

# **BIODIVERSITY AND SUSTAINABLE DEVELOPMENT**

**ADVANCES AND PERSPECTIVES**

Edited by  
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## **CHAPTER 8**

# **Good Agricultural Practices and Economic Analysis of Naga King Chilli Cultivation**

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### **-----ABSTRACT-----**

Naga King Chilli (*Capsicum chinense* Jacq.) was previously acknowledged by the Guinness World Records as the world's hottest chili in 2006. This exotic chilli, native to North-Eastern India, was the first product from Nagaland to receive GI tag. Its production is limited and confined to North-Eastern India only. Scientific cultivation on a larger scale through the adoption of Good Agriculture Practices (GAP) has a huge potential to improve the production significantly. Based on the information and analysis in the present study, it is observed that the gross return and the net returns obtained after adopting GAP as opposed to conventional farming practices are yet to show significant results in the long run as the adoption of the new technologies was undertaken over a 1 year time frame. However, it remains to be determined that significant differences will occur in the long term once farmers are comfortable with the newly introduced GAP. Cost analysis indicated that the cost of production in conventional farming method and the newly introduced GAP approach were minimally different. The introduction of the new technology has motivated more farmers to take up Chilli cultivation in a short period of time. The study showed that the gross return in one acre of land is about Rs. 1, 20,000/-, whereas the net returns is about Rs. 58,400/- after adoption of GAP. It is further observed that the maximum amount is invested in labour cost. Therefore, there is a need to develop labour saving practices by utilising improved tools and optimising planting and harvesting techniques.

**Keywords:** Naga King Chilli, Good agricultural practices, Conventional farming

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### **Introduction**

**N**aga King Chilli (*Capsicum chinense* Jacq.) is an important spice crop of India belonging to the family Solanaceae. It is considered as India's hottest chili and was formerly acknowledged as the world's hottest chili measuring 1,001,304 Scoville Heat Units (SHU) (Guinness Book of World Records, 2006; Kehie et al. 2016). Naga King Chilli is known in local Angami dialect as 'Kedi Chüsi' which literally means the 'King of Chillies', is also known by various other names in different regions such as 'Bhoot jolokia' or 'Bih jolokia' in Assam, 'Naga King Chili' in Nagaland, 'Omorok' in Manipur and

‘Ghost pepper’ by the western media (Meghvansia et al. 2010; Kehie et al. 2013).

This exotic chilli is a native of the North-Eastern India, a region noted as hot-spot for its chilli diversity and more particularly to Nagaland (Bhagowati and Changkija, 2009). It is a self-pollinated semi perennial herb with numerous fruit colour variants viz., green, orange, red, coffee, yellow, white etc. The occurrence of high cross pollination and adaptation to micro-climatic conditions has led to the formation of variants and landraces within the species (Kehie et al. 2016). Naga King Chilli is grown majorly in the North-Eastern India particularly Nagaland (Dimapur, Kohima, Mon and Peren districts), Assam (Golaghat and Tezpur districts) and Manipur (Tamenlong, Ukhrul, Churachanpur districts), among other areas. This chilli has been patented by the Government of Nagaland and registered under Geographical Indication Registry (Kehie et al. 2014). It is important to note that this chili is the first and one of the only two GI tagged crops of the state. Conventionally, the Naga King Chilli is cultivated in *Jhum* (shifting cultivation) paddy fields as a sporadic intercrop limiting its production to only about 1,000 tonnes every year in the whole region of North-Eastern states of India.

Naga King Chilli has a huge potential for domestic and international market. Scientific cultivation on a larger scale through the adoption of Good Agriculture Practices (GAP) will help in employment generation and improve the socio-economic status of the state.

GAP may improve efficiency of farming practices and improve livelihood of vegetable farmers, particularly smallholder vegetable farmers (Rajendran et al. 2017). The concept of GAP evolved recently as a result of the big concern about food safety and quality. GAP offers benefits to farmers and consumers to meet specific objectives of food security, food quality, production efficiency, livelihood and environmental protection (Divya and Sivakumar, 2014). Resources are scarce and this is a major concern to production economist. The economist has to think about ways to allocate the existing resources to have more output with minimum input combination. The farmers should be able to prescribe the level of input with the least cost without changing the production technology to a more expensive one (Wosor, and Nimoh, 2012). Hence, the present study was undertaken to document GAP and analyse the cost and returns of Naga King Chilli cultivation under GAP.

## **Materials and methods**

*Documentation of Good Agriculture Practices:* Documentation of good agricultural practices of Naga King Chilli was carried out based on published literatures. Training and demonstration on GAP were given to selected farmers at Rüzaphema Village, Dimapur, Nagaland for adoption.

*Economic analysis:* The present study investigated the economics of chilli cultivation at Rüzaphema Village, Dimapur, Nagaland. Sampled area was selected as chilli is traditionally cultivated by the farmers for personal consumption and for commercial purpose. Estimates of gross profit margin using financial cost–benefit analysis was used to determine the extent of profitability of newly introduced GAP interventions in the study area. The higher the profit margin, the greater the profitability of a proposed intervention. Gross margin, the amount of profit after paying off costs of production, was used to assess profitability by taking into account revenue and costs involved in production. The cultivation is mainly through various intercropping methods. The primary data was collected through personal interview with organized structure of questionnaire from the 50 selected farmers. Analysis of economics of chilli was carried out following the cost concepts defined by Commission for Agricultural Costs and Prices (CACP) as mentioned below:

Cost A1 = All actual expenses in cash and kind incurred in production by the producer. The items covered in cost A1 are costs on: i) Land preparation, ii) Machinery charges, iii) Raising of Nursery, iv) Transplantation, v) Irrigation, vi) Weeding, Hoeing, Earthing up and other operation, vii) Plant protection, viii) Harvesting, ix) Drying, x) Transportation and Marketing, xi) Seed cost, xii) Organic manure, xiii) Biofertilizers and Biopesticides, xiv) Miscellaneous expenses.

Cost A2 = Cost A1 + Rent paid for leased-in land

Cost B1 = Cost A1 + Interest on value of owned capital assets (excluding land)

Cost B2 = Cost B1 + Rental value of owned land (net of land revenue) and rent paid for leased-in land

Cost C1 = Cost B1 + Imputed value of family labour

Cost C2 = Cost B2 + Imputed value of family labour  
Cost C2\* = Cost C2 + estimated by taking into account statutory or actual wage rate whichever is higher

Cost C3 = Cost C2\* + 10 per cent Cost C2\* to (on account of managerial functions performed by farmers)

Farm business income = Gross return – Cost A1, here the gross return includes all those economic products from chilli as well as bi products.  
Farm investment income = Farm business income – imputed value of family labour.

Family labour income = Gross return – Cost B2

Net income = Gross return – Cost C3

## **Results and discussions**

Adoption of GAP is crucial for reaping maximum benefit in crop cultivation. About 50 farmers who have been trained for adoption of GAP were interviewed to get first-hand information on the adoption of GAP technology. Based on the information and analysis in the present study, it is observed that the gross return and the net returns obtained after adopting GAP as opposed to conventional farming practices are yet to show significant results in the long run as the adoption of the new technologies was undertaken over a 1 year time frame, a period perhaps not long enough to realize its full potentials and positive impact. However, it remains to be determined that significant differences will occur in the long run once farmers are comfortable with the newly introduced GAP and have fully adopted the procedures. Adoption of new technology might differ in the long term because adoption behaviour is time variant. The cost of production in conventional farming method and the newly introduced GAP approach were minimally different indicating that only little additional investment is required by farmers to introduce the new technology. At the time of writing this paper, farmers have not fully adopted the GAP approach, however, many are transitioning to the newly introduced technology for complete adoption. The adoption of GAP is determined to provide benefit to the farmers as GAP when introduced and adopted could help increase net income and improve produce quality through modest prevention and/or control of some pest and diseases (Tilman et al. 2002; Ajayi, 2007; Lazaro et al. 2017). The introduction of the new technology has motivated more farmers to take up chilli cultivation in a short period of time. The GAP approach may help farmers more efficiently utilize

small land parcels by increasing returns through farming system intensification (Lazaro et al. 2017).

GAP has improved crop resistance to diseases and improved the productivity. Spice production in India, like much of the agriculture in the country, is undertaken in millions of tiny holdings and determines the livelihood of a large portion of the rural population (Spices Board, 2011). Technical innovations can improve yield and increase productivity of vegetable crops (Rajendran et al. 2015). Improving agricultural productivity is important for improving the livelihood of smallholder farmers, who typically underutilize resources in farming activities (Msuya, 2008). Future study should be conducted to assess its impact over a longer period of time with a larger sample size to conclusively ascertain its impact and profitability. However, the present study set a baseline information from which extended research can be advanced.

*Economic Analysis:* Data was collected by interviewing selected farmers by survey method with special designed schedule. Collected data then tabulated according to need and purpose of study. Simple tabular analysis was made. To workout economics of chilli production, different cost concept as per CACP was followed. It is evident from the present study that chilly cultivation is yielding more profit as well as improving the livelihood of the farmers in the study area. The tabular presentation showed the estimation of the cost of cultivation of Naga King Chilli crop per acre by the farmers. The data was summarized with the aid of statistical tools and presented in averages to obtain meaningful results. The table 2 showed that the cost of human labour, seed, bio fertiliser and biopesticide, organic manures were the major share in the variable cost. The cost pattern indicated that human labour for operation cost under various inputs viz., land preparation (Rs. 4,500), raising of nursery (Rs. 3,000), transplantation (Rs. 1,500), irrigation (Rs. 3,000), weeding, hoeing, earthing up (Rs. 6,000), plant protection (Rs. 1,500), harvesting (Rs. 3,000), drying (Rs. 3,000), transportation and marketing (Rs. 5,000) was approximately Rs. 30,500 per acre (Cost A1). The materials cost such as seed (Rs. 1,000), organic manure (Rs. 1,000), bio fertilisers and biopesticides (Rs. 1,000) were estimated at a total of Rs. 4,000/- per acre. The present study did not take into account any other external manure sources except the biomass ash manure which is available in the farm, biofertilisers and biopesticides such as *Trichoderma viride*, *Pseudomonas fluorescens*, neem oil etc. Other cost includes organic

certification cost at Rs. 5,000/-. The Cost A2 was found out to be Rs 49,500, Cost B1 Rs 44,500, Cost C1 Rs 46,000, Cost C2 Rs 56,000, Cost C3 Rs 61,600, farm business income Rs 80,500, farm investment income Rs 79,000, and the family labour income Rs 65,500. The study showed that the gross return in one acre of land is about Rs. 1, 20,000/-, whereas the net returns is about Rs. 58,400/-. It is observed from the table 2 that the maximum amount is invested in labour cost. Therefore, there is a need to develop labour saving practices by utilising improved tools and optimising planting and harvesting techniques.

**Table. 1** Documentation of GAP on organic Naga King Chilli cultivation

| Agro-climate          | Soil type                      | Loose sandy loam, clay loam or laterite soil                                                                                                                                  | References                                                                                                                                                                                                         |
|-----------------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | pH                             | 5.5-6.0                                                                                                                                                                       |                                                                                                                                                                                                                    |
| Cultivation practices | Temperature                    | 20-25°C                                                                                                                                                                       | (Borgohain and Devi, 2007; Ngullie and Daiho, 2013; Divya and Sivashankar, 2014; Katakya et al. 2016; George, 2016; Aksh, 2015)                                                                                    |
|                       | Unfavorable weather conditions | Open sun, high humidity, heavy rainfall and water logging                                                                                                                     |                                                                                                                                                                                                                    |
|                       | Nursery bed                    | Appropriately weeded, finely ploughed soil enriched with vermicompost, garden soil and sand (1:1:1) or Top soil, Biomass ash, sand (2:1:1)                                    |                                                                                                                                                                                                                    |
|                       | Seed treatment                 | Hot water treatment @ 45-50°C for 30 minutes, drain the excess water and treat with <i>Tricoderma viredi</i> and <i>Pseudomonas fluorescens</i> , dry in shade for 30 minutes |                                                                                                                                                                                                                    |
|                       | Seed sowing                    | Good quality, disease resistant seeds can be sown in February-March. Moisture content is very important for nursery growth and hence needs judicious watering.                |                                                                                                                                                                                                                    |
|                       | Root treatment                 | Two months old seedlings can be used for root treatment. Roots can be treated with <i>Tricoderma viredi</i> and <i>Pseudomonas fluorescens</i> before transplantation.        | Webpages<br>( <a href="http://agritec.h.tnau.ac.in">http://agritec.h.tnau.ac.in</a> ;<br><a href="https://www.indiaagronet.com/Chilli-Cultivation.html">https://www.indiaagronet.com/Chilli-Cultivation.html</a> ; |
|                       |                                |                                                                                                                                                                               |                                                                                                                                                                                                                    |

|                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transplantation                                                                                        | Seedlings can be transplanted at a spacing of 75cm x 75cm. A wider spacing is preferable.                                                                                                                                                                                                                                                                                             | <a href="https://agriculture.kisanhelp.in/content/organic-production-chilly-crops">https://agriculture.kisanhelp.in/content/organic-production-chilly-crops</a>          |
| Transplanting bed                                                                                      | To a properly ploughed sun exposed soil, add Azatobacter or Azospirillum @1-1.25kg, mixed with 50kg of well decomposed FYM. For one acre of land cultivation, FYM @4-6t and 1-2t of vermicompost can be mixed with the ploughed soil. To this bed the raised nursery can be transplanted. Seedlings watering to be monitored carefully, too much and less water are both detrimental. |                                                                                                                                                                          |
| <b><u>Diseases management</u></b>                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                          |
| <b>Causative organism</b>                                                                              | <b>Symptoms</b>                                                                                                                                                                                                                                                                                                                                                                       | <b>Treatment methods</b>                                                                                                                                                 |
| <i>Colletotrichum capsici</i> and <i>C. gloeosporioides</i> (Anthracnose, fruit rot, die back disease) | Necrosis of twigs from tip downwards, dark sunken spots on fruits.                                                                                                                                                                                                                                                                                                                    | Treatment with <i>Trichoderma viride</i> and <i>Pseudomonas fluorescens</i> on seeds @10g/kg seed                                                                        |
| Chilli leaf curl virus (Leaf curl disease)                                                             | Small leaves, poor growth, absence of fruits, burnt infested plants                                                                                                                                                                                                                                                                                                                   | Neem Oil @ 5ml/litre of water or Dipole (a biopesticide) @ 1-4 teaspoon per 4 litres water spray to control white fly which is vector for transmission of viral disease. |
| <i>Ralstonia solanacearum</i> (Bacterial wilt and Bacterial leaf spot)                                 | Wilt and necrosis of leaves and fruits, sudden drying.                                                                                                                                                                                                                                                                                                                                | Combination of <i>Trichoderma viride</i> and <i>Pseudomonas fluorescens</i> can be applied.                                                                              |

|                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Insect Control Measures</b>                                                             | Insect infestation to the crop plantation can significantly hamper the crop growth and its productivity.                                                                                                                                                                                                                                                                                                                                                                                                           | Neem oil spray @ 5 ml/liter of water after fruit setting to avoid the larval stage. Seed concoction of <i>Melia azadirachta</i> with <i>Urtica dioica</i> can be used for spraying to control pests. Spraying of biocontrol agents once in 15 days is also helpful in controlling thrips and mites, it may also release the larvae of <i>Chrysoperla comae</i> . Traditional provisions such as nets or insect repellents may be made to exclude rodents, insects and other pests from growing areas. |
| Common insects affecting Naga Chilli: Aphids, spider mites, fruit borer, slugs and snails. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Harvesting time, precautionary measures and harvest</b>                                 | Livestock, poultry or pets movement during harvest time to be avoided. Harvest may be made within 120 days of biopesticide application to minimize diseases. Harvesting time is September-October. Fruits must be picked upwards while harvesting. Good sanitary practices to be followed by farmers during harvest and storage.                                                                                                                                                                                   | -do-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Collection and storage of harvest</b>                                                   | Clean harvest bins to be used and must be kept on clean, elevated racks, concrete floors, or mats and not on the bare ground. Storage of harvest must be kept far away from field debris to minimize diseases.                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Processing of harvested products</b>                                                    | Fresh harvested fruits must be sun dried or smoked as soon as possible to prevent deterioration over time. Modern mechanical dryers can also be opted for delivering quality products. Dried fruits can be packed into clean containers for further transport and sale.<br>For effective and quality drying of chillies, two models of dryers; low-cost dryer and biomass tray dryer developed by Sustainable Development Research Centre, Chumoukedima, Dimapur, Nagaland, can be used at a very reasonable cost. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

**Table: 2.** Estimation of the cost of cultivation of Naga King Chilli per acre model.

| Sl. No.                    | Particular of expenses                           | Quantity/Man days | Cost of cultivation per acre. |
|----------------------------|--------------------------------------------------|-------------------|-------------------------------|
| <b>A. Operations</b>       |                                                  |                   |                               |
| 1                          | Land preparation                                 | 15                | 4,500                         |
| 2                          | Raising of Nursery                               | 10                | 3,000                         |
| 3                          | Transplantation                                  | 5                 | 1,500                         |
| 4                          | Irrigation                                       | 10                | 3,000                         |
| 5                          | Weeding, Hoieng, Earthing up and other operation | 20                | 6,000                         |
| 6                          | Plant protection                                 | 5                 | 1,500                         |
| 7                          | Harvesting                                       | 10                | 3,000                         |
| 8                          | Drying                                           | 10                | 3,000                         |
| 9                          | Transportation and Marketing                     |                   | 5,000                         |
|                            | <b>Subtotal of operation</b>                     |                   | 30,500                        |
| <b>B. Materials</b>        |                                                  |                   |                               |
| 10                         | Seed cost                                        | 0.5               | 1,000                         |
| 11                         | Organic manure                                   | 1                 | 1,000                         |
| 12                         | Biofertilizers & Biopesticides                   |                   | 2,000                         |
|                            | <b>Subtotal of materials</b>                     |                   | 4,000                         |
| <b>C. Miscellaneous</b>    |                                                  |                   |                               |
| 13                         | Certification and other costs                    |                   | 5,000                         |
|                            | <b>Subtotal of Miscellaneous</b>                 |                   | 5,000                         |
|                            | <b>Total (A+B+C)</b>                             |                   | 39,500                        |
| <b>II Assumptions</b>      |                                                  |                   |                               |
|                            | Variety                                          |                   | Naga King Chilli              |
|                            | Spacing                                          |                   | 6 x 6 feet                    |
|                            | Seed rate for transplanted crop (Kg/acre)        |                   | 0.5 Kg                        |
|                            | Plant population (no./acre)                      |                   | 1,208                         |
|                            | Quantity of organic manure (FYM) (t/acre)        |                   | 1                             |
|                            | Yield of chilli (q/acre)                         |                   | 4.83                          |
|                            | Number of picking                                |                   | 4                             |
| <b>Financial Parameter</b> |                                                  |                   |                               |
|                            | Cost of seed (Rs./Kg)                            |                   | 2,000                         |
|                            | Labour wage (Rs./manday)                         |                   | 300                           |
|                            | Hiring cost for ploughing (Rs./acre)             |                   | 3,000                         |
|                            | Cost of organic manure (FYM) (Rs./t)             |                   | 1000                          |
|                            | Cost of transportation of chilli (Rs./q)         |                   | 250                           |
|                            | Sale price of chilli (Rs./q)                     |                   | 25,000                        |
| <b>III Economics</b>       |                                                  |                   |                               |
| <b>A</b>                   | <b>Income</b>                                    |                   |                               |
|                            | Sale of chillies 4.83 q @ Rs. 25000 per q        |                   | 1,20,000                      |
| <b>B</b>                   | <b>Expenditure</b>                               |                   |                               |
|                            | Cost of cultivation                              |                   | 61,600                        |

**Table 3.** Cost and return in chilli production (Rs/acre)

| Sl. No. | Particulars            | Amount in Rs. |
|---------|------------------------|---------------|
| 1       | Cost A1                | 39,500        |
| 2       | Cost A2                | 49,500        |
| 3       | Cost B1                | 44,500        |
| 4       | Cost B2                | 54,500        |
| 5       | Cost C1                | 46,000        |
| 6       | Cost C2                | 56,000        |
| 7       | Cost C3                | 61,600        |
| 8       | Gross income per acre  | 1,20,000      |
| 9       | Farm business income   | 80,500        |
| 10      | Farm investment income | 79,000        |
| 11      | Family labour income   | 65,500        |
| 12      | <b>Net income</b>      | <b>58,400</b> |

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