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Assessment of knowledge index of farmers about cultivation of apple (*Malus domestica*) in temperate regions of Kashmir valley

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Abstract

Apple is one of the important fruits grown in different regions of the world, including India. In India, it is mainly cultivated in temperate regions of Kashmir valley due to its well-suited climatic conditions. In Kashmir, most people are directly or indirectly dependent on apple cultivation for their livelihood. Apple is considered the Kashmir's eye as it produces 80% share of the total fruit produced in the country and is the main economy with revenue of around Rs 1500 crores. More than seven lakh families, *i.e.* above 50% of the population in the valley, are associated with this industry and almost 3.5 lakh hectares of land are under apple cultivation. The area under apple fruit has increased, but the production and productivity have not improved satisfactorily. Adopting improved technologies plays an important role in achieving higher production and productivity in Kashmir Valley. A wide gap exists between the available technologies and their actual adoption by the apple growers, which was reflected through poor yield at the grower's field. This gap was due to low knowledge and awareness about different innovative techniques and technologies developed at different research stations. The study was conducted in different regions of Kashmir valley selected purposively, having a maximum area under apple cultivation. A multistage sampling procedure was adopted for the study. From the study, it was found that the mean knowledge index of apple growers in district Shopian was 51.75 percent, followed by the apple growers in district Baramulla (46.76%) and the least mean knowledge index (41.36%) was found among the apple growers of district Budgam. However, all three districts' overall mean knowledge index was 46.62 percent. The study also found that apple growers' knowledge index is determined by age, experience, education, media exposure, innovative proneness, scientific orientation, and risk orientation. Furthermore, apple growers need to follow innovative techniques and technologies to increase the production and productivity of apple fruit, maximize returns, and ensure food security.

Key words: Apple, knowledge index, assessment, Kashmir, yield

Introduction

India enjoys an enviable position in the world's horticultural map as most fruits, vegetables, spices and condiments are grown in the country (Nain and Chandel, 2013). Horticulture has emerged as a fast-growing sector, proving its credibility in improving farmers' income (Shah *et al.,* 2021). It has the potential to generate multiple sources of income, thereby boosting the economic growth of a country (Mitra and Panda, 2020). Apple is one of the horticultural fruits best-loved in many parts of the world and is among the oldest known to man (Negi, 2013). In India, apple is mainly cultivated in Kashmir valley and its value chain is one of the mainstays of the rural economy with revenue of around Rs. 1500 crores (Chadha, 2021). The valley produces 80% of the country's apples, with over seven lakh families (about 33 lakh people) directly or indirectly associated with this industry, producing 1.9 million tonnes of apples in the year 2019 (Tantry, 2020), as it is endowed with congenial agro-climatic conditions for a wide range of horticultural crops including apple (Shah *et al.,* 2019). The area and production of apples in the state during 2018-2019 were 164742 hectares and 1882319 metric tonnes, respectively (DoHK, 2021). The average yield of commercially important apple cultivars per unit area was highest in the country ranging between 11-13 tonnes/ha, but it compares poorly to the yields of 20-40 tons/ha in horticulturally advanced countries of the world (Bhat *et al.,* 2020). However, due to limited land and water resources, an increase in production and quality fruit is hardly possible unless the apple growers adopt effective techniques in the production system (Shah *et al.,* 2017).

There is a considerable increase in the area of apple cultivation in the union territory, but the productivity is not up to mark. This low productivity of apples might be due to a lack of awareness/information about different improved practices of apple cultivation. As innovative techniques and technologies that can boost apple productivity in the state are being developed at different experimental stations, research institutes and farm science centers. However, the technology was neither disseminated properly nor the apple growers are not judiciously utilizing it at their farms (Shah *et al.,* 2020). It was recognized that agricultural development is the process of accepting new ideas and practices that influence farmers' attitudes and lifestyles of farmers to enable them to live better lives (Bhagat *et al.,* 2004). So imparting expert knowledge, up-gradation of skills, and competencies *vis-a-vis* polishing of existing knowledge and skills in production, processing, packaging and marketing techniques of farmers (apple growers) enhance their farm production, maximize returns and ensure food security of more than seven lakh families (about 33 lakh people) (Nain *et al.,* 2013).

In the present scenario, there are still loopholes and lapses, which have rendered our apple industry to such an extent that we are not in a strong position to compete with the global market. Globally China is the leading apple-producing country, with a production of 41 million tons in 2020 and constitutes 63.63% of total world apple production. However, India, the second largest country in the world in terms of area, produced only 23.70 million tons of apples in 2020 and ranks 5th in world apple production (Statista, 2021). India annually imports 2 lakh tonnes of apples (Ghosal, 2021). So despite having a huge area under apple cultivation, the demand is still not fulfilled and low productivity is the main cause for it. The average productivity of apples in India was only 6-8 tonnes per hectare, which was much lower than that of countries like Belgium (46.22tons/ha), Denmark (41.87 tons/ha), and the Netherlands (40.40 tons/ha) (Wani *et al.,* 2021).

Similarly, in Kashmir, the country's main apple-producing region, the average yield of different apple varieties was only 11 tons/ha (Chadha, 2021) compared to other countries' yield. China 17.96 tons/ha, the United States (27.85 tons/ha), Germany (25.40 tons/ha), Italy (40.11 tons/ha) and France (43.98 tons/ha), (FAO, 2016) and world average 15.49 tons/ha (Na, 2016), therefore, the potential yield can be increased to 40-70 tons/ha. Although there has been a quantum jump in apple production, the productivity (11.00 tons/ha) is still far behind the potential and fruit quality does not match the required standards. This indicates an enormous gap between actual productivity and the potential for the productivity of apple crop. To bridge the gap, it's crucial to efficiently communicate research findings to apple growers, enabling them to embrace advanced techniques for improved cultivation. Gaining proficiency in these methods and technologies is pivotal for driving change and boosting productivity. This process involves apple growers and their families adopting new skills, knowledge, and practices, which fosters a positive shift in their attitudes toward apple cultivation, as emphasized by FAO (2022). The present study aimed to explore the technical knowledge of apple growers about improved practices and the factors underpinning knowledge of apple cultivation. Findings are expected to explain the driving factors affecting the knowledge level of apple growers and thus reveal the possible opportunities (Allahyari *et al.,* 2017) to enhance the productivity of this important crop and ensure the food security of more than three million people. It becomes imperative to understand the apple growers' knowledge index regarding improved production technological practices. It is also important to determine the grower's socioeconomic profiles that influence the knowledge practice of apple growers. This understanding will be of great importance to the extension agents saddled with the responsibility of disseminating production technologies in the study area to redesign measures that best suit their client-extension workers relationship.

Materials and methods

The present study was conducted in the union territory of Jammu and Kashmir, extending from 32°-17' to 37°-05' N latitude and 72°-20' to 80°-30' E longitude, with altitude ranging from 215-7012 meters above mean sea level. Three major apple-producing districts (Shopian, Budgam and Baramulla) having a maximum area under apple cultivation were selected purposively. A multistage sampling procedure was adopted to select districts, horticultural zones, villages and apple growers. From each selected district, one horticultural zone and from each zone, one village was selected purposively. A list of apple growers (orchardists) of selected villages was obtained from concerned horticultural development offices and a sample of different apple growers with marginal, small, medium and large land holdings was selected proportionately. Thus, 300 apple growers were selected purposively from nine (9) selected villages using the following formula.

$$n_i = \frac{N_i}{N} n$$

Where:

N_i= Number of sampled apple growers in each village.

N= Total number of apple growers selected for the present study (300).

N= Total number of apple growers in sampled villages.

N_I=Total number of apple growers in ith village.

The structured, closed-end research tool (interview schedule) was prepared in consultation with the scientist of State Agricultural University (SKUAST Kashmir), KVK's, and extension functionaries of line departments (horticultural department). Several extension specialists in the region confirmed the research tool's validity; however, the reliability was measured using the test-retest method. The correlation coefficient (r=0.821) was found to be highly significant at *P*=0.01, indicating a high degree of dependability of the instrument for measuring the knowledge level of apple growers. The schedule was formulated as per the improved practices recommended by SKUAST, Kashmir. The schedule was pretested in a non-sampled area for its practicability and relevancy and the apple growers were personally interviewed (face to face) and the qualitative data was converted into quantitative data by giving scores. The scores obtained by each apple grower in respect of a particular characteristic under the study were worked out and the apple growers were classified logically into different categories based on their scores.

Logit Model: This present study used the logit model (LM) to regress the relationships between a dichotomous response (one for a knowledge index between 50% and above and zero for those apple growers below the 50% threshold) and a set of regression variables. According to Green and Ngongola (1993); the LM is quite applicable to this study because it employed individual choice between two alternatives assumed to be mutually exclusive. In LM, scholars do not need to treat categorical data in any continuous form; this attribute makes LM different from ordered or sequential probit regression. LM estimates the effects of the explanatory variables on explained variables with unordered response categories. LM is normally distributed and the predicted probabilities range between 0 and 1; it eliminates heteroskedasticity in the error term. This attribute is a welcome advantage over the ordinary least square regression approach.

An additional advantage of the Logit model is its computational ease and relative robustness, as measured by goodness of fit or prediction accuracy. This model for the study adopted from Green and Ngongola (1993) is defined as:

$$P_r(Y = 1) = \frac{e^{\beta_x}}{1 + e^{\beta_x}}$$

With the cumulative distribution function given by:

$$f(\beta_x) = \frac{1}{1 + e^{\beta_x}}$$

Where β represents the vector of parameters associated with the factor x_i

Assuming the probability that n apple growers have a knowledge index of 50% and above the computational mean index or below the computational mean index. This knowledge index of apple growers was subjected to 1 for those with 50% and above knowledge index value, while those below 50% knowledge index take up the value of 0. Thus, the individual empirical models to be estimated are specified as:

$$P_1^* = \beta_0 + \beta_1 X_1 + \cdots \beta_n X_n + \varepsilon_i$$
$$P_2^* = \gamma_0 + \gamma_1 X_1 + \cdots \gamma_n X_n + \varepsilon_i$$

Where
P_1^*= apple growers below 50% knowledge index
P_2^*= apple growers between 50% and above knowledge index
β and γ are vectors of respective parameters to be estimated.
X_i vectors of explanatory variables (age, experience, education, annual income, extension contact, media exposure, innovative proneness, scientific orientation, risk orientation). e_t = error terms

Results and discussion

According to Table 1 and 2, the majority of the apple growers from all three districts were having high knowledge index (70.25% in Shopian; 55.46% in Budgam and 65.27% in Baramulla with rank I) regarding pest and disease management aspect of apple cultivation. The highest knowledge index was found in district Shopian and the least knowledge index was found in Budgam for pest and disease management. However, the overall knowledge index for pest and disease management practice of apple cultivation from all three districts was 63.66 percent. To manage the nutritional deficiencies of apple fruits, most of the growers from all three districts had low knowledge index (30.35% Shopian; 28.27% Budgam and 29.65% Baramulla with the lowest rank XV). The lowest knowledge index among all three districts was found in district Budgam. However, the overall knowledge index for managing nutritional deficiencies of apple from all three districts was 29.42 percent. For all the practices cumulatively put together, the majority of the growers from district Shopian had a higher knowledge index in almost all the improved practices compared to the growers of Baramulla and Budgam. Similarly, a lower knowledge index was found among the apple growers of district Budgam in all the improved practices of apple cultivation.

Regarding the high level of knowledge index about managing pests and diseases in apple cultivation, the growers usually spray at least 10-12 pesticides throughout the year. Continuous spraying of different pesticides updates and enhances the skills, knowledge and competencies of apple growers and learns different formulations while spraying (learning by doing). Extension agencies of different development departments usually focus more on managing pests and diseases by conducting different methods and result demonstrations which help to create confidence among apple growers in practice demonstrated. However, for a low level of knowledge index in managing nutritional deficiencies in apple cultivation, the practice needs utilization of micro-nutrients that involve scientific intervention with difficult formulation, which the majority of the growers found difficult to remember, so the apple growers do not use micro-nutrients in their orchards hence low knowledge index. The apple growers of district Shopian had a higher knowledge index in almost all the improved practices. The growers in this district were more innovative risk bearers and had high contact with the extension agencies of the horticulture department and scientists of KVK's and SKUAST Kashmir, as reported by Kaur and Kaur, 2018. Moreover, most of the apple growers were old, hence highly experienced in gaining knowledge regarding improved practices. Similarly, the apple growers of district Budgam were having lower knowledge index regarding different improved techniques and technologies of apple cultivation as the apple cultivation in this region was recently practiced and mostly the growers were young with low experience, having lower extension contact and relying on simple and traditional methods of cultivation.

The number of apple growers having knowledge regarding improved apple cultivation practices is presented in Table 3. Pest and disease management was the most popular practice (71 in Shopian, 48 in Budgam and 74 in district Baramulla), while methods to overcome nutritional deficiency was the least popular practice (31 in Shopian, 24 in Budgam and 34 in Baramulla) in all the three districts. Apple growers from the district Shopian

Table 1. Distribution of the apple growers according to practice-wise knowledge index in recommended apple production technology

S. No.	Recommended practices	Knowledge Index (Percentage)			
		Shopian	Budgam	Baramulla	Over all
A.	Preparation of land and planting	54.8	52.6	53.2	53.5
B.	Training and pruning of apple trees				
1	Pruning of young non-bearing trees	46.5	37.8	39.7	41.3
2	Pruning of bearing trees	47.5	39.8	40.1	42.5
3	Training and pruning of dwarf trees	44.7	34.2	38.7	39.2
C.	Orchard Management				
1	Cultivation and Mulching	44.8	41.0	41.0	42.3
2	Thinning and rejuvenation of unproductive orchards	46.4	31.7	37.4	38.5
3	Irrigation and drainage	48.7	41.4	62.3	50.8
4	Pollination and pre-harvest fruit drop	44.7	39.7	44.4	42.9
D.	Nutrient Management				
1	Organic manures (Fully decomposed FYM)	68.0	47.3	52.4	55.9
2	Inorganic fertilizers	62.2	39.6	41.8	47.9
3	Methods of fertilizer application	31.7	29.6	38.8	33.3
4	Methods to overcome nutritional deficiencies	30.4	28.3	29.7	29.4
E.	Pest and disease management	70.3	55.5	65.3	63.7
F	Harvesting and picking	67.0	53.5	61.5	60.7
G	Packaging and storage	68.7	48.6	55.0	57.4

Table 2. Rank-wise distribution of apple growers according to practice-wise knowledge index in recommended apple production technology

S. No.	Recommended Practices Shopian	Rank according to Knowledge Index		
		Shopian	Budgam	Baramulla
	Preparation of land and planting:	VI	III	V
A.	Training and pruning of apple trees:			
	Pruning of young non-bearing trees:	IX	XI	XI
	Pruning of bearing trees:	VIII	VIII	X
	Training and pruning of dwarf trees:	XII	XII	XIII
B.	Orchard Management:			
	Cultivation and Mulching:	XI	VII	IX
	Thinning and rejuvenation of unproductive orchards:	X	XIII	XIV
	Irrigation and drainage:	VII	VI	II
	Pollination and pre-harvest fruit drop:	XIII	IX	VII
C.	Nutrient Management:			
	Organic manures (Fully decomposed FYM):	III	V	VI
	Inorganic fertilizers:	V	X	VIII
	Methods of fertilizer application:	XIV	XIV	XII
	Methods to overcome nutritional deficiencies	XV	XV	XV
	Pest and disease management	I	I	I
	Harvesting and picking	IV	II	III
	Packaging and storage	II	IV	IV

Rank-wise Knowledge Index:

First Rank holder from all the three districts: Pests and disease management.

Least Rank holder from all the three districts: Methods to overcome nutritional deficiencies.

were more innovative, having more extension contact with the extension agencies and more media contact, which provided them with relevant and innovative technologies for apple cultivation. Similar findings were reported by Shah *et al.* (2021), wherein it was reported, that most of the growers from twin districts (Shopian and Baramulla) had a medium level of contact with different extension functionaries in contrast to district Budgam. The results are also in line with Shah *et al.* (2021) wherein it was reported that most of the apple growers from Shopian and Baramulla had more media exposure than the apple growers in district Budgam.

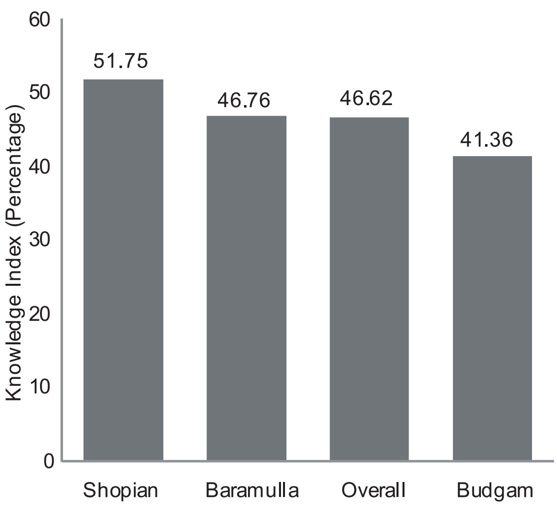

Fig. 1. Mean Knowledge Index of apple growers about recommended production technology.

Table 3. Number of apple growers having knowledge regarding improved apple production technology

S. No.	Recommended Practices	Number of apple growers			
		Shopian	Budgam	Baramulla	Pooled
A.	Preparation of land and planting:	71	48	74	193
B.	Training and pruning of apple trees:				
1	Pruning of young non-bearing trees:	69	46	70	185
2	Pruning of bearing trees:	69	45	70	184
3	Training and pruning of dwarf trees:	69	42	62	173
C.	Orchard Management:				
1	Cultivation and Mulching:	63	41	60	164
2	Thinning and rejuvenation of unproductive orchards:	55	36	59	150
3	Irrigation and drainage:	49	35	50	134
4	Pollination and pre-harvest fruit drop:	48	34	47	129
D.	Nutrient Management:				
1	Organic manures (Fully decomposed FYM):	47	34	46	127
2	Inorganic fertilizers:	47	34	45	126
3	Methods of fertilizer application:	45	33	45	123
4	Methods to overcome nutritional deficiencies	45	29	44	118
E	Pest and disease management	45	27	44	116
F	Harvesting and picking	32	25	42	99
G	Packaging and storage	31	24	34	89

Further perusal of data presented in Fig. 1, it becomes evident that the district of Shopian exhibited the highest average knowledge index (51.75%), while the district of Budgam displayed the lowest average knowledge index (41.36%).

Perusal of data presented in Table 4 revealed a medium level of knowledge among the apple growers in all three districts (Shopian=51.48%; Budgam=45.35%; Baramulla=63.72%). It is worth noting that solely apple growers in the Shopian district exhibit a notably elevated knowledge level, accounting for 25.74 percent. In contrast, a substantial portion (40.70%) of apple growers in the Budgam district falls within the lower range of knowledge levels. Notably, apple cultivation in the Budgam district is concentrated in Kareva's area, where irrigation infrastructure is lacking. This scenario leads to a heightened reliance on local unauthorized service providers for apple cultivation, who possess limited understanding of improved practices.

Table 4. Distribution of apple growers according to knowledge index in recommended apple production technology

Category	District			Overall, N=300
	Shopian=101	Budgam=86	Baramulla=113	
Low	23 (22.77)	35 (40.70)	24 (21.24)	82 (27.33)
Medium	52 (51.48)	39 (45.35)	72 (63.72)	163 (54.33)
High	26 (25.74)	12 (13.95)	17 (15.04)	55 (18.34)
Mean±S.D	50.60±10.41	41.96±11.67	46.38 ± 09.82	46.31±10.63
Range	28-100	22-76	30-87	22-100

Figures within parenthesis indicate respective percentage

Determinants of apple growers' knowledge index of recommended apple production practices: The socioeconomic variables influencing the knowledge-ability or knowledge index of the farmers to the recommended production practices are presented in Table 5. The logistic regression model, which takes care of heteroscedastic data, was used, respondents with a knowledge index value of 50% and above take up 1, and those below 50% take up the value of 0 in integer values. Down the table is the Log-likelihood value of -118.445 and likelihood ratio test statistic of 109.02***. The likelihood ratio test result is statistically significant at 1% level of probability. Obianefo *et al.* (2021) noted that such a model was generally more appropriate. The model returned a Pseudo R^2 value of 0.315 which implies that 31.5% of apple growers' knowledge index of recommended production practices is explained by the joint action of the farmers' socioeconomic characteristics, while the remaining 68.5% unexplained were as a result of the error beyond the respondents' control. This Pseudo R^2 value is within the range of a weak effect size of 0.25 recommended for non-experimental or scientific studies ranging from 0.50 to 1.0 (Moore *et al.*, 2013; Hair *et al.*, 2013 and Uchemba *et al.*, 2021).

Table 5. Determinants of apple growers' knowledge index of improved apple production practices

Knowledge index	Symbol	Marginal effect	S.E	z-stat.
Age	α_1	0.007	0.001	6.47***
Experience	α_2	0.008	0.002	3.98***
Education	α_3	0.032	0.018	1.81*
Annual income	α_4	0.000	0.000	-0.12
Landholding	α_5	0.001	0.002	0.55
Media exposure	α_6	0.008	0.003	2.40**
Innovative proneness	α_7	0.036	0.011	3.26***
Extension contact	α_8	0.000	0.008	0.03
Economic orientation	α_9	0.004	0.004	0.98
Scientific orientation	α_{10}	0.013	0.004	3.36***
Risk orientation	α_{11}	0.011	0.005	2.61**
Constant	α_0	-10.993	1.383	-7.95
Log likelihood	-118.445			
LR text	109.02***			
Pseudo R^2	0.315			
Obs.	300			

Note: Asterisks denote significant at the following levels: *** = 1%, ** = 5%, * = 10%.

The study found that respondents' age, experience, education, annual income, media exposure, innovative proneness, scientific orientation, and risk orientation significantly affect the apple growers' knowledge index of recommended production practices in temperate regions of Kashmir, India. The marginal effect size (α_1 = 0.007 @ 1%) of age is positively significant at a 1% probability level. This suggests that a slight rise in the age of apple growers correlates with a 0.007 unit elevation in the knowledge index for recommended apple production practices. This signifies that older farmers possess higher expertise in apple production practices than their younger counterparts. Again, the marginal effect size (α_2 = 0.008 @ 1%) of apple farming experience was positively significant at a 1% probability level. This finding implies that a marginal increase in apple growing experience is associated with a 0.008 unit increase in the knowledge index of recommended apple production practice in the study area. This result indicates that farmers with experience are more exposed to knowledge of apple production practices. Equally, the marginal effect size (α_3 = 0.032 @ 1%) of the apple grower's level of education was positively significant at a 10% probability level. This finding implies that a marginal increase in the level of education of the apple growers is associated with a 0.032 unit increase in the knowledge index of recommended apple production practices in the study area. Uchemba *et al.* (2021) submitted that education would increase farmers' literacy level to improve their ability to follow some adoption instruction for extension disseminated technologies.

Media exposure's marginal effect size (α6 = 0.008 @ 5%) was positively significant at a 5% probability level. This finding implies that a marginal increase in media exposure of apple growers is associated with a 0.008 unit increase in the knowledge index of recommended apple production practices in the study area. Apple growers with media exposure will get more information from adverts about the recommended production practices. As reported by Srinivasa *et al.* (1998), media exposure helps farmers in Jammu and Kashmir fully or partially adopt agricultural technologies. Again, innovative proneness's marginal effect size (α7 = 0.036 @ 1%) was positively significant at a 1% probability level. This finding implies that a marginal increase in apple growers' innovative proneness or inclination is associated with 0.036 unit increase in the knowledge index of recommended apple production practices in the study area. Mir *et al.* (2015) suggested that farmers with innovative proneness make better use of recommended technology in the state of Jammu and Kashmir.

Furthermore, scientific orientation's marginal effect size (α10 = 0.013 @ 1%) was positively significant at a 1% probability level. This finding implies that a marginal increase in apple growers' scientific orientation is associated with 0.013 unit increase in the knowledge index of recommended apple production practices in the study area. As expected, respondents with more scientific orientation are more knowledgeable about apple production techniques. Finally, risk orientation's marginal effect size (α11 = 0.011 @ 5%) was positively significant at 5% probability level. This finding implies that a marginal increase in apple growers' risk orientation is associated with a 0.011 unit increase in the knowledge index of recommended apple production practices in the study area. As expected in *a priori*, farmers with more risk orientation are more knowledgeable about apple production techniques because they will want to acquaint themselves with every piece of information that will insure them against production loss.

Regular demonstrations and training at farmers' fields can help transfer of knowledge from lab-to-land. Apple growers should contact the extension agencies. Extension agencies must set up Minikit trials in apple-growing areas to test promising practices under growers' resources, abilities, and constraints. Extension agencies must host field days to convince and motivate farmers to adopt innovative technologies and eliminate negative attitudes. Building women's knowledge, skills, and competencies will boost apple production in Kashmir.

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