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Comparative Impact Analysis of Fruit and Vegetable Preservation Training on Rural Women in Haryana

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HIGHLIGHTS

- Trained women scored 32.75 out of 42 on adoption, against 20.60 for women who never attended a course.
- Education, socio-economic status, information sources and economic motivation raised adoption; age pulled it down.
- Most trainees showed moderate impact and food security carried the highest mean score of the six dimensions.
- Labelling, registration and advertising ranked last even after training, pointing to a gap in entrepreneurial support.

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ABSTRACT

Post-harvest losses in fruits and vegetables ran high in India, and preservation at the household level gave rural women a way to cut those losses while adding to family income. Krishi Vigyan Kendras in Haryana ran vocational courses on preservation, but little was known about what the courses left behind. The study was carried out during 2025 in Sirsa, Hisar, Jind and Bhiwani and set out to compare adoption between trained and untrained rural women and to measure the impact of training on beneficiaries. Following an ex post facto design, 80 trained and 80 untrained women were interviewed personally with a structured schedule. Weighted mean scores, correlation, regression and an independent samples t-test were applied. Trained women scored far higher on adoption ($t = 37.54$; $p<0.01$), with 71.25 per cent in the medium and 28.75 per cent in the high category. Education, socio-economic status, information sources and economic motivation went with higher adoption, while age worked against it. Labelling, registration and advertising stayed at the bottom even among trained women. Food security recorded the highest mean impact score. Training built technical skill, but the market side needed support of its own.

INTRODUCTION

Fruits and vegetables carry much of the vitamin, mineral and fibre load of an ordinary Indian diet. India grows them in quantity and horticulture now counts among the faster-moving parts of the farm sector (AABMI & MANAGE, 2021). The trouble begins after harvest. Somewhere between 30 and 40 per cent of the produce is lost every year to careless handling, transport, storage and marketing (Kumar et al., 2017). National estimates put fruits and vegetables at the top of the loss table among all commodity groups (Jha et al., 2015). Cold storage is scarce, supply chains are broken into too many hands and market links stay thin, so the losses hold regardless

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of how much a grower knows (Negi & Anand, 2015). Preservation cuts into the problem directly. It slows spoilage, holds nutrients and stretches supply into the lean months (Bathla et al., 2018) and where it takes root, it opens income at the village level (Roy et al., 2013).

Women sit at the centre of food systems across the developing world (World Bank, 2017). In pickle and cashew processing they make up close to 90 per cent of the workforce (Sabharwal & Panwar, 2015) and globally they spend 85 to 90 per cent of their food-related hours on preparing, processing and preserving (FAO, 2011). Much of that work still follows methods handed down at home rather than tested in a laboratory and spoilage follows (Pandey et al., 2017). Training is meant to close that gap (Kulvir & Shivani, 2022). Kaur and Garg (2016) and Kaur and Kaur (2019) found a good share of trainees putting their new skills to use at home. In the farm sector, family size, land size, turnover and annual income directly determine success (Kobba et al., 2021). Rana (2017) noted a gain in social and economic confidence afterwards. Purohit et al. (2015) and Johnson (2015) tied training to better efficiency and to empowerment more broadly. Group-based work has lifted income, savings and awareness among women in allied sectors (Rajkumar et al., 2024) and training built around stated needs is treated as a pillar of value chain development (Nath et al., 2025; Arun Kumar & Nain, 2025).

Haryana grows fruits and vegetables on a wide scale (Department of Industries and Commerce, Government of Haryana, 2018) and its Krishi Vigyan Kendras hold preservation courses for rural women year after year. What those courses leave behind has rarely been measured. Three objectives shape the present work: to set the adoption of preservation practices by trained women against that of untrained women, to trace how selected socio-personal and psychological variables relate to adoption and to gauge the impact of training across six areas of the beneficiaries' lives. Two null hypotheses follow from these. The first holds that adoption does not differ between trained and untrained women. The second holds that the selected independent variables bear no significant relation to adoption or to impact.

METHODOLOGY

Haryana provided the setting and the fieldwork ran through 2025. An ex post facto design suited the situation, since the trainings were already over and the investigator could not manipulate any of the independent variables. Four districts entered the sample on the strength of their area and production under fruits and vegetables, namely Sirsa, Hisar, Jind and Bhiwani. Women who had attended a preservation course at the local Krishi Vigyan Kendra between 2021-2022 and 2023-2024 made up the participant population. Trainee registers held by each Kendra served as the sampling frame. Twenty names were drawn from every district without replacement using a random number table, which gave 80 participants. For the non-participant group, village lists were obtained from the panchayat and the local extension functionary in the same villages that the trainees came from and 20 women were drawn at random from each district. Each of them confirmed at the time of the interview that she had never attended a preservation course, which took the sample to 160.

A structured interview schedule was built around the objectives and tried out on a non-sample group of respondents. Internal consistency proved satisfactory (Cronbach's alpha = 0.84). Subject-matter specialists went through the content for validity before the schedule was finalised and every response was collected face to face. Both groups answered on age, marital status, family type, education, socio-economic status, land holding, training experience, use of information sources, extension contacts, innovativeness, economic motivation and adoption of preservation practices. Adoption covered 14 practices, each rated as fully adopted, partially adopted or not adopted and scored 3, 2 and 1. Weighted mean scores were worked out practice by practice and ranked, while summated scores placed respondents in low, medium and high categories against the mean and standard deviation of the pooled sample. Impact questions went only to the participants, who alone had the exposure needed to answer them and covered food security, skill development, economic empowerment, personal impact, social impact and family impact. Analysis rested on frequency, percentage, weighted mean score, rank order, Pearson's coefficient of correlation, multiple regression and an independent samples t-test.

RESULTS

Adoption level of participants and non-participants regarding preservation practices

Trained women stood well ahead of untrained women on all fourteen practices (Table 1). Their top three were preserving during the harvesting season, keeping preserved products covered and starting with fresh produce. Registration of products for marketing and advertising sat at the bottom. Untrained women ordered the practices in much the same way but scored lower throughout, their best score going to the use of fresh fruits and vegetables. The gap between the two groups ran widest on the technical practices, sterilization and the correct use of preservatives, colours and flavours in particular, where trained women stood more than a full point ahead. It ran narrowest on the three commercial practices. Labelling, registration and advertising ranked last in both groups and both groups sat close to the floor of the scale. Every non-participant returned the lowest possible score on registration, so the small gap there reflects that floor as much as anything the training did or did not achieve.

Table 2 placed 28.75 per cent of participants in the high adoption category and 71.25 per cent in the medium category, with none in the low category. Non-participants split the other way, 46.25 per cent falling in the low category and the rest in the medium category, with no one reaching the high category. Mean adoption stood at 32.75 for participants against 20.60 for non-participants and the independent samples t-test returned a significant difference ($t(158) = 37.54$, $p<0.01$, Cohen's $d = 5.93$).

Relationship between selected variables and adoption level

Seven variables correlated positively and significantly with adoption among participants, namely education (r=0.374), information sources (r=0.348), socio-economic status (r=0.342), economic motivation (r=0.335), training experience (r=0.319), family type (r=0.310) and land holding (r=0.290), as set out in Table 3.

Table 1. Adoption level of participants and non-participants regarding preservation practices

Statements	Participants WMS	Rank	Non-participants WMS	Rank
Preservation during harvesting season	2.96	I	2.09	II
Use of fresh fruits and vegetables	2.83	III	2.10	I
Use of stainless-steel utensils	2.66	V	1.83	V
Use of ingredients in correct proportion	2.48	VIII	1.63	VI
Preparation within suggested time frame	2.39	IX	1.09	X
Use of right amount of preservatives, colours and flavours	2.54	VI	1.13	IX
Preserved products are not kept open	2.90	II	2.04	III
Packets of preserved products are properly sealed	2.53	VII	1.61	VII
Sealed packets are kept in airtight containers	2.71	IV	1.85	IV
Sterilization of stored preserved products	2.34	X	1.14	VIII
Packaged preserved products are properly labelled	1.63	XII	1.03	XIII
Registration of products for marketing	1.26	XIV	1.00	XIV
Advertising the products to increase demand	1.59	XIII	1.04	XII
Consideration of total production cost	1.95	XI	1.05	XI

WMS = weighted mean score (maximum score 3).

The same variables mattered for non-participants, though socio-economic status led there (r=0.521). Age carried a weak negative sign in both groups. Marital status, extension contacts and innovativeness fell short of significance either way. Taken together the eleven predictors accounted for 41.2 per cent of the variance in adoption among participants, while the ten available for non-participants accounted for 46.1 per cent. Both models were significant, F(11,68)=4.33 and F(10,69)=5.90 (p<0.01).

Table 2. Comparison of adoption level between participants and non-participants

Category (score range)	Participants (%)	Non-participants (%)
Low (up to 20.25)	0.00	46.25
Medium (20.25 to 33.10)	71.25	53.75
High (above 33.10)	28.75	0.00
Mean	32.75	20.60
Standard deviation	2.39	1.64

t(158) = 37.54**; mean difference = 12.15; standard error of difference = 0.32; Cohen's d = 5.93; **significant at p<0.01 (independent samples t-test, 2-tailed).

Table 3. Relationship between selected variables and adoption level

Variables	Correlation coefficient (r) of participants	Correlation coefficient (r) of non-participants
Age	-0.172	-0.142
Marital status	0.215	0.118
Family type	0.310**	0.319**
Education	0.374**	0.254*
Socio-economic status	0.342**	0.521**
Land holding	0.290**	0.287**
Training experience	0.319**	NA
Information sources	0.348**	0.235*
Extension contacts	0.140	0.210
Innovativeness	0.099	0.192
Economic motivation	0.335**	0.251*
R square	0.412	0.461
Adjusted R square	0.317	0.383
F-value (df)	4.33** (11,68)	5.90** (10,69)

*Correlation significant at p<0.05 (2-tailed); **correlation significant at p<0.01 (2-tailed); NA = not applicable as non-participants had no training exposure.

Impact of training on participant rural women

Most participants landed in the medium band on every one of the six impact dimensions, from 56.25 per cent on family impact to 72.50 per cent on personal impact (Table 4). Food security carried the highest mean at 18.36 and economic empowerment the lowest at 9.66. Standard deviations stayed close across dimensions, which suggested fairly uniform responses. Social impact drew the largest share into the high category at 25.00 per cent, while economic empowerment and food security drew the smallest at 8.75 per cent each.

Table 5 showed education (r=0.959), information sources (r=0.775), socio-economic status (r=0.400), economic motivation (r=0.362), extension contacts (r=0.285), training experience (r=0.272) and land holding (r=0.255) correlating positively and significantly with overall impact. Age ran the other way (r=-0.301). Marital status, family type and innovativeness showed no significant relation. Education returned the strongest coefficient of any variable in the study.

DISCUSSION

The distance between the two groups points towards the training. Participants have practised under supervision and practice is what turns instruction into habit, whereas the untrained women work from methods picked up informally without that grounding (Pandey et al., 2017). How far the design can carry that reading is another matter. An ex post facto study cannot separate the training from the women who chose it. Those who enrol at a Kendra may already be more motivated, better exposed or better supported at home than those who stay away and some part of the gap belongs to that difference rather than to the course. With no baseline reading on the participants, the untrained group works as a comparison group and nothing stronger. Similar gaps between beneficiaries and non-beneficiaries turn up in other women-centred programmes (Pandey & Kritika, 2026). Samantaray et al. (2020), Bora and Deka

Table 4. Distribution of participants across dimensions of training impact

Category	Food security	Skill development	Economic empowerment	Personal impact	Social impact	Family impact
Low (<Mean-SD)	21.25	20.00	21.25	13.75	15.00	23.75
Medium (Mean±SD)	70.00	68.75	70.00	72.50	60.00	56.25
High (>Mean+SD)	8.75	11.25	8.75	13.75	25.00	20.00
Mean	18.36	12.70	9.66	13.09	10.29	9.89
SD	1.94	1.60	1.57	1.49	1.62	1.70

Figures denote percentage of participants; SD = standard deviation.

Table 5. Relationship between selected variables of participants and impact of training

Variables	Correlation coefficient (r)
Age	-0.301**
Marital status	0.177
Family type	0.080
Education	0.959**
Socio-economic status	0.400**
Land holding	0.255*
Training experience	0.272*
Information sources	0.775**
Extension contacts	0.285*
Innovativeness	0.073
Economic motivation	0.362**

*Correlation significant at p<0.05 (2-tailed); **correlation significant at p<0.01 (2-tailed).

(2021) report trained women at a moderate level of adoption against a low level among the untrained, while Fatima and Nishad (2017) and Anju and Dahiya (2021) find both groups preserving but the trained group doing so more thoroughly.

The correlates hold few surprises. Schooling and a stronger economic position widen a woman's access to scientific information and her willingness to act on it. Joint families seem to free up the time and the hands that a new practice demands. For the untrained group, land and access to information appear to stand in, at least partly, for the training they never received. The negative pull of age fits Hada and Bansal (2017), Buraka Kanthisri and Sreenivasarao (2018) and Dharshini Priya et al. (2026), all of whom find younger and better-schooled women more responsive to extension programmes. The regression figures deserve a lighter reading than the correlations. Eleven predictors against eighty cases work out to about seven cases per predictor, short of what the method usually asks for and education, socio-economic status and information sources overlap in what they measure. The individual coefficients are therefore indicative rather than settled.

The weak spot lies inside the trained group itself. Labelling, registration and advertising remain the least adopted practices even after training, which says the course builds the technical hand better than the commercial one. Not all of that sits with the trainer. Labelling and registration need packaging suppliers, testing facilities and organised outlets, and rural Haryana is thin on all three (Negi & Anand, 2015). The clustering of respondents in the medium impact band, with family impact and economic empowerment at the lower end, tells a similar story, since confidence and knowledge come first and money later. Hardly anyone reaches the high category on any dimension, which argues for refresher contact rather than a single course (Bharath et al., 2024). The correlation of 0.959 between education and impact towers over everything else in the study and is unlikely to be a plain bivariate relationship. Several impact items turn on information seeking and record keeping, both of which depend on schooling, so the two scales probably overlap in what they capture and the coefficient is not read here as an effect size. The wider picture matches Poshiya et al. (2019), Kumar and Sharma (2018), Sindhu (2019) and Kumar (2025) who describe trained women preserving surplus, feeding their families more evenly through the year and finding a fresh line of income.

CONCLUSION

Trained rural women adopt preservation practices well ahead of untrained women and the lead holds across almost all fourteen practices studied. The pattern fits a training effect, though the design leaves room for self-selection, so the result reads as a strong association rather than settled proof of cause. On the six impact dimensions mostly, trained women show moderate change, strongest in food security and weakest in economic empowerment and family impact. Scientific training therefore does useful work but stops short of the market. Short hands-on modules on labelling, registration and marketing, backed by links to packaging and certification services, would carry it further. Whether these gains last, and whether entrepreneurship support closes the commercial gap, is worth following up.

DECLARATIONS

Ethics approval and consent to participate: The study involved no invasive procedure on human participants as such the committee of Department of Extension Education, CCSHAU, Hisar, India waived the ethical approval. The purpose of the study was explained to every respondent, prior informed consent was obtained, participation was voluntary and the responses were kept anonymous and used solely for research purposes.

Conflict of interest: The authors declare that they have no conflict of interest, financial or non-financial, in relation to the subject matter of this manuscript.

Data availability statement: Data is available upon reasonable request from the first author as well as corresponding author.

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