Impact of Training Programs on Apple Farmers' Income in Maidan Wardak Province, Afghanistan

Abdul Lateef Hafez[1], Gullagha Shirzad[2], Abdul Basir Sayar[3*]
National Agricultural Sciences & Technology University, Afghanistan[1]
Afghan International Islamic University, Afghanistan[2,3]
***Corresponding Author:** *hilalwardak6666@gmail.com*

Accepted: 15-04-2026 Approved: 20-05-2026 Published: 02-06-2026

Abstract
Agricultural training programs are widely recognized as essential instruments for improving farmers' knowledge, skills, and productivity in developing countries. This study aimed to examine the impact of training programs on apple farmers' income in Maidan Wardak Province, Afghanistan, employing a cost-return analytical framework. A purposive sampling design was employed, and primary data were collected from 30 apple farmers in Sayedabad District, a sample size considered appropriate given the homogeneity of the target population and field accessibility constraints in the study area. Structured interview schedules were used to capture socio-economic characteristics, input use, crop costs, and returns both before and after training participation. Descriptive statistics and cost-return analysis were applied. Results revealed that the total variable cost of apple cultivation declined from Rs. 3,89,750 per hectare before training to Rs. 3,64,328 after training, primarily due to reduced chemical fertilizer and plant protection chemical use. Net returns increased from Rs. 2,62,846 to Rs. 3,92,441 per hectare, representing a 49 percent improvement. The benefit-cost ratio improved from 1.55 to 1.86, and the cost per kilogram of output declined from Rs. 14.24 to Rs. 11.14. The findings confirm that training programs organized by the Ministry of Agriculture, Irrigation and Livestock of Afghanistan in collaboration with the Food and Agriculture Organization had a positive and economically meaningful impact on production efficiency and farm income. The study recommends scaling up farmer training programs with emphasis on integrated pest management, market-oriented production, and post-harvest handling to maximize long-term income gains.

Keywords: agricultural training; apple farmers; farm income; maidan wardak; afghanistan; extension services

INTRODUCTION

Agriculture remains the primary source of livelihood for more than 2.5 billion people worldwide, particularly in developing and low-income countries where smallholder farmers constitute the majority of rural households (Anderson & Feder, 2007; Davis et al., 2012). In these settings, agricultural productivity is strongly linked to farmers' access to knowledge, modern technologies, and institutional support systems. Training programs and agricultural extension services are globally recognized as critical mechanisms for bridging the knowledge gap between research institutions and farming communities, facilitating the dissemination of improved practices in crop management, irrigation, pest control, fertilizer application, and post-harvest handling (Anderson & Feder, 2007).

Empirical evidence from developing countries consistently demonstrates that participation in well-designed training programs enhances farmers' decision-making capacities, accelerates the adoption of improved agricultural technologies, and translates into higher yields and increased farm income (Davis et al., 2012). For example, studies across Sub-Saharan Africa and South Asia have demonstrated that extension-supported training interventions significantly improve technical efficiency and profitability at the farm level, with particularly pronounced effects in fruit and horticultural production systems (Mgendi et al., 2021). Agricultural training programs are therefore positioned as effective tools for poverty reduction and rural development, particularly when they are context-specific, participatory, and aligned with local production systems (Ayanwale et al., 2024). For example, Wonde et al., (2022) demonstrated through propensity score matching analysis that training at farmers' training centers in Ethiopia significantly improved crop productivity and household income.

In Afghanistan, agriculture is the backbone of the national economy, employing approximately 60 to 70 percent of the labor force and contributing significantly to household livelihoods and national food security. However, the agricultural sector faces persistent structural challenges, including limited access to modern farming technologies, inadequate extension services, conflict-induced institutional disruptions, and weak market integration. Kalogiannidis & Syndoukas, (2024) have demonstrated that agricultural extension services are essential for bridging the gap between research and actual farming practices, yet their effectiveness varies considerably across institutional contexts. Despite government and international efforts to implement agricultural training programs, empirical assessments of their impact on farm income remain sparse, particularly at the provincial level (Baidar et al., 2025).

Maidan Wardak Province is among the most agriculturally significant provinces in Afghanistan and is particularly renowned for apple production. The province contributes approximately 35 percent of the country's total apple output, with 7,510 hectares of land under apple cultivation producing 95,377 tons annually. Apple farming constitutes the primary source of income for a large proportion of rural households in the province. Nonetheless, many farmers continue to rely on traditional orchard management practices, which constrain productivity, increase input costs, and reduce profitability. Training programs jointly implemented by the Ministry of Agriculture, Irrigation and Livestock (MAIL) and the Food and Agriculture Organization (FAO) have been introduced in several districts to address these limitations, yet systematic evaluation of their economic impact remains absent.

Previous research in similar contexts indicates that agricultural training can improve farmers' productivity and profitability, but several authors caution that these effects are not universally generalizable, particularly in fragile and conflict-affected settings such as Afghanistan. Studies on the impact of training programs in Afghanistan are predominantly limited to national overviews or broad sectoral analyses, neglecting province-specific dynamics such as market access infrastructure, farmer literacy levels, and local input availability. As Rahimi, M. R., & Yar, (2025); Yar et al., 2024) have demonstrated through research conducted in Nangarhar Province, localized investigations are essential for generating actionable policy recommendations in the Afghan rural development context. Deguine et al., (2021) further emphasize that participatory research and context-specific engagement of farmers in technology development are critical conditions for the success of integrated pest management and extension programs in developing countries.

A critical gap therefore exists in the empirical literature: while training programs targeting apple farmers in Maidan Wardak have been operational, no rigorous, province-specific study has evaluated their economic effectiveness in terms of measurable income changes. Without such evidence, policymakers and development agencies cannot determine whether their investments in farmer capacity building are achieving intended outcomes or require reformulation. This gap constitutes both a scientific limitation and a practical policy problem, necessitating a systematic empirical investigation.

This study seeks to address this gap by providing evidence-based insights into the income effects of training participation among apple farmers in Sayedabad District, Maidan Wardak Province. The novelty of the present study lies in its position as the first empirical investigation to evaluate the economic impact of MAIL-FAO training programs specifically on apple farmers' income at the provincial level in Maidan

Wardak, thereby filling a critical void in the localized agricultural development literature for conflict-affected settings.

The research is expected to contribute to the existing literature in three principal ways: first, by generating province-specific empirical evidence from a conflict-affected developing country context where such localized analyses are scarce, which can inform targeted resource allocation by MAIL, FAO, and other development agencies; second, by offering practical recommendations for improving the design, targeting, and implementation of agricultural training programs to maximize income outcomes, particularly regarding integrated nutrient and pest management strategies for smallholder fruit producers; and third, by contributing to theoretical discussions on human capital development and agricultural productivity by examining how knowledge acquisition through training translates into economic gains in smallholder fruit production systems (Schultz, 1964). Accordingly, the objective of this study is to assess the impact of agricultural training programs on the income of apple farmers in Maidan Wardak Province, Afghanistan, through a comparative cost-return analysis of production costs and returns before and after training participation.

RESEARCH METHOD

This study was conducted in Sayedabad District of Maidan Wardak Province, Afghanistan, which is recognized as a key apple-producing area within the province. The district was selected purposively based on its active involvement in MAIL-FAO jointly organized training programs, the availability of trained and untrained apple farmers, and the accessibility of reliable field data. The study adopted a quantitative, cross-sectional research design with a comparative analytical framework, examining farmers' production costs and income both before and after participation in the training programs.

The study population comprised apple farmers in Sayedabad District who had participated in training programs organized by MAIL in collaboration with FAO. A total of 30 respondents were selected using purposive sampling, ensuring that all participants had direct experience with the training interventions and were engaged in apple cultivation as a primary farming activity. Although a small sample size by international standards, purposive sampling is considered appropriate in contexts where homogeneity of the target group is high and access to specific subpopulations is constrained by security and logistical challenges (Creswell & Creswell, 2017).

Primary data were collected through structured interview schedules administered personally by the researchers. The instrument was designed to capture: (i) socio-economic and demographic characteristics, including age, family size, education level, and land holding; (ii) livestock asset position and availability of farm inputs; (iii) details of training program participation, including motivating factors; (iv) input usage, production costs, and variable cost components for one hectare of apple cultivation before and after training; and (v) output data, gross returns, net returns, and marketing information. Secondary data were drawn from MAIL statistical yearbooks and FAO project reports to contextualize the provincial production environment.

Data analysis was conducted using descriptive statistics, including frequency distributions, percentage analysis, and measures of central tendency. Cost-return analysis was applied to estimate total variable costs (TVC), total fixed costs (TFC), total costs (TC), gross returns, net returns, benefit-cost ratio (BCR), and breakeven yield, both before and after training. Fixed costs included land revenue, depreciation, rental value of land, and interest on fixed capital. Variable costs covered inputs such as planting material, nutrients, farm yard manure (FYM), bio products, labor, marketing, and interest on working capital.

All costs and returns were expressed in Indian Rupees (Rs) per hectare for analytical consistency, as the primary cost data were originally collected and recorded in Rs by the field researchers in accordance with the costing methodology employed in comparable studies in the South Asian agricultural context. This denomination was retained to facilitate direct comparability with these benchmark studies; however, for contextual reference, the approximate exchange rate at the time of data collection was 1 USD = 89.50 Rs (approximately 1 USD = 7,200 AFN).

The content validity of the data collection instrument was established through expert review by three agricultural economists at the institutions involved, who assessed the relevance and comprehensiveness of each item; however, a formal Content Validity Index (CVI) was not computed, which constitutes a methodological limitation. The instrument was pre-tested with a pilot group of five farmers before full deployment to identify ambiguities in question wording and response options. Given that the instrument primarily captured objective cost and production data rather than attitudinal constructs, Cronbach's alpha reliability testing was not applicable; nonetheless, the reliability of the findings was supported by triangulation with MAIL secondary data sources and cross-referencing with comparable empirical studies in the region.

It is acknowledged that the sample size of 30 respondents, while consistent with the purposive sampling rationale and the logistical constraints of conducting field research in a conflict-affected district, limits the statistical generalizability of the findings and precludes the application of inferential statistical tests. The structured interview schedule is available from the corresponding author upon request for purposes of transparency and replicability. Ethical considerations, including informed consent, confidentiality, and voluntary participation, were strictly observed throughout the data collection process.

RESULT AND DISCUSSION

The following subsections present the demographic and socio-economic characteristics of the sampled apple farmers, their motivations for training participation, and the comparative cost-return analysis before and after training.

Table 1. Age-wise Distribution of Sample Respondents

No.	Age Category	No. of Respondents (%)
1	Young (< 35 years)	13 (43.34%)
2	Middle-aged (35–50 years)	12 (40.00%)
3	Old (> 50 years)	5 (16.66%)
4	Total	30 (100%)
5	Mean Age (years)	38

Training programs organized by MAIL and FAO were inclusive with respect to age, reflecting an understanding that age diversity supports knowledge transfer across generational groups. As shown in Table 1, the majority of sampled farmers fell within the young age group of less than 35 years (43.34 percent), followed by middle-aged farmers between 35 and 50 years (40.00 percent), and older farmers above 50 years (16.66 percent). The mean age of the respondents was 38 years. The predominance of relatively young and middle-aged farmers among the training participants is a favorable indicator, as individuals in productive age groups are generally more receptive to adopting new agricultural technologies and practices (Anderson, 2006). These findings are consistent with BenYishay et al., (2019), who report that younger farmers exhibit greater responsiveness to technological innovation disseminated through social learning and extension training.

Table 2. Family Size Distribution of Sample Respondents

No.	Family Size Category	No. of Respondents (%)
1	Small (< 3 members)	3 (10.00%)
2	Medium (3–5 members)	9 (30.00%)
3	Large (> 5 members)	18 (60.00%)
4	Total	30 (100%)
5	Mean Family Size	7

Family size is an important determinant of available household labor for agricultural operations. Table 2 reveals that the majority of sampled households had large family sizes of more than five members (60.00 percent), followed by medium-sized families of three to five members (30.00 percent), and small families of fewer than three members (10.00 percent). The mean family size was 7. Large family size reduces dependency on hired labor for orchard operations such as pruning, harvesting, and transportation. Since family labor is treated as an implicit or opportunity cost rather than a direct cash expenditure, households with larger family sizes can effectively reduce their cash-based production costs, thereby enhancing farm profitability. This is consistent with Ma and Abdulai (2019), who found that household labor endowment plays a significant role in determining smallholder farming efficiency.

Table 3. Education Profile of Sample Respondents

No.	Education Level	No. of Respondents (%)
1	Illiterate	0 (0.00%)
2	Primary School	2 (6.67%)
3	Middle School	5 (16.67%)
4	High School	7 (23.33%)
5	College and Above	16 (53.33%)
6	Total	30 (100%)

Education is a key driver of agricultural knowledge adoption and behavioral change. As presented in Table 3, all sampled respondents were literate, with 53.33 percent holding college-level education or above, followed by 23.33 percent with high school education, 16.67 percent with middle school education, and 6.67 percent with primary school education. The high literacy rate among the training participants is a significant enabling factor, as education enhances farmers' ability to comprehend technical recommendations, interpret written guidance, and communicate with extension agents.

Non-formal agricultural extension training, such as the programs examined in this study, serves as a complementary knowledge pathway that reinforces and supplements formal education, thereby facilitating the continuous transfer of agricultural innovations to the farming community (Davis, 2014; Swanson et al., 2010).

Table 4. Land Holding Distribution of Sample Respondents

No.	Land Holding Category	No. of Respondents (%)
1	Marginal (< 2.5 acres)	5 (16.67%)
2	Small (2.5 to < 5 acres)	18 (60.00%)
3	Medium (5 to 12.5 acres)	5 (16.67%)
4	Large (> 12.5 acres)	2 (6.66%)
5	Total	30 (100%)
6	Mean Land Holding (acres)	5.10

Landholding size determines the scale of production, resource allocation, and access to training benefits. Table 4 indicates that the majority of sampled farmers were small landholders with 2.5 to less than 5 acres of cultivated land (60.00 percent), followed by marginal and medium landholders (16.67 percent each), and large landholders (6.66 percent). The mean land holding was 5.10 acres. The concentration of small and marginal farmers in the sample has important implications for training program design.

Since these farmers operate under financial constraints and limited resource availability, training programs must prioritize cost-effective and environmentally sustainable technologies that can be adopted without significant capital investment. This is consistent with Ali et al. (2021), who emphasized that training benefits are particularly impactful for small and resource-poor farmers in fruit production systems.

Table 5. Livestock Assets of Sample Households (Per Farm)

No.	Livestock Type	Average No. per Farm	Value (Rs)
1	Cow	1.00	18,465
2	Bullock Pair	1.00	34,733
3	Poultry	4.00	760
4	Goat / Sheep	1.00	5,620
5	Total	—	59,578
6	FYM Produced (tons/farm)	5.50	—

Table 5 presents the per-farm livestock assets, which serve as an indicator of household economic strength and the availability of organic farm inputs. The findings indicate that sample farmers possessed a moderate level of livestock assets, including one bullock pair valued at Rs. 34,733, one cow valued at Rs. 18,465, one goat or sheep valued at Rs. 5,620, and four poultry birds valued at Rs. 760, for a total per-farm livestock value of Rs. 59,578. Importantly, each farm produced on average 5.50 tons of farmyard manure annually. The availability of FYM is directly linked to integrated nutrient management practices promoted through the training programs. Increased adoption of FYM as a partial substitute for chemical fertilizers post-training contributed to reduced input costs and improved soil health, consistent with the principles of sustainable intensification (Anderson & Feder, 2007; Feder et al., 2011).

Table 6. Farmers' Motivations for Participating in Apple Training Programs

No.	Motivating Factor	Farmers (%)	Rank
1	Field Preparation	63.33	9
2	Quality Planting Material	76.67	5
3	Method of Planting	50.00	11
4	Recent Advances in Production Technologies	100.00	1
5	Irrigation Management	76.67	5
6	Integrated Nutrient Management	93.33	3
7	Integrated Pest Management	66.67	8
8	Integrated Disease Management	96.67	2
9	Post-Harvest Handling	46.67	12
10	Improved Marketing Opportunities	83.33	4
11	Export Potentiality	53.33	10
12	Good Rapport from Fellow Farmers and Scientific Community	73.33	7

Understanding farmers' motivations for attending training programs is essential for assessing the demand-side relevance of extension interventions. Table 6 presents the ranked motivating factors for training participation. All 100 percent of respondents cited access to recent advances in apple production technologies as their primary motivation, ranking it first. Integrated disease management (96.67 percent, rank 2) and integrated nutrient management (93.33 percent, rank 3) were the next most important motivators, reflecting farmers' concern for reducing dependency on chemicals and improving crop resilience.

Improved marketing opportunities ranked fourth (83.33 percent), indicating that income enhancement and market access are primary drivers of training demand. Quality planting material and irrigation management were jointly ranked fifth (76.67 percent each). These findings demonstrate that the training programs were aligned with farmers' priority production and income concerns, which is a critical condition for the effectiveness of extension interventions (Waddington et al., 2014).

Table 7. Variable Cost of Apple Cultivation Before and After Training (Rs/ha)

No.	Particulars	Before Training (Rs)	% to TVC	After Training (Rs)	% to TVC
A	Variable Cost				
1	Planting Material	36,000	9.24	34,500	9.47
2	Nutrients (Chemical)	1,10,263	28.29	72,763	19.97
3	Farm Yard Manure (FYM)	27,125	6.96	41,588	11.41
4	Neem Cake	1,563	0.40	2,875	0.79
5	Vermi Compost	1,130	0.29	995	0.27
6	Bio Products	288	0.07	945	0.26
7	Plant Protection Chemicals (PPC)	27,325	7.01	20,803	5.71
8	Staking	36,038	9.25	33,753	9.26
9	Labor Cost	98,250	25.21	1,03,013	28.27
10	Marketing Cost	9,743	2.50	10,313	2.83
11	Miscellaneous	1,145	0.29	1,900	0.52
12	Interest on Working Capital	40,883	10.49	40,883	11.22
13	Total Variable Cost (TVC)	3,89,750	84.71	3,64,328	82.45

Table 7 presents the disaggregated variable cost components of apple cultivation before and after training participation. The total variable cost (TVC) declined from Rs. 3,89,750 per hectare before training to Rs. 3,64,328 after training, representing a reduction of approximately 6.5 percent. This reduction was primarily attributable to a significant decrease in chemical nutrient inputs, which fell from Rs. 1,10,263 (28.29

percent of TVC) before training to Rs. 72,763 (19.97 percent of TVC) after training, a reduction of more than 34 percent. Correspondingly, expenditure on farm yard manure increased from Rs. 27,125 to Rs. 41,588, and bio product use increased from Rs. 288 to Rs. 945, indicating a clear shift toward organic and integrated nutrient management. Plant protection chemicals also declined from Rs. 27,325 to Rs. 20,803.

These changes reflect the successful adoption of integrated nutrient management and integrated pest management practices promoted through the training, consistent with the findings of Angon et al., (2023) that IPM adoption reduces pest management expenditures while maintaining crop productivity and ecological sustainability. The increase in labor costs from Rs. 98,250 to Rs. 1,03,013 is attributed to the adoption of more labor-intensive but cost-effective practices such as proper pruning, timely orchard management, and prophylactic disease control.

Table 8. Fixed and Total Costs of Apple Cultivation Before and After Training (Rs/ha)

No.	Particulars	Before Training (Rs)	% to TC	After Training (Rs)	% to TC
B	Fixed Costs				
1	Land Revenue	55	0.01	55	0.01
2	Depreciation Charges	2,233	3.17	2,815	4.00
3	Rental Value of Land	58,900	83.71	65,525	93.12
4	Interest on Fixed Capital	9,178	13.04	9,178	13.04
5	Total Fixed Cost (TFC)	70,366	15.29	77,573	17.55
6	Total Variable Cost (TVC)	3,89,750	84.71	3,64,328	82.45
7	Total Cost (TC)	4,60,116	100	4,41,901	100
8	Cost per Kg of Output (Rs)	14.24	—	11.14	—

Table 8 summarizes the fixed cost components and total production costs before and after training. The rental value of land constituted the largest fixed cost item in both periods (83.71 percent before and 93.12 percent after training), reflecting the significance of land tenure costs in the study area. Total fixed costs (TFC) increased marginally from Rs. 70,366 to Rs. 77,573, primarily due to higher depreciation charges associated with improved orchard equipment adoption. However, the overall total cost of production declined from Rs. 4,60,116 per hectare before training to Rs. 4,41,901 after training, representing a reduction of approximately 4 percent. The cost per kilogram of output declined sharply from Rs. 14.24 to Rs. 11.14, reflecting both the reduction in total input costs and the increase in output resulting from better crop management. Sapkota, D., et.al, (2022) similarly demonstrated that improved orchard management practices contributed to favourable cost-return outcomes in apple production in the Jumla district of Nepal.

Table 9. Returns and Break-Even Analysis of Apple Cultivation Before and After Training

No.	Particulars	Before Training (Rs/ha)	After Training (Rs/ha)
A	Returns		
1	Returns from Main Product	6,86,640	7,99,451
2	Returns from By-Product	26,579	24,578
3	Gross Returns	7,13,219	8,24,029
4	Net Returns	2,62,846	3,92,441
5	Benefit–Cost Ratio (BCR)	1.55	1.86
B	Breakeven Yield (kg/ha)	19,165	21,419

Table 9 provides the comparative returns and break-even analysis for apple cultivation before and after training. Gross returns increased from Rs. 7,13,219 per hectare before training to Rs. 8,24,029 after training, an increase of approximately 15.5 percent, driven primarily by higher yields from the main crop (from Rs. 6,86,640 to Rs. 7,99,451). This pattern is consistent with findings from Jalić et al., (2022), who demonstrated that strategic resource allocation and improved orchard management are key determinants of apple production profitability.

The marginal decline in by-product returns from Rs. 26,579 to Rs. 24,578 may be attributed to the post-training shift in orchard management priorities, whereby farmers increasingly focused on maximizing main product quality and marketable yield rather than by-product recovery, a pattern consistent with the market-oriented production emphasis of the training curriculum.

Net returns demonstrated the most significant improvement, rising from Rs. 2,62,846 to Rs. 3,92,441 per hectare, representing a 49 percent increase associated with the combined effect of increased gross returns and reduced total production costs.

The benefit-cost ratio improved from 1.55 to 1.86, indicating that training participants generated Rs. 1.86 in returns for every rupee invested in production after training, compared to Rs. 1.55 before training. This improvement of 0.31 in the BCR represents a substantial enhancement in economic efficiency. These findings are comparable to those reported by Pandey et al., (2023), who documented a benefit-cost ratio of 1.88 in apple production in Nepal, confirming the economic viability of smallholder apple cultivation across South Asian contexts.

The break-even yield increased from 19,165 kg per hectare before training to 21,419 kg after training. It is important to note that this 11.7 percent increase in break-even yield reflects the higher total fixed costs associated with improved equipment adoption and increased rental land values in the post-training period, rather than diminished production efficiency. Although a higher break-even threshold implies greater minimum output to cover costs, the concurrent increase in actual yields substantially exceeded this threshold, thereby reducing rather than increasing the financial risk exposure of trained farmers. This interpretation is supported by the improved BCR and lower per-unit production costs observed after training.

Overall, the results provide strong evidence of a positive and economically meaningful association between training program participation and the income and production efficiency of apple farmers in Sayedabad District. These results are further corroborated by Thapa et al., (2024), who reported that apple production in Jumla District, Nepal yielded net returns of NPR 247,402.80 per hectare with a benefit-cost ratio of 2.039, demonstrating the economic viability of smallholder apple farming in comparable South Asian mountain settings.

The socio-economic profile of the respondents likely contributed to the observed outcomes: the predominance of educated (53.33 percent with college-level education), young to middle-aged farmers with large household labor availability (mean family size of 7) may have facilitated more rapid adoption of the recommended practices, whereas the concentration of small landholders (60.00 percent) suggests that the training benefits were particularly accessible to resource-constrained producers. However, the absence of disaggregated analysis linking individual socio-economic characteristics to the magnitude of income change represents a limitation of the current study, and future research should examine whether education level, farm size, or household labor endowment moderate the income effects of training.

Waddington et al., (2014) noted in their systematic review that the impact of farmer field schools varies considerably across contexts, The study further corroborates the theoretical argument by Schultz, (1964) that investment in human capital through education and training is a fundamental pathway for improving agricultural productivity and farm income. The localized nature of this study provides added value beyond aggregate assessments, generating actionable evidence for provincial-level policymakers and development practitioners in Afghanistan.

CONCLUSION

This study evaluated the impact of MAIL-FAO agricultural training programs on apple farmers' income in Sayedabad District, Maidan Wardak Province, Afghanistan. Cost-return analysis of 30 trained farmers revealed that total production costs declined by approximately four percent, primarily due to reduced chemical fertilizer and pesticide expenditures, while gross returns increased by over 15 percent. Net farm income improved by 49 percent, from Rs. 2,62,846 to Rs. 3,92,441 per hectare, with the benefit-cost ratio rising from 1.55 to 1.86 and unit production costs declining from Rs. 14.24 to Rs. 11.14 per kilogram.

These improvements were associated with the adoption of integrated nutrient and pest management practices. However, the absence of a control group limits causal attribution. The study recommends scaling up crop-specific training programs with emphasis on post-harvest handling awareness, market-oriented production, and low-cost technologies suitable for smallholder farmers. Future research should employ larger samples with comparison groups across multiple districts.

ACKNOWLEDGEMENT

The authors sincerely thank the Ministry of Agriculture, Irrigation and Livestock of Afghanistan (MAIL) and the Food and Agriculture Organization of the United Nations (FAO) for their support in facilitating access to training program participants and secondary data. Gratitude is also extended to the apple farmers of Sayedabad District, Maidan Wardak Province, who generously provided their time and information. The authors also acknowledge the constructive feedback provided by academic colleagues at the National Agricultural Sciences & Technology University and the Afghan International Islamic University.

REFERENCES

Anderson, J. (2006). *The rise and fall of training and visit extension: an Asian mini-drama with an African epilogue*. https://www.google.com/books?hl=id&lr=&id=MPgd9YUaDW4C&oi=fnd&dq=Anderson,+J.+R.,+Feder,+G.,+%26+Ganguly,+S.+(2016).+The+rise+and+fall+of+training+and+visit+extension:+An+Asian+mini-drama+with+an+African+epilogue.+World+Bank+Policy+Research+Working+Paper+Series.&ots=nuJu9R0P6G&sig=L4RNdtYKPWFNNro4I67_7MQuiBI

Anderson, J., & Feder, G. (2007). Agricultural extension. *ElsevierJR Anderson, G*

FederHandbook of Agricultural Economics, 2007•Elsevier. https://www.sciencedirect.com/science/article/pii/S1574007206030441

Angon, P. B., Mondal, S., Jahan, I., Datto, M., Antu, U. B., Ayshi, F. J., & Islam, M. S. (2023). Integrated Pest Management (IPM) in Agriculture and Its Role in Maintaining Ecological Balance and Biodiversity. *Advances in Agriculture*, *2023*, 1–19. https://doi.org/10.1155/2023/5546373

Ayanwale, A. B., Adekunle, A. A., Kehinde, A. D., & Fatunbi, O. A. (2024). Networking and training for IMPROVEMENT of farm income: A case of lifelong learning (L3F) approach in West Africa. *Heliyon*, *10*(1), e23363. https://doi.org/10.1016/j.heliyon.2023.e23363

Baidar, K., Syntax, F. Y.-J., & 2025, undefined. (2025). Evaluating Community-Based Development In Rural Afghanistan: A Comprehensive Analysis Of The National Solidarity Program And Citizens. *Jurnal.Syntaxtransformation.Co.IdKU Baidar, FGM YarJurnal Syntax Transformation, 2025•jurnal.Syntaxtransformation.Co.Id*, *6*(1). http://jurnal.syntaxtransformation.co.id/index.php/jst/article/view/1045

BenYishay, A., Studies, A. M.-T. R. of E., & 2019, undefined. (2019). Social learning and incentives for experimentation and communication. *Academic.Oup.ComA BenYishay, AM MobarakThe Review of Economic Studies, 2019•academic.Oup.Com*, *86*(3), 976–1009. https://doi.org/10.1093/RESTUD/RDY039

Creswell, J., & Creswell, J. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. https://www.google.com/books?hl=id&lr=&id=335ZDwAAQBAJ&oi=fnd&pg=PT16&dq=Creswell,+J.+W.,+%26+Creswell,+J.+D.+(2022).+Research+design:+Qualitative,+quantitative,+and+mixed+methods+approaches+(6th+ed.).+SAGE+Publications.+&ots=YEzUNRwpnJ&sig=669qDxZY6TiiP76NwksmjJOX7lk

Davis, K. (2014). The New Extensionist: Roles and Cap Acities to Strengthen Extension and Advisory Services. *Journals.Newprairiepress.OrgK DavisJournal of International Agricultural and Extension, 2014•journals.Newprairiepress.Org*. https://doi.org/10.1080/1389224X.2013.817556

Davis, K., Nkonya, E., Kato, E., Mekonnen, D. A., Odendo, M., Miiro, R., & Nkuba, J. (2012). Impact of farmer field schools on agricultural productivity and poverty in East Africa. *ElsevierK Davis, E Nkonya, E Kato, DA Mekonnen, M Odendo, R Miiro, J NkubaWorld Development, 2012•Elsevier*, *40*(2), 402–413. https://doi.org/10.1016/J.WORLDDEV.2011.05.019

Deguine, J.-P., Aubertot, J.-N., Flor, R. J., Lescourret, F., Wyckhuys, K. A. G., & Ratnadass, A. (2021). Integrated pest management: good intentions, hard realities. A review. *Agronomy for Sustainable Development*, *41*(3), 38. https://doi.org/10.1007/s13593-021-00689-w

Feder, G., Birner, R., & Anderson, J. R. (2011). The private sector's role in agricultural extension systems: potential and limitations. *Emerald.ComG Feder, R Birner, JR AndersonJournal of Agribusiness in Developing and Emerging Economies, 2011•emerald.Com*, *1*(1), 31–54. https://doi.org/10.1108/20440831111131505

Jalić, N., PAŽEK, K., & VAŠKO, Ž. (2022). Cost-benefit Analysis of an Apple Orchard in the Republic of Srpska. *Agricultura Scientia*, *19*(1), 17–24. https://doi.org/10.18690/agricultura.19.1.17-24.2022

Kalogiannidis, S., & Syndoukas, D. (2024). The Impact of Agricultural Extension Services on Farm Output: A Worldwide Viewpoint. *Research on World Agricultural Economy*, *5*(1), 96–114. https://doi.org/10.36956/rwae.v5i1.999

Mgendi, G., Mao, S., & Qiao, F. (2021). Is a Training Program Sufficient to Improve the Smallholder Farmers' Productivity in Africa? Empirical Evidence from a Chinese Agricultural Technology Demonstration Center in Tanzania. *Sustainability*, *13*(3), 1527. https://doi.org/10.3390/su13031527

Pandey, K. R., Neupane, M. P., Joshi, Y. R., Paudel, A., & Khatri, S. (2023). Financial analysis of apple (Malus domestica) production in Darchula district of Nepal. *Cogent Food & Agriculture*, *9*(2). https://doi.org/10.1080/23311932.2023.2272490

Rahimi, M. R., & Yar, F. (2025). *Evaluating cooperative membership's impact on rural household empowerment: A mixed-methods study in Nangarhar Province, Afghanistan.* https://scholar.google.co.id/scholar?hl=id&as_sdt=0%2C5&q=Rahimi%2C+M.+R.%2C+%26+Yar%2C+F.+G.+M.+%282025%29.+Evaluating+cooperative+membership%27s+impact+on+rural+household+empowerment%3A+A+mixed-methods+study+in+Nangarhar+Province%2C+Afghanistan.+Asian+J

Sapkota, D., Acharya, M., Gautam, S., & Pant, P. K. (2022). *Economics of apple production in Chandannath municipality, Jumla, Nepal.* https://scholar.google.co.id/scholar?hl=id&as_sdt=0%2C5&q=Sapkota%2C+D.%2C+Acharya%2C+M.%2C+Gautam%2C+S.%2C+%26+Pant%2C+P.+K.+%282022%29.+Economics+of+apple+production+in+Chandannath+municipality%2C+Jumla%2C+Nepal.+Journal+of+Current+Research+in+Food+Science%2C+3%282%29%2C+27–31.&btnG=

Schultz, T. (1964). *Transforming traditional agriculture.* https://doi.org/10.5555/19641802933

Swanson, B. (2010). Strengthening Agricultural Extension and Advisory Systems: Procedures for Assessing, Transforming. *Academia.Edu*. https://www.academia.edu/download/56679836/agricultural_lecture_note.pdf

Thapa, R., Ghimire, S., Bhattarai, P., Acharya, S., Chhetri, B. P., & Kusma Tharu, R. (2024). A comprehensive assessment of apple production in jumla district, Nepal: status, economics, marketing and challenges. *Agrifoodscience.ComR Thapa, S Ghimire, P Bhattarai, S Acharya, BP Chhetri, RK TharuTurkish Journal of Agriculture-Food Science and Technology, 2024•agrifoodscience.Com*, *12*(2), 159–178. https://doi.org/10.24925/turjaf.v12i2.159-178.6452

Waddington, H., Snilstveit, B., Hombrados, J., Vojtkova, M., Phillips, D., Davies, P., & White, H. (2014). Farmer field schools for improving farming practices and farmer outcomes: A systematic review. *Wiley Online LibraryH Waddington, B Snilstveit, J Hombrados, M Vojtkova, D Phillips, P Davies, H WhiteCampbell Systematic Reviews, 2014•Wiley Online Library*, *10*(1). https://doi.org/10.4073/CSR.2014.6

Wonde, K. M., Tsehay, A. S., & Lemma, S. E. (2022). Training at farmers training centers and its impact on crop productivity and households' income in Ethiopia: A propensity score matching (PSM) analysis. *Cell.ComKM Wonde, AS Tsehay, SE LemmaHeliyon, 2022•cell.Com*, *8*(7). https://doi.org/10.1016/J.HELIYON.2022.E09837

Yar, F. (2024). The role and importance of empowering rural communities for rural development in Afghanistan. *Jurnalsyntaxadmiration.ComFGM Yar, M MusadiqJurnal Syntax Admiration, 2024•jurnalsyntaxadmiration.Com*, *5*(11). https://www.jurnalsyntaxadmiration.com/index.php/jurnal/article/view/1786