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Relationship Between Demographic Factors, In-Service Training, and Professional Competencies in Agricultural Extension

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Abstract

This study assessed the professional competency gaps and training needs of Agricultural Extension Field Staff (EFS) in three districts of southern Punjab, Pakistan, using a descriptive research design with a 5-point Likert scale questionnaire. A sample of 120 extension professionals was selected to examine the relationship between demographic variables and professional competencies. The results revealed that the extension workforce is well-educated and experienced, with a strong foundation in agricultural practices and training programs. However, significant training needs were identified, particularly in digital communication methods, including the use of radio, television, and projectors, which were found to be the most critical areas for skill development. Additionally, participatory extension techniques, such as farmer engagement and agricultural extension methodologies, exhibited considerable skill gaps, necessitating specialized training. In contrast, supervisory competencies for extension activities and junior staff were found to be relatively strong, requiring minimal additional training. The findings further indicated that agricultural experience significantly influenced the need for participatory extension training, while age had a minor effect on supervision and administration competencies. However, qualifications, job experience, and general agricultural experience did not show a substantial impact on administrative competency requirements, suggesting a more even distribution of training needs in this area. Based on these findings, several recommendations were proposed to enhance professional competencies. These include the development of specialized training programs, focusing on farmer engagement and participatory approaches, and improving digital

communication skills to enhance outreach efforts. Expanding in-service training programs, customizing training based on agricultural experience, ensuring equitable access to training opportunities, and integrating practical field-based learning approaches were also emphasized. Additionally, policy support for continuous professional development was recommended to ensure the long-term capacity building of EFS. Implementing these measures will strengthen agricultural extension services, improve knowledge dissemination, and enhance farmer participation in rural development programs.

Key words: Agricultural Extension, Supervision, Participatory Extension Approaches, Digital Communication in Agriculture, Training Needs Assessment, In-Service Training

Introduction

Agriculture has always been a major part of Pakistan's economy, going all the way back to the Indus Valley Civilization and other prehistoric cultures. For the majority of the population, agriculture has been a significant source of employment and income due to Pakistan's fertile land and plentiful water resources. Agriculture in Pakistan during the British colonial period was heavily concentrated on cash crops like cotton, wheat, and rice, which were grown mainly for export. The Pakistani government launched a number of policies and programs to increase agricultural productivity and guarantee food security for the country's expanding population after it gained freedom in 1947. The Green Revolution, which promoted the use of contemporary farming techniques, high-yielding crop varieties, and enhanced irrigation systems, was first implemented in Pakistan in the 1960s. As a result, agricultural output significantly increased, especially that of wheat and rice, and Pakistan's food supply became self-sufficient (Khan, 2024), and Khan *et al.,* 2024). The geographical and historical environment of Pakistan is ideal. According to Yaqub *et al.,* (2015), Pakistan is geographically split into the Baluchistan Plateau, the Indus River plain, and the northern highlands. According to the discovery of ancient remains, the region is rich with a civilization that dates back to 7000 BC, making it as old as the Stone Age. Pakistan's geography offers a superb mix of landscapes, including some of the world's most fertile basins and incredibly vast deserts. (Azam and Muhammad, 2017). From the Arabian Sea's shore in the south to the Karakoram Range's mountains in the north, it is covered in plateaus. Numerous species of vegetation and fauna are supported by the area's distinctive ecological conditions, which are created by the enormous altitudinal and latitudinal variation. Pakistan shares a Durand boundary with Afghanistan on its northwestern side and continues to benefit from the Strait of Hormuz and the Gulf of Oman, which are located south of it in the Arabian Sea. Pakistan's western boundary is shared with Iran, while its northern border is shared with China. (Yaqub *et al.,*2015). The longest and most dangerous boundary between Pakistan and India is on its east side. The four regions of Pakistan are Sindh, Baluchistan, KPK, and Punjab (UNDP, 2015). The majority of industrial and commercial centers are located in Punjab province, which also accounts for about 55% of the population and makes significant contributions to agricultural output (Piesse, 2015). This province provides roughly 76% of the nation's annual grain production, 73% of its sugar cane production, and 82% of its cotton production. (Mekonnen *et al.,* 2016). Punjab's economy is primarily built on agriculture, though industry also contributes significantly. Despite the region's dry climate, it has a thriving agricultural sector thanks to widespread irrigation. The province is contributing significantly to agricultural output. (Ahmad *et al.,*2021). It contributes roughly 63740.4 thousand tonnes, or 59.85%, of the nation's overall agricultural output. Of the total output at the national level, Punjab contributes 74.12% of cereals, 81.75% of pulses, 55.45% of cash crops, 9.39% of edible oils, 59.95% of fruits, and 77.54% of vegetables. (Badar *et al.,* (2007), Chesneau, Jamal, and Shafiq, (2022), and (Hussain *et al.,* 2023). Rice-wheat, cotton-wheat, and

mixed cropping systems are the three main grain production methods in Punjab (Hussain *et al.,* 2023; Elahi *et al.,* 2015; Aslam, 2016). Pakistan is a agricultural country, with agriculture serving as the foundation of its income. Pakistan has a wide range of cropping systems that differ by location and cropping style. Wheat, rice, sugarcane, cotton, and maize are among the principal crops produced in Pakistan. Some of the most popular cropping methods in Pakistan are as follows.

Current Situation of Agriculture in Pakistan

Overcoming both the target of 3.5% and the growth rate of 3.48% from the previous year, the agriculture industry experienced a remarkable growth rate of 4.40% in 2021–22. High yields, favorable output prices, supportive government policies, better access to certified seeds, pesticides, and agricultural credit were some of the main drivers of this development. With a growth rate of 6.58% versus 5.96%, the crops industry outperformed its performance from the previous year. Important crops, other crops, and cotton ginning all experienced substantial growth at the sub-sector level, with growth rates of 7.24%, 5.44%, and 9.19 percent, respectively, compared to growth rates of 5.83%, 8.27%, and -13.08% the year before. Important crops like cotton, rice, sugarcane, and maize all saw increases in output, with rates of growth of 17.9%, 10.7%, 9.4%, and 19.0%, respectively (Government of Pakistan 2021-22), (Khan, (2024), and Khan *et al.,* 2024). The country's wheat production increased by 8.1% in 2020–21 compared to the previous year, hitting 28.3 million tons, exceeding the target of 27.2 million tons, according to the most recent Economic Survey of Pakistan. Government initiatives like the provision of high-quality seeds and subsidies for pesticides and fertilizers helped to cause this rise. However, owing primarily to unfavorable weather, rice production fell by 1.1% in 2020–21 compared to the prior year, reaching 8.4 million tones. A total of 81.2 million tons of sugarcane were produced in 2020–21, a 2.6% decrease from the previous year. In contrast, 8.5 million bales of cotton were produced, a rise of 22.2% due to better weather and government initiatives (Government of Pakistan 2021-22). With a 14.04 percent GDP share and a 61.89 percent agricultural share, respectively, livestock saw growth of 3.26 percent in 2021–22 compared to 2.38 percent at the same time last year. The fishing industry, which contributes 1.39 percent to the value added to agriculture and 0.32 percent to GDP, saw growth of 0.35 percent compared to 0.73 percent during the same time last year. A positive growth of 6.13 percent was reported in the forestry sector, which accounts for 2.14 percent of the value added to farmland and 0.49 percent of GDP, as opposed to a negative growth of 0.45 percent the year before (Government of Pakistan 2021-22).

Table 1: Yield comparison (tone/hectare) of Different crops between Pakistan and other countries

Country	Wheat	Rice	Maize	Sugarcane	Cotton
Pakistan	2.8	2.7	4.0	63.2	0.9
India	3.4	2.5	2.5	71.4	0.5
United States	3.3	7.3	10.6	62.7	0.8
China	4.7	6.7	6.0	64.2	1.8

(FAO, 2021)

Certainly, this table examines the crop yields per hectare (in tons) of five important crops in Pakistan, India, the United States, and China. The chart includes wheat, rice, maize, sugarcane, and cotton as the crops. The figures in the above table show the real yield per hectare for the crops in each nation. The real wheat yield in Pakistan, for instance, is 2.8 tons per hectare, which is lower than the yields in China (4.7 tons per hectare) and India (3.4 tons per hectare). Similar to China's rice output of 6.7 tons per hectare, Pakistan's actual rice yield of 2.7 tons per hectare is lower than

China's yield of 2.5 tons per hectare and India's yield of 2.5 tons per hectare. In general, the table reveals that Pakistan's crop yields are lower than those of the other three nations for almost all crops, with the exception of sugarcane, where Pakistan's yield is greater than those of the US and China. The difference in crop yields could, however, be caused by a number of factors, including variations in farming methods, climatic conditions, soil quality, and technological advancements (FAO 2021) The term "yield gap" describes the discrepancy between current food yields and the yields that could be obtained under ideal agricultural conditions. Yield gap analysis is a technique used to measure this discrepancy and pinpoint the causes, including bad soil quality, insufficient irrigation, pests, and diseases. Understanding the productivity potential of agricultural systems and spotting chances to raise crop yields, lessen hunger, and improve sustainability all depend on yield gap analysis. The potential to increase crop yields in various areas and nations has been evaluated by numerous studies using yield gap analysis. For instance, research in sub-Saharan Africa discovered that better management techniques and improved soil fertility could increase maize yields by 50–100% (Tittonell *et al.,* 2010). Another research in South Asia suggested that with improved irrigation and nutrient management, wheat and rice yields could be increased by 25–50% (Jat *et al.,* 2014). In agribusiness, yield gap analysis is also used to guide investment and policy choices. Reduced yield gaps in important crops, for instance, have been linked to significant increases in agricultural production, rural income, and food security, according to a study conducted in China (Zhang *et al.,* 2017). Similar to this, a study conducted in the United States found that closing yield gaps in maize could boost output by 45% and have significant positive effects on the economy and the environment (Van Wart *et al.,* 2019). To sum up, yield gap analysis is a helpful instrument for understanding the productivity potential of agricultural systems, spotting chances to increase crop yields, and guiding investment and policy choices in agriculture. For instance, based on the production method used, a study published in the Pakistan Journal of Agricultural Sciences in 2021 found a yield gap for wheat ranging from 28 to 48 percent. A further investigation found a 35 percent yield gap for rice in Pakistan in the Journal of Animal and Plant Sciences in 2020. Similar estimates of the yield gap for maize in Pakistan were made in a study that was released in the Journal of Animal and Plant Sciences in 2021. A 2019 study that was released in the Journal of Agricultural Science and Technology estimated that the yield gap for sugarcane in Pakistan was between 30 and 40 percent. In addition, a study released in the Pakistan Journal of Agricultural Research in 2020 indicated that Pakistan had a yield gap for cotton of about 45%. In order to reduce the yield gap in Pakistan and increase agricultural output, these studies emphasize the need for improved agricultural practices, such as better-quality seeds, soil fertility management, and pest control.

Table 2: Yield gap between potential and actual yield of major crops in Pakistan

Crop	Potential Yield (tons per hectare)	Actual Yield (tons per hectare)	Yield Gap (tons per hectare)
Wheat	5.5	2.8	2.7
Rice	8.0	2.7	5.3
Maize	9.0	4.0	5.0
Cotton	2.3	0.9	1.4

(FAO, 2019)

The yield gap analysis for the main crops grown in Pakistan, such as wheat, rice, maize, and cotton, is shown in the given Table. While the actual yield is the yield presently being produced, the potential yield represents the yield that could be attained under ideal agricultural practices and conditions. The difference between the potential yield and the real yield is known as the yield gap.

It differs by 2.7 tons per hectare for wheat, 5.3 tons per hectare for rice, 5.0 tons per hectare for corn, and 1.4 tons per hectare for cotton. The absence of access to contemporary farming technologies, poor soil quality, inadequate irrigation, pest and disease control, and insufficient use of fertilizers and pesticides are the main causes of the yield gap. The analysis of the yield gap is a crucial tool for determining the causes of poor crop yields and formulating solutions. Farmers can raise their output and incomes by addressing the yield gap. The primary causes of the yield disparity are lack of access to modern farming technologies, poor soil quality, inadequate irrigation, pest and disease management, and insufficient use of fertilizers and pesticides. The analysis of the yield gap is a crucial tool for determining the causes of poor crop yields and formulating solutions. Farmers can increase their output and income by addressing the yield gap. (Food and Agriculture Organization 2019).

Research Gap and Need for Study

Training need Assessment is the procedure for determining, prioritizing, and implementing concrete measures to address training requirements as part of a training program. (TNA). Particularly in the beginning stages, it is regarded as being a crucial element of the planning process. TNA is used to improve, modify, and adapt current programs to suit a client's unique needs. Although the overall goal is to close the performance gap between current and intended performance, TNA can take many different forms depending on the program. It is an essential component of the training cycle and overall planning process. By serving as a conduit between farmers and the government, extension workers in Pakistan play a crucial part in the development of the agricultural sector. The Training Needs Assessment (TNA) is a crucial tool for extension workers to find their knowledge and ability gaps, which can then be filled through the right training programs to enhance performance. The crucial value of TNA in determining the training requirements of extension workers was emphasized by a study conducted by Ali *et al.,* (2021) in the Pakistani province of Khyber Pakhtunkhwa. The research emphasized the necessity of ongoing TNA in order to maintain the applicability and efficacy of the training programs provided to extension workers. Similar research was done by Ahmad *et al.,* (2019) in Punjab province, where they discovered that training programs based on TNA greatly increased the knowledge and abilities of agricultural extension workers. Mahmood *et al.,* (2018) highlighted the importance of TNA in creating tailored training programs for extension workers in Pakistan in another research. According to the study's findings, TNA was useful in identifying the knowledge gaps that extension employees had, and training programs created using TNA were more successful in boosting their performance. In summary, TNA is an indispensable tool for developing effective training programs for extension workers in Pakistan. Regular TNA can identify knowledge and skill gaps, leading to relevant and effective training programs. In Pakistan, the agriculture extension service is heavily criticized for not doing its work well. Investigating the effects of studies on the responsibilities and skills of agriculture development staff is necessary. It is imperative to pinpoint the areas in which extension staff members require instruction. A training program could not be designed effectively without a clear understanding of the extension personnel's areas of weakness. In order to determine, evaluate, and prioritize the in-service training requirements and competencies of extension personnel, a study is being done. This research is anticipated to contribute to the development of efficient training programs for extension personnel in the competency areas where they are lacking and to the formulation of policy recommendations for their capacity building in order to enhance the overall extension system (Khan, (2024), and Khan *et al.,* (2024). However, a quick online review of different research shows that there is limited research available on the training needs assessment of extension workers specifically in Southern Punjab. However, there are studies available on the training needs assessment of extension workers

in Punjab province, which Bahawalpur is a part of. The study highlights the importance of TNA in identifying the training needs of extension workers and suggests that regular TNA can help improve their performance.

Extension Work and Professional Competencies

Professional competences are an essential component of an effective workforce, covering the knowledge, abilities, attitudes, and behaviors required for excellent performance within a field (Khan 2024). These capabilities vary from basic knowledge to more sophisticated skills including application, synthesis, and critique (Farooq Zeshan and Najeeb, 2021). Competencies are critical in the field of Extension services because they enable professionals to successfully adjust to social changes while maintaining a high level of public service (Elliott-Engel *et al.,* (2021); Lakai *et al.,* (2012) and Donaldson, and Vaughan (2022). A Scoping Study of United States Extension Professional Competencies. Journal of Human Sciences and Extension, (Narine and Ali (2020). Assessing Priority Competencies for Evaluation Capacity Building in Extension. Journal of Human Sciences and Extension, research on Extension professional competences has made a substantial contribution to connecting Extension educational programs with the field's practical demands, bridging the theory-application divide (Scheer *et al.,* 2006). Furthermore, these studies have aided professional growth projects by assisting in the preparation of training programs (Brodeur *et al., 2011*; Lakai *et al.,* 2014 and Cummings *et al.,* (2015).), designing individual learning plans (Baker *et al.,* (2009); Franck *et al.,* (2017), and improving job descriptions and performance appraisals for Extension professionals (Baker *et al.,* 2009 and Downey; 2022). Extension professionals must possess a wide variety of professional and technical competencies. Expertise consists of communication, program planning, task execution, adult education methodologies, and behavioral analysis, whereas technical competencies involve topic-specific specialization in post-harvest management, pest control, disease management, and agricultural innovation dissemination. Khan (2000) found that while most extension agents had good technical expertise, many lacked effective communication skills, which are necessary for figuring out solutions, assessing needs, as well as farmer psychology. Similarly, Khan (2003) and Epley (2019) discovered that public extension agents emphasized four key professional competencies: human behavior and public relations, designing programs, approaches related to training, and supervision/administration. Professional competencies remain a chronic concern, especially among underdeveloped nations (Easter, 1985; and Epley (2019). According to Pezeshki-Raad *et al.* (1994), in order to work professionally across emerging zones, extension professionals require being knowledgeable about communication, program design and execution, adult education, and extension methodology. Issahaku (2014) and Umar, Kofarmata and Abdullahi (2024), also found a shortage of professional competencies among extension workers, claiming that such weaknesses impede farmers' adoption of contemporary agricultural technologies. Governments and organizations understand the importance of balancing professional and technical skills among extension personnel. Rohit *et al.,* (2019) outlined a competency framework that included essential professional skills such as communication, planning, management, monitoring, evaluation, and extension methodologies, as well as technical expertise in fertility of soil, infectious disease and pest management, animal health, aquaculture, apiculture, and agribusiness. Similarly, empirical studies (Rohit *et al.,* 2019) have shown that extension of workers' capacity to encourage farmers and provide relevant information is a critical factor influencing the adoption of new technology. To successfully impact on farmer behaviors, effective extension personnel must be both technically informed and skilled at interpersonal communication. A major difficulty for outreach organizations in underdeveloped countries is a lack of synergy between technical expertise and professional competencies (Yuvaraj, R. (2011). In past centuries, the concentration on technical abilities has

resulted in a lack of professional growth, limiting the overall effectiveness of extension services. In the view of Gibson and Hillison (1994); and Khan Pongquan and Ullah (2009), professional abilities are the foundation of effective extension work, requiring mastery of a wide range of skills to deal with complex issues in the field. These abilities not only boost individual performance, but also the overall effectiveness of agricultural extension activities. Key professional abilities needed for efficient work in extension involve organizing an agricultural extension program, using extension methods effectively, communication and presentation skills, supervision and administration, program evaluation and impact assessment, participatory extension techniques, computer and digital proficiency, and relations management and interaction with the community (Khan *et al.,*2008). Demographic factors such as age, education, employment experience, and agricultural background all have a significant impact on the training requirements and professional competences of Agricultural Extension Field Staff. According to research, younger extension workers frequently require more training in supervisory and administrative positions, whereas those with more agricultural experience have higher participatory extension skills (Khan *et al.,* 2022). Furthermore, in-service training programs greatly improve extension practitioners' digital communication skills, particularly their use of electronic media for information dissemination (Ali & Hussain, 2023). However, degrees and job experience have had little impact on administrative competences, highlighting the importance of equitable training opportunities for all employees (Rahman *et al.,* 2023). Tailored training programs that take into account demographic differences and prior training experience can assist overcome competency gaps and increase the overall efficacy of agricultural extension services Khan *et al.,* (2024).

Statement of Problem

Through study, several potential reasons for yield gaps in Pakistan have been found. Low yields and bad crop quality may be the outcome of restricted access to high-quality inputs like seeds, fertilizer, and pesticides (Qasim *et al.,* 2021). In Pakistan's semi-arid and arid areas, inadequate irrigation infrastructure can also cause water stress, which lowers yields (Hussain *et al.,* 2020). Another important factor in production gaps is poor soil quality brought on by erosion, nutrient depletion, and soil degradation (Rafiq *et al.,* 2019). If not properly controlled, pests and diseases can considerably lower crop yields. Another element causing yield gaps is the non-adoption of contemporary farming techniques and technologies. Crop rotation, resistant crop varieties, and precision agriculture methods like satellite imagery and remote sensing can all help reduce pest and disease problems. Another element causing yield gaps is the non-adoption of contemporary farming techniques and technologies. Crop rotation, the use of resistant crop varieties, and precision agriculture methods like satellite imaging and remote sensing can all help reduce pest and disease issues and enhance soil quality. By addressing these issues, sustainable and creative farming methods can help Pakistani farmers close yield gaps and boost crop growth (Khan *et al.,* 2021; Sher *et al.,* 2020; Hussain *et al.,* 2021; Rehman *et al.,* 2021) and (Khan, (2024), and Khan *et al.,* 2024). By supplying farmers with the information and skills they need to increase their output and income, extension services are essential in closing the yield gap in agriculture. Through extension services, farmers can access information on market opportunities, adopt more advanced technologies, and engage in sustainable farming practices. Numerous studies have emphasized the usefulness of extension services in closing the agricultural yield disparity. For instance, Gebremedhin *et al.,* (2021) discovered that by supplying farmers with better technologies and management techniques, extension services greatly increased the yield of maize and wheat crops. Similar to this, Akrobortu *et al.,* (2021) discovered that extension services greatly increased tomato crop yields by educating farmers on pest control and better production methods. Numerous studies have shown how effective extension services are at closing the yield disparity in Pakistani

agriculture. According to a study by Ahmad *et al.,* (2021), for instance, the yield of wheat and maize crops in Pakistan was considerably increased by the provision of extension services, which included training and field demonstrations. The use of input subsidies and extension services increased the adoption of improved rice varieties and greatly increased rice yields in Pakistan, according to a study by (Shahzad *et al.,* 2020). The success of an extension program is determined by the capacity of extension agents who are qualified, extremely responsible in their work, and capable in the extension process. Many extension techniques and tactics rely on peasant approval of technology transfer with thorough development (Axinn, 1988). The extension agent must establish credibility with clients by displaying the degree of proficiency necessary to motivate others (Oakley and Garforth, 1997 and Ali and Safdar, 2022). With issues like poverty, food insecurity, and climate change, among others, the need for skill in agriculture is currently more important than ever (Rivera *et al.,* 2020). Providing an efficient connection service relies on how well extension agents communicate with farmers about their various agricultural innovations. (Umar *et al.,*2018). It also demonstrates the need for extension agents to learn more in order to be able to meet the demands of customers who are becoming more sophisticated and varied. Extension agents who are successful at disseminating information that can improve life need to know more. The need for routine evaluation and analysis of the technical capacity and ability was verified by the role of extension agents as conduits connecting the various stakeholders (Oakley and Garforth, 1997). The extension officers who are among agriculture extension agents must improve their professional competencies, such as competencies in organization and social community, in addition to their knowledge of agriculture (Shah
*et al., 2*013). The level of agricultural output can be significantly impacted by extension workers' professional incompetence. Extension personnel are people who work closely with farmers to give them knowledge, instruction, and professional assistance to enhance their agricultural practices. These employees may unintentionally give farmers inaccurate or out-of-date information if they lack the required knowledge and abilities, which would lower agricultural productivity. According to a study by Rana (2023) farmers in Bangladesh were less likely to adopt new practices and technologies as a result of the extension workers' professional incompetence. Farmers' incomes also suffered as a consequence of the decreased agricultural productivity. Similar to this, in a study in Nigeria by Omoregie and Isitor (2015) found that farmers adopted unsustainable practices like monoculture and excessive fertilizer use due to extension workers' lack of knowledge and expertise in managing soil fertility and crop production, which in turn caused a decline in soil fertility and agricultural productivity. Furthermore, farmers may implement environmentally harmful practices as a result of the extension employees' professional incompetence. Finally, the incompetence of extension workers can have a significant negative effect on agricultural production, resulting in decreased productivity, lower farmer incomes, and environmental degradation. In order to give farmers accurate and current information and support, it is crucial to make sure extension agents have received the proper training and possess the required knowledge and skills. Research on the effects of extension workers' professional incompetence on Pakistani agricultural output is scarce. In Punjab, Pakistan, Hussain *et al.,* (2021) evaluated the skill of agricultural extension employees and its effect on farmers' adoption of suggested practices. The research discovered that farmers did not implement recommended practices because extension workers' competence was low, which caused a decline in agricultural productivity. The efficacy of agricultural extension services in Pakistan in promoting sustainable farming practices was assessed in a different study by Arshad *et al.,* (2020). According to the research, extension agents were unable to effectively support farmers with technical assistance because they lacked the required knowledge and skills. Farmers did not adopt sustainable practices as a result, which decreased agricultural output. Additionally, Ullah *et al.,*'s study (2019) found that Pakistani extension workers lacked the skills and knowledge

necessary to effectively promote modern agricultural practices among farmers, which resulted in low adoption rates and decreased agricultural output. In conclusion, the professional incompetence of Pakistani extension employees can significantly affect agricultural production, resulting in decreased productivity and lower incomes for farmers. It is crucial to ensure that extension agents have received the appropriate training in order to ensure that they can provide farmers with accurate and up-to-date information and assistance. A balanced approach to professional training is required to boost extension services, especially in rural and developing areas. Extension staff can become more successful agents of agricultural innovation and rural development by improving their communication skills, implementing participatory approaches, and developing program plans. Extension organizations can improve their workforce's ability to bridge the gap between research and practical application by using a systematic competency-based training framework, supporting global sustainable agricultural development. Therefore, this study was designed to analyze the professional in-service training needs assessment and demographic relationship of Extension Field Staff of three selected district of South region of Punjab, Pakistan.

Objectives of the study

The general objective was to study the in-service training needs assessment of public agricultural extension field staff to encounter the threats and challenges for future agriculture. Specific objectives of the research were to evaluate the professional in-service training needs assessment and demographic relationship of Extension Field Staff of three selected district of South region of Punjab, Pakistan.

Methodology

This descriptive research design included all agricultural extension workers in the department of agriculture extension, Punjab, Pakistan. The electronic questionnaire, self-developed after reviewing literature, was distributed to them. From the selected three districts namely Bahawalpur, Bahawalnagar and Lodhran,, 120 agricultural extension agents, representing about (82%) of the study population, responded. A validity test was conducted on the questionnaire by presenting it to specialists in the Agricultural Extension Department and the rural community, as well as a stability test using the Cronbach Alpha coefficient 0.87. In its final form, the researchers placed it on an agricultural guide platform, which includes all agricultural extension workers in the study area. The respondents' responses were collected, and then those responses were processed statistically using some statistical methods such as frequencies, percentages, the arithmetic mean, standard deviation, and chi square test through the statistical program SPSS.

Results and Discussion

Socio-Economic Characteristics of the Respondents

The respondents' demographics are thought to have a significant role in determining whether or not they are aware of and embrace current manufacturing practices (Hassan 2015; Ali et al.,2019; Jones, and Garcia (2021); Thompson and Smith (2016). Similarly, Rehman *et al.,* (2013) and Khan *et al.,* (2024) found a substantial correlation between farmers' socioeconomic characteristics and their ability to obtain agricultural knowledge in order to embrace new technologies. It is believed that a person's attitude and behavior can be influenced by their demographic characteristics. Given the significance of these variables, data has been supplied on the respondents' age, area of jurisdiction, professional education, duration of service, family history, agricultural experience, and attendance at in-service training courses and refresher courses.

Table 3: Demographics of Agricultural Extension Field Staff (N=120) Category-wise Distribution

Category	Frequency (f)	Percentage (%)
Age (in years)		
20-30	31	26.00
31-40	34	28.00
41-50	48	40.00
50 and above	7	6.00
Education		
3 Years diploma	28	23.66
B.Sc. (Hons.) Agri	50	41.66
M.Sc. (Hons.) Agri	37	30.66
Ph.D. (Agri)	5	4.02
Service Length (No. of years spent on job)		
1-5	38	31.67
6-10	44	36.67
11-15	29	24.33
16 and above	9	7.33
Family Background		
Farming	78	65.00
Non-Farming	42	35.00
Training (Attended)		
On job training	91	75.67
Refresher course	76	63.67
No. of trainings		
No	4	3.67
1-5	68	57.00
6-10	34	28.67
11 or above	13	10.66

Results presented in table 1, demographic analysis of the Agricultural Extension Field Staff (N=120) reveals information on their age range, educational credentials, service length, family history, and training experiences. The age distribution reveals that the majority of respondents (40%) are between the ages of 41 and 50, followed by 28% between the ages of 31 and 40 and 26% between the ages of 20 and 30. Only 6% are over the age of 50. This demonstrates that a large proportion of the workforce comprises of seasoned experts, with a moderate number of younger people entering the area. In terms of educational credentials, the majority of field personnel (41.66%) hold a B.Sc. (Hons.) Agriculture degree, while 30.66% have earned an M.Sc. (Hons.) Agriculture. A lesser fraction (23.66%) has a three-year diploma, whereas only 4.02% have a Ph.D. in agriculture. This shows that the majority of professionals have at least a bachelor's degree, resulting in a highly qualified workforce. According to the service length distribution, the majority (36.67%) have worked for 6-10 years, followed by 31.67% with 1-5 years of experience. Meanwhile, 24.33% have spent 11-15 years in service, with only 7.33% serving for 16 years or more. This reflects a fair mix of early- and mid-career professionals, with fewer long-term employees. In terms of family background, the majority (65%) are from farming families, with 35% from non-farming origins. This demonstrates that a considerable proportion of field staff have personal experience with agriculture, which may improve their understanding of farmers' issues

and demands. According to data on training participation, 75.67% of the participants received on-the-job training, while 63.67% took refresher courses. This implies that the majority of field personnel are involved in ongoing professional development to improve their knowledge and abilities. As it comes to the number of trainings attended, the majority (57%) attended one to five programs, while 28.67% completed six to ten. Furthermore, 10.66% completed 11 or more courses, while only 3.67% obtained no training at all. This shows that the majority of staff members have obtained proper training, which adds to their professional expertise in extension services.

Table 4: Mean ± STD of Required and Possessed level, Prioritization of Training Needs Based on Discrepancy Value (DV) and Rank Order of Professional Competencies of Respondents in study area

Competency Use of Mobile and PTCL Phone-Related Skills	Required Competency Level (RCL)(Mean±STD)	Possessed Competency Level (PCL) (Mean ± STD)	Training Need (DV = RCL - PCL)	Rank Order
Communicate information through radio	3.72 ± 0.96	1.46 ± 0.681	2.26	**1**
Communicating information through television	3.52 ± 0.80	1.34 ± 0.722	2.18	**2**
Use a slide projector	3.21 ± 1.10	1.19 ± 0.573	2.02	**3**
Use of overhead projector	3.24 ± 0.99	1.39 ± 0.888	1.85	**4**
Use of visual aids to deliver information	3.49 ± 0.98	1.83 ± 0.941	1.66	**5**
Use of multimedia projector	3.15 ± 1.23	1.59 ± 0.675	1.56	**6**
Communicate ideas through written messages	3.49 ± 1.05	2.03 ± 1.085	1.46	**7**
Promote inter-office communications	3.54 ± 0.80	2.46 ± 0.999	1.08	**8**
Organize thoughts logically	3.82 ± 0.84	2.78 ± 0.902	1.04	**9**
Communicate ideas through vocal communication	3.58 ± 1.23	3.27 ± 0.903	0.31	**10**
Overall	**3.48 ± 0.99**	**1.93 ± 0.85**		
1.55				
Competency Supervision of Extension Activities	**Required Competency Level (RCL)(Mean±STD)**	**Possessed Competency Level (PCL) (Mean ±STD)**	**Training Need (DV = RCL - PCL)**	**Rank Order**
Coordinate extension efforts of allied departments	3.73 ± 1.14	2.21 ± 0.90	1.52	**1**
Establish advisory committees	3.54 ± 0.75	2.18 ± 1.04	1.35	**2**
Supervise the implementation of work	3.30 ± 1.60	2.50 ± 1.08	0.80	**3**
Record supervisory observations	2.96 ± 1.45	2.41 ± 0.95	0.55	**4**

Inspect village-level Hub activities	2.86 ± 1.42	2.74 ± 1.05	0.12	**5**
Design daily, weekly, and monthly work schedules	3.15 ± 1.52	3.08 ± 1.05	0.07	**6**
Help field assistants plan extension activities	3.01 ± 1.62	3.03 ± 0.83	-0.02	**7**
Guide field staff for official duties	3.05 ± 1.49	3.10 ± 0.80	-0.06	**8**
Supervise field assistants under your command	2.88 ± 1.48	2.99 ± 0.88	-0.11	**9**
Overall 0.47	**3.16 ± 1.39**	**2.69 ± 0.94**		

Competency Supervision of Junior Staff	**Required Competency Level (RCL) (Mean±STD)**	**Possessed Competency Level (PCL) (Mean ± STD)**	**Training Need (DV = RCL - PCL)**	**Rank Order**
Direct junior staff to perform efficiently	3.86 ± 0.849	2.98 ± 0.738	0.91	**1**
Prepare terms of reference/job descriptions	2.83 ± 1.282	2.04 ± 0.897	0.79	**2**
Conduct official inquiries	3.45 ± 1.174	2.67 ± 1.057	0.78	**3**
Maintain office up to standard	3.34 ± 1.057	2.70 ± 0.729	0.64	**4**
Dealing with service matters	2.68 ± 1.408	2.04 ± 0.960	0.64	**4**
Manage work with available resources	3.24 ± 1.579	2.61 ± 0.977	0.63	**5**
Understand implementation policies	2.83 ± 1.484	2.47 ± 1.003	0.36	**6**
Hold/conduct staff meetings	3.00 ± 1.534	2.78 ± 0.843	0.22	**7**
Deal effectively with subordinates' problems	2.56 ± 1.656	2.94 ± 0.672	0.11	**8**
Handle complaints effectively	2.56 ± 1.656	2.66 ± 1.023	-0.10	**9**
Overall 0.54	**3.13 ± 1.34**	**2.59 ± 0.87**		

Competency Participatory Techniques	**Required Competency Level (RCL)(Mean ± STD)**	**Possessed Competency Level (PCL)(Mean ± STD)**	**Training Need (DV = RCL - PCL)**	**Rank Order**
Monitor overall FFS working	4.34 ± 0.65	2.36 ± 1.04	1.99	**1**
Train FFS members in participatory work	4.18 ± 0.59	2.28 ± 0.972	1.90	**2**
Diffuse agricultural innovation in FFS	4.30 ± 0.64	2.40 ± 1.041	1.90	**2**
Maintain working relationships	4.27 ± 0.60	2.35 ± 1.047	1.77	**3**

Use FFS technique	4.17 ± 0.63	2.94 ± 1.20	1.70	**4**
Guide FTP members	4.34 ± 0.55	3.18 ± 0.840	1.16	**5**
Use FTP technique	4.39 ± 0.57	2.47 ± 1.094	1.14	**6**
Explain FTP features to farmers	4.29 ± 0.56	3.24 ± 0.752	1.05	**7**
Overall	**4.25 ± 0.60**	**2.65 ± 0.99**	**1.60**	

The results shown in table 4 reveal that the category of Use of Mobile and PTCL Phone-linked Skills, among ten responses, had the highest training needs, notably in abilities linked to communication via electronic means. The three highest ranked talents with the most training deficits were: "Communicating information through radio" (DV=2.26, Ranked 1st). The largest disparity indicates respondents' lack of proficiency in using radio as a communication tool. Because radio has remained an important norm in numerous places, customized instruction in broadcast-based communication has become crucial. Table further indicates that Television communication (DV=2.18, Ranked 2nd) as second-highest disparity which indicates an analogous deficit for sharing information. As visual communication becomes more crucial, this shortcoming highlights the requirement for strengthening capacity measures in television-based communication and using a slide projector (DV=2.02, Ranked 3rd) being the third main training need is the usage of slide projectors, showing that professionals want basic presenting skills, which are required for efficient communication during workshops and training sessions. In contrast, little training has been identified within this area for articulating concepts through vocal communication (DV = 0.31, Ranked 10th). It indicates that professionals are relatively skilled at verbal communication, with little need for more training in this domain. Regarding category, Supervision and administration of Extension Activities related competencies of respondents above table depicts the training requirements in this domain were moderate, with the biggest disparities noted in: “Coordinating extension efforts with other associated departments” (DV=1.52,Ranked1st).This highlights a lack of teamwork and coordination abilities, which are crucial for successful extension operations across departments followed by “Setting up advisory panels” (D =1.35, Ranked 2nd) showing as professionals need to increase their ability to establish advisory boards for decision-making and community engagement in extension work and “Supervising the implementation of work” (DV=0.80, ranked 3rd) explaining that this skill is moderately inadequate, underlining the need for formal training in supervisory roles to effectively execute expansion projects. According to the above table, the least amount of training is required for supervising field assistants under command (DV= -0.11, Rank 9), indicating that individuals are already proficient in management field workers. Above table reveals skills regarding Supervision of Junior Staff of respondents as the training requirements for supervising junior workers were very low in comparison to other categories, with the highest-ranked deficits noted in: “Efficiently and effectively direct junior personnel” (DV=0.91, Ranked 1st), highlighting the necessity for leadership and management training to improve workplace efficiency followed by “Creating terms of reference or job descriptions” (DV=0.79, Ranked 2nd) reflecting that a lack of defined job definitions may impact staff performance and responsibility. And “Conducting official enquiries” (DV = 0.78, Ranked 3rd) showing that respondents require additional skills for handling workplace investigations and enquiries. The lowest-ranked training need was dealing with or disposing of complaints (DV= -0.10, Ranked 9th), indicating the individuals already have experience of coping with complaints from staff and problems at work. The data presented in the above table shows that the Participatory Techniques-related skills had considerable training needs, particularly in successfully involving farmers and members of the community. The most important three prioritized training

requirements were: "Monitoring the overall operation of Farmer Field Schools" (DV=1.99, Ranked 1st) This shows a crucial gap in assessing the effectiveness of participatory agricultural interventions. followed by "FFS members should get organized training to engage farmers in participatory learning and decision-making" (DV=1.90, Rank 2nd) and "Difficulty distributing agricultural advances among FFS members" (DV=1.90, Rank 2nd). Training is necessary to improve knowledge-sharing systems in farming communities. The lowest need of training required in "Define the main characteristics of the Farmers Training Program (FTP) to farmers" (DV=1.05, Ranked 7th), demonstrating that professionals understand how to explain FTP principles to farming communities.

Bivariate Analysis: Association Between Demographic Variables and In-service Training Needs

The Chi-Square test is used to determine the relationship between demographic information and EFS level competency. The Chi-Square results and significance are shown in the table below.

Table 5: Association Between Demographic Variables and In-service Training Needs of EFs regarding Professional Competencies

Variables	Chi-Square Value	df	Sig.	Gamma
Age-**Supervision and Administration**	14.69	9	.10*	-.079
Qualification-Supervision and Administration	1.90	6	.928	.030
Job Experience-Supervision and Administration	8.45	9	.489	.012
Farming Experience-Supervision and Administration	7.17	12	.846	-.038
Inservice training-Supervision and Administration	1.72	9	.995	.010
Age_ **Skills of Participatory Extension Techniques**	9.18	9	.421	.032
Qualification_ Skills of Participatory Extension Techniques	3.18	6	.786	.024
Job Experience_ Skills of Participatory Extension Techniques	7.29	9	.607	.080
Farming Experience_ Skills of Participatory Extension Techniques	33.50	12	.001**	-.138
Inservice training-Skills of Participatory Extension Techniques	16.59	9	.05*	.020

Significance value. **Highly significant, * significant

Table 5 shows the findings of an analysis of the relationship between various demographic characteristics and the in-service training needs of Extension Field Staff (EFS) in terms of professional competences, utilizing Chi-square tests and Gamma coefficients to establish significance and direction of associations. For association between professional competencies in Supervision and Administration and selected demographic characteristics of respondents, The research shows that age has a weak but statistically significant association (p =.10) with supervision and administration competencies (χ^2 = 14.69, df = 9, γ = -0.079), indicating that younger and older professionals may require different administrative training. Other demographic characteristics, such as qualification (p =.928), employment experience (p =.489), farming experience (p =.846), and in-service training (p =.995), showed no significant link with supervision and administration competencies. The Gamma values for these variables are close to zero, indicating that these parameters have little influence on EFS administrative training needs. Similarly in case of Skills in Participatory Extension Techniques the study found a significant association (p =.001, χ^2 = 33.50, df = 12, γ = -0.138) between farming experience and the need for

training in participatory extension techniques. This suggests that individuals with different farming backgrounds may require different skill enhancements. In-service training had a statistically significant connection ($p = .05$, $\chi^2 = 16.59$, $df = 9$, $\gamma = 0.020$), indicating the importance of earlier training in shaping competencies for participatory techniques. In contrast, age ($p = .421$), qualification ($p = .786$), and job experience ($p = .607$) do not have significant relationships with participatory extension technique training needs. The low Gamma values for these variables indicate weak or negligible directional correlations, showing that age and formal education level may not be the key determinants of training requirements in this area.

Conclusion

It was concluded having results of the study that the demographic mix of the agricultural extension staff represents a well-educated and experienced workforce, with a strong basis in agricultural practices and training programs which establish positive contribution to their continuous professional development. Further, according to the findings, communicating by electronic media (radio, television, and projectors) requires the most training across all competencies. There are considerable skill gaps in the participatory approaches category, particularly in farmer engagement and agricultural extension methodologies. Supervisory abilities for both extension activities and junior staff, on the other hand, appear to require less training because professionals appear to be competent in these areas. Addressing these competency gaps through focused training programs will increase the efficiency and effectiveness of extension specialists, resulting in better agricultural knowledge distribution and farmer participation. Prioritizing training initiatives in such fields allows organizations to close important gaps in competence and improve the effectiveness of agricultural extension and rural development workers.in the last association between demographics and professional competencies of extension staff it was concluded that agricultural experience has a substantial impact on the requirement for participatory extension abilities, whereas age has a minor effect on supervision and administration competencies. Furthermore, earlier in-service training is essential for developing participatory extension abilities. However, qualifications, job experience, and general agricultural experience have no significant influence on administrative competence, implying that these training requirements may be more evenly dispersed among EFS. These findings highlight the necessity of specialized training programs that take into account field staff's previous agricultural experience and in-service training history in order to effectively improve professional competencies.

Recommendations

Based on the study's findings and conclusions, the following recommendations are made to improve the professional competences of Agricultural Extension Staff (EFS) and the effectiveness of agricultural extension services.

- **Developing Specialized Training Programs:** To address skill shortages in participatory extension approaches, tailored training programs should focus on improving farmer engagement, agricultural extension methodologies, and participatory technologies. This will help field staff communicate and collaborate more effectively with rural communities.
- **Improving Digital Communication Skills:** To improve outreach and knowledge dissemination, extension organizations should implement capacity-building programs focusing on digital literacy, multimedia communication, and ICT-based extension services. Electronic media (radio, television, and projectors) are the most critical areas for training.
- **Improving In-service Training Programs:** The study found that early in-service training is critical for establishing participatory extension skills. As a result, extension agencies should

broaden and diversify in-service training opportunities to promote ongoing skill development, particularly for professionals who have limited exposure to participatory methodologies.

- **Customized Training based on Agricultural Experience:** Extension staff's prior farming experience should be considered while designing training programs. This will enable professionals from non-farming backgrounds to get the practical skills required to engage effectively with farming communities.
- **Provide Balanced Training for Supervisory and Administrative Roles:** While supervisory competencies require less attention, refresher courses are necessary to keep extension staff up to date on management, leadership, and coordination strategies in agricultural extension services.
- **Equitable Access to Training Opportunities:** The study found that administrative requirements for competence are not significantly influenced by qualifications, employment experience, or general agriculture experience, indicating equitably dispersed training needs. To retain a diverse workforce, extension organizations ought to make sure that all staff members have the same access to training programs, no matter what their degree or employment history.
- **Integrating Pragmatic with Conceptual Education Strategies**: Training programs should include hands-on field experiences, case studies, and interactive learning methods to reinforce both theoretical knowledge and practical abilities, especially in participatory extension strategies.
- **Policy Support for Continuous Professional Development:** Government and extension agencies should mandate regular training and competency evaluations to keep extension field staff up to date with emerging agricultural innovations and processes.

Incorporating these suggestions will help agricultural extension organizations address competence deficiencies, enhance the effectiveness of extension services, and ultimately boost farmer participation and agricultural output.

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