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Farmer's Knowledge Level towards Temperature, Storage and Packaging of Horticultural Produce

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Authors' contributions

This work was carried out in collaboration among all authors. Authors PSS and JSM designed the study and help in corrections of manuscript. Author VK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

India is one of the world's largest producers of fruits and vegetables, but one-third of its produce rots because of poor storage technologies and infrastructure, packaging, transport and distribution system. Food is wasted throughout the supply chain, from initial agricultural production to final household consumption. Therefore, value-addition may raise the value of products or something can add that enables to increase the profit margin and demand for consumption. The present study was conducted in Haryana state and two districts Hisar from Southwest and Sonipat from Northeast were selected, purposively. From each district, three blocks were selected randomly because not all the farmer have experience of post-harvest management practices in fuits and vegetables crops. Further, three villages were selected from each block making a total of 18 villages. From each village, ten farmers were selected randomly, making a total sample of 180 farmers. Hence, one hundred eighty farmers were interviewed for the study. The study found that majority of the farmers (62.78 per cent) had partial level (26.11 per cent) had high and 11.11 per cent had no knowledge regarding 'Room cooling: placing the crops in cold storage'. The results also shows that majority of the farmer (65.56 per cent) had high level 32.78 per cent had partial and 1.66 per cent had no knowledge regarding 'Cleaning: chemical must be removed from produce before packing. e.g. Insecticides, pesticides etc'. It was found that majority of the farmers (66.11

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per cent) had high level, 33.89 per cent had partial level of knowledge regarding 'Flexible sacks: Made of plastic jute, such as bags (small sacks and nets made of open mesh)', and none was found to have no knowledge of it. To reach the results aggregates total was calculated for each statement separately and on the basis of calculated scores, mean scores and mean score percentage were obtained which were ranked according to their maximum to minimum mean score percentage for assessing the knowledge level of the farmers.

Keywords: Knowledge; cleaning; insecticides; pesticides.

1. INTRODUCTION

Temperature management is a key tool for preventing the development of postharvest rots. The growth rate of the micro-organisms (bacteria and fungi) that cause postharvest rots is controlled by temperature. These disease-causing organisms grow faster at warmer temperatures. Therefore if storage temperatures are low the rate of disease development can be considerable reduced and the storage life and quality of the fresh product can be assured.

Rapid cooling after harvest has been clearly shown to prolong the shelf life of freshly harvested produce. During busy harvest times, it is important to have practical systems in place to minimise the amount of field heat accumulating in harvested fruit, as well as having an efficient system for removing that heat at the cool store.

Study found that value addition in vegetables production, processing and export from Bangladesh and revealed that the export of fresh vegetables is more profitable due to high value addition. Bangladeshi vegetables were still not well known to the foreign consumers. To familiarize Bangladeshi vegetables to the foreigners and foreign super markets, quality of those vegetables has to be improved by different value addition activities like upgrading the packaging, Processing, handling, grading and transportation system [1].

Post-harvest loss of fruits and vegetables occur due to lack of proper technique of harvesting, transportation, storage and distribution. The freshness of fruits and vegetables after harvest is controlled by water content, respiratory rate, ethylene production, endogenous plant hormones and exogenous factors such as microbial growth, temperature, relative humidity and atmospheric compositions. Therefore, post-harvest loss of fruits and vegetables can be considerably reduced and their shelf life increased by careful manipulation of these factors. The loss can be reduced by implementing the important cultural methods, careful handling and packaging. The use of appropriate chemicals at pre and postharvest stage may prolong the availability of fresh produce for a long period of time by protecting them from pathogens and other environmental factors. Also controlled atmosphere storage and redurization at low temperature has been found to be effective for fruits and vegetables [2].

In the market chain, unavailability of a recognized pricing structure that give priority to quality of harvest in some ways appear to be a discouraging fact at grass root level to minimize waste of produce. In addition, implementing post-harvest operations such as sorting, grading and pre-cooling at satisfactory level, improving storage facilities to maintain the basics of reducing handling waste seems promising steps in improving status quo of the present-day post-harvest process. In this regard a firm government policy and regulatory enforcement in post-harvest handling, storage and transportation aspects will certainly make sure the governments subsidies disbursed at grassroots level for farming are better utilized [3].

The postharvest quality status and shelf life of the fruits in part will depend on some postharvest handling practices and treatments carried out after harvest. Even though the quality of any fruit after harvest cannot be improved by the use of any postharvest handling practices or treatment methods, it can however be maintained. Shelf life of the fruit can also be extended when appropriate postharvest handling practices and treatment methods are employed. Postharvest handling practices like harvesting, precooling, cleaning or disinfecting, sorting and grading, packaging, storage, and transporting played an important role in maintaining quality and extending shelf life of the tomato fruits after harvest [4].

Value addition is an inter-disciplinary science and technique applied to agricultural produce after harvest for protection, conservation, processing,

packaging, distribution, marketing and utilization leading to meet the food, nutritional and livelihood security of the people in relation to their needs. Value addition deals with chain of operations right from harvesting till utilization by the consumer. In broader vision, it deals with variety of operations like deciding economic maturity standards, grading, post-harvest processing, waste management, fortification, packaging, labeling, storage and marketing [5].

Poor infrastructure for storage, processing and marketing of fruits and vegetables contributed to losses to the farmers. Smallholder farmers generally focused on production activities and showed relatively little interest in post-harvest and marketing activities. The presence of informal middlemen at Mbare and Machipisa Vegetable Markets had led to considerable reduction of the farmers' profit margins [6].

The results revealed that bulks of farmers were made up of fairly young people. Most of the farming operations were done manually with tomato and onions produced majorly. Products were majorly sold immediately after harvest with poor processing, packaging, transporting and storage systems. Conclusively, the farmers lacked general knowledge in storage technology, properly due lack of farming experience, therefore, these could be responsible for the huge losses of fruits and vegetables in Kano state and the country at large [7].

Today fruits and vegetable farming as a diversified farming is important to generate employment round the year, supplement farm economy and to earn foreign exchange also by enhancing the export. As well as fruits play an important role in human nutrition offer diversity indirect, ecological sustainability and fight against hunger. They are sources of essential minerals, vitamins, dietary fibre, supply complex carbohydrates and proteins. They are good sources of calcium, phosphorus, iron, magnesium and contribute over 90 per cent of vitamin C. It is generally stated that the living standard of people can be judged by the production as well as consumption of fruits.

2. MATERIALS AND METHODS

2.1 Locale of the Study

The present study was conducted in Haryana state and two districts Hisar from Southwest and Sonipat from Northeast were selected, purposively. From each district, three blocks were selected randomly because not all the farmers have the experience of post-harvest management and value addition of fruits and vegetables crops. Further, three villages were selected from each block making a total of 18 villages. From each village, ten farmers were selected randomly, making a total sample of 180 farmers. Hence, one hundred eighty farmers were interviewed for the study. Three blocks from each district i.e. Hisar and Sonipat were selected, purposively. From Hisar, three blocks namely, Hisar I, Hisar II, Adampur and from Sonipat, blocks Ganaur, Gohana, Sonipat were

Map 1. Map of Haryana showing the locale of study

selected, randomly. Thus, six blocks were selected for the study. Out of the six selected blocks, two villages from each block were selected, randomly. Thus a total number of eighteen villages namely, Dobhi, Dhiranwas, Ladwa from block Hisar I, Saharwa, Chiraud, Talwandi Rukka from block Hisar II and Kherampur, Kohli, Siswal from block Adampur while Bain, Chirsmi, Mohamadpur Majra from Ganaur , Jagsi, Riwara, Baroda Thuthan from Gohana block and Makimpur, Dipalpur, Moi from Sonipat block were selected, randomly also.

2.2 Collection of Data

For assessing the knowledge data was collected by conducting personal interview with the respondent at their home/working center. The interview of every individual was taken separately so that the others did not influence the answers. To find out the knowledge level of the farmers about value addition of horticulture and vegetable crops, an inventory of knowledge level was prepared on the basis of available literature, personal experience, discussion with experts and farmers growing fruits and vegetable. A list of knowledge level was prepared and the farmers were asked to speak out their responses against each statement. Whether it was 'high', 'partial', and 'no knowledge' weight age given to these response categories were 3, 2 and 1 respectively. Aggregate total was calculated for each statement separately and on the basis of calculated scores, mean scores and mean score percentage were obtained which were ranked according to their maximum to minimum mean score percentage for assessing the knowledge level of the farmers.

2.3 Analysis of Data

The information collected through the responses of the respondents, were suitably coded, tabulated and analyzed to draw meaningful inferences by using statistical tools such as frequency distribution, percentages, weighted mean scores, rank order, correlation and regression.

3. RESULTS AND DISCUSSION

3.1 Cooling Methods and Temperature

Packing fresh produce with crushed or flaked ice provides rapid cooling and can provide a source of cooling and high RH during subsequent handling. The use of crushed ice is, however, limited to produce that is tolerant to direct contact with ice and packaged in moisture-resistant containers.

Clean, sanitized water is used as the cooling medium for the hydrocooling (shower or immersion systems) of commodities that tolerate water contact and are packaged in moisture-resistant containers. Vacuum cooling is generally applied to leafy vegetables that release water vapor quickly, thereby allowing them to be rapidly cooled.

Table 1 found that majority of the farmers (62.78 per cent) had partial level (26.11 per cent) had high and 11.11 per cent had no knowledge regarding 'Room cooling: Placing the crops in cold storage'. It was observed that about 'Air pre-cooling with cold air: done in refrigeration cars, storage room, tunnels or forced air cooler', 63.89 per cent of the respondents possessed partial level of knowledge, 26.11 per cent had no knowledge level and 10.00 per cent had high level of knowledge about it.

The study reveals that majority of the farmers (51.67 per cent) possessed partial level while 48.33 per cent had no knowledge on 'Icing: Done with placing a layer of crushed ice directly top on the crops 'and none was found to have high level of knowledge of it.

Regarding 'Pre-cooling: 3-6°C, majority (63.33 per cent) of respondents had no knowledge, 36.67 per cent had partial level of knowledge, and none was found to have high level of knowledge of it. It was revealed from Table 1 that majority of the respondents (81.11 per cent) had no knowledge level whereas 18.89 per cent of the respondents had partial level of knowledge about 'Hydro-cooling: Crop is submerged in cold water', and none was found to have high level of knowledge of it. In case of 'Vacuum cooling: latent heat of vaporization rather than conduction', most of the respondents (96.11 per cent) had no knowledge level, 3.89 per cent had partial level of knowledge, and none was found to have high level of knowledge of it.

3.2 Storage of Horticultural and Vegetable Produce

It is also observed from Table 2 that 78.33 per cent of the respondents had partial level of knowledge while, 19.44 per cent had high level and 2.22 per cent had no knowledge regarding provide even supply. It was found that majority of the respondents (87.77 per cent) had partial

level, 9.44 per cent had no knowledge level and only 2.77 per cent had high level of knowledge about protect from no knowledge and high temperature. It is also observed from Table 2 that 77.77 per cent of the respondents had partial level of knowledge while, 15 per cent had no knowledge level and 7.22 per cent had high level of knowledge regarding prevent shortage. It was found that majority of the respondents (58.33 per cent) had no knowledge level, 28.33 per cent had partial level and only 3.33 per cent had high level of knowledge about no knowledge of down ageing (respiration, moisture loss, decay, disease, etc.).

Table 1. Cooling methods and temperature (n=180)

S. no.	Statements	Knowledge level (%)			Total weighted Score	Weighted mean score
		High	Partial	No knowledge		
1.	Room cooling : placing the crops in cold storage	47 (26.11)	113 (62.78)	20 (11.11)	387	2.15
2.	Air pre-cooling with cold air: Done in refrigeration cars, storage room, tunnels or forced air cooler	18 (10.00)	115 (63.89)	47 (26.11)	331	1.83
3.	Icing : done with placing a layer of crushed ice directly top on the crops	0 (0.00)	93 (51.67)	87 (48.33	271	1.51
4.	Pre-cooling : 3-6°C	0 (0.00)	66 (36.67)	114 (63.33)	246	1.36
5.	Hydro-cooling: Crop is submerged in cold water	0 (0.00)	34 (18.89)	146 (81.11)	214	1.18
6.	Vacuum cooling: Latent heat of vaporization rather than conduction	0 (0.00)	7 (3.89)	173 (96.11)	187	1.03

Figures in parentheses in column 3, 4 and 5 indicate percentages; column 6 indicates total weighted score and column 7 indicates weighted mean scores

Table 2. Farmer's knowledge regarding storage of horticultural and vegetable produce (n=180)

S. no.	Statements	Knowledge level (%)			Total weighted score	Weighted mean score
		High	Partial	No knowledge		
1.	Preserve crop produce to consume in off season	52 (28.88)	128 (71.11)	0 (0.00)	412	2.28
2.	Avoid gluts (supply)	46 (25.55)	134 (74.44)	0 (0.00)	406	2.25
3.	Obtain higher prices	43 (23.88)	137 (76.11)	0 (0.00)	403	2.23
4.	Keep food in good condition	38 (21.11)	142 (78.88)	0 (0.00)	398	2.21
5.	Provide even supply	35 (19.44)	141 (78.33)	4 (2.22)	391	2.17
6.	Protect from low and high temperature	5 (2.77)	158 (87.77)	17 (9.44)	348	1.93
7.	Prevent shortages	13 (7.22)	140 (77.77)	27 (15)	346	1.92
8.	No knowledge of down ageing (respiration, moisture loss, decay, disease etc.)	6 (3.33)	69 (38.33)	105 (58.33)	261	1.45

Figures in parentheses in column 3, 4 and 5 indicate percentages; column 6 indicates total weighted score and column 7 indicates weighted mean scores

3.3 Operation Prior to Packaging

Table 3 shows that majority of the farmer (65.56 per cent) had high level 32.78 per cent had partial and 1.66 per cent had no knowledge regarding 'Cleaning: Chemical must be removed from produce before packing. e.g. Insecticides, pesticides etc'. Regarding 'Artificial waxing provides a protective coating over entire surface', it was observed that 69.44 per cent of the respondents possessed partial level of knowledge, 21.11 per cent had no knowledge level and 9.44 per cent had high level of knowledge about it. The study revealed that majority of the farmers (68.89 per cent) possessed partial level while only 21.67 per cent no knowledge and 9.44 per cent had high level of knowledge regarding 'Seals small cracks and dents in the rind or skin'. Regarding 'Seals off stem scars or base of petiole', majority (68.33 per cent) of the respondents had partial, 22.22 per cent had no knowledge and 9.44 per cent had high level of knowledge.

Table 3 shows that majority of the respondents (58.33 per cent) had partial level whereas 32.22 per cent of the respondents had no knowledge level and 9.44 per cent had high level of knowledge about packaging that it 'Reduces moisture loss'. Regarding 'Permits natural respiration, majority of the respondents (54.44 per cent) had partial level, 36.11 per cent had no knowledge and only 9.44 per cent had high level of knowledge. It is also observed from Table 3 that 46.67 per cent of the respondents had partial level of knowledge while 43.89 per cent had no knowledge and 9.44 per cent had high level of knowledge regarding packaging that it 'Extends shelf life'. Regarding 'Enhances sales appeal', of the respondents (46.67 per cent) had partial level of knowledge while 43.89 per cent had no knowledge and 9.44 per cent had high level of knowledge.

3.4 Classification of Packaging

It was found that majority of the farmers (66.11 per cent) had high level, 33.89 per cent had partial level of knowledge regarding 'Flexible sacks: Made of plastic jute, such as bags (small sacks and nets made of open mesh)', and none was found to have no knowledge of it. It was observed that about 'Wooden crates' 58.89 per cent of the respondents possessed high level of knowledge, 38.33 per cent had partial level and 2.77 per cent had no knowledge about it.

Table 3. Operation prior to packaging (n=180)

S. no.	Statements	Knowledge level (%)			Total weighted score	Weighted mean score
		High	Partial	No knowledge		
1.	Cleaning: chemical must be removed from produce before packing e.g. insecticides, pesticides, etc.	118 (65.56)	59 (32.78)	3 (1.66)	475	2.63
2.	Artificial waxing :					
(I).	Provides a protective coating over entire surface	17 (9.44)	125 (69.44)	38 (21.11)	339	1.88
(ii).	Seals small cracks and dents in the rind or skin	17 (9.44)	124 (68.89)	39 (21.67)	338	1.87
(iii).	Seals off stem scars or base of petiole	17 (9.44)	123 (68.33)	40 (22.22)	337	1.87
(iv).	Reduces moisture loss	17 (9.44)	105 (58.33)	58 (32.11)	319	1.77
(v).	Permits natural respiration	17 (9.44)	98 (54.44)	65 (36.11)	312	1.73
(vi).	Extends shelf life	17 (9.44)	84 (46.67)	79 (43.89)	298	1.65
(vii).	Enhances sales appeal	17 (9.44)	84 (46.67)	79 (43.89)	298	1.65

Figures in parentheses in column 3, 4 and 5 indicate percentages; column 6 indicates total weighted score and column 7 indicates weighted mean scores

The study revealed that farmers 49.44 per cent possessed high level while only 45.56 per cent partial and 5.00 per cent had no knowledge 'Plastic crates: Expensive but last longer than wooden & cartoon crates'. Regarding 'Nets for roots crops (potato, onion)', 51.67 per cent of respondents had high, 37.22 per cent had partial and 11.11 per cent had no knowledge.

Table 4 indicates that 40.56 per cent had high level whereas 33.33 per cent of the respondents had partial level and 26.11 per cent had no knowledge about 'Carton (fiberboard boxes): Tomato, cucumber, ginger'. In case of 'Basket made of woven strips of leaves, bamboo, plastic etc.', most of the respondents (63.89 per cent) had no knowledge level, 33.3 per cent had partial level and only 2.77 per cent had high level of knowledge. It was also observed that 64.44 per cent of the respondents had no knowledge, while 32.78 per cent had partial and 2.77 per cent had high level of knowledge regarding Pallet boxes and shipping container.

Table 4. Classification of packaging (n=180)

S. no.	Statements	High	Knowledge Level (%)	No knowledge	Total weighted score	Weighted mean score
			Partial			
1.	Flexible sacks : Made of plastic jute, such as bags (small sacks and nets made of open mesh)	119 (66.11)	61 (33.89)	0 (0.00)	479	2.66
2.	Wooden crates	106 (58.89)	69 (38.33)	5 (2.77)	461	2.56
3.	Plastic crates : expensive but last longer than wooden & cartoon crates	89 (49.44)	82 (45.56)	9 (5.00)	440	2.44
4.	Nets for root crops (potato, onion)	93 (51.67)	67 (37.22)	20 (11.11)	433	2.40
5.	Carton (fiberboard boxes) : tomato, cucumber, ginger	73 (40.56)	60 (33.33)	47 (26.11)	386	2.14
6.	Basket made of woven strips of leaves, bamboo, plastic, etc.	5 (2.77)	60 (33.33)	115 (63.89)	250	1.38
7.	Pallet boxes and shipping container	5 (2.77)	59 (32.78)	116 (64.44)	249	1.38

Figures in parentheses in column 3, 4 and 5 indicate percentages; column 6 indicates total weighted score and column 7 indicates weighted mean scores

Table 5. 19 Relationship between farmers' personality traits and their knowledge level (n=180)

S. no.	Variables	Correlation coefficient
1	Age	0.903**
2	Education	0.831**
3	Land holding	-0.017NS
4	Farming System	-0.314**
5	Experience in value addition	0.031NS
6	Farm Implement	0.066NS
7	Training attended	-0.312**
8	Source of irrigation	-0.792**
9	Farm power	-0.716**
10	Extension contact	0.504**
11	Innovation Proneness	0.624**
12	Mass media exposer	0.555**

Significant at 0.05 level of probability

3.5 Relation between Farmers' Personality Traits and Their Knowledge Level in Post-harvest Management and Value Addition of Horticulture and Vegetable Crops

The findings on the type and magnitude of relationship of selected variables or personality traits with knowledge level of farmers. The data shows that the relationship between the personality traits like age (r=0.903), education (r=0.831), extension contact (r=0.504), innovation proneness (r=0.624) and mass media exposure (r=0.555) with the knowledge level had positive and significant correlation (at 0.05 level of probability). This means that farmer having higher age, education, extension contact, innovation proneness and mass media exposure possessed higher level of knowledge of value addition in horticulture and vegetable crops. However, all the remaining factors namely land holding, farming system, experience in value addition, farm implement, training attended, source of irrigation and farm power did not show any significant association with knowledge level of farmers. Therefore, it can be inferred that these variables are not associated with the knowledge level of farmers.

4. CONCLUSION

While the quality of a product cannot be improved after harvest, it can be maintained with proper postharvest sanitation, cooling, packaging, handling, storage, and management. This primarily means reducing metabolic rates and water loss because those can lead to reductions in quality and weight, and ultimately reduced sales. It was concluded from the observation that most of the respondents had medium to high level of knowledge towards value addition horticulture and vegetable crops in Hisar and Sonipat districts. It was found that farmers were interested to know about the value addition in horticulture and vegetable crops to raise their income. In terms of cooling methods, small-scale producers have a few options. However, each option presents advantages and disadvantages, and no single cooling method will work for all commodities. Some commodities, such as peaches, may be cooled using hydrocooling, forced-air cooling, or room cooling depending on the shelf life required for the marketing system. Alternatively, hydrocooling is the best choice for removing heat from squash and snap beans, both because those are relatively perishable products, and thus benefit from more rapid cooling, and because they tolerate contact with water. Contact icing is also a cheap, effective means of cooling fresh produce once harvested; however, as with hydrocooling, the commodity must be able to withstand some contact with water. Additionally, using ice for cooling would not be compatible with any crop that is sensitive to chilling injury. Vacuum cooling, while efficient at removing heat, is too expensive and, therefore, is not likely to be a viable cooling option for smaller produce operations. The study found that majority of the farmers (62.78 per cent) had partial level (26.11 per cent) had high and 11.11 per cent had no knowledge regarding 'Room cooling: Placing the crops in cold storage'. It is also observed that 78.33 per cent of the respondents had partial level of knowledge while, 19.44 per cent had high level and 2.22 per cent had no knowledge regarding provide even supply. The results also shows that majority of the farmer (65.56 per cent) had high level 32.78 per cent had partial and 1.66 per cent had no knowledge regarding 'Cleaning: Chemical must be removed from produce before packing. e.g. Insecticides, pesticides etc'. It was found that majority of the farmers (66.11 per cent) had high level, 33.89 per cent had partial level of knowledge regarding 'Flexible sacks: Made of plastic jute, such as bags (small sacks and nets made of open mesh)', and none was found to have no knowledge of it. Maintaining the cool chain is important for several reasons, all of which relate to maintaining product quality. For example, temperature has a direct effect on the respiration rate of the product and this is an indication of the rate of deterioration of the product. Temperature also affects the rate of growth of postharvest rots. If the cool chain is maintained, both these factors can be slowed down and the shelf life can be extended and quality maintained.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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