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CONSTRAINTS DETERMINATION AND FINANCIAL ANALYSIS OF MANDARIN PRODUCTION IN DARCHULA DISTRICT, NEPAL

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ABSTRACT
The study was conducted in Darchula district under the whole command area of PMAMP, citrus zone to find the major mandarin production constraints and evaluate financial feasibility among mandarin farmers. A survey was conducted in five major citrus-producing localities from March to May 2022. From the sampling frame of 120 farmers, an appropriate sample size of 95 was found by using Raosoft software at a 95% confidence interval, and proportionate stratified sampling was done for each locality. Mandarin farming was found to be a financially feasible enterprise with a BC ratio and payback period of 2.2 and 6.7 years, respectively. Mandarin productivity for Darchula district was found to be 4.78 quintals per ropani. The constraints faced by mandarin producers were categorized into three main types: input constraints, production constraints, and marketing constraints, as well as post-harvest constraints. Lack of high-yielding saplings followed by a lack of subsidies was found to be the major technical and socioeconomic constraints, respectively. Poor irrigation facilities, high physical damage to fruits, and a lack of a suitable price for mandarin were found to be major production constraints, post-harvest constraints, and marketing constraints, respectively. Red ants, bugs, and fruit flies were found to be the major insect pests in mandarin production. Citrus greening, fruit drop, gummosis, and sooty mold were found to be the most serious diseases. Thus, based on the findings of this study, related agencies are needed to supply input subsidies as well as train the poor farmers to increase the productivity of mandarin throughout the district.

KEY WORDS
B/C ratio, insect-pests, mandarin marketing, net present value, payback period.

As a major sector of Nepal's economy, agriculture became the base of livelihood, employment, the economy, and social transformation for Nepalese people. About 21.32% of total GDP is contributed by agriculture (O'Neill, 2022). The majority of the cultivated land is covered with cereal crops and vegetables, and only a small portion (3.8%) is occupied by fruit crops, with total production and productivity of 1,249,764 MT and 10.50 MT/ha, respectively (MoALD, 2021). Moreover, horticulture crops are of great importance for increasing the share of agriculture in GDP. Among total fruit-cultivated land (177,568 ha), about 28.29% (50,235 ha) of the area is occupied by citrus fruits, with production and productivity of 311,188 MT and 9.7 MT/ha, respectively (MoALD, 2021). Citrus is a subtropical type of fruit that can tolerate slightly higher temperatures with a mild moisture content. They are widely adapted to tropical, subtropical, borderline subtropical, and temperate regions of the world (Li et al., 2010). The suitable geography for mandarin cultivation in Nepal includes the mid-hill north region of Nepal, lying between 260 45’ and 290 40’ north latitude and 800 15’ to 880 12’ (Pokhrel, 2011). There is no exact history of citrus cultivation, but fossil records suggest its genus dates back to 7 million years ago (Citrus, 2022). Cultivation, industrial development, and trade in citrus are found to have rapidly increased worldwide after the Second World War (Liu et al., 2012). Asia is the largest producer of citrus fruits, followed by South America and Africa (Shahbandeh, 2022), and the highest citrus producer countries are China and Brazil (USDA, 2022). Among different citrus species, mandarin occupies the largest area (53.22%), followed by sweet orange (15.58%)

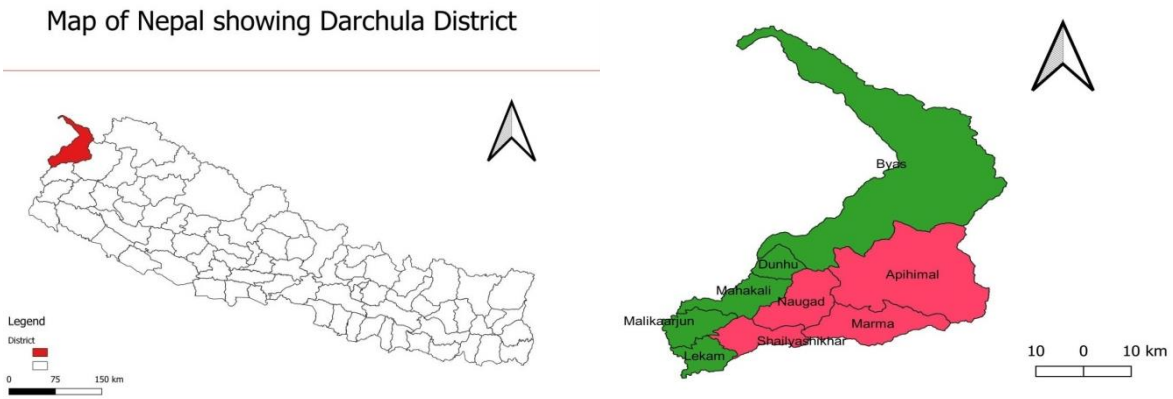
and lemon (5.44%), and the remaining 5.82% is occupied by other citrus species (MoALD, 2021).

Provided with good moisture, it can tolerate higher temperatures but is sensitive to frost. It prefers soil with a depth of one meter and good drainage up to 60 cm. Darchula district is considered a mountainous region, with both subtropical and temperate types of climate. The climate varies due to various elevations, and rainfall and humidity are more predominant. Dracula district is considered a citrus zone under PMAMP, so the majority of farmers are directly involved in citrus farming as a major occupation. Around 86 ha of the 112 ha of citrus cultivated area are productive, with productivity and production of 10.46 tons per ha and 904 tons per year, respectively (MoALD, 2021). Citrus fruits are the most important and promising flora for Nepal's mid-hill regions (Panth & Dhakal, 2019). Despite the fact that mandarin farming is a major occupation, many farmers are dissatisfied with their output and income from their toil. Farmers are unable to access necessary resources due to research gaps between farmer problems and extension agents.

Among major constraints, a huge gap between the yield of mandarins at orchards and the research field is found to be more critical (Roy et al., 2018). Research conducted by Roy et al. (2018) revealed that the major constraints perceived by key respondents were weak farm management operations and a lack of irrigation facilities, and similarly, citrus growers also discerned poor labor availability and a lack of irrigation facilities as major problems in Darjeeling. According to Khan et al. (2007)'s research on "Constraints faced by farmers of Narsing Kheda village of India," the major constraints facing citrus growers are a lack of electricity for irrigation water, higher diesel costs, and a lack of information. Pant et al. (2019) found that insect pest problems are a major production constraint, followed by irrigation availability. The majority of the hilly areas with higher potential for citrus production have to stay away from easy access to chemical fertilizers and pesticides, as well as high-yielding citrus saplings. Despite the huge possibilities of mandarin production in Nepal, no significant increase in yield has been found in recent years (AITC, 2019). Also, there were many faulty intercultural practices due to a lack of proper coordination between farmers and extension agents during research activities. Proper research was still needed to address the farmers' problems. Further, Thapa et al. (2004) stated that more of the increase in production is due to an increase in area than increased productivity. Thus, it is crucial and challenging to determine the costs of production for the analysis of profit. Consequently, this research was done with the aim of financial analysis and constraint determination for mandarin farmers in Darchula district, Nepal.

METHODS OF RESEARCH

The study was carried out in Darchula district of Sudurpaschim Province. It covers an area of about 2,322sq km with an altitude of 518m to 7132 masl. Under the Prime Minister Agriculture Modernization Project (PMAMP), Darchula district is allocated as a citrus zone. The research area of this zone includes four rural municipalities namely, Duhu, Byas, Malikarjun, Lekam and one municipality (Mahakali).



Raosoft software was used to select the sample size from the sampling frame of 120 registered citrus farmers at Citrus Zone Darchula. 92 farmers were selected by using a proportionate stratified sampling technique based on respective farmer numbers in a local body, as depicted in Table 1.

Table 1 – Sample size from different localities

Number of farmers	Local body	Selected sample size
50	Mahakali	38
25	Malikarjun	19
15	Byas	12
18	Duhu	14
12	Lekam	9
120	Total	92

Household surveys (scheduled interviews), Key Informants interviews (KII), and Focus Group discussions (FGD) were conducted to collect the primary data, whereas various reports, articles, and websites were assessed for the collection of relevant secondary information on cirtus farming.

The data collected from the socio-economic survey were coded, tabulated, and analyzed using Microsoft Excel and the Statistical Package for Social Science (SPSS). The qualitative data were analyzed qualitatively. The collected quantitative data were analyzed using both descriptive and analytical statistics. A five-point scaling technique was used to measure the relative severity of production and marketing problems. The index was calculated using the following formula:

$$I = \sum \frac{SiFi}{N}$$

Where: I= Index of Importance; S_i=Scale value at i^{th} severity; F_i = frequency of the i^{th} severity given by nursery holders; N= total number of farmers.

The total costs of production over a 20-year production period were collected along with the revenue generated per ropani. Then, by using a 12% discounting rate, the present values of all the costs and revenue were calculated to calculate the NPV. The benefit-cost ratio is defined as the ratio of gross return to total cultivation cost (Bheel & Burark, 2013). Any value greater than 2 is considered a safe value of the BC ratio; that means farmers are getting 2 rupees for every rupee they incur (Reddy & Reddi, 2005). Kafle (2017) concluded that, for getting higher benefits, self-marketing and high-scale production are crucial.

$$PV= FV* 1/(1+i)^n$$

Where: NPV= Net Present value; PV= Present Value; FV= Future value.

Similarly, B:C= Net PV of inflows/ Net Present value of outflows.

RESULTS AND DISCUSSION

The mean and standard deviation of the age of the respondents in the research area were found to be 49.32 and 13.873, respectively. The respondents were within the age range of 23 to 80 years. Study results showed that a higher percentage of respondents were male (75%), and only 10% were females involved in mandarin farming. The majority of the respondents were found to have primary-level education, followed by lower-level secondary education. The agriculture sector was found to be the primary source of income (75.82%) for the majority of the households, followed by services (14.29%), business (5.49%), and wages (4.407%).

From the survey, two types of land based on the availability of irrigation were categorized: Khet, referring to a plain land area with a more uniform slope, and Pakho, referring to a more sloppy land area. The mean area of sloppy land was found to be 3.39

ropani and the average khet area to be 8.61. About 79 percent of the respondents were involved in mandarin farming as their main business. From the study, the approximate count of plants was 11437, with mean, maximum, and minimum plant numbers of 124, 1200, and 15, respectively.

From the field survey, the majority of the farmers were found to be using seed propagated (non-grafted seedlings), and a few were found to be using grafted as well as non-grafted saplings. Though PMAMP and AKC were providing improved saplings at a cheaper price, the majority of the farmers were found planting their own local varieties as the source of planting material. The major fertilizer source throughout this locality was found to be FYM from animal sheds. The majority of the farmers have been exclusively dependent on rainfall as a source of irrigation for their fields.

The average productivity of mandarin in Darchula district was found to be 4.78 quintals per ropani, which was statistically at par with the national average of 4.5 quintals per hectare. At a 95% confidence level and 91 degrees of freedom, the calculated t-value was less than the tabulated value on one sample t-test. This signified that there was no significant difference between the national average productivity and the local average productivity in Darchula. Mahakali municipality was found to have the highest productivity (6.06 quintals/ropani), followed by Duhu (4.55), Lekam (4.01), Malikarjun (3.90), and Byans (2.90).

Due to a lack of adequate technical manpower and guiding personnel, farmers were compelled to overcome orchard problems based on their own past experience and what they had heard and learned. Those farmers whose orchards were closer to the technical agencies had easier access to technical aids for identifying and managing diseases and pests.

The major pests prevalent in the study area associated with mandarin production were identified prior to questionnaire preparation through a key informant's Interview. Based on it, mandarin growers were asked to rank the prevalence and severity of the different insects, whose ranking is shown in Table 2.

Table 2 – Major insect pests in mandarin orchard in Darchula district

Insects	No problem	Low problem	Moderate problem	High problem	Index	Rank
Fruit fly	0	44	32	16	0.67	3
Ant	9	22	33	28	0.71	1
Aphid	46	33	9	4	0.42	4
Bug	12	28	22	30	0.69	2

Source: Field survey, 2022.

A stem parasite, locally named Aijeru, was found to be a major problem in mandarin trees. This was prevalent for a long time and was found growing haphazardly upon the tree, and the majority of the trees were found dying due to this reason. Citrus greening was also found to be the second major problem, followed by fruit drop, gummosis, and shooty mold.

Table 3 – Major diseases in mandarin orchard in Darchula district

Major Diseases	No problem	Low Problem	Moderate Problem	High Problem	Index	Rank
Gummosis	20	37	21	14	0.57	4
Citrus greening	10	36	21	25	0.66	2
Shooty mold	36	23	21	12	0.52	5
Stem parasite(Aijeru)	14	17	36	25	0.69	1
Fruit drop	31	20	21	20	0.58	3

Source: Field survey, 2022.

Major input problems in mandarin orchards were categorized into two types namely, technical problems and socioeconomic problems.

Among the major technical problems in mandarin orchards, a lack of high-yielding saplings was found to be the most significant technical constraint, followed by a lack of nursery raising structures, a lack of training, a lack of mechanical tools, and a lack of grafted

saplings. Gautam et al. (2020) also reported the lack of technical guidance as one of the major marketing problems associated with Mandarin farmers in Gulmi district.

Table 4 – Major technical constraints for inputs

Major problems	Number of peoples choosing following ranks of respective problems						
	Rank1	Rank2	Rank3	Rank4	Rank5	Total weightage	Rank
Lack of mechanical tools	7	13	17	24	31	217	4
Lack of high yielding saplings	39	23	15	10	5	357	1
Lack of grafted sapling	0	8	14	33	37	177	5
Lack of nursery raising structures	28	23	19	10	12	321	2
Lack of training	18	25	27	15	7	308	3

Source: Field survey, 2022.

Among major management and socioeconomic constraints, lack of subsidy was found to be a major problem, followed by low purchasing power, lack of knowledge about inputs, low marketing linkage, and lack of coordination among communities, respectively.

Table 5 – Major management and socioeconomic constraints

Major problems	Number of peoples choosing following ranks of respective problems						
	Rank1	Rank2	Rank3	Rank4	Rank5	Total weightage	Rank
Low Purchasing power	16	38	22	14	2	328	2
Low marketing linkage	3	8	9	39	33	185	4
Lack of Subsidy	44	33	15	0	0	397	1
Lack of knowledge about input	28	12	36	13	3	325	3
Lack of coordination among community	0	2	16	26	48	156	5

Source: Field survey, 2022.

Lack of adequate irrigation facilities was found to be a major production constraint in mandarin production. Other production problems were inadequate technical assistance, insect and disease problems, poor quality planting material, and insufficient labor during peak periods. Pant et al. (2019) also found the unavailability of mechanical tools, followed by a lack of high-yielding varieties, as the major input technical constraints faced by citrus growers. They also concluded that planting materials were easily available to farmers, but high-yielding varieties were not easily accessible to them. Pokhrel (2011) also concluded that inadequate irrigation facilities were the major production constraint for mandarin production. In agreement with this result, Baral et al. (2021) also reported poor irrigation facilities as a major production constraint and poor marketing facilities.

Table 6 – Major production constraints of mandarin

Major problems	Number of peoples choosing following ranks of respective problems						
	Rank1	Rank2	Rank3	Rank4	Rank5	Total weightage	Rank
Insect and disease problem	21	15	25	29	2	300	3
Poor quality planting material	13	25	30	17	7	296	4
Inadequate technical assistance	19	30	20	20	3	318	2
Inadequate irrigation facility	39	22	15	15	1	359	1
Unavailability of sufficient labor	0	0	2	15	75	111	5

Source: Field survey, 2022.

After the production of a huge amount of mandarin, the majority of farmers were found to have many post-production constraints. Poor marketing prices were found to be the major production constraint, followed by poor transportation facilities, high interference from middlemen, a lack of storage facilities, and high insect attacks, respectively.

Among the marketing constraints, low price value was found to be the major problem, followed by poor marketing facilities, high post-harvest losses of produce, a lack of storage and processing facilities, and poor transportation facilities, respectively. According to Pant et al. (2019) and Baral et al. (2021), poor storage facilities, poor road facilities, a lack of

transportation facilities, and a lack of market information were reported to be the major marketing constraints among citrus growers. Roy et al. (2018), in their study, also concluded that the presence of middlemen was a major marketing constraint for citrus growers.

Table 7 – Major post-production constraints of mandarin

Major problems	Number of peoples choosing following ranks of respective problems						
	Rank1	Rank2	Rank3	Rank4	Rank5	Total weightage	Rank
Poor transportation facility	31	25	15	17	4	338	2
Lack of storage facility	0	13	21	46	12	219	4
More physical damage of produce	47	45	0	0	0	415	1
High insect attack	0	9	22	16	45	179	5
High interference of middleman	14	0	34	13	31	229	3

Source: Field survey, 2022.

Table 8 – Major marketing constraints of mandarin

Major problems	Number of peoples choosing following ranks of respective problems						
	Rank1	Rank2	Rank3	Rank4	Rank5	Total weightage	Rank
Low price	68	14	10	0	0	426	1
Poor marketing facility	0	60	25	7	0	329	2
Lack of storage and processing	10	0	26	39	17	223	4
Poor transportation facility	0	0	11	38	43	152	5
High post-harvest loss	14	18	20	8	32	250	3

Source: Field survey, 2022.

Average variable costs and average fixed costs for the 20-year production period of Mandarin were considered to calculate the BC ratio and payback period. During the first four years of the production cycle, the cost incurred was considered an investment cost, as fruit bearing only started in the fifth year of production. Details about average fixed costs and variable costs are explained hereunder in the respective tables.

Table 9 – Average variable and fixed cost up to four year

S.N		Year 1	Year 2	Year 3	Year 4
A	Variable Costs (Per Ropani)	Amt.(Rs.)	Amt.(Rs.)	Amt.(Rs.)	Amt.(Rs.)
1	Human Labor				
	Training and Pruning	0	0	500	500
	Irrigation and Maintenance	300	300	300	300
	Manuring and Weeding	1200	1200	1200	1200
2	FYM(Farm Yard Manure)	500	500	500	500
3	Plant Protection Measures				
	Bordeaux Paste	0	0	0	0
	Total Variable Cost	2000	2000	2500	2500
B	Fixed Costs (Per ropani)				
1	Land Preparation and Layout	2000	0	0	0
2	Sapling @ 27	2160	560	0	0
3	Pit Digging and seedling establishment	5400	1400	0	0
4	Fencing	2000	0	0	0
5	Irrigation Channel Installation	0	0	0	0
6	Tools and Equipment	2000	0	0	0
7	Land Lease	2000	2000	2000	2000
8	Land tax	50	50	50	50
9	Water Charge	40	40	40	40
	Total fixed cost	15650	4050	2090	2090
	Total cost (fixed + variable)	17650	6050	4590	4590

Source: Field survey, 2022.

After five years, all costs were increased according to the views of respondents. After five years, production of mandarin is found to be increasing, and the views of farmers about their overall financial status are delineated in the table below.

Table 10 – Average variable and fixed cost from five year to twenty year

S.N	Cost items	Year (5-9)	Year (10-14)	Year (15-20)
A	Variable costs (per ropani)	Amt (Rs.)	Amt (Rs.)	Amt (Rs.)
1	Human labor			
	Training and Pruning	1500	2000	2500
	Irrigation and Maintenance	300	300	300
	Manuring and Weeding	1500	2000	3000
2	Fym(farm yard manure)	2000	2200	2500
3	Plant protection measures			
	Bordeaux paste	500	800	1000
	Total variable cost	5800	7300	9300
B	Fixed Costs (Per ropani)			
1	Land lease	1500	2000	2000
2	Land tax	50	50	50
3	Water charge	40	40	40
	Total fixed cost	1590	2090	2090
	Total cost (fixed + variable)	7390	9390	11390

Source: Field survey, 2022.

Total revenue per ropani was calculated by averaging production per ropani from all respondents and multiplying by the price per unit of production. The average revenue per ropani for a total production period of twenty years was calculated and has been delineated in Table 11.

Table 11 – Average costs and revenues per ropani throughout the production period

Year	Average Production per ropani	Total return Per Ropani	Costs
1	0	0	17650
2	0	0	6050
3	0	0	4590
4	0	0	4590
5	0	0	5000
6	416.67	25000	5500
7	500	30000	6000
8	533.33	32000	6500
9	471.43	33000	7000
10	500	35000	7500
11	571.43	40000	8000
12	560	42000	8300
13	586.67	44000	8500
14	562.50	45000	9000
15	600	48000	9200
16	444.44	40000	9500
17	350	35000	9700
18	250	25000	10500
19	200	20000	11000
20	180	18000	11200

Source: Field survey, 2022.

By using the time value of money, the present value of all costs and benefits was calculated, and the NPV was calculated. A discount rate of 12% was used to calculate the present value. The BC ratio was calculated by dividing PV of revenue by PV of costs over 20 years and finally averaging the results. The present value of total costs per ropani over 20 years is found to be NRs. 59334.70, and similarly, the PV of revenue per ropani is NRs. 131731.63. Over a 20-year period, the average benefit-cost ratio was found to be 2.22.

More BC ratio, the more will be the feasibility of enterprise. The BC ratio of mandarin farming businesses in Darchula district is 2.22. According to field research by Baral et al. (2021), the BC ratio of mandarin farming in Baglung district is also 2.93, which is similar to our findings. Similarly, a BC ratio of 1.82 was found by Regmi et al. (2020) in Dailekh district, which might be due to more production constraints in Dailekh district.

Table 12 – Calculation of NPV of benefits and costs along with Benefit Cost ratio

Year	Cost	Benefit	Discount Factor	PV of cost at 12% DR	PV of Benefit at 12% DR	NPV at 12% DR	BC Ratio
1	17650	0	0.89	15758.93	0	-15758.93	0
2	6050	0	0.79	4823.02	0	-4823.02	0
3	4590	0	0.71	3267.07	0	-3267.07	0
4	4590	0	0.64	2917.028	0	-2917.027	0
5	5000	0	0.57	2837.13	0	-2837.13	0
6	5500	25000	0.50	2786.47	12665.77	9879.30	4.54
7	6000	30000	0.45	2714.09	13570.47	10856.38	5
8	6500	32000	0.40	2625.24	12924.26	10299.02	4.92
9	7000	33000	0.36	2524.27	11900.13	9375.86	4.71
10	7500	35000	0.32	2414.78	11269.06	8854.26	4.67
11	8000	40000	0.28	2299.80	11499.04	9199.23	5
12	8300	42000	0.26	2130.40	10780.35	8649.95	5.06
13	8500	44000	0.23	1947.98	10083.66	8135.68	5.17
14	9000	45000	0.20	1841.58	9207.89	7366.31	5.0
15	9200	48000	0.18	1680.80	8769.42	7088.61	5.21
16	9500	40000	0.16	1549.65	6524.87	4975.21	4.21
17	9700	35000	0.14	1412.75	5097.55	3684.80	3.61
18	10500	25000	0.13	1365.41	3250.99	1885.57	2.38
19	11000	20000	0.12	1277.17	2322.13	1044.96	1.82
20	11200	18000	0.10	1161.06	1866.00	704.93	1.60
Total				59334.70	131731.63	72396.92	2.22

Source: Field survey, 2022.

The payback period is the amount of time it takes for the entire investment to be repaid as income. It is calculated in a non-discounting way, i.e., without considering the time value of money. PBP is calculated by expressing it in the table below along with the formula given below. Mandarin farming in Darchula district has a payback period of 6 years and 9 months when the investment period is 5 years. A payback period of 5 years and 6 months in citrus farming was found by Fauzi et al. (2021).

Table 13 – Calculation of Payback Period

Year	Cost	Benefit	Net Benefit	Cumulative Net Benefit
1	17650	0	-17650	-17650
2	6050	0	-6050	-23700
3	4590	0	-4590	-28290
4	4590	0	-4590	-32880
5	5000	0	-5000	-37880
6	5500	25000	19500	-18380
7	6000	30000	24000	5620
8	6500	32000	25500	31120
9	7000	33000	26000	57120
10	7500	35000	27500	84620
11	8000	40000	32000	116620
12	8300	42000	33700	150320
13	8500	44000	35500	185820
14	9000	45000	36000	221820
15	9200	48000	38800	260620
16	9500	40000	30500	291120
17	9700	35000	25300	316420
18	10500	25000	14500	330920
19	11000	20000	9000	339920
20	11200	18000	6800	346720

Source: Field survey, 2022.

Payback Period= $Year\ of\ transition + \frac{Amount\ remaining\ to\ be\ paid}{Revenue\ of\ next\ year}$ = 6 year and 9 month and 5 days

CONCLUSION

Mandarin farming is a feasible and suitable enterprise for Darchula district, with a promising BC ratio and an early payback period. The average mandarin productivity in Darchula district was found to be very close to the national average. Among all the problems, a lack of irrigation was found to be the major production problem. Further research regarding value chain analysis and farming practices would aid in getting major findings that are helpful for farmers. Subsidies regarding irrigation, marketing, and good saplings should be taken into prime consideration by the project. Intermittent visits to farmers' fields should be done, along with training activities regarding Mandarin farming among all farmers.

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