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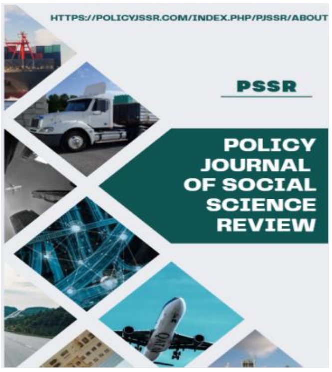


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# CAPACITY BUILDING NEEDS OF FARMERS FOR SUSTAINABLE CROP PRODUCTION

**[1]Muhammad Saleem, [2]Samrat Sikdar, [3]Syed Taimoor Shah, [*4]Sana Shaukat**

[1]Institute of Agriculture Extension, Education and Rural Development, University of Agriculture, Faisalabad

[2]School of Human Sciences, College of Agriculture & Life Sciences, Mississippi State University, Starkville, MS 39762, USA

[3]Lecturer Agriculture Extension, Balochistan Agriculture College Quetta

[*4]Institute of Forest Sciences, Faculty of Agriculture and Environment, The Islamia University of Bahawalpur, 63100, Pakistan

[*4]sk244375@gmail.com

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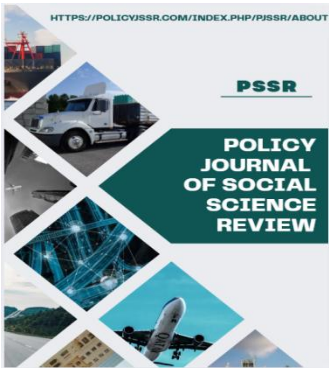
**Corresponding Author: Sana Shaukat**

## ABSTRACT

Capacity building is a key factor in sustainable crop production, as it improves farmers' knowledge and skills, and their capacity to make decisions. Although agricultural extension programs are available in Pakistan, there is a paucity of evidence regarding farmers' priority training requirements for sustainable farming, and especially in the climate sensitive districts of the southern Punjab. The present study aimed to evaluate the capacity-building requirements of farmers to gain sustainable crop production in Muzaffargarh and Dera Ghazi Khan districts and to explore the socioeconomic factors related to the capacity-building requirements for sustainable crop production. A quantitative cross sectional survey design was used and the primary data was obtained by conducting face to face structured interviews with 140 farmers selected by multistage sampling. Descriptive statistics, independent-samples t-test, one-way ANOVA, chi-square test, Pearson correlation, and multiple regression analysis with IBM SPSS Statistics was used to analyze data. The results showed that water conservation and irrigation management (Mean = 4.42), Integrated Pest Management (IPM) (Mean = 4.35) and climate-smart agriculture (Mean = 4.21) were the most critical capacity building needs, suggesting farmers' awareness of water scarcity, pests, and climate variability. Organic farming (Mean = 3.05) and marketing and value addition (Mean = 3.31) were given a relatively low priority. There was significant difference between the two districts ($t = 2.11$, $p = 0.037$) and across education level ($F = 5.29$, $p = 0.006$) in overall training needs. Pearson correlation analysis revealed that age ($r = -0.187$, $p = 0.027$) and education ($r = -0.241$, $p = 0.004$) were negatively related to the overall capacity building needs of farmers. Multiple regression analysis also showed that education ($\beta = -0.263$, $p = 0.001$) and age ($\beta = -0.176$, $p = 0.021$) was significant

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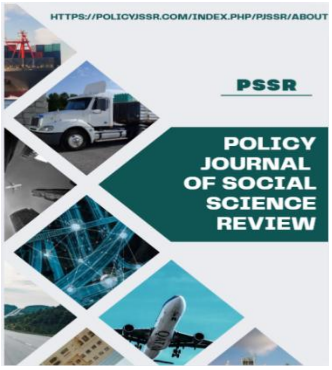
when used independently to predict training needs, while farming experience and land holding were not significant. The study found that extension approaches cannot be uniform and need to be based on capacity building interventions that are demand-driven and location-specific for sustainable crop production in southern Punjab. Training should be given preference for water management, IPM and climate smart agriculture to improve technology adoption, climate resilience and long term sustainability of agriculture by adapting training methods to farmers' education level.

**Keywords:** Capacity building, sustainable crop production, integrated pest management, water conservation

## Introduction

Agriculture is the backbone of Pakistan's economy. It employs a large share of the rural Pakistan's economy revolves around agriculture. It has a high percentage of the working population in the rural areas and provides food and raw material for the export industries of the country. Punjab is the home to 70% of Pakistan's agricultural exports, 60% of wheat, cotton, sugarcane, and maize production of the country (Jabbar et al., 2022). In Punjab, the southern districts, including Muzaffargarh and Dera Ghazi Khan are considered to be very important agricultural regions, and they are also resource-poor and vulnerable to disasters. According to Pakistan Disaster Management Authority these districts have been identified as high vulnerability areas, most of them are frequently facing floods, water scarcity and unequal land distribution which causes farmers to have very small plots (Jabbar et al., 2020a). It is not a matter of access to new inputs or new machinery to boost farm productivity in such an environment. It relies on the knowledge and skills of farmers in implementing sustainable practices appropriately. This is where there is a consistent vacuum in literature: Pakistan's farmer training and extension inputs have been repeated over and over but the content of farmer training has not necessarily aligned with farmers' needs on the ground. A history of mismatched extension effort, the pattern is not new. An initial assessment of the success of T&V in irrigated Punjab revealed that the intensity of extension-farmer interaction had a positive impact on the amount of interaction, but little effect on the quality of the interaction and hence on the level of technical knowledge and adoption of new wheat technology held by the farmers (Hussain et al., 1994). This disconnect is reflected in more recent studies as well, 30 years later. A study conducted in Farmer Field Schools in Rawalpindi revealed that the training provided to farmers was not in accordance with the farmer's self perceived

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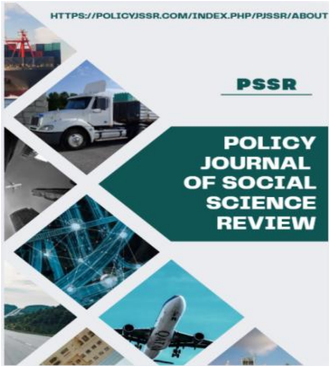
needs (Iqbal et al., 2016). The study of the agricultural extension personnel also identified similar supply side gaps: agricultural officers in Punjab reported real problems in various professional and technical skills such as using audio-visual training aids (Khan et al., 2010). The same is true in a new form of digital extension. Since the farmer population is mostly rural and poor, the mobile-based farm advisory services have reached the majority of the surveyed farmers, but the penetration of farmers using the mobile-based farm advisory services was found to be low especially for the older and less educated farmers (Khan et al., 2019; Khan et al., 2020). Information and the capacity to action it are very different things. The soil fertility and nutrient management results of soil testing conducted in Muzaffargarh district showed that most of the soil samples tested were deficient in organic matter and available phosphorous and majority of soils exhibited moderate to high sodicity (Akram et al., 2014). However, education and extension outreach and membership in farmer groups are key factors that strongly influence the adoption of Integrated Soil Fertility Management (ISFM), making it difficult for farmers who lack these resources to adopt this practice even in situations where it is most needed, as demonstrated by the wheat farmers in Punjab (Jabbar et al., 2022). Water productivity of wheat in Pakistan is one of the lowest in the region and water saving technologies like laser land leveling, raised-bed planting and high water use efficiency irrigation systems are not well adopted despite estimates of water savings of up to 80% under some technologies (Shahid et al., 2022). It was revealed that many farmers were not aware of the principles of IPM and the role of pesticide quality-control departments in the study of cotton farmers in Punjab (Ali et al., 2024). This is consistent with wider survey conducted in the industrial zone of Punjab, where the majority of the farmers surveyed lacked knowledge of insecticide mode of action, biological pest control and unsafe disposal of pesticide containers (Afsheen & Uludag, 2021). Education and access to extension services as well as farmers' risk assessment play a significant role in the adoption of climate-smart practices among the crop and livestock farmers in Punjab (Sardar et al, 2021; Faisal et al, 2021). Climate shocks have had a more pronounced effect on farmers who have no extension contact than on those who do (Ali & Erenstein, 2017).

Farm size, education and off-farm income opportunities, rather than only awareness of diversification, motivate farmers in mixed cropping zones in Punjab to diversify from the dominant wheat-cotton and wheat-rice production patterns (Shahbaz et al., 2017). Two areas – organic farming and agricultural mechanization –

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are more linked than they may seem first: a research study on the organic farmers in Punjab revealed that the adoption of various machines (tube-wells, tillage equipment, threshers) was at its centre to make organic farming viable at scale, while capital constraints prevented many smallholders from accessing them (Akram et al., 2020). Agroforestry and land based diversification, although not listed directly, is a useful parallel in that farm size, farm income and household characteristics were again more important in driving adoption by smallholders in northern irrigated plains of Punjab than simply awareness (Ahmad et al., 2023). Owners of land are more likely to be able to implement almost any of the above practices than are tenants. Tenants in southern Punjab were more likely to be coping by engaging in off-farm diversification than by investing in on-farm risk management measures like improved varieties and crop insurance (Jabbar et al., 2020a). This is particularly important when the study sample is selected from Muzaffargarh and Dera Ghazi Khan which is known to have a wide variation in landholding size. Another line of research attempts to determine not what farmers require, but what determines the likelihood that they will adopt a practice after seeing it. The three factors that are consistently mentioned in all the studies conducted in Pakistan are education, extension contact and farming experience (Ullah et al., 2023; Jabbar et al., 2020b). All else equal, age generally goes against the grain; the older the farmer, the less inclined they are to embrace new technologies (Ullah et al., 2023). This provides an evidence-based, not an assumption-based, basis for predicting a farmer's socio-economic profile (age and education, landholding, experience) to be predictive of the extent and type of capacity building needed. Cotton is a stark example of what you get when you don't address capacity gaps. Although cotton is a major economic activity in the textile sector of Pakistan, production has not increased, resulting in a decrease in cotton yield and an increase in production expenses such that many farmers are leaving cotton for alternate crops (Ashraf et al., 2024). This abandonment has been reported by the farmers themselves and attributed to poor quality seed, pest pressure (whitefly, pink bollworm) and inconsistent use of pesticide, all of which will be directly assessed in the practice areas of this study. The literature as a whole clearly indicates that Pakistan is not a shortfall of extension infrastructure and training. It simply fails to match, time and again, the soil requirements of farmers and what they receive in training. A majority of the above evidence was from single-practice studies, with one paper on IPM, one on irrigation, and one on soil fertility, as opposed to a study that compares a suite of sustainable-production

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training needs against one another for the same farmers in the same districts at the same time. However, there is also limited district level evidence for Muzaffargarh and Dera Ghazi Khan in particular, which have been identified as vulnerable districts and provide a considerable share of the cropping area in Punjab. This study directly tackles that lack of research. It evaluates the magnitude and prioritisation of farmers' capacity building needs on the 12 sustainable production practices and explores the association of age, education, landholding and farming experience with the farmers' reported needs. The purpose is to provide extension planners with a needs based approach, not a supply based approach, and to overcome the 30 year gap this literature has shown.

## Methodology

### Study Area

The study was carried out in Muzaffargarh and Dera Ghazi Khan district. These districts are in the southern part of Punjab and are amongst the key agricultural areas of Pakistan. Main crops cultivated in the study area are wheat, cotton, sugarcane, maize and different vegetable crops. The districts were chosen because of their agricultural significance and a need to determine farmers' need for capacity building to support sustainable crop production.

### Research Design

This study used a quantitative cross sectional survey design to determine the capacity building needs of farmers on sustainable production of crops. Primary data was collected from farmers using structured questionnaire at one point in time. This approach was deemed suitable as it allows the acquisition of standardised data from a relatively high sample of respondents and statistical analysis of farmers' training needs.

### Target Population

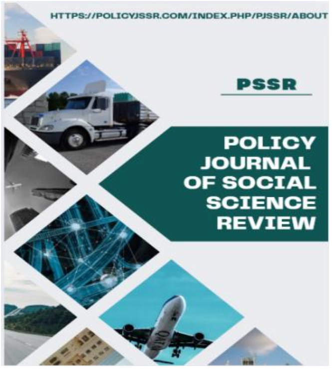
The target population comprised of all the farmers of the selected tehsils of Muzaffargarh and Dera Ghazi Khan districts who were actively involved in the crop production in the study period.

### Sampling Procedure

A **multistage sampling technique** was employed for selecting respondents.

- **Stage I:** Two districts, Muzaffargarh (4 Tehsils) and Dera Ghazi Khan (Three Teshils), were purposively selected because of their significant contribution to agriculture and the prevalence of diverse cropping systems.
- **Stage II:** All tehsils within the selected districts were included in the study.
- **Stage III:** From each tehsil, **20 farmers** were selected using a simple random sampling technique.

| District | Farmers/Tehsil | Total Farmers |
|---|---|---|
| Muzaffargarh | 20 | 80 |

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|---|---|---|
| Dera Ghazi Khan | 20 | 60 |
| Grand Total | 20 | 140 |

Thus, the final sample comprised **140 farmers**.

**Data Collection Instrument**

Primary data were collected through a structured interview schedule (questionnaire) developed after reviewing relevant literature on sustainable agriculture and farmers' capacity-building needs. The questionnaire consisted of two major sections:

- **Section A:** Socio-economic characteristics of respondents (age, education, farming experience, landholding, farming income, and cropping pattern).
- **Section B:** Capacity-building needs related to sustainable crop production practices, including:

1. Soil fertility and nutrient management
2. Water conservation and irrigation management
3. Integrated Pest Management (IPM)
4. Integrated Nutrient Management (INM)
5. Climate-smart agriculture
6. Safe pesticide use
7. Crop diversification
8. Organic farming practices
9. Use of improved seed
10. Agricultural mechanization
11. Post-harvest management
12. Marketing and value addition

Responses regarding training needs were measured using a **five-point Likert scale**, where:

1 = Very Low Need
2 = Low Need
3 = Moderate Need
4 = High Need
5 = Very High Need

**Pre-testing of the Instrument**

Before the final survey, the questionnaire was pre-tested with approximately **15 farmers** from a neighboring area that was not included in the final sample. Based on respondents' feedback, ambiguous questions were revised to improve clarity, reliability, and validity.

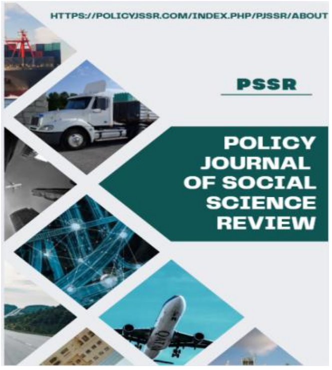
**Data Collection Procedure**

Data were collected through face-to-face interviews conducted by the researcher. Prior informed consent was obtained from each respondent before the interview. Farmers were informed about the objectives of the study, and confidentiality of their responses was assured. Each interview lasted approximately 25–35 minutes.

**Data Analysis**

The collected data were coded, entered, cleaned, and analyzed using **IBM SPSS Statistics**. The following statistical techniques were employed:

1. Frequency distribution
2. Percentages

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3. Mean
4. Standard deviation
5. Ranking of capacity-building needs
6. Independent sample t-test (where applicable)
7. One-way ANOVA (where applicable)
8. Pearson correlation analysis
9. Multiple regression analysis to identify factors influencing farmers' capacity-building needs

Statistical significance was determined at the **5% level (p ≤ 0.05).**

**Results**

*Table 1 Socio-Economic Characteristics of Respondents*

| Characteristic | Category | f | % |
|---|---|---|---|
| Age | Up to 30 years | 31 | 22.1 |
| | 31–45 years | 58 | 41.4 |
| | Above 45 years | 51 | 36.5 |
| Education | Illiterate | 40 | 28.6 |
| | Primary–Middle | 49 | 35.0 |
| | Secondary and above | 51 | 36.4 |
| Farming Experience | Up to 10 years | 42 | 30.0 |
| | 11–20 years | 55 | 39.3 |
| | Above 20 years | 43 | 30.7 |
| Landholding | Up to 5 acres | 64 | 45.7 |
| | 6–12.5 acres | 48 | 34.3 |
| | Above 12.5 acres | 28 | 20.0 |

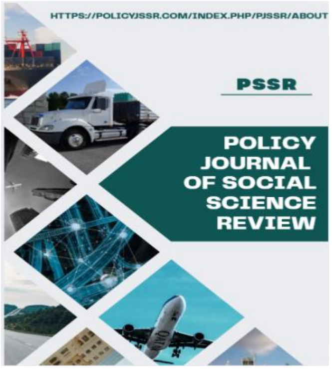


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Table 2

*Mean scores, standard deviations, and ranking of farmers' capacity-building needs for sustainable crop production*

| Capacity-Building Area | Mean | SD | Rank |
|---|---|---|---|
| Water conservation and irrigation management | 4.42 | 0.61 | 1 |
| Integrated Pest Management (IPM) | 4.35 | 0.68 | 2 |
| Climate-smart agriculture | 4.21 | 0.72 | 3 |
| Soil fertility and nutrient management | 4.10 | 0.70 | 4 |
| Safe pesticide use | 3.98 | 0.75 | 5 |
| Use of improved seed | 3.87 | 0.66 | 6 |
| Integrated Nutrient Management (INM) | 3.79 | 0.81 | 7 |
| Post-harvest management | 3.62 | 0.77 | 8 |
| Crop diversification | 3.55 | 0.69 | 9 |
| Agricultural mechanization | 3.40 | 0.83 | 10 |
| Marketing and value addition | 3.31 | 0.79 | 11 |
| Organic farming practices | 3.05 | 0.85 | 12 |

Table 3

*Cross-Tabulation: Need Level by Landholding (Chi-Square Test)*

| Landholding | Low Need (%) | Moderate Need (%) | High Need (%) | Row |
|---|---|---|---|---|
| Up to 5 acres | 9.4 | 28.1 | 62.5 | 64 |
| 6–12.5 acres | 14.6 | 35.4 | 50.0 | 48 |
| Above 12.5 acres | 21.4 | 39.3 | 39.3 | 28 |

$\chi^2 = 9.84$, df = 4, p = 0.043

Table 4

*Comparison of Capacity-Building Needs by District (Independent Sample t-test)*

| District | Mean | SD | t-value | p-value |
|---|---|---|---|---|
| Muzaffargarh (n=80) | 3.94 | 0.58 | 2.11 | 0.037* |
| Dera Ghazi Khan (n=60) | 4.08 | 0.63 | | |

**Significant at p ≤ 0.05.*

Table 5

*One-Way ANOVA: Capacity-Building Needs by Education Level*

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 6.812 | 2 | 3.406 | 5.29 | 0.006* |
| Within Groups | 88.140 | 137 | 0.643 | | |

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|---|---|---|
| Total | 94.952 | 139 |

**Significant at $p \leq 0.05$.*

**Table 6**

*Pearson Correlation between Socioeconomic Variables and Overall Capacity-Building Need*

| Variable | Pearson's $r$ | $p$ |
|---|---|---|
| Age | -0.187 | 0.027* |
| Education | -0.241 | 0.004** |
| Landholding | -0.129 | 0.128 |

$p < 0.05$; $p < 0.01$.

**Table 7**

*Multiple Regression: Factors Influencing Capacity-Building Needs*

Dependent variable: overall capacity-building need score.

| Predictor | B | SE | Beta | t | Sig. |
|---|---|---|---|---|---|
| (Constant) | 4.912 | 0.312 | – | 15.74 | .000 |
| Age | -0.021 | 0.009 | -0.176 | -2.33 | .021 |
| Education (years) | -0.048 | 0.014 | -0.263 | -3.43 | .001 |
| Farming experience | 0.012 | 0.010 | 0.098 | 1.20 | .232 |
| Landholding (acres) | -0.007 | 0.011 | -0.054 | -0.64 | .524 |

**Table 8**

*Model Summary for Multiple Regression Analysis*

| Model | R | $R^2$ | Adjusted $R^2$ | Standard Error of the Estimate | Durbin–Watson |
|---|---|---|---|---|---|
| 1 | 0.441 | 0.194 | 0.170 | 0.552 | 1.89 |

**Table 9**

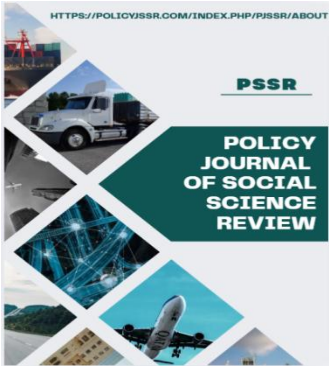
*ANOVA for Multiple Regression Model*

| Source | Sum of Squares | df | Mean Square | F | $p$ |
|---|---|---|---|---|---|
| Regression | 18.460 | 4 | 4.615 | 15.15 | <0.001 |
| Residual | 41.120 | 135 | 0.305 | | |
| Total | 59.580 | 139 | | | |

Note: Dependent variable = Overall capacity-building need score

## Discussion

The results offer empirical insights into the capacity-building requirements of the farmers of the agricultural hub of Pakistan. The results indicate a clear training priority, in which water conservation and irrigation

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management is highlighted (Mean = 4.42, SD = 0.61), followed by Integrated Pest Management (Mean = 4.35, SD = 0.68) and climate-smart agriculture (Mean = 4.21, SD = 0.72). The rankings are in line with the reported vulnerabilities of the study districts (Jabbar et al., 2020a; Shahid et al., 2022).

The top ranked water conservation and irrigation management is a critical area of concern that is consistent with the water productivity issues noted in Pakistan. Shahid et al. (2022) found that even with the adoption of water conservation technologies like laser land leveling, raised beds and high efficiency irrigation system, Pakistan's water productivity for wheat is low among the region. The high training need reported here indicates farmers awareness of water scarcity but lack of technical knowledge to act promptly as reported by the study districts as high vulnerability zones (Jabbar et al., 2020a).

IPM training was the second highest need (Mean = 4.35) indicating continuous pest pressure in Pakistan cotton belt. Ali et al. (2024) revealed that the knowledge of the principle of IPM was low among the cotton growers of Punjab and there was a lack of knowledge about the quality control of pesticides. Similarly, Afsheen and Uludag (2021) also reported that the majority of farmers in the industrial belt of Punjab had a lack of understanding about the modes of action of insecticides, and no awareness of biological pest control, and even disposed of them in an unsafe manner. This is a direct correlation with the problem farmers dealing with cotton due to the pest pressure, poor quality seed, inconsistent use of pesticide etc., which is solved by the problem of IPM training (Ashraf et al., 2024).

Climate-smart agriculture was third (Mean = 4.21), in line with Sardar et al. (2021) who identified that adoption of climate-smart agriculture was influenced by education and access to extension services, and by risk perception; and with Ali and Erenstein (2017) who suggested that adoption of climate-smart agricultural practice was influenced by food security and poverty reduction outcomes. In the high need, farmers are directly experiencing climate variability, but they do not have technical tools to adapt.

Soil fertility and nutrient management ranked fourth (Mean = 4.10) which was lower than what Akram et al. (2014) have observed in most of the soil samples in Muzaffargarh, with the poor soils showing widespread sodicity. One possible reason is that farmers already have a good understanding of soil management and consider that the need to fill the gap is a secondary need rather than a primary need. This is similar to the results of Jabbar et al. (2022) who reported that access to education and extension services has been linked to the adoption of ISFM, where

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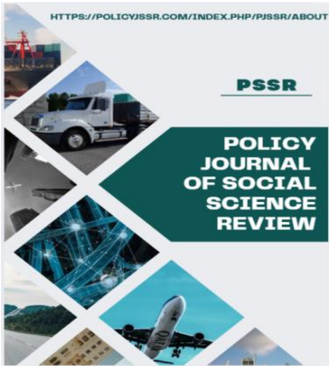


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farmers lacking these services might not even know that ISFM is something they should seek training on to reduce the reported need.

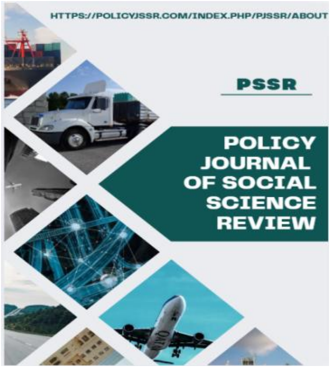
Safe pesticide use was the fifth ranked activity (Mean = 3.98). This ranking should also not be interpreted as suggesting that the problem is less serious than IPM or water problems, but rather as a farmer's ranking of the issue in comparison to other needs; this is based on the results of Afsheen and Uludag (2021) which revealed inadequate pesticide knowledge in the same region.

The lowest ranking areas (Organic farming – Mean = 3.05; Marketing and value addition – Mean = 3.31) may be due to the fact that farmers are more interested in production risk as compared to post-production or transitional investment. Although it was found that the viability of organic farming is closely associated with the adoption of machinery, it was also found that the small farmers were locked out by the problem of capital access, indicating that the low ranking might be due to farmers' perceptions of the unviability of organic farming and not because it lacked significance.

Overall need was most strongly predicted by education (Beta = -0.263, p = 0.001), with increased education resulting in decreased training needs. This is consistent with the other adoption studies, as education has been a consistent determinant of adoption behavior (Ullah et al., 2023; Jabbar et al., 2020b; Jabbar et al., 2022). This is likely due to the farmers' ability to learn about and process information independently due to education, which lessens the need for formal training. This has planning implication that, lower educated farmers are likely to require more intensive and hands on delivery and better educated farmers can be given more technical content directly.

The age was also found to be negatively related with the reported need (Beta = -0.176, p = 0.021), which supports the findings of Ullah et al. (2023). This may be because older farmers have gained enough experience in practice that they need not undergo formal training; or because they are less likely to seek out new information, which the data cannot distinguish, and the study should not say more.

There was no significant relationship between farming experience and training needs (Beta = 0.098, p = 0.232). This is a valuable negative result in that it suggests that the length of time spent growing crops does not automatically mean that people need less structured training, as would be the case if they were in school. The result of this study only strengthens findings by Hussain et al. (1994) that introducing the Training and Visit system increased the amount of farmer-extension contact, but did not enhance the quality of the contact

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or the farmers' actual technical knowledge — farmer-extension contact is not an alternative to structured capacity building.

The chi square test indicated that smaller landholders reported a greater proportionate need than larger landholders ($\chi^2$ = 9.84, p = 0.043), however, this was not significant in the regression (Beta = -0.054, p = 0.524). This is not a footnote, it is a fact. The most probable reasons are that the impact of landholding in the bivariate test is being captured in the multivariate test, and secondly that smaller landholders in this sample also tend to be less educated, so that once education is taken into account the effect of landholding is reduced. This should be interpreted rather than confirmed as a mechanism, and should be kept in mind that the data available is not sufficient to clearly differentiate between the two effects.

The overall training needs of the farmers were higher in Dera Ghazi Khan (Mean = 4.08) than in Muzaffargarh (Mean = 3.94; t = 2.11, p = 0.037). It is not possible to determine from the data gathered in the study why (differences in extension service coverage, cropping systems, or exposure to flood and water-scarcity risk are possible reasons; Jabbar et al., 2020a). These are plausible explanations, and not causes.

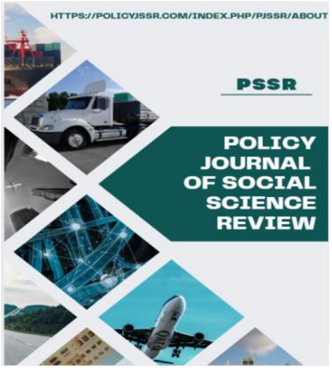
The ranked needs serve as a basis for prioritisation for extension planners, with water conservation and IPM having a top ranking and being in line with reported production constraints (Shahid et al., 2022; Ali et al., 2024). It directly tackles the challenge faced by Hussain et al. (1994) and Iqbal et al. (2016) of lack of match-up between trainings delivered and farmers' needs.

The role of education in predicting need implies that the extension content should vary according to the farmer's level of education, with more participatory, visual content for less educated farmers and more technical content for better-educated farmers (Khan et al., 2010). Farmers' age and level of education affect their ability to use digital advisory tools (Khan et al., 2019, 2020) which is why delivery methods are important as well as content.

The district-level difference serves to confirm the fact that a single province-wide training program will not necessarily fit both districts well and that needs assessment must be done at the district level – it is not an extra added on.

The low status of organic farming and marketing doesn't reflect that they should be excluded from extension planning. It is more likely to be a balancing act on farmers' risk assessment of other more pressing production risks. These areas could be integrated into more important training elements too, instead of being concentrated as separate training programmes competing for scarce attention.

Finally, the gap between the farmer's access to mobile advisory information and action

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that they can take on it is the same gap that was documented by Khan et al. (2019, 2020) in this study. Ranking needs is only useful when extension delivery is restructured to fit the need, not the volume of information available, as was the case with the T&V system 30 years ago (Hussain et al., 1994).

## Conclusion

Conclusion This study determined the capacity building requirement of farmers in Muzaffargarh and Dera Ghazi Khan districts of southern Punjab (Pakistan) in relation to sustainable crop production. The results show that farmers need significant training to implement sustainable agriculture practices, with three key areas of training that have been identified as water conservation and irrigation management, Integrated Pest Management (IPM) and climate smart agriculture being the highest priorities. The priorities indicate the growing problems of water shortages, pest infestation and climate variability in the study area. While soil fertility management, safe pesticide use, improved seed and integrated nutrient management were also identified as moderate needs by farmers, comparatively lower priority was given to skills related to organic farming and marketing. The study also identified that the needs of the farmers in terms of capacity building are different based on their socio-economic profile. The level of perceived training needs was found to be significantly related to level of education and age of the farmers, thus suggesting that less educated and younger farmers need more institutional support and technical guidance. There are differences in capacity building by district as well, indicating that a uniform approach to capacity building across the region would be inappropriate. In conclusion, the results show that while technologies and agricultural inputs are necessary for achieving sustainable crop production, the capacity of farmers to strengthen their knowledge, skill and decision making abilities would require strengthening their capacities through effective extension and training programs. Hence, a farmer-centric and needs-based extension is essential for increasing agricultural productivity, building climate resilience and agricultural sustainable development in the southern part of Punjab.

## Recommendations

The study identified water conservation and irrigation management, Integrated Pest Management (IPM), and Climate-Smart Agriculture as the most important capacity development needs of farmers and should be emphasized in training programs in agriculture extension departments. Extension activities need to have participatory and practical learning approach that increase adoption of sustainable agricultural practices such as field demonstrations, farmer field schools, and hands-on learning. Extension materials should be developed in simple local languages for farmers with lower educational level, and should be accompanied by visual and hands-on demonstration to ensure that

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it is easily understood and applied by farmers who have low education levels. In addition, training plans should be created on a district basis as farmers' needs vary between districts. Agricultural extension departments, research institutions, universities and non-governmental organizations should be encouraged to work together to make technical assistance and new technologies available to farmers in good time. Conventional Extension services should be complemented by digital Advisory services such as mobile based Agricultural information system, but providing enough guidance to farmer to use digital information effectively. Finally, future studies should include larger samples from different agroecological regions of Pakistan and examine additional socioeconomic, institutional, and behavioral factors affecting farmers' capacity-building needs to support the development of more comprehensive and evidence-based extension policies.

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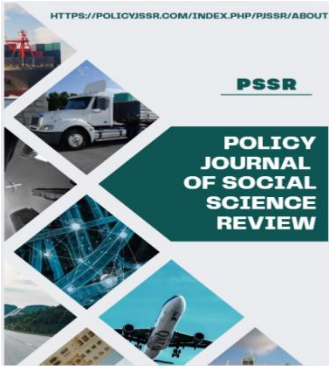


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