



Economics of khasi mandarin cultivation in Meghalaya: Analysis of economics feasibility and constraints faced by farmers during its cultivation

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ABSTRACT

The study was focus on production aspect of Khasi mandarin in Meghalaya through estimation of the feasibility of investment in Khasi mandarin cultivation and also identifying the problem faced by the growers. The study was conducted in four selected villages *i.e.* Mawphu and Umblai villages (Shella block) of East Khasi Hills and Nongnah and Keniong villages (Ranikor block) of West Khasi Hills districts of Meghalaya. A total of 80 respondent farmers were drawn using probability proportionate to size sampling method. The study indicates that even though the production is declining with ages of orchards, the economic indicators' such as NPV, B: C ratio, IRR and PBP was found to be profitable, economically feasible and financially viable. Thus mandarin cultivation proves to be a profitable enterprise in the study area across all the groups of orchards. Major constraints cause by pest and diseases, rain fall and high wind during flowering season, lack of recommended package of practise (water and fertilizer management), lack of extension advisory and training exposure have directly affected the fruit yield.

1. Introduction

Horticulture occupies almost 8.5 per cent of the gross cropped area of the country and contributes 33 per cent to the GDP of agriculture and 52 per cent of export earnings in agriculture (NHB, 2018). India ranks second both in area and production among fruits and vegetable producing countries of the world after China. Among the horticulture crops produce in India, fruit placed 2nd (31.2%) in production which increased from 50.9 million MT (2004-05) to 97.35 million MT (2017-18). There is an impressive growth in the exports of fresh fruits from ₹489.08 crore in 2003-2004 to ₹4817.35 crores during 2018-19 (APEDA, 2019). Among fruits, citrus occupies a place of importance in the horticultural wealth and economy of India and occupies an area of about 1003 thousand hectares with production of 12546 thousand MT which accounts for 12.89 per cent of total fruit production.

The most important commercial citrus species in India are mandarin orange (*Citrus reticulata*), sweet orange (*Citrus sinensis*) and acid lime (*Citrus aurantifolia*) sharing 40.66 per cent, 26.03 per cent and 25.09 per cent, respectively (NHB, 2018). Mandarin with 1st most cultivated citrus fruits crop grown in India has a total production of 5101 thousand MT from 428 thousand ha. Mandarin are mostly grown in the states of Madhya Pradesh with share in production of 41.24 per cent, Punjab (23.69%), Maharashtra (15.64%), Rajasthan (6.23%) and in North Eastern state of India like Assam (3.99%), Arunachal Pradesh (1.37%), Nagaland (0.93%), Meghalaya (0.89%), Mizoram (0.86%), Manipur (0.78%), Tripura (0.50%) and Sikkim (0.37%) (APEDA, 2020). The most promising cultivars grown in India are Nagpur santra, Coorg santra, Khasi mandarin, Mudkhed, Shringar, Butwal, Kara (abohar), Darjeeling mandarin, sumithra mandarin, seedless-182 and kinnow mandarin (NHB, 2015).

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The North Eastern (NE) region of India has diverse agro climatic conditions offer immense scope for development in the horticulture sector. It is home to many citrus species and rich genetic diversity occurs in the region. However, there are only few indigenous species/ genetic resources which have got commercial value. Among these, Khasi mandarin, Kachai lemon and Assam lemon are the most important commercial citrus fruits of the region. Mandarin contributes about 24 per cent of the total area and 9.69 per cent of the total production of the country. In NE mandarin is mostly produce in Assam (41.22%) followed by Arunachal Pradesh (14.11%), Nagaland (9.58%), Meghalaya (9.15%), Mizoram (8.91%), Manipur (8.07%), Tripura (5.12%) and Sikkim (3.84%) (NHB, 2018).

Meghalaya is favourable for a variety of sub-tropical and temperate fruits. Sub-tropical fruits grown include citrus species (such as Khasi mandarin, Assam lemon, pomelo *etc*), pineapple, banana, papaya, guava and jackfruit. Temperate fruits such as pear, peach and plum are widely grown. Among the citrus species of Meghalaya, the most dominant is Khasi mandarin and have been adjudged as an important variety, widely known throughout NE as well as outside and having good acceptance among the consumers. It is a perennial horticulture fruit crops and differentiated from other orange by its thin and loose peel, sweet and juicy. Khasi mandarin is locally called as 'soh-niamtra' (in khasi language). It is mainly grown in the sub-mountainous tract along the Indo-Bangladesh border region of the state and contributes about 79.74 per cent of the total citrus production of the state. The total area of Khasi mandarin in Meghalaya is 9.26 thousand hectare and production is 44.02 thousand MT. It is cultivated in all the eleven districts of Meghalaya with East Khasi Hills and West Khasi Hills districts contributing about 59.74 per cent of the total area and 67.77 per cent of the total production of mandarin in the state (GoM, 2019). The fruit, grown abundantly in Meghalaya, had earned a spot at the Geographical Indication (GI) tagging category which pave the way for better branding and marketing of these products both in domestic and international market (APEDA, 2015).

The investment in citrus orchards was a profitable enterprise with higher gross return against the expenditure (Christian and Zala, 2014) which is reflected by the feasibility in the investment in cultivation of the fruit crops (Gangwar *et al.*, 2005).

The viability in the production has shown a positive NPV, B:C ratio greater than one and IRR which is greater than the opportunity cost of the capital (Bhat *et al.*, 2011). Seasonality and localized to favoured agro-climatic conditions coupled with the perishability

of mandarin produce pose several problems on the growers. Most of the growers lack knowledge on standard package of practices, the incidence of pests and diseases, poor orchard management (Hangsing *et al.*, 2014) and poor access to extension personnel or exposure to training programmes (Thamizhselvan and Murugan, 2012). High cost of cultivation especially initial investment (Alipour *et al.*, 2013) and planting material, labour wage and unavailability of credit pose problem to farmers (Rymbai, 2012). Several constraints such as lack of transportation, communication, weak cooperatives organizations and storage facility in the rural areas also cause problem on the farmers (Mahanta and Konwar, 2014). In the backdrop of above situation, the studies can be very helpful in identifying alternative solutions that may be adopted by farmers and policy makers. The specific objectives of the study were to analyse the economic feasibility and to identify the problem faced by the mandarin growers during cultivation.

2. Methodology

The present study was conducted in Meghalaya state located at latitude of 25°01' N to 26°05' N and at a longitude of 89°49' E to 92°52' E with an area of 22,429 km². It has a population of 29,66,889 (79.93% rural population). The population density in the state is 132 per km². The sex ratio is 989: 1000 (female: male) and the literacy rate is at 74.43 per cent (Indian Census, 2011). Khasi, Jaintia and Garo are the major tribal groups of the state (GoM, 2015). The state has eleven districts. It has generally very humid climate with a typical South-West monsoon climate and North East winter winds. The maximum and minimum temperatures during winter are 21°C and 15°C and during summer are 30°C and 22°C, respectively. The amount of total annual rainfall in the state varies between 4000 mm and 12000 mm.

For conducting of present research work dealing with time series data regarding area and production of Khasi mandarin the newly developed district has been merged to the previous district to formed seven districts as no time series data is available for newly formed district.

A multi stage sampling was adopted for the selection of districts, blocks, and villages. The study was conducted in 4 selected villages which include Mawphu and Umblai villages from Shella Bholaganj block of East Khasi Hills and Nongnah and Keniong villages from Ranikor block of West Khasi Hills districts of Meghalaya. The selection was based on highest area, production and productivity of Khasi mandarin (Table 1). Total of eighty (80) respondent farmers from the four villages have been drawn by using probability proportionate to size sampling method. This paper was based on primary data collected from a survey of mandarin producer and various stakeholders. The required information was collected through

personal interview method, using well-designed and pre-tested schedules.

3. Analytical Tools

Growth rate analysis

In view of assessing the performance of growth during study period, compound growth rates in area, production and yield of mandarin in Meghalaya were estimated by using the Log Linear model.

$$\ln Y = a + bt$$

Where,

Y = dependent variable (e.g. Area, production and productivity)

t = time

a = intercept

b = slope coefficient

Thus, compound annual growth rate (CAGR) in % will be computed as:

$$(CAGR) = (\text{antilog } b - 1) \times 100$$

Financial feasibility analysis

To examine worthiness of an investment or economic feasibility four indicators were used viz., Net Present value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Returns (IRR) and Pay Back Period (PBP).

Net Present value (NPV)

The difference between the present value of investment outlays (costs) and that of cash inflows (returns) is known as the net present worth. The criterion is presented below.

$$NPV = \sum_{i=1}^n \frac{Y_n}{(1+r)^n} - C$$

Where,

Y_n = Net cash inflows in the n^{th} year

r = Discount rate

C = Initial cost of investment

n = Economic life of the mandarin orchard.

Benefit Cost Ratio (BCR)

Benefit cost ratio is the ratio of the discounted net benefits to the initial investment. The benefit cost ratio was worked out by using following formula.

$$BCR = \frac{\text{Gross present value of income}}{\text{Gross present value of costs}}$$

Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is the rate of return which equates the present worth of benefits to present worth of costs, which means the rate at which the net present value of project is equal to zero. The internal rate of return may be then estimated by interpolation. Interpolation is a simple method of determining the intermediate value between two discount rates. The rate followed for interpolating the value of internal rate of return is as follows.

$$IRR = \left(\frac{\text{lower discount rate}}{\text{rate}} \right) \times \left(\frac{\text{difference between two NPV}}{\text{two discount rate}} \right) \times \left(\frac{\text{NPV at lower discount rate}}{\text{different between two NPV}} \right)$$

Table 1: Area, production and productivity of Khasi mandarin in Meghalaya (2017-18)

District	Area (ha)	Production(MT)	Productivity (MT/ ha)
Ri-Bhoi	271 (2.97)	1132 (2.57)	4.18
East Khasi Hills (EKH)	4250 (46.57)	23571(53.54)	5.55
West Khasi Hills (WKH)	1202 (13.17)	6264 (14.23)	5.21
Jaintia Hills (JH)	1100 (12.05)	5867 (13.33)	5.33
East Garo Hills (EGH)	535 (5.87)	2414 (5.48)	4.51
West Garo Hills (WGH)	1576 (17.27)	4196 (9.53)	2.66
South Garo Hills (SGH)	192 (2.10)	580 (1.32)	3.02
Total	9126 (100)	44024 (100)	4.82

Note: Figures in the parentheses are percentage to the total

Sources: GoM, 2019

Pay Back Period (PBP)

Pay Back Period represents the length of time required for the stream of cash proceeds produced by the investment to be equal to the original cash outlay.

$$PBP = \frac{\text{Initial investment}}{\text{Net annual cash flow}}$$

Constraints faced by mandarin grower

To analyse the various constraints faced by mandarin grower in the production, Garrett's Ranking Technique (Garrett and Woodworth, 1969) was used.

$$\text{Per cent position} = \frac{100(R_{ij} - 0.5)}{N_j}$$

Where,

R_{ij} = rank given for i^{th} item by j^{th} individual

N_j = number of items ranked by j^{th} individual

4. Results and Discussion

Growth rate in area, production and yield of khasi mandarin in Meghalaya

The growth rate with respect to area production and yield of Khasi mandarin in Meghalaya for a period of 15 years *i.e.* from 2003-04 to 2017-18 were analysed (Table 2). The compound annual growth rate of area under mandarin in Meghalaya had shown increasing trends of 9.30 per cent, 3.17 per cent, 2.28 per cent, -0.17 per cent, 16.78 per cent, 5.82 per cent, 5.27 per cent and 3.38 in Ri-Bhoi, East Khasi Hills, West Khasi Hills, Jaintia Hills, East Garo Hills, West Garo Hills, South Garo Hills and overall, respectively. Similarly, The compound annual growth rate of production under has shown increasing trends of 9.70 per cent, 4.17 per cent, 3.65 per cent, -0.15 per cent, 18.84 per cent, 6.31 per cent, 25.18 per cent and 4.03 per cent in Ri-Bhoi, East Khasi Hills, West Khasi Hills, Jaintia Hills, East Garo Hills, West Garo Hills, South Garo Hills and overall, respectively. The compound annual growth rate of productivity on the other hand was found to be very less of 0.37 per cent, 0.97 per cent, 1.33 per cent, 0.02 per cent, 1.77 per cent, 0.46 per cent, 18.92 per cent and 0.58 per cent in Ri-Bhoi, East Khasi Hills, West Khasi Hills, Jaintia Hills, East Garo Hills, West Garo Hills, South Garo Hills and overall, respectively.

It has been observed that the district wise area and production of Khasi mandarin in Meghalaya has clearly showed a positive and significant growth rate (Porwal, 2014) except in Jaintia Hills. The graph depicts a direct relationship between area and production which was more or less in a proportionate way with an exception in South Garo Hills. Similarly, the growth rate of productivity shown a

positive and significant growth rate but it increases less than the increase in area and production. So, it was reflected that growth rate of productivity was not due to an advancement of technology. Hence, increase in production was influenced by the increase in the area.

Distribution of Khasi mandarin growers

Mandarin growers from all the villages were categorized into five groups' base on the year of planting and on the number of fruit plant grown per ha by the farmers in his orchard *viz.*, Group I (100-300 plants), Group II (301-500 plants), Group III (501-700 plants), Group IV (701-900 plants) and Group V (900 and above plants).

The study reveals that out of the total 80 selected mandarin household's grower's maximum numbers of household were keeping the orchards between 301-500 (31.25 %) plants followed by 100-300 (26.25 %) plants, 701-900 (17.50 %) plants, 501-700 (15 %) plants and 901 and above (10 %) plants. In the beginning of year 1970-80, mandarin household's growers in all groups of orchard were less but in the year 1981-90 the number of household were increase as the farmers intensify their plant material. Similar trend was observed in 1991-2001 and 2001-2010 for group I and group II as far as the number of fruit tree planted. But the trends start declining as the year passing in all the group of orchards. It has been observed that between 1970-80 and 1981-90 the number of mandarin households' grower in all different groups of orchards were in an increasing trend. It indicates that on the eve of globalisation and commercialisation it had tremendous effect on mandarin households' grower but that maintenance has not been kept as the number of mandarin households' growers in the year 1981-90 to 1991-00 no particular trends were observed for group III, group IV and group V orchards. It was also revealed that from the year 1991-00 to 2001-10, the numbers of mandarin households' had increased for group I and group II orchards, whereas, group III and Group IV and group V orchards had declined. During the year 2001-10 and 2011 and above the numbers of mandarin household growers were decreasing in all different group of orchards. It may be inferred that commercialisation had touched to the mandarin farm of the selected household but did not take its position in increasing trends.

Table 2: Compound annual growth rate of area, production and yield of Khasi mandarin in Meghalaya (2003-04 to 2017-18)

State	Area	Production	Yield
Ri-Bhoi	9.3	9.7	0.37
East Khasi Hills	3.17	4.17	0.97
West Khasi Hills	2.28	3.65	1.33
Jaintia Hills	-0.17	-0.15	0.02
East Garo Hills	16.78	18.84	1.77
West Garo Hills	5.82	6.31	0.46
South Garo Hills	5.27	25.18	18.92
Overall	3.38	4.03	0.58

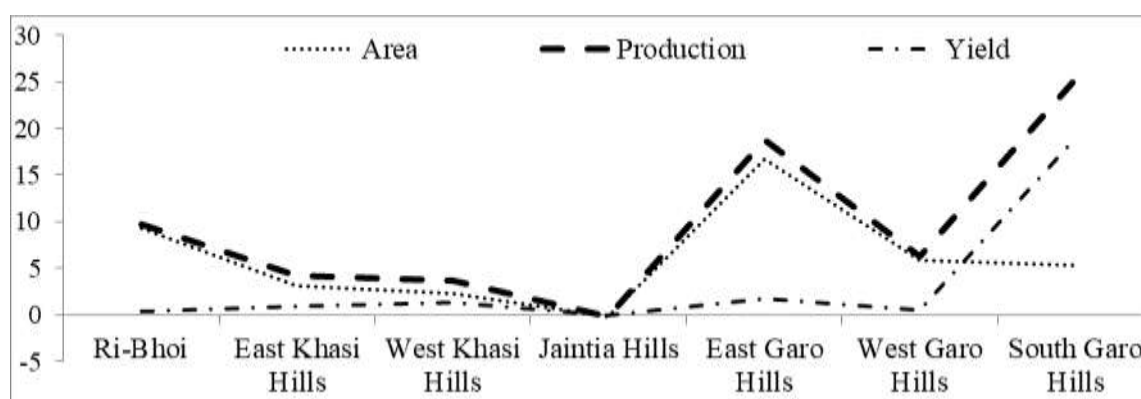


Figure 1: Compound annual growth rate of Khasi mandarin

Table 3: Distribution of Khasi mandarin household growers (Number)

Year	Group I	Group II	Group III	Group IV	Group V	Total
1970-80	-	2 (2.5)	3 (3.75)	1 (1.25)	1 (1.25)	7 (8.75)
1981-90	4 (5)	4 (5)	4 (5)	7 (8.75)	3 (3.75)	25 (31.25)
1991-00	6 (7.5)	7 (8.75)	3 (2.5)	4 (5.00)	2 (2.50)	24 (30)
2001-10	9 (12.25)	10 (12.5)	2 (2.5)	2 (2.50)	2 (2.50)	19 (23.75)
2011 and above	2 (2.5)	2 (2.5)	1 (1.25)	-	-	5 (6.25)
Total	21 (26.25)	25 (31.25)	12 (15.00)	14 (17.50)	8 (10)	80 (100)

Note: Figures in parentheses are percentage of the total of 80 respondents

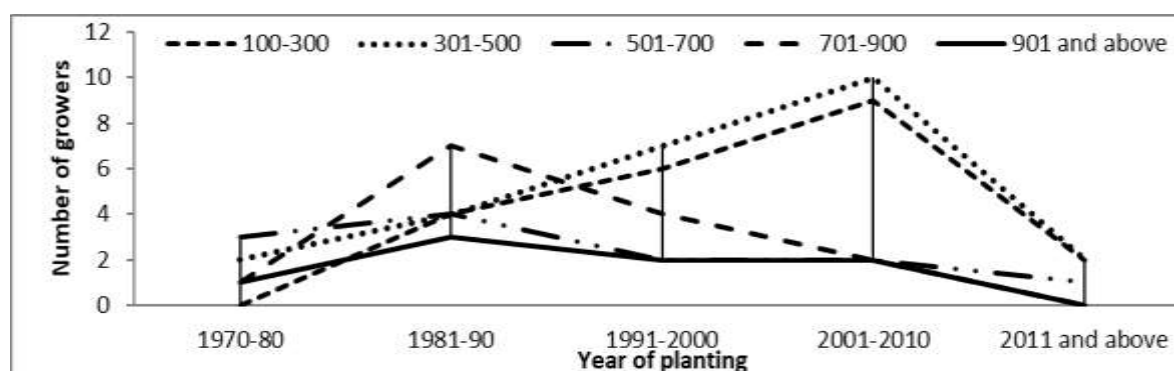


Figure 2: Distribution of mandarin plant according to household growers

The reason for the reducing in the number of household growers in the region was mainly because of the declining in the production of the fruits as a result of disease and pest such as citrus trunk borers, scales, aphids and leaf miners (Lakshman, 2017) and also the change in climate which deteriorated the production of orchards (Abobatta, 2019). Lack of knowledge on management of the orchards such as rejuvenation, control of pest and disease, nutrient and water management make farmers losing interest for further cultivation and thus forces them to shift or cultivate different crops such as broom stick cultivation to avoid losses as reported by the farmers in the study area.

Economic viability of Khasi mandarin cultivation

The annual estimates cost provides an over view of the extent of expenditure incurred and returns accrued to sample growers during different years of plantation. These estimates do not reveal the extents of benefits and costs involved in the plantation. Therefore, in order to obtain more logical results, the sample plantations have been appraised over the years taking into account various components of costs and returns. While appraising the sample plantation, information on all the components of costs incurred during each years from the inception of plantation till the last stage of production were collected from each of the mandarin growers. This information not only included establishment costs incurred by the growers during the initial year of establishment but also annual maintenance costs during the whole life cycle of the orchards (25 years). The costs and returns estimates were discounted at an annual rate of interest at 10 per cent for each year. Following the procedure, the estimates relating to discounted costs and benefits were obtained for the mandarin growers. With the help of discounted costs and benefits, the Net Present Value (NPV), Internal Rate of Return (IRR), Benefits Cost Ratio (BCR), Pay Back Period (PBP) were computed

Net Present Value (NVP)

The net present value is simply the present value of net returns which is discounted at the opportunity cost of capital. In other words, the net present worth of an investment is the difference

between the present value of series of inflows (returns) and outflows (costs) over the economic life period of mandarin. The net present values of Khasi mandarin per hectare discounted at 10 per cent opportunity cost of capital were ₹30526.50, ₹06827.94, ₹04746.25, ₹04056.82, ₹78925.95 and ₹83211.41 for group I, group II, group III group IV, group V and overall orchards, respectively. There is a positive net present value (Gondalia and Patel, 2007) of mandarin cultivation which signified the feasibility of cultivation (Table 4).

Benefit Cost Ratio (B: C Ratio)

The benefit cost ratio was obtained by dividing the discounted net returns by the discounted costs. This criterion indicates the rate of return per rupee invested in mandarin plantation. The net present value of costs and returns were obtained by discounting the cost and return by the opportunity cost of capital. The benefit cost ratio at 10 per cent discount rate obtained in mandarin were 1.93, 2.51, 2.85, 3.23, 3.36 and 2.50 for group I, group II, group III group IV, group V and overall orchards, respectively. The ratio of net profit to capital employed is very impressive from the point of view of capital investment (Lama and Sankar, 2013) It indicates that Khasi mandarin orchards were financially acceptable venture (Table 4).

Internal Rate of Return (IRR)

This represents the rate of return over the life period of mandarin. This criterion measures the rate of return that can be realized by investment in mandarin plantation. Hence, the IRR indicates an important basis of investment and better than other criteria of evaluation. The value of IRR generally depends on the magnitude of returns realized in each year over the economic life period and more particularly in the initial years of mandarin plantation. Thus IRR is known as 'marginal efficiency' of capital or yield on investment. It is the discount rate at which the present values of the net cash flows are just equal to zero, *i.e.*, NVP is equal to zero. The internal rate of return in mandarin cultivation were 21.23 per cent, 24.04 per cent, 25.33 per cent, 26.57 per cent, 26.17 per cent and 24.05 per cent for group I, group II, group III group IV, group V and

Table 4: Financial feasibilities of investments in mandarin orchard

Particulars	Household (No.)	NPV (₹)	B:C Ratio	IRR (%)	Pay-back period (years)
Group I	21	230526.50	1.93	21.23	8.96
Group II	25	306827.94	2.51	24.04	8.18
Group III	12	304746.25	2.85	25.33	8.91
Group IV	14	304056.82	3.23	26.57	8.71
Group V	08	278925.95	3.36	26.17	8.68
Total	80	283211.41	2.50	24.05	8.20

overall orchards, respectively. The IRR was greater than the opportunity cost of capital which (Karegaonkar *et al.*, 2011) indicates a higher marginal efficiency of capital per unit (Table 4).

Payback Period (PBP)

The payback period refers to the period required to recover the establishment cost of the cultivation. In the present study the pay-back period were 8.96 years, 8.18 years, 8.91 years, 8.71 years, 8.68 years and 8.20 years for group I, group II, group III group IV, group V and overall orchards, respectively. This clearly indicates that in all the different groups of orchards except group I the growers can get their initial investment within 9 year *i.e.* after 1.5-2 years of harvesting (Table 4).

The foregoing analysis revealed that NPV was positive, BCR was greater than one and IRR was higher than the opportunity cost of the capital (10%). The initial investments in mandarin orchard could be recovered within 1.5-2 years of harvesting which was in conformity with the finding of Bhat *et al.*, 2011. Thus, the results of this study clearly revealed that even though the production of the orchard start declining with ages but eventually the investments in mandarin cultivation were profitable, (Gangwar *et al.*, 2005). Therefore, the farmers of the region should be enlighten about the benefit of the enterprises so that they can invest more on their orchards through adoption the latest

technology so that the declining in the fruit crops can be reduce to a great extent. Thus, the farmers can generate huge income through this enterprise which serves as an employment generation for livelihood sustainability.

Constraints faced by farmers in production of Khasi mandarin

The study was conducted to know the problem faced by the mandarin growers and was analysed using Garrett's ranking technique. Khasi mandarin growers faced several constraints during production such common constraint, technical and economic constraints. The constraints were ranked based on the Garrett's score (GS) computed. These constraints are briefly brought as under (Table 5).

A. Common constraints

The study revealed that undulated topography/ steep slope of land was considered to be the major constraints faced by mandarin growers in Meghalaya which made it difficult for the growers to carry their produce and was placed in first rank by the mandarin growers (GS: 78.25). The respondent also reported about labour problem (Maske and Jain, 2011) during peak season of harvesting (GS: 61.44). The mandarin growers have to hired labours for carrying their produce by foot from their orchards to vehicle accessible roads to finally reach the markets and were placed as second rank by the mandarin producer. It was followed by small land holding (GS: 55.75) (Hemambara *et al.*, 2014), rainfall and high

Table 5. Constraints in production of Khasi mandarin

A	Common constraints	GS	Rank
1	Undulated land (steepness)	78.25	I
2	Labour problem	61.44	II
3	Small land holding	55.75	III
4	Rain fall and high wind	50.36	IV
5	Quality sapling	49.35	V
6	Lack of recommended package of practise	44.85	VI
B	Technical constraints (lack of knowledge about)		
1	Control of pests and diseases	78.55	I
2	Extension advisory	63.64	II
3	Training exposures	53.63	III
4	Soil suitability	53.41	IV
5	Fertilizer management	45.58	V
6	Water management	45.20	VI
C	Economic constraints		
1	High labour charges	71.44	I
2	High initial investment	57.19	II
3	Lack of credit facilities in the area	54.63	III
4	Costly plant material	41.75	IV

wind (GS: 50.36) during flowering season (Lakshman, 2017) cause dropping of the flowering which resulted in less fruit formation, quality sapling (GS: 49.35) and lack of recommended package of practices (GS: 44.85) such as maintaining of spacing will resulted in competition of nutrient and water from soil among fruit crops.

B. Technical Constraints

In technical study, it was noted that lack of knowledge about various cultivation practices was the major constraints expressed by the farmers. Also, respondents reported that they have very low technical knowledge of improved management practices which directly or indirectly affected the production of Khasi mandarin. It was evident that the growers faced the major problem in control of disease and pest infestation and place in first rank (GS: 78.55). Pest infestation and diseases (Maske and Jain, 2011) had drastically affected the plant and caused partially dying of the plant resulting in less fruit bearing. The other major technical constraints faced by the growers in the study area were lack of extension advisory (GS: 63.64) (Bhagat and Dhar, 2012) and was considered as second rank which was followed by training exposures (GS: 53.63), soil suitability (GS: 53.41), lack of knowledge about fertiliser management (GS: 45.58) and water management (GS: 45.20).

C. Economic constraints

Economic constraint also had major effect in Khasi mandarin production. It was evident that mandarin growers faced the problem of high rate of labour charges (Phuse *et al.*, 2008) as it was ranked first (GS: 71.44). This was mainly due to non-availability of motorable road in study area because of which farmers hired a labour to carry their produce up to vehicle accessible road. The other economic problem such as high initial investment (GS: 57.19) (Yadav *et al.*, 2013), lack of credit facility in the area (GS: 54.63) and high cost of planting material (GS: 41.75) were also considered as major constraints faced by the mandarin growers.

5. Conclusion and Suggestion

- The compound annual growth rate of area and production in all the districts in Meghalaya had shown an increasing trend but the growth rate of productivity increase less than increase in production which shows that the increase in productivity was influence by the increase in area.
- The distribution of household growers for different group of orchard shows that majority farmers maintain their orchards between 301-500 fruit plants followed 100-300 fruit plants and with few growers for other group of orchards.
- The distribution of household farmers decreases with passing of years as a result of climate change, disease and pest infestation which causes declining in fruits yield and

thus the farmers losing interest in continuation with orchards cultivation.

- The study revealed that NPV was positive, BCR was greater than one and IRR was higher than the opportunity cost of the capital (10%). The initial investments in mandarin orchards could be recovered within 1.5-2 years after harvesting.
- The results of this study clearly revealed that even though the production of the fruit crop start decline with the age of the orchards but eventually the investments in mandarin cultivation were profitable, economically feasible and financially viable.
- Farmers of the region faced several problems in raising their orchard which has drastically affected the production of the fruit crops. Many of them have reported that because of the inability the orchard to bears more fruit has force them to shift to broom stick cultivation.

The study revealed that farmers had faced several problems during cultivation of Khasi mandarin such as dropping of reproductive flowering part causes by rainfall and high wind, disease and pest infestation as a result of low technical knowledge of improved management practices has directly or indirectly affect the production of fruits. High initial investment, costly planting material and non-availability of credit facilities in the area cause difficulty among farmers to invest and expanding their orchard. The steepness or undulated land in the area combine with unavailability of transport facilities especially those who live and farming deep valleys had to carry sack full of oranges weighing up to 80-100 Kgs on their back or as head load and climb steep hills of more than 2000 feet with slope of 60-70 degrees making their arduous climb extremely hard. For carrying the fruit to the point where road accessibility is available especially during peak season of harvesting farmers need to hired labours which charges them higher price due to unavailability of labour during such period. With the perishability of the produce, the options available to them were limited and therefore they were prone to high level of exploitation and distress sale. Even where road accessibility was available the transportation costs cut deep into the final sale price. For distances of up to 15-20 kms, the farmers pay up to ₹30 per basket of 50 kilograms.

Therefore, effort should be taken up by the state government and concern authority to provide immediate support for development of better road facility and marketing infrastructure such as cold storage or small processing unit in those areas so that they can increase their productivity on large scale and better marketing of their produce. The policy implications suggested, if properly

implemented may result in increased revenue of the farmers in particular and the state in general. Thus it enhances the livelihood and income opportunities of the farmers.

6. Reference

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Appendices

Appendix-I: Compound annual growth rate of Khasi mandarin in Meghalaya																								
Year	Ri-Bhoi			East Khasi Hills			West Khasi Hills			Jaintia Hills			East Garo Hills			West Garo Hills			South Garo Hills			Meghalaya		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
2003-04	89	244	2742	2024	12038	5948	822	3760	4575	1113	6092	5473	68	280	4118	627	1948	3107	87	23	264	4830	24385	5049
2004-05	113	345	3053	3397	13673	4025	904	4139	4579	1137	6338	5574	102	417	4088	918	2879	3136	121	92	760	6692	27883	4167
2005-06	98	575	5867	3433	16921	4929	947	4183	4417	1104	6152	5572	100	421	4210	926	2004	2164	115	72	626	6723	30328	4511
2006-07	101	590	5842	3377	16819	4980	1003	4512	4499	1122	6152	5483	107	450	4206	930	2020	2172	115	60	522	6755	30603	4530
2007-08	112	588	5250	3441	16854	4898	1010	4545	4500	1136	6095	5365	112	472	4214	954	2071	2171	120	62	517	6885	30687	4457
2008-09	172	612	3558	3837	18381	4790	1091	4875	4468	1185	6201	5233	329	369	1122	1258	2696	2143	129	67	519	8001	33201	4150
2009-10	228	812	3561	3887	18498	4759	1095	4807	4390	1027	5231	5093	404	1701	4210	1333	2879	2160	164	340	2073	8138	34268	4211
2010-11	232	831	3582	3892	18074	4644	1094	4783	4372	1042	5150	4942	450	1895	4211	1364	2939	2155	165	338	2071	8239	34010	4128
2011-12	233	835	3584	3893	18135	4658	1095	4832	4413	1043	5202	4988	453	1917	4232	1445	3126	2163	166	347	2090	8328	34394	4130
2012-13	245	963	3931	3913	20678	5284	1105	5605	5072	1071	5952	5557	460	2038	4430	1455	3897	2678	173	491	2838	8422	39624	4705
2013-14	253	1020	4032	3995	21317	5336	1128	5765	5111	1092	6112	5597	472	2118	4487	1481	4043	2730	179	517	2888	8600	40892	4755
2014-15	258	1052	4078	4079	22015	5397	1146	5900	5148	1111	6284	5656	482	2178	4519	1503	4122	2743	183	533	2913	8762	42084	4803
2015-16	264	1087	4117	4163	22775	5471	1175	6159	5242	1139	6534	5737	491	2261	4605	1543	4324	2802	187	550	2941	8962	43690	4875
2016-17	270	1127	4174	4249	23560	5545	1199	6246	5209	1098	5857	5334	533	2404	4510	1574	4189	2661	191	577	3021	9114	43960	4823
2017-18	271	1132	4177	4250	23571	5546	1202	6264	5211	1100	5867	5334	535	2414	4512	1576	4196	2662	192	580	3021	9126	44024	4824
GAGR	9.30	9.70	0.37	3.17	4.17	0.97	2.28	3.65	1.33	-0.17	-0.15	0.02	16.78	18.84	1.77	5.82	6.31	0.46	5.27	25.18	18.92	3.38	4.03	0.58
Note: Area (A)-ha, Production (P)-MT and Yield (Y)-Kg/ha; GAGR- Compound Annual Growth Rate																								

Appendix-II: Cash flow in khasi mandarin orchard										
	100-300					301-500				
Year	Cash outflow	Cash inflow	Discounted cash outflow (10%)	Discounted cash inflow (10%)	Discounted net cash flow (10%)	Cash outflow	Cash inflow	Discounted cash outflow (10%)	Discounted cash inflow (10%)	Discounted net cash flow (10%)
0	60151.72	0.00	60151.72	0.00	-60151.72	62073.03	0.00	62073.03	0.00	-62073.03
1	6683.52	0.00	6075.93	0.00	-6075.93	6897	0.00	6270	0.00	-6270
2	12791.01	0.00	10571.08	0.00	-10571.08	9927.74	0.00	8204.74	0.00	-8204.74
3	13209.88	0.00	9924.78	0.00	-9924.78	10050.41	0.00	7551.02	0.00	-7551.02
4	12616.41	0.00	8617.18	0.00	-8617.18	8924.41	0.00	6095.49	0.00	-6095.49
5	13858.09	0.00	8604.78	0.00	-8604.78	9484.75	0.00	5889.29	0.00	-5889.29
6	13592.48	0.00	7672.60	0.00	-7672.60	10095.53	0.00	5698.66	0.00	-5698.66
7	28938.73	65601.76	14850.15	33664.08	18813.93	21596.37	69958.43	11082.35	35899.73	24817.38
8	28938.73	73801.98	13500.13	34429.17	20929.04	21596.37	78703.23	10074.87	36715.64	26640.77
9	28938.73	82002.20	12272.85	34776.94	22504.09	21596.37	87448.04	9158.97	37086.50	27927.53
10	28938.73	96434.59	11157.13	37179.71	26022.58	21596.37	102838.89	8326.34	39648.84	31322.50
11	28938.73	104962.82	10142.85	36788.83	26645.98	21596.37	111933.48	7569.40	39232.00	31662.60
12	28938.73	113053.70	9220.77	36022.39	26801.62	21596.37	120561.69	6881.27	38414.67	31533.40
13	28938.73	130766.18	8382.51	37878.30	29495.79	21596.37	139450.47	6255.70	40393.83	34138.13
14	28938.73	137763.70	7620.47	36277.49	28657.02	21596.37	146912.7	5687.00	38686.71	32999.71
15	28938.73	144323.88	6927.70	34549.99	27622.29	21596.37	153908.54	5170.00	36844.48	31674.48
16	28938.73	152196.09	6297.91	33122.30	26824.39	21596.37	162303.55	4700.00	35321.98	30621.98
17	28938.73	136342.33	5725.37	26974.60	21249.23	21596.37	145396.93	4272.73	28766.01	24493.28
18	28938.73	123987.33	5204.89	22300.22	17095.33	21596.37	132221.43	3884.30	23781.19	19896.89
19	28938.73	112069.68	4731.72	18324.29	13592.57	21596.37	119512.31	3531.18	19541.22	16010.04
20	28938.73	100589.37	4301.56	14951.97	10650.41	21596.37	107269.59	3210.16	15944.94	12734.78
21	28938.73	89546.41	3910.51	12100.46	8189.95	21596.37	95493.25	2918.33	12904.06	9985.73
22	28938.73	78940.79	3555	9697.56	6142.56	21596.37	84183.31	2653.03	10341.58	7688.55
23	28938.73	68772.51	3231.83	7680.39	4448.56	21596.37	73339.75	2411.84	8190.45	5778.61
24	28938.73	64945.75	2938.03	6593.66	3655.63	21596.37	69258.84	2192.58	7031.56	4838.96
25	28938.73	59314.93	2670.93	5474.53	2803.60	21596.37	63254.08	1993.26	5838.10	3844.84

Appendix III: Cash flow in khasi mandarin orchard										
	501-700					701-900				
Year	Cash outflow	Cash inflow	Discounted cash outflow (10%)	Discounted cash inflow (10%)	Discounted net cash flow (10%)	Cash outflow	Cash inflow	Discounted cash outflow (10%)	Discounted cash inflow (10%)	Discounted net cash flow (10%)
0	55213.97	0.00	55213.97	0.00	-55213.97	48549.93	0.00	48549.93	0.00	-48549.93
1	6134.89	0.00	5577.17	0.00	-5577.17	5394.44	0.00	4904.04	0.00	-4904.04
2	7446.46	0.00	6154.10	0.00	-6154.10	6337.41	0.00	5237.53	0.00	-5237.53
3	7416.70	0.00	5572.28	0.00	-5572.28	6276.62	0.00	4715.72	0.00	-4715.72
4	7137.61	0.00	4875.08	0.00	-4875.08	5977.48	0.00	4082.70	0.00	-4082.70
5	7521.89	0.00	4670.50	0.00	-4670.50	7202.98	0.00	4472.49	0.00	-4472.49
6	7546.72	0.00	4259.93	0.00	-4259.93	6958.15	0.00	3927.69	0.00	-3927.69
7	16538.68	64282.90	8486.96	32987.29	24500.33	12814.75	60349.70	6575.99	30968.94	24392.95
8	16538.68	72318.26	7715.41	33737.00	26021.59	12814.75	67893.42	5978.17	31672.78	25694.61
9	16538.68	80353.62	7014.02	34077.78	27063.76	12814.75	75437.13	5434.70	31992.71	26558.01
10	16538.68	94495.86	6376.37	36432.24	30055.87	12814.75	88714.06	4940.64	34203.11	29262.47
11	16538.68	102852.63	5796.71	36049.22	30252.51	12814.75	96559.52	4491.49	33843.52	29352.03
12	16538.68	110780.86	5269.73	35298.19	30028.46	12814.75	104002.65	4083.17	33138.45	29055.28
13	16538.68	128137.24	4790.66	37116.79	32326.13	12814.75	120297.07	3711.98	34845.78	31133.80
14	16538.68	134994.08	4355.15	35548.16	31193.01	12814.75	126734.38	3374.52	33373.12	29998.60
15	16538.68	141422.37	3959.23	33855.39	29896.16	12814.75	132769.35	3067.75	31783.93	28716.18
16	16538.68	149136.32	3599.30	32456.41	28857.11	12814.75	140011.31	2788.86	30470.54	27681.68
17	16538.68	133601.28	3272.09	26432.30	23160.21	12814.75	125426.80	2535.33	24815.02	22279.69
18	16538.68	121494.67	2974.62	21851.88	18877.26	12814.75	114060.94	2304.84	20514.86	18210.02
19	16538.68	109816.61	2704.20	17955.89	15251.69	12814.75	103097.41	2095.31	16857.25	14761.94
20	16538.68	98567.11	2458.37	14651.37	12193.00	12814.75	92536.21	1904.83	13754.92	11850.09
21	16538.68	87746.15	2234.88	11857.19	9622.31	12814.75	82377.34	1731.66	11131.71	9400.03
22	16538.68	77353.75	2031.71	9502.60	7470.89	12814.75	72620.81	1574.24	8921.17	7346.93
23	16538.68	67389.90	1847.02	7525.98	5678.97	12814.75	63266.60	1431.13	7065.50	5634.37
24	16538.68	63640.07	1679.10	6461.10	4782.00	12814.75	59746.21	1301.02	6065.77	4764.75
25	16538.68	58122.45	1526.45	5364.47	3838.02	12814.75	54566.19	1182.75	5036.24	3853.49

Appendix IV: Cash flow in khasi mandarin orchard										
	901 and above					Overall				
Year	Cash outflow	Cash inflow	Discounted cash outflow (10%)	Discounted cash inflow (10%)	Discounted net cash flow (10%)	Cash outflow	Cash inflow	Discounted cash outflow (10%)	Discounted cash inflow (10%)	Discounted net cash flow (10%)
0	47779.93	0.00	47779.93	0.00	-47779.93	56743.97	0.00	56743.97	0.00	-56743.97
1	5308.88	0.00	4826.25	0.00	-4826.25	6304.89	0.00	5731.72	0.00	-5731.72
2	6154.97	0.00	5086.75	0.00	-5086.75	9301.57	0.00	7687.25	0.00	-7687.25
3	5590.19	0.00	4200.00	0.00	-4200.00	9378.28	0.00	7046.04	0.00	-7046.04
4	4685.14	0.00	3200.01	0.00	-3200.01	8685.90	0.00	5932.59	0.00	-5932.59
5	4943.58	0.00	3069.57	0.00	-3069.57	9484.90	0.00	5889.37	0.00	-5889.37
6	4902.54	0.00	2767.36	0.00	-2767.36	9562.82	0.00	5397.96	0.00	-5397.96
7	10053.19	54440.10	5158.88	27936.38	22777.50	20073.98	64730.11	10301.12	33216.78	22915.66
8	10053.19	61245.12	4689.89	28571.30	23881.41	20073.98	72821.38	9364.66	33971.71	24607.05
9	10053.19	68050.13	4263.54	28859.90	24596.36	20073.98	80912.64	8513.33	34314.86	25801.53
10	10053.19	80026.95	3875.94	30853.85	26977.91	20073.98	95153.27	7739.39	36685.70	28946.31
11	10053.19	87104.17	3523.58	30529.48	27005.90	20073.98	103568.18	7035.81	36300.02	29264.21
12	10053.19	93818.45	3203.26	29893.45	26690.19	20073.98	111551.56	6396.19	35543.77	29147.58
13	10053.19	108517.27	2912.05	31433.59	28521.54	20073.98	129028.69	5814.72	37375.02	31560.30
14	10053.19	114324.22	2647.32	30105.14	27457.82	20073.98	135933.24	5286.11	35795.47	30509.36
15	10053.19	119768.23	2406.65	28671.56	26264.91	20073.98	142406.25	4805.55	34090.92	29285.37
16	10053.19	126301.04	2187.87	27486.79	25298.92	20073.98	150173.86	4368.68	32682.20	28313.52
17	10053.19	113144.68	1988.97	22385.07	20396.10	20073.98	134530.75	3971.53	26616.19	22644.66
18	10053.19	102891.80	1808.15	18505.99	16697.84	20073.98	122339.92	3610.48	22003.91	18393.43
19	10053.19	93001.84	1643.78	15206.54	13562.76	20073.98	110580.61	3282.26	18080.81	14798.56
20	10053.19	83474.83	1494.34	12408.00	10913.66	20073.98	99252.84	2983.87	14753.30	11769.43
21	10053.19	74310.74	1358.49	10041.65	8683.16	20073.98	88356.61	2712.61	11939.68	9227.07
22	10053.19	65509.59	1234.99	8047.59	6812.60	20073.98	77891.90	2466.01	9568.71	7102.70
23	10053.19	57071.38	1122.73	6373.63	5250.90	20073.98	67858.74	2241.83	7578.34	5336.51
24	10053.19	53895.70	1020.66	5471.79	4451.13	20073.98	64082.81	2038.02	6506.04	4468.02
25	10053.19	49222.93	927.87	4543.08	3615.21	20073.98	58526.81	1852.75	5401.79	3549.04