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CONTENTS

Strategies for Improving Agricultural practices: A case study of tomato growers from Uttarakhand

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ABSTRACT: Agricultural practices in India are diverse and heavily influenced by the country's varying climatic conditions, soil types, and socio-economic factors.Farmers uses age-old techniques like ploughing with bullocks, manual sowing, and harvesting. Organic farming practices, such as the use of natural fertilizers (compost, manure), are prevalent in some areas while Some of them uses tractors, harvesters, and advanced machinery. Chemical fertilizers, pesticides, and high-yield variety (HYV) seeds are commonly used. India's agricultural practices are a blend of traditional wisdom and modern technology. While significant progress has been made in terms of productivity and diversification, ongoing challenges require innovative solutions and sustainable practices to ensure long-term food security and economic stability for millions of farmers. This research is purposely planned to analyse the agricultural practices performed by the farmers of Nainital district and the to identify the awareness of farmers towards the post-harvest management practices. It includes 160 farmers that are involved in growing vegetables. The results reveals that only 52.16%agricultural practices are as per the standard guidelines described by the Govt. Organization. The farmers need to be more aware about the latest agricultural practices and the agricultural programs planned by the Govt. institution to uplift the performance of the farmers.

Key words: Agricultural practices, harvesting, HYV, farmers, vegetables, Supply chain

Harvesting and purchasing farm products are the first steps in the supply chain, which concludes with the delivery of finished goods to customers. How much value is added to the final product between the time of produce procurement and delivery greatly influences how efficiently the supply chain operates. Due to the industrialization of agriculture and the uncertainty brought on by variations in product quality and safety, the agricultural supply chain has recently attracted the attention of many researchers (Henson and Loader, 2001).

Due to the transition of agribusiness from a goods system to a vertically coordinated food system, competition in agribusiness emerges within the supply chain rather than between individual entities. Many researchers have recognized recently the importance of supply chain management for the agri-food industry. (Van der Vorst, 2000; Hobs and Yong, 2000; Fearne, 1998) Agri-products' supply chains are more vulnerable because of their perishable nature and need to control deterioration. The advantages of farm products are spoiled due to long distance transportation, improper technique use, or careless actions by any supply chain actor. The definition of supply chain management is "a network of interconnected and autonomous organizations working cooperatively and mutually to control, manage, and improve the flow of materials and information from supplier to end user (Christopher, 1998).

The competition in agribusiness practices Logistics operations improve the competitiveness and information flow in the agri-supply chain, which adds value. Basic logistical tasks include purchasing, managing transportation and inventories, processing orders and distributing them, adhering to quality standards, offering services to end users, and supporting tasks like handling, handling, handling, packaging, and information flow-related tasks (Istudor, 2011).

In the current scenario an agri-food supply chain operates with an evolutionary system in which the approach is market oriented rather than being production oriented; in other words, towards creating a system that is responsive to the changing needs of

the consumers (Roekel, Willems, and Boselie, 2002). By gaining knowledge through various distribution channels and efficient logistics management, agri supply chains in the majority of developing nations are focusing on the key issues that dynamically respond to changes in consumer demand and consumption patterns, maintaining consumer health and safety, and maintaining a focus on quality. Due to rising urbanization, shifting consumer preferences and eating habits, increased economic accessibility, increased infrastructure development, favourable margins, and intense competition, agrifood consumption patterns in Asia are changing.

The SCM in agriculture is illustrated in Fig. 1 Agricultural activities begin from cultivation with the use of various agri inputs, production than harvesting and delivery of final produce through various channels, each step in this process is a part of supply chain and viewed as link in a chain. Therefore, for effective operation each link needs to be properly integrated and must add value to enhance the efficiency of whole supply chain. It includes management of entire production, transformation, transportation, distribution and marketing operations by which the desired product is supplied to the right consumer (Acharyulu& Sudhakar, 2007).

The major constraints in production of fresh fruits and vegetables have been identified in several research studies are: (i) non-availability of quality seeds (ii) inadequate irrigation facilities (iii) lack of soil testing facility and extension staff (iv) inefficiency in pest management (v) credit availability constraint (vi) high cost of production (vii) lack of information (viii) huge post-harvest losses due to lack of proper roads, cold storage and inadequate space for storage (ix) high transportation cost (Mittal, 2007).

The common distribution related challenges seen in the supply chain of fresh produce are (i) lack of timely delivery (ii) lack of uniform grading of harvested produce (iii) improper packaging (iv) poor quality of produce (v) poor market infrastructure (vi) improper pricing (vii) lack of standardized weights and measures. Besides these constraints, there is a poor dissemination of market information resulting in lowered productivity (Surendra *et al*., 2009).

Many consumers rely entirely on SC for a variety of perishable products such as fruits and vegetables, fish, bread, packaged salads and fresh meals. The supply chain plays a key role in getting this produce from farmers' baskets to retailers' shelves, adding value by ensuring timely availability in the right

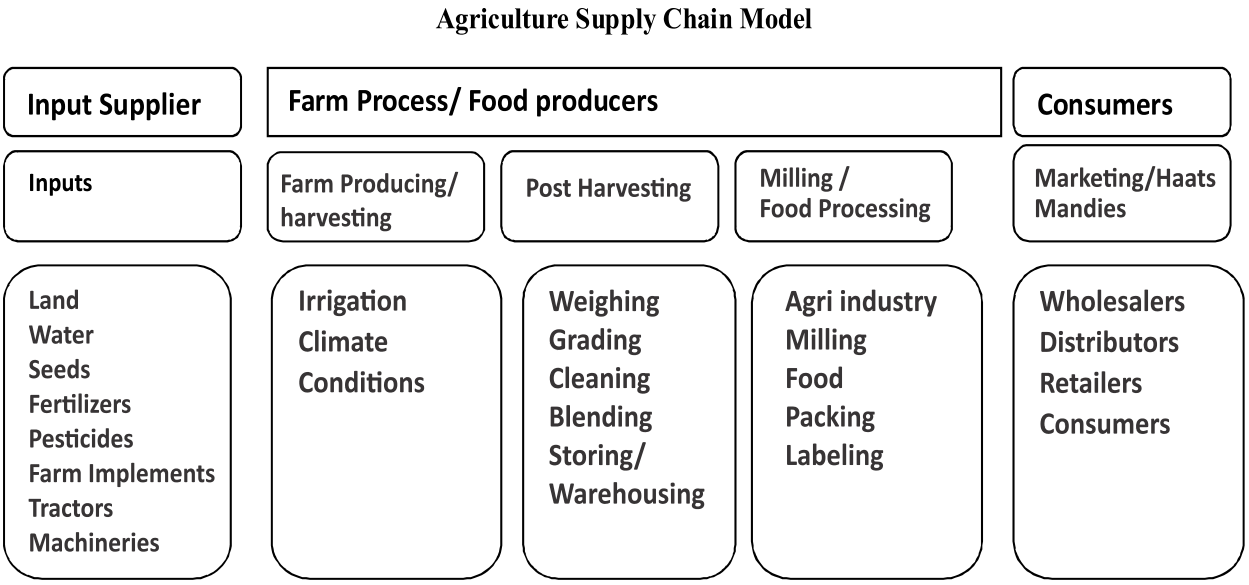

Fig. 1: Agriculture Supply Chain Model

conditions. In most developing countries, SC operators face time and distance issues.Time and distance play a very important role in improving SC performance. Whether the SC operator respects time and covers the distance from source to destination plays an important role, resulting in less wastage and spoilage of perishables. Perishables typically spend upto half of their shelf life between supplier and retailer, so the potential or risk of spoilage begins from harvest by the farmer to the final consumer. That's why watches are ticking from the moment they hit retail shelves. Therefore, fresh supply chain operators must use professional,exclusive and advanced equipment and technology to extend product freshness and reach consumers in the best possible condition.

Production Trends in Tomato

In this the detail information has been discussed about the trends in tomato and area utilized, production and productivity of tomato in India from past years.

Tomato production in India

Tomato production in India of 27 percent in the global production places it in the third rank. The main varieties of Tomato are Pusa Ruby, Pusa Early Dwarf, Arka Abha, Arka Alok, Pant Bahar, Pusa hybrid-1, Pusa hybrid-2, MTH-6, Arka Vardan etc. The Table 1 shows that the cultivation of tomato has gone up continuously from 4.2 million tons in 1991-92 to 11.1 MT in 2008-09. Tomato contributes to 9.3 percent of total Indian vegetable production and 13 percent of the total area.

The area of tomato crop has been decreased from 2010 to 20120 i.e. 13.61million hectares to 12.75 million hectares during the period. Despite of that it has been observed that the productivity of tomato is increased at constant pace in the given periods from 19.4 tons to 25.33 tons. The share of tomato production of the total vegetable production is 12.17 percent to 9.32 percent during 2010-2020 whereas the portion of area devoted for tomato cultivation from total vegetables area is decreased 13.61 to 12.75 percent during the period.

The Table 3 represents block wise area, production and productivity of tomato crop in Nainital district. It shows that the major contributing blocks are Haldwani, Kotabagh, Ramgarh, Bhimtal and Ramnagar with 15.83, 14.89, 13.51,11.69 and 7.84 level of productivity.

Objectives of the study was to analyze the cultivation and post-harvest management practices among the farmers and to analyze the existing supply chain practices of tomato distribution in the study area.

Various studies regarding production and marketing practices of fruits and vegetables, harvesting practices by fruits and vegetable industry have been reviewed to gain deep insight of the conditions of fruits and vegetables production and existing

Table 1: Area, Production and Productivity of Tomato in India

Area, Production and Productivity of Tomato in India from 2008-09 to 2019-20					
Year	Area (Ha)	% of Total Area	Production (MT)	% of Total Production	Productivity (P/A)
2010-11	865	13.61	16826	12.17	19.4
2011-12	907	14.27	18653	13.4	20.6
2012-13	880	13.9	18227	13.1	20.7
2013-14	882	13.9	18736	13.4	21.3
2014-15	767	12.1	16385	11.8	21.4
2015-16	774	13.06	18732	9.02	24.2
2016-17	797	13.08	20708	10.2	26
2017-18	789	13.09	19759	9.96	25
2018-19	781	7.75	19007	9.63	24.34
2019-20	812	12.75	20573	9.32	25.33

Source: *National Horticulture Board (2019)*

Table 2: Production of Tomato in Uttarakhand

Nainital is reported as leading district for tomato production in Uttarakhand. Table 2 reveals that tomato productivity in district Nainital is (13.74 MT/ha).

State Wise Area, Production and Productivity of Tomato in Uttarakhand during 2021-2022

District	Area (Ha)	Production (MT)	Productivity (MT/Ha)
Nainital	1577.40	21673.60	13.74
U.S.Nagar	1014.60	20290.00	19.99
Uttarkashi	1431.21	12365.56	8.63
Haridwar	788.00	16791.60	21.30
Dehradun	1271.00	7201.00	5.66
Pithoragarh	884.04	10474.19	11.84
Champawat	612	6273.00	10.25
Others	1837.39	15,608.53	8.49
Total	9415.64	1106077.48	117.47

***Source**: Directorate of Horticulture, Uttarakhand 2021-2022*

Table 3: Block wise production of tomato in major blocks.

Block Wise Area, Production and Productivity of Tomato in Nainital during 2019-2020

S.No	Block	Area (Ha)	Production (MT)	Productivity (MT/Ha)
1.	Bhimtal	47.48	555.20	11.69
2.	Dhari	138.48	814.50	5.88
3.	Okhalkanda	38.48	404.10	10.50
4.	Ramgarh	72.10	974.20	13.51
5.	Betalghat	75.50	747.40	9.90
6.	Haldwani	794.90	12580.60	15.83
7.	Kotabagh	337.52	5025.60	14.89
8.	Ramnagar	72.31	566.90	7.84
	Total	1577.20	21669.50	13.74

procurement and marketing practices.

Slathia (2017) suggested use of four species of Trichoderma viz., *T. harzianum, T. viride, T. viride E.*and *T. virens* against *Colletotrichum capsici* causing rot in *Capsicum annum.* All four antagonists caused significant inhibition of mycelial growth of the test fungus. It also recommends that this non-chemical, eco-friendly integrated module of plant extracts, fungal antagonists and brassinosteroids to be used for effective management fruit and vegetable rots.

Kabdwal *et al.* (2016) the study is done on cultivation and pest management practices of tomato growers in Uttarakhand. In this study the research observed that grower's preference for hybrids was because of the yield parameters as most of the growers accepted that these hybrids were high yielding. Some of the growers prefer hybrid seeds due to its susceptible to pests and diseases. The study also reveals the major diseases encountered are leaf curl locally known as kodh, late blight (jhulsa), early blight (kala), sclerotinia stem rot (haddi rog) and wilt (sukha). According to this study integrated pest management practices were followed by 14 per cent farmers in which they included soil solarization of the nursery beds and application of bio- control agents at different crop stages as soil application, seedling stage and also during crop stage.
The study also explains that farmers are investing huge amount of money in pesticides and because of the improper applications, they are not getting full benefit. The reason might be the label expiry, adulteration and under dosage.

Prakash (2002) The study conducted by the researcher states that the major reason behind inefficiency in marketing practices is due to the small and medium sized land holdings and lack of integrated information system. The study also recommends having some scope to fill the gap between farmers and market functionaries by using contract farming and other procurement practices. According to the results of the study the causes of wide fluctuation in prices include involvement of so many intermediaries in the supply chain of fresh produce. According to his study this would direct to better control of production variables. It improve the availability of better quality of tomato and also in better economies of scale and operations.

Saxena (2015) tried to extract the constraints faced by farmers and other intermediaries in this study. Through the study several challenges are identified like problem of insect, pests and diseases, lack of packing facilities, high level bargaining in buyer level because lack of competition among buyers of selected crops. The study also reveals the quality is highest for channel 4 (10.95) followed by channel 2 (10.90), channel 3 (9.18) and channel 1 (9.13) respectively whereas quantity is highest for channel 2 (6.80) followed by channel 3 (5.43), channel 1

(5.13) and channel 4 (4.35) respectively because traders trade in large volume so it cost low. Channel 2 is the most preferred channel in terms of quantity parameters. Post harvest losses were high in case of small and medium farmer in tomato, i.e., 28.96 kg. Very few people utilize the refrigerated vans. 35.48 percent of small and medium farmers do not store their produce, 3.22 percent of respondents use cold stores while 26.67 percent large farmers use cold stores.48 percent of small and medium farmers do not store their produce.

Thakur (1997) found tomato crop as a leading vegetable crop grown and marketed by the farmers in Himachal Pradesh. The study opted to analyze the cultivation and marketing practices of farmers of Himanchal. Study reveals that a significant increase in tomato production from past few years has boosted the Marketed surplus of farmers.

Andhari *et al.* (2010) conducted a study on "Technological gap in tomato cultivation" The study reveals that majority of tomato cultivators had medium level of knowledge about recommended cultivation practices. The present study shows high technology gap in use of growth regulators, irrigation and nutrient management and plant protection. The study observed 40.53 per cent gap in use of growth regulators 34.24 per cent of gap in nutrient management, under that 35.46 per cent of gap was in application of FYM in tomato cultivation, 29.69 per cent of gap in tomato nursery management.

MATERIALS AND METHODS

In the present investigation, purposive sampling technique has been used for the selection of blocks, village and the farmers of Nainital district of the State of Uttarakhand. The objective of present investigation is to study the various gaps in the cultivation practices of tomato in Nainital district. For that purpose, a sample of 160 farmers were selected from four blocks of the district. To investigate the efficiency in Agri-practices and various gaps in the pre- and post-harvest agricultural practices of tomato in Nainital district different structured questionnaires for farmer were developed by the researcher herself.In addition, the study requires both primary and secondary data. Secondary data include published research papers, journals, magazines, newspapers and data published by various government agencies like District Horticulture Offices, Planning Commission, National Horticulture board, Directorate of Agriculture and FAO.

RESULTS AND DISCUSSION

This study is undertaken to analyse the Agriculture Practices among Farmers in Tomato Farming and Problems faced by Farmers in Nainital district of Uttarakhand and thus to frame strategies for improvement of the performance of agricultural practices in the district. For the process of data analyses, researcher has done careful attempt to study the characteristics of data and designed appropriate method for analyses of the data by using SPSS program. The result is presented in two parts as follows:

- Demographic Characteristics of Farmers.
- Analysis of Agriculture Practices among Farmers in Tomato Farming and Problems faced by Farmers.

Demographic Characteristics of Farmers

In this section a detailed description of the demographic characteristics of farmers has been given. Table 4 to Table 6 show the land used in Tomato production the demographic profile of the farmers (Age, Gender, Education, Size of Family, Land used in Tomato crop, Total Tomato Production, Available Labor, Source of Information etc.).

Land used in tomato crop:It can be noticed from the Table 5 that 50.0% (80) farmers have less than five bigha lands for Tomato farming, 35.6% (57) farmers have 5 to 10 bigha land for tomato farming and only 14.4% (23) farmers have more than ten bigha land for tomato farming. The results reveal that from past few years the farmers are lacking their interest in tomato farming. From the past 5 years they have reduced the area used in cultivation of

tomato crop and the reasons for this low-price realization, loss of crop due to insects and fungal infection, need much care to grow, need much efforts in harvesting and other post-harvest practices as compare to other regular crops, non-availability of proper market, inability to store the produce, high perishability etc.

Table 4: Total land used in tomato production

Land Used	Frequency	Percent
Less than 1.25 hactare	80	50.0
1.25 to 2.5 hactare	57	35.6
Above 2.5 hactare	23	14.4
Total	160	100.0

Total production of tomato:Table 6 represents that majority of farmers are able to produce less than 100 quintals in the district. As the farmers are making use of less lands in tomato crops the production is also not as per the expectation. Farmers are still practicing old aged cultivation and marketing practices that results low production and low-price realization. They are still dependent over the commission agents to sell out produce and unable to make direct contact with organized retailers and big firms to receive good deals. Other reasons for low productivity are close planting done by the farmers, lack of pruning, poor adoption of strategies for the control of early and late blight disease, leaf curl, and fruit borer due to low awareness among the rural farmers.

Source of information-It is evident from the study thatmajority of them get information from KVK's and private players. 37% (40) farmers get information from only KVKs. Rest of the farmers get information from either internet. KVK's through their programs try to enhance youth capacity building and skill building.

Analysis of Agriculture Practices Among Farmers in Tomato Farming and Problems Faced by Farmers

Through this study an attempt has been made to analyse the agriculture practices among farmers for growing tomato. For assessment of agriculture practices among farmers, 42 statements were included in the farmer's questionnaire.

Table 6: Total tomato production by farmer of Nainital district

Production (in Ton)	Frequency	Percent
Less than 5.5 Ton	43	26.9
5.6 to 11 Ton	53	33.1
11.1-16.5 Ton	25	15.6
16.6-22 Ton	24	15.0
Above 22 Ton	15	9.4
Total	160	100.0

Table 5: Demographic Characteristics of Farmers

Demographic profile	Groups	Frequency No. of Farmers= 160	Percent
Age	Below 40 Years	37	23.1
	41 – 50 Years	83	51.9
	Above 50 Years	40	25.00
Gender	Male	148	92.5
	Female	12	7.5
Education	Illiterate	20	12.5
	Up to 5th Standard	41	25.6
	Up to Intermediate	67	41.9
	Graduation	32	20.0
Farming loan	Yes	141	88.1
	No	19	11.9
Source of loan	Bank	38	27.0
	Commission Agent	28	19.8
	Cooperative Societies	8	5.7
	Bank and Commission Agent	28	19.8
	Bank and Cooperative Societies	10	7.1
	Commission Agents and Cooperative Societies	29	20.6

Table 7: Total variance explained by identified factors/components

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.27	29.50	29.50	13.27	29.50	29.50	10.27	22.81	22.81
2	8.52	18.93	48.42	8.52	18.93	48.42	8.72	19.37	42.18
3	6.47	14.37	62.79	6.47	14.37	62.79	7.70	17.12	59.30
4	4.31	9.59	72.38	4.31	9.59	72.38	4.90	10.89	70.19
5	3.75	8.32	80.70	3.75	8.32	80.70	4.73	10.51	80.70
6	1.01	1.98	82.68	1.01	1.98	82.68	2.43	1.98	82.68
7	0.51	1.38	84.06						
8	0.50	1.11	85.17						
9	0.46	1.01	86.18						
10	0.43	0.94	87.13						
11	0.36	0.80	87.93						
12	0.33	0.74	88.66						
13	0.32	0.71	89.38						
14	0.30	0.67	90.05						
15	0.28	0.63	90.68						
16	0.27	0.60	91.28						
17	0.26	0.59	91.87						
18	0.25	0.56	92.42						
19	0.24	0.52	92.95						
20	0.22	0.49	93.43						
21	0.21	0.47	93.90						
22	0.21	0.46	94.36						
23	0.19	0.42	94.78						
24	0.18	0.39	95.17						
25	0.17	0.38	95.55						
26	0.17	0.37	95.93						
27	0.16	0.35	96.27						
28	0.15	0.33	96.61						
29	0.15	0.32	96.93						
30	0.14	0.30	97.23						
31	0.12	0.28	97.51						
32	0.12	0.26	97.77						
33	0.11	0.25	98.02						
34	0.11	0.24	98.26						
35	0.10	0.21	98.47						
36	0.09	0.20	98.67						
37	0.09	0.19	98.86						
38	0.08	0.18	99.04						
39	0.06	0.13	99.66						
40	0.06	0.12	99.78						
41	0.05	0.11	99.89						
42	0.05	0.11	100.00						

Table 8: Mean and SD values for agriculture practices for tomato crop among the farmers of Nainital district.

S.N.	Agriculture Practices/Dimensions	N	Mean	% of Mean	SD
1.	Use of Hybrid Seed	160	15.19	60.75%	3.10
2.	Nursery Management and Seedling Treatment	160	28.34	70.86%	3.46
3.	Harvesting and Post-harvest Practices	160	25.69	64.22%	4.07
4.	Use of Fertilizer and Pesticides	160	20.62	51.55%	4.54
5.	Cold Store and Logistics	160	7.39	21.13%	2.02
6.	Weed Controlling	160	12.32	41.06%	3.02
	Overall Agriculture Practices	160	109.55	52.17%	10.42

*__Extraction Method:__ Principal Component Analysis

In the present study, subscale alpha coefficients exceed 0.5 with an overall alpha value 0.685 for the entire questionnaire.To evaluate the reliability of the scale, the Cronbach (1951) alpha coefficient for this subscale (42 statements) has been calculated.

Cronbach's Alpha	No. of Items
0.685	42

The result shows the derived factors represent the different element of agriculture practices in tomato farming of farmers which form the underlying factors from the original 5-point scale of 42 statements. The result showed that out of 42 variables 6 variables explained over 82.68% of the total variances.

The result showed that 82.68% of the total variance is represented by the information contained in the factor matrix of the 6 factors. The variance percentage was more than 50% therefore it was sufficient to say that variables were somehow related to each other.

Following is the detailed analysis for each of the six components extracted from the Principal Components analysis.

Use of hybrid seed: The matrix revealed After rotation, the factor represented by these variables accounts for 22.81% of data variance**.** The factor has been named use of Hybrid Seed because farmers felt that use of hybrid seed is the most important factor in agriculture practices of tomato farming.

Nursery management and seedling treatment: This factor accounts for about 18.93% of data variance explained. The rotation sums of squared loadings show that this factor accounts for about 19.37% of data variance after orthogonal rotation of component matrix.

Harvesting and post-harvest practices: The third factor was explained by 14.37% of data variance before rotation and about 17.12% of data variance after rotation; thereby making the result more reliable. It is important for the farmers to consider each element that is important for the better production of tomato crop.

Use of fertilizer and pesticides: The fourth factor account for 10.89% of the variance.

Cold store and logistics: This factor account for 10.51% of the variance. Farmers consider the cold storage and logistics as an important factor in agriculture practices of tomato crop.

Weed controlling: The sixth factor account for 1.98% of the variance.

Descriptive analysis of agriculture practices among farmers

Table 8 summarizes the overall mean and standard deviation (SD) values for all dimensions of agriculture practices.

From Table 8 it can be seen that for the whole sample (n = 160) the mean score of the factor one is 15.19 and standard deviation is found to be 3.10. The percentage of mean for this factor is 60.75 percent which indicates an average practice of using hybrid seed among farmers. For factor two, the mean score is 28.34 with standard deviation 3.46. Second factor has percentage of mean 70.86 percent which shows that on an average the farmers have good practice of nursery management and seedling treatment for tomato crop. Regarding the third factor of agriculture practices, the mean and SD is 25.69 and 4.07 respectively. An average harvesting and post-harvest practices among farmers can be predicted as the percentage of mean is observed 64.22 percent for this factor. The mean and SD of fourth factor of agriculture practices i.e.., use of fertilizer and pesticides is 20.62 and 4.54. The percentage of mean for this factor is found to be 51.55 percent which point to a below average practices among farmers regarding the use of fertilizers and pesticides in tomato farming.

CONCLUSION &RECOMMENDATIONS

In the recent year's horticulture has shown huge

potential in terms of production as well as consumption of F&V that realized a reform in Indian agricultural. One prime reason for awe-inspiring rise in horticulture crops over traditional crops is the change in the consumption pattern. Despite of all growth in horticulture crop production and consumption still our farmers are struggling with the challenge of raising efficiency in production and distribution of F&V.

Moreover, it is evident from the Table 8 that the mean agriculture practices among farmers is 109.55. The standard deviation is found to be 10.42. The percentage of mean is 52.17 percent, from which it can be inferred that the farmers have below average agriculture practices for tomato crop in Nainital district.

The summary of important recommendations for action is as below:

- To improve the production and productivity farmers need to use right and authentic variety of seeds.
- The farmers need to upgrade their skill and knowledge regarding pre-hravest and post-harvest practices and for skill development of farmers creative knowledge and training about farming practices can be provided through different programmes.
- For weed controlling and moisture control mostly farmers use chemicals very few farmers practice mulching. Farmers need to apply these methods to control weeds and maintain moisture in the fields.
- Pest management is the common constraint faced by most of the farmers involved in tomato farming. Farmers used to take suggestions for pest from the agriculture departments/ Universities, local progressive farmers and pesticides dealers in their area.
- Improper handling of harvested crop is one of the causes of perishability of tomatoes.

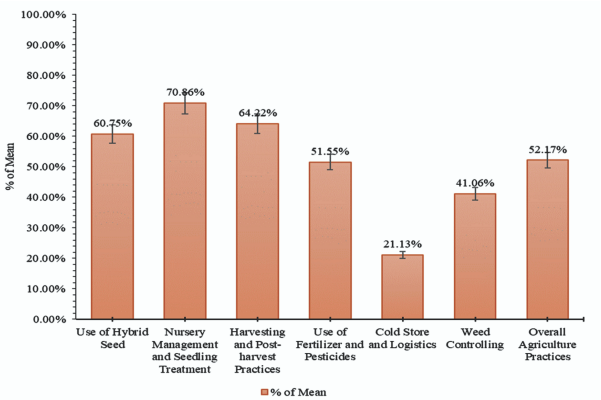

Fig.2: Agriculture practices for tomato crop among the farmers of Nainital district

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