical guidance for organic chilli cultivation is being provided by Master Trainers at the block level working with the Department of Agriculture. Service Providers of Uttarakhand Organic Commodity Board at the district level also help these Master Trainers in guiding the farmers. Apart from this, G B Pant University of Agriculture and Technology, Uttarakhand Organic Commodity Board may also be approached for technical guidance and marketing of the produce.

8.2 Export Oriented Production

Spices Board supports production, processing, certification and marketing of organic spices. The Spices Board is also implementing the scheme for Export Oriented Production during the XI Plan wherein assistance is being provided for promotion of organic chilli under various

programmes indicated in Annexure II.

8.3 Supply Chain Management

At present, dry chilli are being marketed by the farmers mostly in the village itself to traders. Some of the farmers sell dry chilli at Ramnagar and Haldwani mandies. Chilli is one of the major commodity traded in Ramnagar market. Since the chilli of the target area commands premium price due to their pungency, marketing has not been a problem for the farmers. The movement in chilli prices is inversely related to the market arrivals. The market arrival of chilli in the country is highest during the period of May-September and lowest during October-November. Conversely, the price of chilli is highest in October-December. The harvesting season in Uttarakhand hills starts from September and extends upto November. The low market arrivals during this period also helps the farmers of Uttarakhand to realise better prices apart from their quality.

Organic Producers Groups (OPG) are formed in each of the Bio Villages which are commodity specific. These groups are involved in Production, Grading and Packaging of Organic Products. Master Trainers at block level working with the Department of Agriculture give feedback to Service Providers working with Uttarakhand Organic Commodity Board at a higher level. Two nodal persons (Supply Chain Officers) in each region i.e. Kumaon and Garhwal are placed for effective supply chain management.

Uttarakhand Organic Commodity Board has facilitated marketing of organic chilli by bringing these organic producers groups in contact with marketing partners registered with them. Buyers are directly linked to these groups for procurement. Further, the Organic Producers Groups are in the process of setting up Common Facility Centres for handling various organic commodities.

9. Financial Aspects :

9.1 Sale Price

The income from chilli depends on the cost of cultivation, yield and price of dry chilli. While the price fluctuates from Rs.40 - 90 per kg depending on the season and also on the quality of the produce, in the present model, a conservative price of Rs.50 per kg has been considered, even though, the chilli from the Betalghat area commands premium price in the market owing to high levels of pungency.

9.2 Cost of cultivation

In the present model, the cost of cultivation for development of organic chilli in acre of land works out to be Rs.21500. This may be modified to suit the local conditions taking into account the different techno-financial parameters prevailing in the locality. The details of various costs and benefits are presented in **Annexure-III**.

9.3 Margin

The percentage of margin / down payment to total cost of development prescribed is 5, 10 and 15% for small, medium and large farmers respectively. The rest of the cost of development will be provided as bank loan. Margin considered in the present model is 10%.

9.4 Bank Loan

Bank loan of 85 - 95 % shall be available from the financing institution. Bank loan considered in the model is 90%.

9.5 Rate of interest

The rate of interest to be charged to the ultimate borrower would be guided by RBI guidelines issued from time to time. However, the ultimate lending rate has been considered as 12 % for working out the bankability of the model scheme.

9.6 Security

Banks are guided by RBI guidelines issued from time to time in this regard.

10. Conclusion :

The net income from organic cultivation of chilli is Rs.17300/acre. The activity is technically feasible, financially viable and bankable.