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Awareness and Adoption Status of Good Agricultural Practices in Mandarin (*Citrus reticulata* Blanco.) among Farmers of Syangja, Nepal

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Abstract Mandarin, as one of the important sub-tropical fruits under citrus species, is a high potential bearing crop in different mid-hill regions of Nepal, mostly Syangja due to climatic and topographical suitability. In addition, the use of scientific cultivation practices determines the production output. The research was designed from February to June 2022, to assess the awareness and adoption status of good agriculture practices among mandarin growers in Syangja, Nepal. The command areas of the Mandarin superzone under PMAMP were purposively selected for this study. The sampling was done by stratified proportionate random method to represent farmers of the Superzone area. Primary data was collected by face-to-face interviews, FGDs, and KII using a pre-tested semi-structured questionnaire from 98 respondents. IBM SPSS Statistics 26 software was used to analyze the data and Descriptive statistics, index values were used to interpret the findings. Findings revealed, that most of the respondents (56.1%) only partially knew about GAP and adoption was also at an early level in many farmers (39.8%). Awareness was found significantly higher (p=0.034) among males than females. Respondents from Putalibazar municipality were likely to be more aware (52) and adopting GAP (48) in Mandarin orchards than the rest of the area. The GAP adoption related to standards of planting material fertilizers, and soil additives was found high among (60.7%) and (51.4%) of the respondents respectively while it was low for the irrigation standards i.e. 12.7% of the total. Citrus fruit fly with an index of (0.94) was the severe pest and the powdery mildew with an index value of (0.91) was the major disease reported in the study area. Also, disease and pest problems were more pronounced as the high-ranked production constraints of Mandarin.
Keywords Adoption; GAP; Mandarin; Quality; Standards

Introduction

Citrus is the major fruit crop grown in Nepal, which occupies 28.19% of the total fruit-growing area (Regmi, 2020). The mid-hill climatic condition of Nepal ranging between 800 to 1,400m elevation shows suitability for the cultivation of citrus-related species from east to west (Paudel et al., 2022). The most important three species of citriculture in Nepal are mandarin (*Citrus reticulata*), sweet orange (*Citrus sinensis*), and lime (*Citrus aurantifolia*) (Paudyal et al., 2016).

Mandarin is cultivated in 27,002 hectares (ha) of land area with annual production and productivity of 198,406 metric tons (mt) and 10.80 mt per hectare respectively which contributes almost 0.85% in AGDP (MoALD, 2021). Syangja is one of the mid-hill districts in Gandaki province with an area of 1,164 km^2 (https://lgisnepal.com/en/province/4). About 942 ha of land in Syangja district is utilized for citrus production (PMAMP, PIU, 2076); Mandarin covers an area of 1,969 ha, of which the productive area remains 1,389 ha with a production of 13,800 mt and 10 mt/ha productivity (MoALD, 2021). It is a comparatively advantageous fruit crop in mid-hills than traditional food crops in the aspect of income and profit. However, farmers have faced different production-related problems, disease and pest prevalence, and low net income in Mandarin (Pant et al., 2019).

Good agricultural practice is a novel concept and redesigned practice in the Nepalese agricultural system which emphasizes decreasing chemical inputs aiming at the production of healthy outputs (Joshi et al., 2019). It is a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social, and environmental

sustainability (FAO, 2016). However, most of the farmers are unaware and fall behind in the adoption of this practice. European Union has rejected Nepalese food products (Singh, 2007) during trade, and also poor certification of products and faulty practices of cultivation have induced such a situation. The Nepal government formulated GAP implementation Directives to meet the increasing demand for food safety and certification of products (MoAD, 2018). The NEPAL GAP scheme enlisted five modules under GAP; Food safety, quality, environment management, workers' health, welfare, and general farm requirements (MoAD, 2015). GAP seems to have high potential to increase crop yield by up to 36%, reduce agrochemicals use by 31%, increase SOM from a mean of 3.32%-3.77%, and increase farmers' income by more than 100% (Kharel et al., 2022). Almost a gross worth of Rs. 1 billion was obtained by farmers from Mandarin cultivation in Syangja in the year 2023. The production trend however seems declining due to the lack of proper orchard management and recommended practices (https://risingnepaldaily.com/news/35381). Despite being the major production hub for Mandarin, the issues of poor practices in orchard maintenance confront farmers. The wide use of chemical fertilizers in fruits like mandarin is making them unsafe to consume and has welcomed a threat to producers as well as consumers in Nepal. Any agricultural technology or practice to be adopted requires adequate awareness but different conditions may affect adoption and awareness (Bernier et al., 2015). In this context, no previous study was done to appraise the awareness and adoption of GAP in Syangja.

The study examined the existing scenario of GAP awareness and adoption in Mandarin which guides as an instructive document to the different authorities in further execution and improvement of the mentioned standards under Nepal GAP.

Syangja district holds good potential prospects for the successful cultivation of Mandarin due to its characteristic topography and suitable climatic conditions. The majority of the farmers in rural areas of Syangja solely depend on Mandarin production for the economy and running livelihood. However, the production still inclines below the optimum range due to a lack of technical assistance and know-how in orchard management. Poor orchard management practices are the major cause of citrus decline in Nepal (Prasad and Chandra, 2019). Wide use of chemical fertilizers has led to poor markets, insecure food safety, and different security hazards on fruit. The high volume of produced mandarin fetches low prices in the market. Despite having high potential, the fruit quality stands as the main hindrance during export to distant markets and abroad. Moreover, the disease and pest severity have been a significant issue for many growers of the region. The poor acquaintance of good agriculture practices (GAP) and farmers' alignment with the traditional approach for production without any standards of inputs and required protocols is prevailing as a major drawback in Mandarin cultivation.

To assess the awareness and adoption level of (GAP) good agricultural practices in Mandarin in Syangja, Nepal. The specific objectives of the study are as follows: To know the awareness status of good agriculture practices among Mandarin farmers; To examine the GAP standards adopted by farmers in relevance to the Nepal GAP Scheme, 2020 (DFTQC) in Mandarin; To identify the major pests, diseases, and constraints involved in Mandarin production.

Mandarin growers apply large amounts of pesticides for pest management, which not only has reduced the quality but also induced climate-related hazards. The faulty agricultural practices including uncertified sapling, excess chemical use, inappropriate pruning practices, and mishandling during harvesting and transportation have further declined the quality of the fruit. Mandarin production relies on increasing the area of cultivation, utilizing available resources properly, and adopting production-hastening orchard management technology (Dahal et al., 2019). The adoption of best management practices aids in minimizing the yield gap in any crop (Assefa et al., 2021). Awareness and implementation of good agricultural practices can be an added factor to it. However, farmers were compelled to fetch low yields and low prices for the mandarin due to the less authenticity in quality and standards of the produce.

This research will thus help to figure out the extent of good agricultural practices, adopted category, and neglected standards of GAP, which will lay a groundwork for superzone and other government authorities to prioritize the

areas of improvement in the GAP scenario. It will also determine the production challenges faced by farmers that can be addressed for efficient utilization of resources maximizing production with the least possible cost.

1 Materials and Methods

1.1 Study site

The study was conducted in the Mandarin superzone commanding areas of Syangja district (Table 1). It lies in the hilly region at an altitude ranging from about 300 meters along the banks of Kaligandaki River up to 2,512 masl extending from a latitude of 28°4'60 North and a longitude of 83°52'0 East (https://lgisnepal.com/en/province/4). A preliminary study was carried out before the main survey to collect various socio-economic, demographic, and geophysical information about the study site. The questionnaires were prepared and the sampling framework was outlined by the use of the information.

Table 1 Details of the study area

S. N	Municipality/ Rural Municipality	Sample size
1.	Putalibazar Municipality	60
2.	Bhirkot Municipality	10
3.	Waling Municipality	10
4.	Arjunchaupari Rural Municipality	18
	Total	98

1.2 Sampling technique

Commercial registered Mandarin farmers from the PMAMP superzone were included in the sample. The total sample size (98) was determined using Yamane's formula at 10% margin of error,

I.e. $n= \frac{N}{1+Ne^2}$

Proportionate stratified followed by simple random sampling was done. Each municipality was defined as a stratum and the sample size in each was identified as per the population of every stratum. Mandarin farmers were then selected randomly as per the sample size from each stratum.

1.3 Research design

The household survey was done to find out the orchard management practices of mandarin under the citrus superzone.

1.3.1 Preparatory phase

The questionnaires and checklists relating to the adoption of good orchard management practices in Mandarin were prepared and sampling criteria and methodology were fixed.

1.3.2 Literature review

Different literature regarding the study areas and other relevant documents related to the adoption of improved agricultural technology and GAP assessment was reviewed.

1.3.3 Pre-testing of the questionnaire

Pre-testing of the questionnaire was done to assess the clarity of the questionnaire and its relevance to the participants. The necessary adjustments were made as per the requirements in the interview schedule.

1.3.4 Key informant's interview

The major key informants included were farmers, stakeholders, and concerned officers to know about the present scenario of mandarin cultivation and the status of orchard management in Syangja.

1.3.5 Questionnaire survey

A field survey was conducted with mandarin growers in the target site to gather data related to socio-economic status, household information, and various orchard management practices. In addition, field visits and informal discussions were done with the respondents and pertinent information was recorded.

1.3.6 Focus group discussions

Focus group discussion was conducted at the study area after completing the interview schedule with the help of a checklist to verify the result obtained from the household survey and discuss the distribution of mandarin growers in the area.

1.4 Data and data types

1.4.1 Primary data

The primary data was collected from the farmers of the respective sites. It was done through a questionnaire survey, key informant interviews, and farm visits.

1.4.2 Secondary data

Secondary data was meticulously gathered by conducting a thorough literature review across a variety of sources. These included the Annual Progress Report from the Project Implementation Unit (PIU) in Syangja, an array of journal articles and publications, insights drawn from previous recommendations, and publications from both the Central Bureau of Statistics (CBS) and the Ministry of Agriculture and Livestock Development (MoALD). Additional resources such as publications from the Agriculture Knowledge Center (AKC) Syangja and the National Crop Resources Program (NCRP) specific to the Syangja district were also reviewed, providing a comprehensive foundation for our research.

1.5 Techniques of data analysis

Data entry and analysis were done by using computer software packages like the Statistical Package for Social Science (SPSS v. 26) and Microsoft Excel 2019.

1.5.1 Qualitative Data Analysis

Qualitative data obtained from field surveys like gender, education, soil testing, training received on mandarin cultivation, different categories of orchard management, etc. were analyzed using frequency and percentage.

1.5.2 Quantitative Data Analysis

Quantitative data were analyzed by using both descriptive and analytical statistics.

1.5.3 Indexing/Scaling Technique

The importance of scale was used to rank the major diseases, pests, and production problems in the study area. Based on response frequencies, a weighted index was calculated for the analysis indicating the highest value as the most serious and the lowest value as the least serious problem respectively. The index of importance was computed by using the formula:

$$I_{imp} = \sum \frac{Sifi}{N}$$

Where I_{imp} = index of importance; $\sum$ = summation; S_i = I^{th} scale value; F_i = frequency of i^{th} importance given by the respondents; N = total number of respondents

1.6 Parameters studied

1.6.1 Socio-demographic and land characteristics

Socioeconomic and land characteristics of the respondents like gender, ethnicity, family size, source of training, source of sapling, source of income, land distribution, problem categorization, etc. were analyzed using descriptive statistics, and representation of the results was made by using a frequency table, mean, bar diagram, pie-charts, etc. Additionally, a chi-square test was done to know the significance of the mentioned variables with awareness and adoption.

1.6.2 GAP awareness

GAP awareness and its related variables among farmers of the study site in the superzone area were assessed by open-ended questions. Awareness was categorized into three stages; full, partial, and nil, which were studied concerning different variables.

1.6.3 GAP Adoption

The adoption of GAP in the research site was appraised for the Nepal GAP scheme and its standards. The study sought the application of GAP standards in three phases; early, moderate, and not practiced, related to the mentioned five GAP modules in the scheme (Nepal GAP Scheme, 2020).

2 Results and Discussion

2.1 Land distribution (ha) and tree population

The results showed that the average land holding size of farmers was 0.5 ha, out of which Mandarin shares 0.38 ha (Table 2). The minimum area used for mandarin cultivation was 0.05 ha while the maximum was up to 1.5 ha. The average number of mandarin trees was 346 and, it was found that 56.67% of the total trees in the orchard were bearing fruit.

Table 2 Land use distribution in the survey area, 2022

Description	Average	Minimum	Maximum	Standard deviation
Landholding size	0.5	0.1	2.1	0.38
Mandarin cultivation area	0.38	0.05	1.5	0.32
Total trees	346.08	37	3200	443.71

Source: Field Survey, 2022

2.2 Household size and involvement in agriculture

The average number of family members per household was 5 while only two members were involved in the agriculture sector (Table 3).

Table 3 Household size and involvement in agriculture in the survey area, 2022

Description	N	Range	Minimum	Maximum	Mean	Std. deviation
Household size	98	16	1	17	5.05	2.281
Number of family members in agriculture	98	3	1	4	2.04	0.872

Source: Field Survey, 2022

2.3 Status of GAP Awareness

2.3.1 Awareness scenario of the respondents

About (56.1%) of the respondents were partially aware, (21.4%) fully aware, and (22.4%) were unaware of GAPs in the study site (Figure 1). Most of the farmers have access to the idea of GAP through the Mandarin superzone.

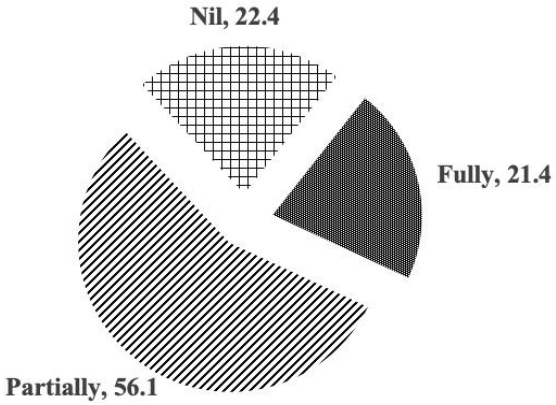

Figure 1 Percentage of respondents having awareness of GAP in the survey area, 2022 (Source: Field survey, 2022)

2.3.2 Socio-economic variables of the respondents

Out of the 98 respondents, many were males. About 45 respondents were partially aware of GAP while 12 were unaware of it and only 11 respondents among females were partially known. Different ethnic groups were observed in the area, Brahmin share the higher proportion (37), followed by Chhetri (18) and Dalits were the least

(8). The majority of the economically active population (78) was dependent on agriculture, as a main source of income. Many of the respondents (42) have completed S.L.C. level education and very few (1) were at the bachelor's level. Awareness of GAP was at a medium level in all categories of ethnic groups, and different income-based populations. Very less of the respondents were highly known of it. Males were found significantly more aware of GAP benefits compared to females (p=0.034) while there was no effect of ethnicity, education level, and income source on the level of awareness of GAP among farmers (Table 4).

Table 4 Socio-economic variables of the respondents in the survey area, 2022

Description	Category	Awareness of GAP benefits			Chi-square value	p-value
		Fully	Partially	Nil		
Gender	Male	17	45	12	6.75	0.034*
	Female	4	11	9		
Ethnicity	Brahmin	7	25	5	-	-
	Chhetri	2	8	8		
	Janajati	5	17	10		
	Dalit	2	4	2		
	Others	2	1	0		
Education level	Below class 5	11	21	8	-	-
	S.L.C.	7	28	7		
	Intermediate	0	6	6		
	Bachelors	0	0	1		
Source of Income	Agriculture	21	45	12	-	-
	Business	0	5	4		
	Gov. Jo	0	1	3		
	Others	0	4	3		

Note: *indicates significant at 0.05 level of significance (Source: Field Survey, 2022)

2.3.3 Source of training used

Farmers were accessed to training in GAP and its benefits from different sources (Table 5). Mandarin superzone in the area was the major institution involved in the delivery of GAP-related information to the more mandarin growers (34), followed by AKC (20). Only some partial know-how in GAP was observed in more no. of respondents (45) concerning training provision.

Table 5 Training source used by the respondents concerning awareness in the survey area, 2022

Description	Source	Awareness of GAPS		
		Fully	Partially	Nil
Access to the training	MoALD	2	4	4
	SuperZone	2	23	9
	NGO/INGO	3	6	9
	AKC	5	12	3
	Others	0	0	1

Source: Field Survey, 2022

2.3.4 Municipality-wise scenario of GAP awareness

Many respondents (35) from Putalibazaar municipality were partially aware of GAPs, 10 were fully known and 17 of the total were unknown about it (Figure 2). The mandarin growers of Waling municipality were in 2nd rank in the level of awareness with (7) fully known and (7) partially known. In addition, farmers from Arjunchaupari rural municipality were at least awareness level among all.

2.3.5 Source of sapling

Among the sources used for procuring the sapling, 49 choose private nurseries, 38 choose superzone and very few (2) depend on NGOs/INGOs (Table 6). Also, awareness was observed higher in the farmers contacting superzones for planting materials.

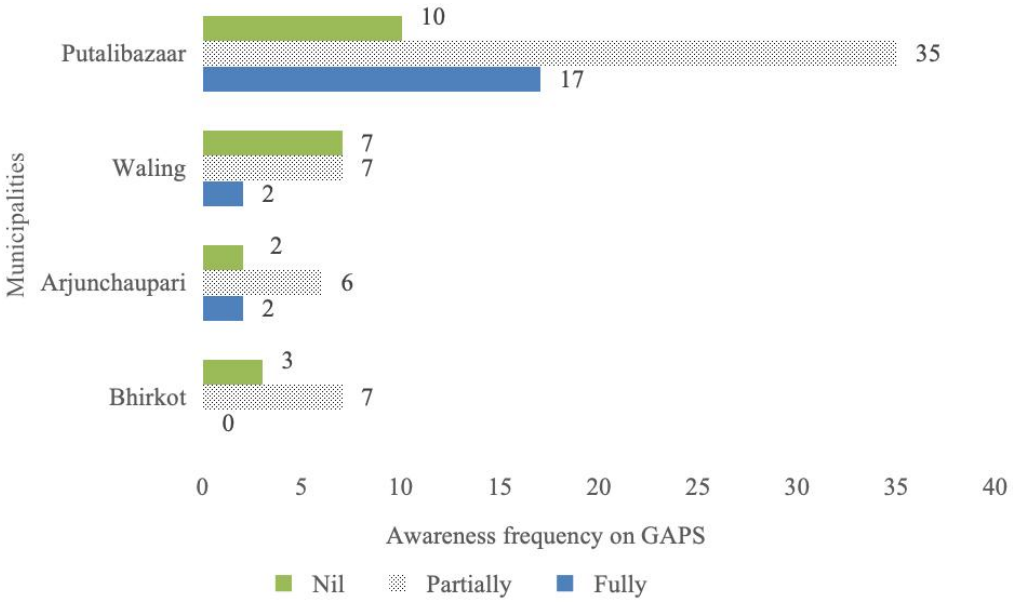

Figure 2 Municipality-wise distribution related to GAP awareness in the survey area, 2022 (Source: Field Survey, 2022)

Table 6 Source used by the respondent concerning awareness of GAP in the survey area, 2022

Description	Institution	Awareness on GAP		
		Fully	Partially	Nil
Source of sapling	Private nurseries	11	23	15
	Government nurseries	0	7	2
	NGO/INGO	0	2	0
	Citrus superzone	10	23	5

Source: Field Survey, 2022

2.4 GAP adoption

2.4.1 GAP adoption scenario of the respondents

The adoption status is in the early phase in the majority of the respondents (39.8%), moderate (14.3%), and not in practice among (45.9%) of the farmers (Figure 3). The awareness and adoption scenario of GAPs is similar at the beginning stage in the study area.

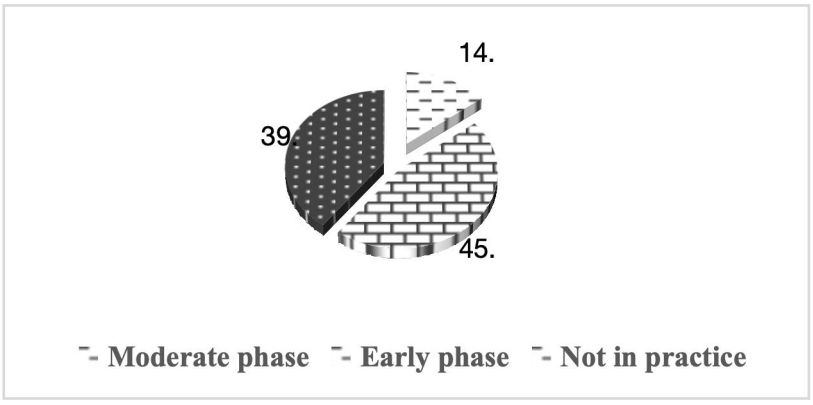

Figure 3 Status of GAP adopters in Mandarin in the survey area, 2022 (Source: Field Survey, 2022)

2.4.2 Socio-demographic variables of the respondents

The majority of the respondents (74) were males, 34 of whom were in the early phase of adoption of GAP, while 24 were females with 11 in the early phase (Table 7). High no. of both males (30) and females (9) were not found to be adopting GAPs. The Brahmins were ahead in adoption (24) followed by Janjatis (14) and Chhetris (12).

Dalits (6) and other ethnic groups (3) were backward in the adoption. Both gender and ethnicity were not found to statistically affect the adoption status of GAP in the study area.

Table 7 Socio-demographic variables distribution to the adoption status of GAP in the survey area, 2022

		Adoption level				
Variables	Category	Moderate phase	Early phase	Not in practice	Chi-square value	p-value
Gender	Male	10	34	30	0.168	0.919
	Female	4	11	9		
Ethnicity	Brahmin	7	17	13	8.350	0.398
	Chhetri	3	6	9		
	Janajati	2	12	18		
	Dalit	1	5	2		
	Others	1	2	0		

Source: Field Survey, 2022

2.4.3 Municipalities-wise distribution of the respondents

The early phase of adoption of GAPs was observed more in Putalibazaar municipality(36), followed by Bhirkot (6), Waling (2) and Arjunchaupari (1). However, some farmers from Putalibazaar (12) and a few from Arjunchaupari (2) were a little ahead in adoption (Figure 4).

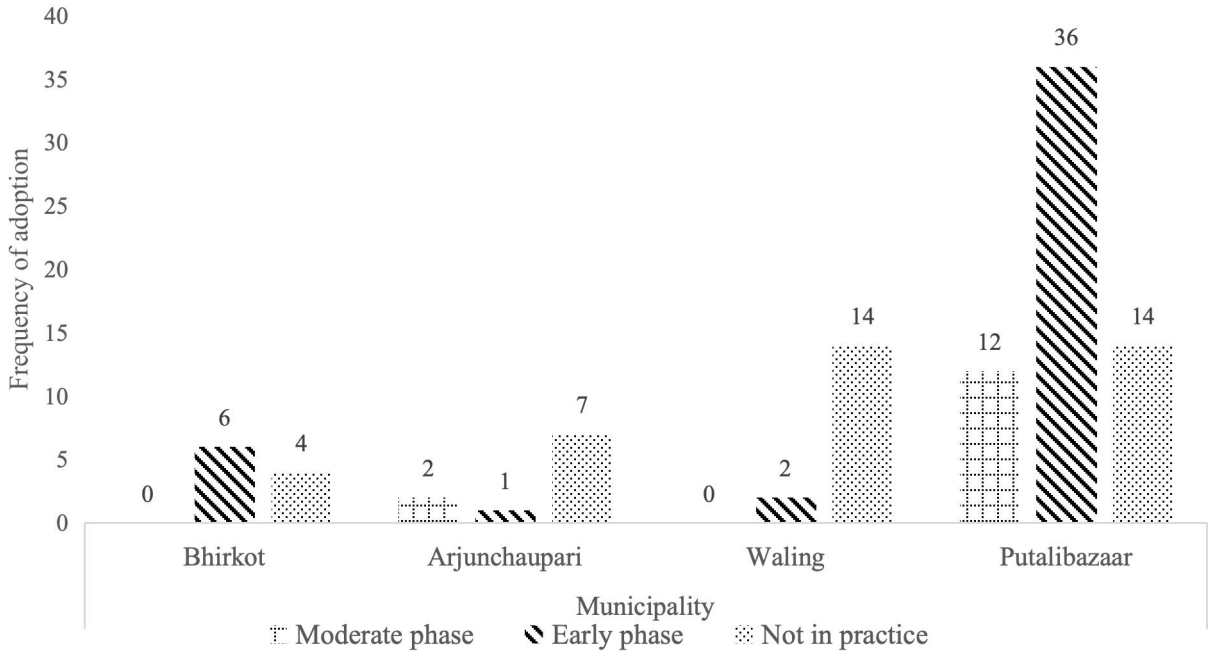

Figure 4 Municipalities-wise distribution of GAP adopters in Mandarin in the survey area, 2022 (Source: Field Survey, 2022)

2.5 Standards under GAP adoption

2.5.1. Site history taking and management

Among the total respondents, only 15 farmers were known to study the site for risk analysis and 10 followed safety measures on the site before planting (Table 8). This was due to low awareness of GAP among the farmers.

Table 8 GAP standards related to the history and management of the site in the survey area, 2022

Description	Frequency (Yes)	Frequency (No)
Study and identification of risk	15 (15.30%)	83 (84.69%)
Follow safety measures for risk reduction before planting	10 (10.20%)	88 (89.8%)

Source: Field Survey, 2022

2.5.2 Planting material

It was observed that about 62.2% of the respondents took the record of the nursery from where they bought the planting material (Table 9). About 58.2% of the respondents knew about the background certification of the contacted nursery while 41.8%% of the respondents were with no idea of the certification. Inspection of planting material was done by 70.4% of the respondents for any sign of disease and pests.

Table 9 GAP standards related to buying the Planting Material in the survey area, 2022

Description	Frequency (Yes)	Frequency (No)
Record maintenance of nursery	61 (62.2%)	37 (37.8%)
Certification of nursery	57 (58.2%)	41 (41.8%)
Inspection of planting material	69 (70.4%)	29 (29.6%)

Source: Field Survey, 2022

2.5.3 Soil nutrient management

The results showed that none of the farmers assessed the chemical and biological risk at Mandarin orchard (Table 10). About 36.7% of respondents performed soil tests before the establishment of the Mandarin orchard, and 24.5% of the respondents were known to use micronutrients. None of the respondents applied biofertilizers and treated FYM before use. About 12.2% of the respondents used green manure crops in the field. Out of the total, 33.7% and 15.3% of the respondents practiced crop rotation and intercropping respectively. During storage, 69.7% of the respondents seemed to store produce separately from the stored chemical fertilizer. In the context of record management, 71.4% were found to maintain the record of fertilizer use.

Table 10 GAP standards related to Soil Nutrient Management in the survey area, 2022

Description	Frequency (Yes)	Frequency (No)
Assessment of chemical and biological risk	0	98 (100%)
Soil analysis	36 (36.7%)	62 (63.3%)
Micronutrient	24 (24.5%)	74 (75.5%)
Treatment of FYM before use	0	98 (100%)
Well prepared FYM	98 (100%)	0
Bio-fertilizers	0	98 (100%)
Green Manure	12 (12.2%)	86 (87.7%)
Crop rotation	32 (33.7%)	66 (67.3%)
Intercropping	15 (15.3%)	83 (84.6%)
Storing produce separately from chemical fertilizer.	68 (69.4%)	30 (30.6%)
Fertilizer Use Record	70 (71.4%)	28 (28.6%)

Source: Field Survey, 2022

2.5.4 Irrigation

About 61.2% of the respondents had their source of irrigation (Table 11). Testing of water before application was not done by any of the farmers, while repairing irrigation equipment was done by the majority of the respondents (89.8%).

Table 11 GAP standards related to Irrigation in the survey area, 2022

Description	Frequency (Yes)	Frequency (No)
Owned source of irrigation	60 (61.2%)	38 (38.7%)
Water test	0	98 (100%)
Repair of Irrigation equipment	88 (89.8%)	10 (10.2%)

Source: Field Survey, 2022

2.5.5 Workers' Hygiene

Only 65.3% of the respondents maintained the hygiene of workers and precautions for the welfare of workers (Table 12). The hygiene criteria included the use of gloves and protection equipment and the availability of immediate medications.

Table 12 GAP standards related to workers' hygiene in the survey area, 2022

Description	Frequency (Yes)	Frequency (No)
Hygiene and precautions applied for workers	64 (65.3%)	33 (34%)

Source: Field Survey, 2022

2.5.6 General requirement

Out of the total respondents, about 26.9% of the farmers paid attention to visitor's safety. Almost 32.3% of the respondents included suggestions from the visitors and 35.9% of them have well-maintained farm regulations. Registration of respective Mandarin farms was seen among 91.8% of the respondents. Documentation and record of farm income and expenses, management actions, and all inventory was performed by 56.12% of the respondents. Also, 15.3% of the respondents had well-prepared farm plans to act upon during the implementation of activities (Figure 5).

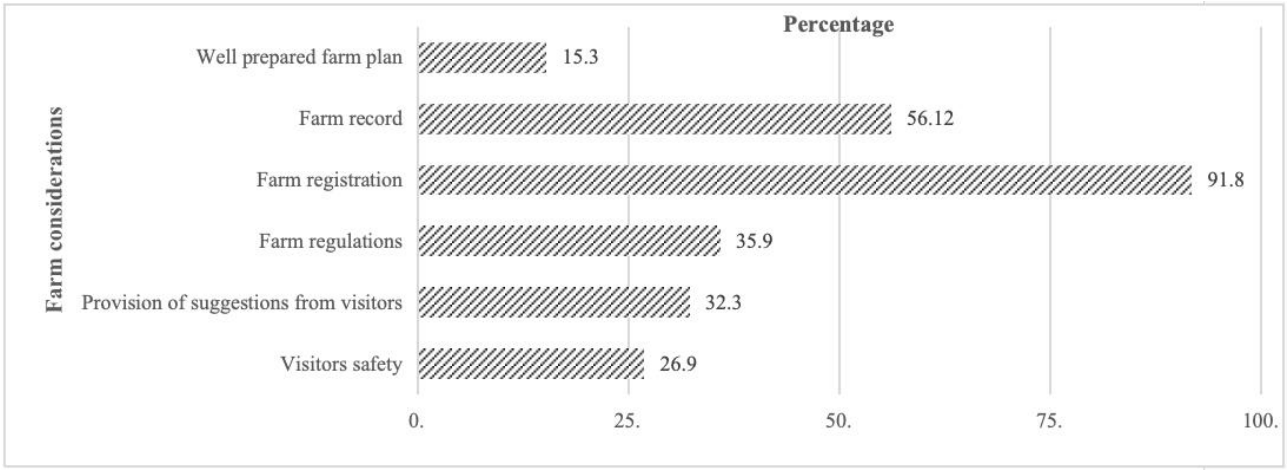

Figure 5 Adoption of General requirement of the Farms under GAP in the survey area, 2022 (Source: Field Survey, 2022)

2.5.7 Variables related to GAP adoption

Adoption of GAP was studied and classified based on three bases moderate phase (1), early phase (0-1), and not in practice (0). As observed from the table, the majority of farmers (15.4%) were seen in the moderate phase of adoption of planting material, followed by fertilizer and soil additives (10.2%). Only 3.2% of the farmers were adopting the standards under the general requirement in moderate status. About 45.3% of the respondents were in the early phase of adoption of standards related to planting material, followed by fertilizer and soil additives (41.2%), and very less (7.5%) were adopting irrigation standards to the early stage (Figure 6). A high percentage of farmers were seen not adopting the GAP variables compared to the applied one. Overall status of adoption was found ahead for planting material while at a slow pace for irrigation requirements.

2.6 Disease problem

The response from the farmers showed that the major disease prevailing in the mandarin orchard was powdery mildew with an index value of 0.91, while citrus canker was the less problematic one with a value of 0.68 (Table 13). Foot rot, sooty mold, and dieback also brought hazards in the optimum production and return from Mandarin.

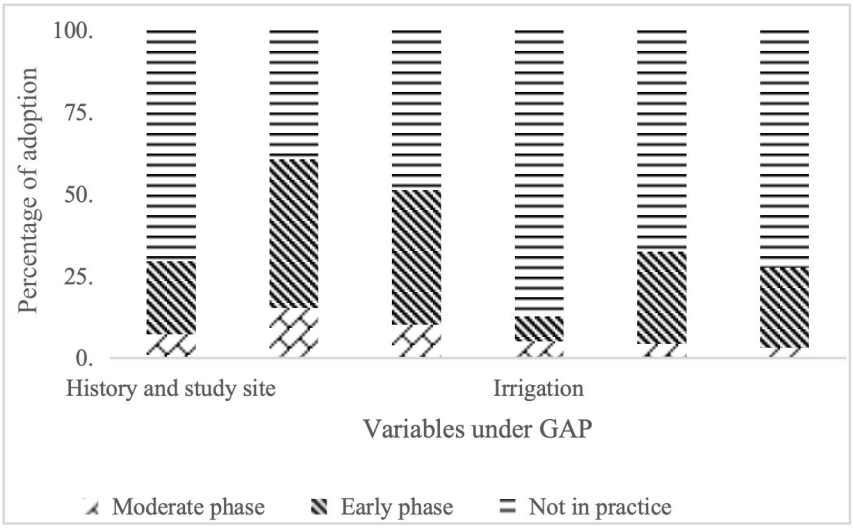

Figure 6 Adoption status of variables of GAP in the survey area, 2022 (Source: Field Survey, 2022)

Table 13 Ranking of the diseases observed in Mandarin Orchard in the survey area, 2022

Diseases	P1	P2	P3	P4	P5	Index value	Rank
Powdery mildew	68	20	7	2	1	0.91	I
Footrot	43	33	9	9	4	0.80	II
Sooty mold	32	33	20	10	3	0.76	III
Dieback	24	37	13	14	10	0.70	IV
Citrus canker	18	30	32	13	5	0.68	V

Note: P: signifies the priority of the disease according to severity; index value (1-0) denotes major to minor disease (Source: Field Survey, 2022)

2.7 Pests problem in the orchard

Ranking of the pests was done by using an indexing technique. A higher index value represents a major pest while a low value represents a minor one. From the study, it was found that Fruit Fly was ranked as the major problematic pest with an index value of 0.94 followed by Lemon butterfly (0.79), stem borer (0.77), aphid (0.70), and Leaf miner a minor pest with an index value (0.65) (Table 14). The respondents reported that the larvae of fruitflies were observed in dropped fruits.

Table 14 Ranking of the pests observed in Mandarin orchard in the survey area, 2022

Pests	P1	P2	P3	P4	P5	Index value	Rank
Fruitfly	69	24	-	-	-	0.948	I
Lemon butterfly	34	31	20	6	2	0.791	II
Stem borer	27	44	10	10	-	0.776	III
Aphid	19	28	32	13	1	0.709	IV
Leaf miner	3	41	26	23	-	0.652	V

Note: P: signifies the priority of the pest according to severity; index value (1-0) denotes major to minor pest (Source: Field Survey, 2022)

2.8 Production problems in the orchard

Problems reported by the Mandarin growers were ranked using an indexing technique. Out of the total respondents, most of them responded to diseases and pest occurrence as the major problem with an index value of 0.9, and lack of subsidy and crop insurance access as the comparatively minor one among the listed problems with an index of 0.69 (Table 15). Farmers were also found deprived of scientific fruit production knowledge. They had to depend on rainfall to irrigate the field. Also, the timely availability and access to production and input materials seemed a pronounced hindrance in the research area.

Table 15 Ranking of the problems faced by Mandarin growers in the survey area, 2022

Production problems	P1	P2	P3	P4	P5	Index value	Rank
Occurrence of diseases and pests	63	27	3	4	1	0.9	I
Lack of knowledge on improved production	50	26	10	8	4	0.82	II
Lack of irrigation facilities	34	31	25	7	1	0.78	III
Unavailability of production materials	27	34	15	13	9	0.72	IV
Lack of insurance and subsidy	19	28	32	16	3	0.69	V

Note: P: signifies the priority of the problem according to severity; index value (1-0) denotes major to minor problem (Source: Field Survey, 2022)

2.9 SWOT analysis

SWOT in Mandarin was addressed by conducting FGDs and KII among personnel of the implementation committee of PMAMP, PIU- and AKC, Syangja (Figure 7). Progressive farmers' opinion was also included.

Strengths	**Opportunities**
a. Good and favorable altitude and climate in the region. b. Access to developed road network and transport facility. c. Availability of cultivable and excess land. d. Citrus from the district bears a delicacy, aroma, and good quality. e. Mandarin farmers of Syangja hold a stable financial status. f. Knowledge of propagation techniques among Mandarin growers.	a. Superzone has been supported by other gov. agencies. b. Access to cultivation inputs and improved saplings from local bodies and cooperatives. c. Scope for distant markets to Pokhara, Butwal, Ktm, Narayangadh, etc. d. Subsidy to farmers in different sectors of agriculture practices.
Weaknesses	**Threats**
a. Farmers lack proficiency in the orchard management techniques. b. High post-harvest loss and insufficient technical knowledge. c. Lack of value addition provision. d. Low price for produce due to the lack of support price during selling. e. Absence of efficient storage facilities. f. Unaware of improved and existing varieties of citrus.	a. Pest infestation problems like citrus lemon butterfly, citrus green stink bug, etc. b. Disease problems like greening, footrot, etc. c. Potential damage to the fruits from living animals, monkeys, etc. d. Fluctuations in weather.

Figure 7 SWOT analysis in Mandarin

3 Conclusion

GAP is a driving factor for enhancing production efficiency in Mandarin and several other commodities by ensuring safe food production, environment management, and long–term sustainability. Mandarin cultivation in Syangja governs the major basis of dependence of farmers for their socioeconomic upgrade and income. However, the farmers seem to conceptualize and follow the GAP and its standards to some limited extent to only some criteria of planting material and soil additives. They also lack irrigation and other plant protection-based knowledge which has raised the problem of disease and pests in the mandarin orchards. Thus, it brings a need to take the lead from the government, policymakers, NGOs, and other fruit production-related authorities, in cooperation with the PMAMP superzone and farmers of Syangja through training, subsidies, field–based observance, and recommendations to influence the farmers to adhere to and adopt the mentioned modules of GAP.

Author's contributions

NA was involved in framing the research idea, designing the experiments, data analysis, and interpretation. KA was involved in the supervision of the research and the review process of the manuscript. NA, along with KB, KA PA, SP, and DPC supported in experiment conduct, drafting, and final shaping of the manuscript. All authors read and approved the final manuscript.

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