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SME Owners' Willingness to Adopt Renewable Energy Technologies for Socio-Economic Development: A Perspective for Policy Decision Makers

Khalil Ahmed[1], Asif Ali Shah[2], Arabella Bhutto[3], Zahid Hussain Sahito[4]

[1] Research Scholar, MUISTD, Mehran University of Engineering and Technology, Jamshoro, Sindh, Pakistan.
Email: palhkhalil@gmail.com
[2] Professor, MUISTD, Mehran University of Engineering and Technology, Jamshoro, Sindh, Pakistan.
Email: asifali.shah@faculty.muet.edu.pk
[3] Vice Chancellor, SABS University of Arts, Design and Heritage, Jamshoro, Pakistan.
Email: vc@sabsu.edu.pk, arabella.bhutto@faculty.muet.edu.pk.
[4] Research Scholar, MUISTD, Mehran University of Engineering and Technology, Jamshoro, Sindh, Pakistan.
Email: zahid.sahito1980@gmail.com

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ABSTRACT

This study investigates the willingness of small and medium enterprise (SME) owners and farmers in the rural Khairpur district of Sindh, Pakistan, to adopt clean energy initiatives (CEIs) in the agricultural sector. The research applies the Theory of Planned Behavior (TPB) to evaluate eight hypotheses related to attitudes, subjective norms, and perceived behavioural control (PBC) factors influencing the adoption of CEIs. Data was collected from 108 participants, and IBM SPSS was used for analysis. Key factors such as production quality, seasonal expenses, peer influence, market demand, and switching costs were examined. The results indicate that attitudes toward CEIs, such as improved production quality, lower seasonal expenses, and peer influence, positively impact the willingness to adopt CEIs. However, government policies and the diffusion of technologies were found to have an insignificant effect. The study concludes with policy recommendations aimed at facilitating the broader adoption of CEIs in agriculture to promote socio-economic development.

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Corresponding Author's Email: palhkhalil@gmail.com

1. Introduction

Agriculture has been a cornerstone of Pakistan's economy since its independence, playing a crucial role in its economic growth and transformation from a primarily agrarian society to a more industrialised economy (Ghani.U, 2022). As the most vital sector, agriculture accounts for nearly one-fifth of Pakistan's Gross Domestic Product (GDP), contributing around 19% to the national economy and employing approximately 45% of the country's labor force (Mirza, Najam, Mehdi, & Ahmad, 2015). This dual role—fueling economic growth and providing widespread employment—illustrates the sector's immense significance, especially in rural areas, where agriculture employs 38.5% of the population (Yaseen, Abbas, & Rehman, 2022). Nevertheless, the agriculture sector continues to struggle with persistent challenges, such as inefficient resource management, outdated agricultural techniques, and water shortages, despite its central role. In addition to being the leading supplier of industrial inputs, such as cotton, for the textile industry, Pakistan's agricultural sector is crucial to the country's ability to produce food. This, in turn, encourages industrial activity focused on exports and domestic markets. The agriculture sector plays a crucial role in contributing to Pakistan's economic and social stability due to its reliance on both domestic consumption and foreign trade (Zaman, Ishaq, & Niazi, 2021). However, a sizable segment of the labour force in agriculture is still underpaid and trapped in poverty. Even though over half of Pakistan's labour force works in agriculture, the reliance of many farmers, especially smallholders, on antiquated techniques that cannot keep up with contemporary agricultural innovations limits their ability to move up the economic ladder (Ali, Hakim, & Abdullah, 2017; Abdul Rehman & Hussain, 2016; Spielman, Malik, Dorosh, & Ahmad, 2017)

A significant fraction of women contribute to the agriculture sector in Pakistan (Mohiuddin et al., 2020). The agriculture sector holds vast potential to create jobs and ensure food security.

Pakistan has a vast potential to produce a huge amount of raw agricultural materials for industries and international exports, which highlights its larger economic dynamics (Jatoi, 2020). However, the agriculture system of Pakistan mainly depends on the consumption of traditional energy resources, which results in environmental degradation (Kaveh, Amiri Chayjan, Taghinezhad, Rasooli Sharabiani, & Motevali, 2020). A faster transition towards more sustainable-renewable energy technologies is needed. Agricultural carbon footprint might be significantly reduced while output and sustainability could be increased by transitioning to renewable energy technologies (RETs) (Chel & Kaushik, 2011; Mathur, Waswani, Singh, & Ranjan, 2022). To speed up this transition, it is essential to understand the elements that affect farmers' desire to adopt renewable energy technologies. Geographically, Pakistan holds immense potential for renewable energy resources in applications such as solar-powered irrigation systems and bioenergy, especially in areas like Sindh (Wang, Li, Haq, & Shahbaz, 2023). Despite its potential, a number of barriers create hurdles to adopting these technologies for decision-makers. The purpose of this study is to find the willingness of farmers to adopt renewable energy resources to improve the agriculture productivity in District Khairpur, Sindh, Pakistan. The agriculture is primary resource of population for livelihood in district Khairpur comprising of a number of rural areas like many rural regions in Pakistan. However, many of rural areas in Pakistan, such as, Khairpur district, having limited access to modern techniques and technologies, practice traditional methods in agriculture practices. Hence, the factors from the field survey and literature review were found that encourage or discourage the farmers in adopting renewable technologies. It was analyzed from the survey and literature that the solar-powered, photovoltaic (PV) pumps can optimize the agricultural productivity by providing constant, and cost-effective energy for pro and post-harvest processes. However, considering a number of variables, such as financial limitations, insufficient technical expertise, social pressures, and perceived risks related to adopting new technology, influence farmers' willingness to utilize modern technologies (Ahmed, Shaikh, & Shah, 2017). Therefore, the aim of this study is to find the factors that make farmers willing to adopt renewable energy technologies, and make them acceptable socially and how they are well-acknowledged. It was found that the government support in terms of finances and technology have a huge impact on farmers' to utilize renewable energy technologies. The public-private institutions must understand the dynamics to devise the policies to adopt renewabe energy technologies in agriculture sector and enable the socio-economic development of rural areas.

2. Research Hypotheses

In this study, some factors were considered and studied that influence an individual's behaviour towards clean energy technologies and its successful diffusion through the theory of planned behaviour (TPB). It was analysed how SME Owners behave in adopting renewable technologies. The three significant factors are studied: (i) perceived behavioural control (PBC), (ii) attitude towards the behaviour (AB), and (iii) subjective norms (SN) that can have an impact on an individual's behaviour (Ajzen, 1991). This research examines eight hypotheses based on the Theory of Planned Behaviour (TPB), each comprising three components.

2.1. SMEs' attitude towards behaviour

An individual's attitude towards utilising or investing in renewable energy technologies matters most (Conradie, De Ruyck, Saldien, & Ponnet, 2021; Gangakhedkar & Karthik, 2022; Halder, Pietarinen, Havu-Nuutinen, Pöllänen, & Pelkonen, 2016). The social acceptance of RETs is essential for its development and adoption, so for this, it is important to establish individuals' intention to utilise them. To promote this and make their intention clear, it is important to educate the public about the impacts of traditional methods on the environment and the financial benefits of RETs (Liobikienė, Dagiliūtė, & Juknys, 2021). Therefore, it was analysed that SME owners' and farmers' behaviour have a significant role in shaping their attitudes toward behaviour (AB). Their beliefs undoubtedly influence an individual's judgement of an action. With a positive outlook on renewable technologies, farmers and SMEs are more likely to integrate them into agricultural production (Conradie et al., 2021; Gangakhedkar & Karthik, 2022; Halder et al., 2016). The attitude refers to the general feelings towards using renewable technologies instead of replacing what is traditional with what is needed for better production. The following three factors are noteworthy to influence their behaviour:

1) Production Quality (2) Seasonal Expenses (3) Increase in Wages

Reviewing literature assists in comprehending that modern methods of cold storage, drying or heating improve product quality parallel to reducing the time taken compared to traditional methods (Lamidi, Jiang, Pathare, Wang, & Roskilly, 2019). Also, expenses falling under renewable technology are marginally associated with what damps in wastage and substandard quality with traditional (Chel & Kaushik, 2011; Wang et al., 2023). The two hypotheses are projected for the willingness of farmers & SME owners:

H1: The adoption of modern and renewable practices will enhance the quality of agricultural production.
H2: Reducing seasonal expenses and losses in the production cycle compared to Modern methods with renewable technologies will have a positive impact on SOW (SME Owners Willingness).

2.2. SMEs' subjective norms

Subjective norms, or the social pressure perceived by individuals to perform or avoid a specific behaviour, strongly influence intentions to adopt or invest in renewable energy technologies (Yun & Lee, 2015). It is mainly developed through public opinion, especially through influential groups or individuals such as local organisations, personal networks (family and friends), and fellow producers who share common beliefs. This can either promote or create hindrances in the willingness of SME owners to make the shift towards renewable technologies (Halder et al., 2016; Li, Li, & Wang, 2013; Yun & Lee, 2015).

In this study, it is assessed how subjective norms (SN) affect the willingness of SME proprietors by studying the three hypotheses and three associated sub-factors:

- Governmental Policies: Government policies, such as loans, regulations, and subsidies, are crucial in adopting renewable technologies. Farmers believe more in government initiatives to shift towards modern renewable technologies, and they are more likely to adopt these technologies when local organisations support them financially (Blazquez, Nezamuddin, & Zamrik, 2018; Ogunrinde, Shittu, & Dhanda, 2018).
- Governments must develop significant policies to use and innovate renewable energy sources through financial incentives, regulations, and other social factors. For a faster transition, market-driven mechanism is more effective. Additionally, the policymakers need to develop custom policies considering the regions and technologies required (Abban & Hasan, 2021; Marques, Fuinhas, & Pereira, 2019).
- Fellow farmers Influence (Friends, family and peer- -pressure) - In rural areas of Pakistan, where agriculture is a significant source of employment and the majority of the population relies heavily on agriculture for food, the majority of farmers follow the opinions of fellow farmers (Samman, 2000). Thus, the knowledge is disseminated through peers sharing their experiences and lessons with fellows to help them do well for their product (Blazquez, Nezamuddin, & Zamrik, 2018).
- Local market (Acceptance and incentivised space for improved qualities)- In the context of Pakistan, the adoption of new technologies in the agriculture sector depends on the demand for high-quality products in local markets, SOW is influenced and affected by the demand for improved quality products in local markets (Abban & Hasan, 2021).
  The three hypotheses are proposed For SN based on three sub-factors:

H3: Government interventions through different policy instruments for the diffusion of modern methods and renewable technologies have a positive impact on SOW.
H4: Fellow farmers' influence has a positive impact on SOW.
H5: Local agriculture market demand would have a positive impact on SOW.

3. Farmers' perceived behavioural control

The perceived ease or difficulty of executing a behavior, known as perceived behavioral control, significantly impacts intention, although its effect is usually moderate. Technical facilitating conditions can influence this perception (Yun & Lee, 2015). Perceived behavioral control (PBC) significantly influences the adoption of renewable energy technologies by boosting individuals' confidence in their capacity to adopt these innovations, positively impacting their intention. Factors such as technical facilitating conditions, health awareness, and social influence

reinforce this relationship. For policymakers and managers, leveraging these insights can enhance strategies to encourage renewable energy adoption (Mustafa, Zhang, Sohail, Rana, & Long, 2023; Yun & Lee, 2015).

For SME owners and farmers, PBC reflects their perception of control in adopting modern renewable technologies, shaped by resources, past experiences, and available information. Key factors influencing their beliefs include financial resources, adoption costs, incentives, sustainability, quality, and family finances. Accordingly, three hypotheses based on three sub-factors of PBC are proposed to explore the adoption of renewable technologies (Mustafa et al., 2023). Although farmers & SME owners have different sources with limited resources and finances, many still are pitiful. With increasing installation upfront costs, adopting modern methods affects willingness, thus lowering the FW factor. However, with the popularity of modern renewable technologies, the demand and diffusion can increase, leading to an increasing FW factor. The hesitation to change can give nightmares, thus farmers and SME owners rarely do not upgrade, fearing the prospects of change. Proper awareness training and local market demands for such technologies can change the rationale among farmers and SME owners. Therefore, the following three hypotheses are proposed.

H6: The additional SOWitching cost for modern methods and renewable technologies hurts SOW.
H7: Diffusion of these technologies on a trial basis will positively impact SOW.
H8: Modern methods of agriculture processing will positively impact willingness.

3.1. The structure of the model

The binary logistic regression is applied to independent variables against eight hypotheses, and SOW (SME and Farmer's willingness) is a defined variable, with SOWers gathered through “yes” or “no.”

3.1.1. Survey Design

The survey questionnaire was adopted from previous literature. The field visit was accompanied by the people involved in the agriculture sector of District Khairpur, Sindh, to test the instrument, and several discussions were carried out to modify the instrument and increase its scope. Among them, the majority were SME growers & farmers directly involved in production and selling.

The survey questionnaire was modified and revised based on the field experience gained through meeting discussions. Two volunteers were involved in the whole process of data collection and consultation meetings. Furthering the field visits and data collection process, including volunteers, contributed much to aid. The volunteers helped to cover the communication gap, relying on maximum care, so accurate data collection regarding respondents' demographic information should be obtained. Convenient and snowball sampling was used to collect the data mentioned above (Hair, 2005). This final questionnaire contained three specific steps to serve the purpose. These were:

Step 1: Initially, to develop trust among farmers and ease the whole interview process, growers were briefed about the study's scope and objectives and how they could benefit from it.
Step 2: Respondents were briefed on the advantages and benefits of renewable technologies available for agriculture production. Volunteers helped create an environment for a discussion comparing traditional drying processes with modern ones. A brief cost-benefit analysis was also discussed with farmers and SME owners.
Step 3: In the last stage of the interview, the respondents were asked to express their level of satisfaction with the current means of agriculture production and their willingness to adopt renewable-based technologies and other modern techniques.

3.2. Measurement instrument & Reliability

The questionnaire was adapted from prior studies on farmers' willingness and based on the three key components of the theory of planned behaviour (TPB)—attitude, subjective norm, and perceived behavioural control—using validated measures from the literature (Alam & Bhattacharyya, 2017). A five-point Likert scale was applied to assess the independent variables. The table (2) presents the mean and standard deviation values. The reliability of the questionnaire, tested using Cronbach's alpha (0.745), was appropriate for this exploratory study, as a value above 0.60 is acceptable (Li, Li, & Wang, 2013).

4. Results and Discussion

4.1. Demographics

The agricultural sector's acceptance of change is closely linked to age, with older farmers generally more resistant to adopting new technologies (Ren et al., 2023). The study grouped respondents into three age categories: young (under 30 years), middle-aged (30-50 years), and old (over 50 years). As Table 1 shows, 56% of respondents were middle-aged, 27.8% were young, and 16.7% were older. The younger group was the most willing to adopt modern post-harvest methods (Figurek, Morphi, & Thrassou, 2023).

4.2. Education

Pakistan's extremely low literacy rate is a significant factor behind its sluggish agricultural growth and declining economy (A Rehman, Jingdong, & Hussain, 2016). The neglect of education, particularly in rural regions, has resulted in insufficient human capital development, which continues to hinder the country's economic progress (Abdul Rehman, Jingdong, & Hussain, 2015). Over 75% of districts in Pakistan, including large sections of Balochistan and rural Sindh, suffer from low literacy rates. Rural Sindh, in particular, falls well behind urban areas and other provinces regarding educational attainment (Husain & Qasim, 2005). The literacy rate significantly affects a nation's economic development (Riasat, Atif, & Zaman, 2011). Education is a cornerstone for development, playing a critical role in influencing human behaviour and acceptance of new technologies. The study reveals that 34.3% of farmers have no formal education, 23.1% have only primary education, and 16.7% have matriculation qualifications. Additionally, 14.8% have a college degree, and 11.1% are university graduates. Education and age are major determinants in farmers' willingness to adopt renewable energy, with solar energy being the most popular choice (Tate, Mbzibain, & Ali, 2012). Most farmers in rural Sindh live in joint families, with more than 15 members, while 24.1% have smaller families of 0-5 members, highlighting the prevalence of combined family systems in the region.

Table 1: Demographics

	N	Per cent
Age		
Young (15-30 years)	30	27.8
Middle Aged (31-50 Years)	60	55.6
Old (Above 50)	18	16.7
Education		
No Formal Education	37	34.3
Primary	25	23.1
Metric	18	16.7
Enter	16	14.8
Masters	12	11.1
Family Size		
0 -5 Members	26	24.1
6 - 10 Members	43	39.8
10-15 Members	22	20.4
Above 15 Members	17	15.7
Farm Ownership		
Contracted	32	29.6
Owned	54	50.0
Both	22	20.4
Total	108	100.0

Table 2: Descriptions of variables

Factor	Hypothesis	Evaluation of variable	Mean	SD
Production Quality	H1/ X1	The adoption of modern and renewable practices will enhance the quality of agricultural production.	3.6	1.02
Seasonal Expenses	H2/ X2	Reducing seasonal expenses and losses in the production cycle compared to Modern methods with renewable technologies will have a positive impact on SOW (SME Owners Willingness).	3.9	1.45
Government Policies	H3/ X3	Government interventions through different policy instruments for diffusion of modern methods and renewable technologies have a positive impact on SOW.	2.3	0.96
Fellow farmers	H4/ X4	Fellow Farmers' influence has a positive impact on SOW.	4.3	1.34

influence				
Local market	H5/ Xt 5	Local agriculture market demand would have a positive impact on SOW.	4.2	0.89
Additional Costs	H6/ X6	The additional switching cost for modern methods and renewable technologies has a negative impact on SOW.	4.5	1.20

4.3. Family size

In rural regions where agriculture dominates as the main livelihood, most families live in combined households with large family sizes. According to the results (Table 1), 39.8% of farmers have 6-10 family members, 20.4% have 11-15 members, and 11.1% belong to other family-size groups.

Table 3

Diffusion	H7/ X7	Diffusion of these technologies on a trial basis will positively impact SOW.	2.516	0.746
Time Constraint	H8/ X8	Modern methods of agriculture processing will positively impact willingness.	3.156	0.578

Table 4: Variables in equation (1)

	Bi	S.E	Wald	d f	sig
X1	.444	.113	5.989	1	.012
X2	.541	.317	3.237	1	.040
X3	.016	.087	.064	1	.673
X4	.601	.149	10.645	1	.005
X5	.512	.341	3.425	1	0.024
X6	.323	.142	4.212	1	0.019
X7	.022	.080	.294	1	0.710
X8	0.446	.098	4.528	1	0.44
Constant	-.868	.669	3.010	1	.403

Table 5: Model Summary

Coxand Snell R2	Nagelkerke R2	χ2	Sig:
.397	.513	33.173	p=0.03

The hypothesis H1 was supported with "sig = 0.12" and Bi (.444). Compared with traditional processing techniques, modern and renewable methods of storage, heating, or drying have a positive impact on the quality of food and can also lead to farmers' willingness. The second hypothesis, H2, was supported with "sig = 0.040" and Bi (.541). Comparing modern methods with renewable technologies to reduce annual expenses and losses in the production cycle would have a positive impact on SOW because finance is a significant problem among local farmers. Third hypothesis H3 was rejected with "sig = 0.673" and Bi (.016). Government interventions through different policy instruments to diffuse modern methods and renewable technologies have a negative impact on SOW. The reasons for rejecting hypothesis H3 are the non-availability of government policies for the agriculture sector, improper loan distribution, and lack of government market mediation. The fourth hypothesis H4 and fifth hypothesis H5 were supported with "sig = 0.005, Bi (.601)" and "sig = 0.024, Bi (.512)." Fellow farmers' influence and local market demand are two major factors influencing SOW. In rural areas, farmers trust their fellow farmers and their local neighbours to make the majority of the decisions, and they are also their primary sources of knowledge. The hypothesis H6 was also accepted: "sig = 0.019" and Bi (.323). The majority of farmers cannot afford extra finances to test and experiment with new technologies, which puts an extra burden on them. Therefore, the additional Switching cost for modern methods and renewable technologies has a negative impact on SOW. The seventh hypothesis, H7, was also rejected with "sig = 0.710" and Bi (.022) since the diffusion of such technologies on a trial basis has a negative impact on SOW. Scalability and sustainability are two significant challenges for any new technology, so the lack of agri-extension services presents a hurdle to the successful diffusion of renewable technologies. Hypothesis H8 was accepted with "sig = 0.44" and Bi (.446), as reduced time with modern agricultural methods will have a positive impact on SOW. Monsoon rains are a significant threat to agriculture production in Pakistan. Therefore, renewable energy solutions can help increase productivity. Six of the eight hypotheses, H1, H2, H4, H5, H6, and H8, were supported and significantly impacted the SOW. Only two of the eight hypotheses, H3 and H7, were rejected and did not significantly impact the SOW.

5. Conclusion

This study examines the factors that determine the readiness of SME owners and farmers in rural Pakistan to undertake clean energy initiatives (CEIs). Employing the Theory of Planned Behaviour (TPB), eight hypotheses were proposed, and the findings indicate that six were validated, offering substantial insights into the factors influencing or obstructing adoption. Significant support was given to hypotheses H1 and H2, which dealt with attitudes about the advantages of CEIs. According to the study, farmers and SME owners were more inclined to use CEIs if they believed that implementing clean energy practices would enhance crop quality and reduce seasonal expenses due to the observable advantages that new clean energy techniques like solar-powered drying or heating offer in terms of efficiency and product quality, improved production quality (H1) had a significant positive impact. Similarly, it was thought to be beneficial to lower seasonal costs (H2) by utilising renewable energy for irrigation or storage because it results in higher profitability and decreased waste. Hypothesis H3 was rejected. It highlighted the lack of effective government support for supporting CEIs in the agricultural sector. Despite the potential for subsidies and loans to boost adoption, the study finds that inadequate policy frameworks and poor implementation of existing policies create hurdles. The lack of streamlined government support makes it difficult for farmers and SME owners to get financial resources or build confidence in the switch to renewable energy technologies.

Hypotheses H4 and H5 investigated the role of subjective norms, specifically the impact of other farmers and local market demand. Both assumptions were supported. Fellow farmers' opinions (H4) have a substantial impact on SME owners' decisions to use CEIs, especially in rural areas where peer recommendations and shared experiences are important in decision-making. Similarly, demand from local markets (H5) for higher-quality, more sustainable products enhances the inclination to use CEIs. These social elements show that community-based influence and market incentives are critical for encouraging clean energy adoption. Hypothesis H6, which addressed the perceived behavioural control factor of switching costs, also received substantial support. The substantial deterrent effect of the high upfront costs associated with transitioning to renewable energy technologies is evident. Despite the potential benefits of CEIs, the burden of these additional costs discourages most SME owners and producers from adopting them, as they face financial constraints in the absence of sufficient financial aid or incentives. Hypothesis H7, which pertains to the diffusion of CEIs on a trial basis, was denied. The results show that limited or experimental promotion of sustainable energy technologies is ineffectual in their widespread adoption and acceptance. This could be due to the lack of technical assistance and training for small-business owners and farmers. Hypothesis H8 was found supportive, which explains that adopting modern and clean energy practices enhances the possibility of saving time. By using clean energy technologies, the immediate advantages mitigate time restrictions in irrigation or post-harvest storage. Hence, the results show the importance of overcoming the financial and policy-related barriers hindering the adoption of CEIs. Governments must develop accessible policies for the provision of financial incentives and encourage communities to drive campaigns to adopt CEIs. The adoption of CEIs is essential for Pakistan's agriculture sector to reduce environmental impacts and is crucial for improving productivity and promoting socio-economic development in rural areas. This will result in sustainable agricultural practices and strengthen economic growth in the future.

5.1. Policy Recommendation

For the feasible transition towards renewable energy technologies, targeted subsidies and low-interest loans should be encouraged in the agriculture sector to reduce the financial burden on farmers and small- to medium-sized business owners. Grant programs or tax breaks can boost the adoption of CEIs.

Customised Policy Frameworks: The policies should be developed in view to meet the specific needs of farmers such as limited financial resources, lack of awareness, and shortcomings in infrastructure in rural areas like Khairpur. Local governments must work with agricultural stakeholders to develop policies that reflect the socioeconomic conditions of the specific areas.

Public-Private Partnerships (PPPs): The Public-private partnerships (PPPs) in providing technical assistance and training programs for farmers and small- and medium-sized business owners can speed up the advancement and spread of clean energy technologies through research, development, and implementation of renewable energy initiatives in agriculture.

Technical Assistance and Training Programs: The technical expertise necessary to implement and uphold sustainable energy technology is frequently lacking among agricultural producers and small to medium-enterprise proprietors.

It is analyzed that the governments need to develop training programs that expand farmers' skills and knowledge in using energy-efficient machinery, and bioenergy systems. It is important to establish technical support centres in rural areas.

Market-Based Incentives: The government need to incentivise local markets to support and widespread CEIs.

Improved Regulatory Environment: By streamlining the process of procuring financial assistance, ensuring an equitable distribution of loans and grants, and establishing an accountability mechanism for government support programs, the regulatory environment can be improved. In addition, policies should be implemented to protect producers from the exorbitant transition costs that frequently impede the implementation of CEIs.

Awareness Campaigns: The governments and private organizations need to launch awareness campaigns to educate the public, and SME proprietors about environmental and economic advantages of RETs. It can help in the long-term cost savings, enhance production quality, and contribute to national energy security.

Pilot Programs for CEIs: The government must establish such programs to ensure the successful adoption of RETs and such policies that help in its improvement and development in agriculture sector.

Strengthening Agri-Extension Services: Enhance agricultural extension services to serve as vital intermediaries between the government and farmers in facilitating the use of clean energy. These services include practical demonstrations of CEIs, technical guidance, and tailored counsel, assisting farmers in overcoming their hesitance to shift from conventional practices to contemporary, energy-efficient options.

Research and Development (R&D) Support: Allocate government funds to support research and development initiatives that are dedicated to the creation of renewable energy solutions that are both sustainable and affordable for small-scale farmers. Innovative, context-specific technologies that address the unique challenges of rural farming communities can be developed through collaborative research initiatives among academic institutions, private sector players, and government bodies.

5.2. Limitations

There are four limitations to this study:

- Due to time and resource constraints, this study was limited to the agriculture sector district of Khairpur, Sindh.
- Several factors can and might be affecting SOW, but only eight factors were studied.
- Simple binary logistic regression was used to infer results.
- Data Sample was limited due to the availability of farmers.

References

Abban, A. R., & Hasan, M. Z. (2021). Revisiting the determinants of renewable energy investment - New evidence from political and government ideology. *Energy Policy, 151*, 112184. doi:10.1016/j.enpol.2021.112184

Ahmed, K., Shaikh, S., & Shah, A. A. (2017, 10/2017). *Contributions of post-harvesting technologies in alleviating poverty: A case study of date palm cluster in Khairpur district, Sindh, Pakistan.* Paper presented at the 2017 IEEE Global Humanitarian Technology Conference (GHTC).

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211. doi:10.1016/0749-5978(91)90020-T

Alam, M., & Bhattacharyya, S. (2017). Are the off-grid customers ready to pay for electricity from the decentralized renewable hybrid mini-grids? A study of willingness to pay in rural Bangladesh. *Energy, 139*, 433-446. doi:10.1016/j.energy.2017.07.125

Ali, A., Hakim, R., & Abdullah, H. (2017). Relationship between Government spending on education and economic growth of Pakistan. *Asian Journal of Multidisciplinary Studies, 5*(2), 1-10.

Blazquez, J., Nezamuddin, N., & Zamrik, T. (2018). Economic policy instruments and market uncertainty: Exploring the impact on renewables adoption. *Renewable and Sustainable Energy Reviews, 94*, 224-233. doi:10.1016/j.rser.2018.05.050

Chel, A., & Kaushik, G. (2011). Renewable energy for sustainable agriculture. *Agronomy for Sustainable Development, 31*(1), 91-118. doi:10.1051/agro/2010029

Conradie, P. D., De Ruyck, O., Saldien, J., & Ponnet, K. (2021). Who wants to join a renewable energy community in Flanders? Applying an extended model of Theory of Planned Behaviour to understand intent to participate. *Energy Policy, 151*, 112121. doi:10.1016/j.enpol.2020.112121

Figurek, A., Morphi, K., & Thrassou, A. (2023). A Sustainable Risk Management Model and Instruments for Young Farmers in EU Agriculture. *Sustainability, 16*(1), 283. doi:10.3390/su16010283

Gangakhedkar, R., & Karthik, M. (2022). Behavioural Theories and Purchase Intention of Renewable Energy Technologies—A Meta-Analysis. *Journal of Infrastructure Development, 14*(2), 141-159. doi:10.1177/09749306221140737

Ghani.U. (2022). Sector Wise Contribution of Agriculture to the Economic Growth of Pakistan. *Global Journal of Humanities and Social Sciences Research*. doi:https://doi.org/10.59129/gjhssr.v2.i1.2022.3

Hair, J. F. (2005). Anderson, RE/Tatham, RL/Black, WC (1998): multivariate data analysis. *PrenticeYHall, Upper saddle river, NJ*.

Halder, P., Pietarinen, J., Havu-Nuutinen, S., Pöllänen, S., & Pelkonen, P. (2016). The Theory of Planned Behavior model and students' intentions to use bioenergy: A cross-cultural perspective. *Renewable Energy, 89*, 627-635. doi:10.1016/j.renene.2015.12.023

Husain, F., & Qasim, M. A. (2005). Inequality in the Literacy Levels in Pakistan: Existence and Changes Overtime. *South Asia Economic Journal, 6*(2), 251-264. doi:10.1177/139156140500600206

Jatoi, F. Z. (2020). Agriculture in Pakistan and it's impact on Economic growth. *SSRN Electronic Journal*. doi:10.2139/ssrn.3771914

Kaveh, M., Amiri Chayjan, R., Taghinezhad, E., Rasooli Sharabiani, V., & Motevali, A. (2020). Evaluation of specific energy consumption and GHG emissions for different drying methods (Case study: Pistacia Atlantica). *Journal of Cleaner Production, 259*, 120963. doi:10.1016/j.jclepro.2020.120963

Lamidi, R. O., Jiang, L., Pathare, P. B., Wang, Y. D., & Roskilly, A. P. (2019). Recent advances in sustainable drying of agricultural produce: A review. *Applied Energy, 233-234*, 367-385. doi:10.1016/j.apenergy.2018.10.044

Li, X., Li, H., & Wang, X. (2013). Farmers' willingness to convert traditional houses to solar houses in rural areas: A survey of 465 households in Chongqing, China. *Energy Policy, 63*, 882-886. doi:10.1016/j.enpol.2013.09.004

Liobikienė, G., Dagiliūtė, R., & Juknys, R. (2021). The determinants of renewable energy usage intentions using theory of planned behaviour approach. *Renewable Energy, 170*, 587-594. doi:10.1016/j.renene.2021.01.152

Marques, A. C., Fuinhas, J. A., & Pereira, D. S. (2019). The dynamics of the short and long-run effects of public policies supporting renewable energy: A comparative study of installed capacity and electricity generation. *Economic Analysis and Policy, 63*, 188-206. doi:10.1016/j.eap.2019.06.004

Mathur, S., Waswani, H., Singh, D., & Ranjan, R. (2022). Alternative Fuels for Agriculture Sustainability: Carbon Footprint and Economic Feasibility. *AgriEngineering, 4*(4), 993-1015. doi:10.3390/agriengineering4040063

Mirza, F. M., Najam, N., Mehdi, M., & Ahmad, B. (2015). Determinants of technical efficiency of wheat farms in Pakistan. *Pakistan Journal of Agricultural Sciences, 52*(2), 565-570.

Mohiuddin, I., Kamran, M. A., Jalilov, S.-M., Ahmad, M.-u.-D., Adil, S. A., Ullah, R., & Khaliq, T. (2020). Scale and Drivers of Female Agricultural Labor: Evidence from Pakistan. *Sustainability, 12*(16), 6633. doi:10.3390/su12166633

Mustafa, S., Zhang, W., Sohail, M. T., Rana, S., & Long, Y. (2023). A moderated mediation model to predict the adoption intention of renewable wind energy in developing countries. *PLOS ONE, 18*(3), e0281963. doi:10.1371/journal.pone.0281963

Ogunrinde, O., Shittu, E., & Dhanda, K. K. (2018). Investing in Renewable Energy: Reconciling Regional Policy With Renewable Energy Growth. *IEEE Engineering Management Review, 46*(4), 103-111. doi:10.1109/EMR.2018.2880445

Rehman, A., & Hussain, I. (2016). Agricultural and economic development in Pakistan and its comparison with China, India, Japan, Russia and Bangladesh. *Andamios. Revista de Investigación Social, 12*(1), 180-188.

Rehman, A., Jingdong, L., & Hussain, I. (2015). The province-wise literacy rate in Pakistan and its impact on the economy. *Pacific Science Review B: Humanities and Social Sciences, 1*(3), 140-144. doi:10.1016/j.psrb.2016.09.001

Rehman, A., Jingdong, L., & Hussain, I. (2016). Literacy Rate in Pakistan, Province Wise and its Impact on Economy. *ANDAMIOS, 13*(1), 23-38.

Ren, C., Zhou, X., Wang, C., Guo, Y., Diao, Y., Shen, S., . . . Gu, B. (2023). Ageing threatens sustainability of smallholder farming in China. *Nature, 616*(7955), 96-103. doi:10.1038/s41586-023-05738-w

Riasat, S., Atif, R. M., & Zaman, K. (2011). Measuring the impact of educational expenditures on economic growth: evidence from Pakistan. *Educational Research, 2*(13), 1839-1846.

Samman, G. F. a. E. (2000). The importance of the post-production sector to sustainable rural livelihoods. *GASGA Seminar* 9-20.

Spielman, D. J., Malik, S. J., Dorosh, P., & Ahmad, N. (2017). *Agriculture and the Rural Economy in Pakistan: Issues, Outlooks, and Policy Priorities*. Philadelphia: University of Pennsylvania Press.

Tate, G., Mbzibain, A., & Ali, S. (2012). A comparison of the drivers influencing farmers' adoption of enterprises associated with renewable energy. *Energy Policy, 49*, 400-409. doi:10.1016/j.enpol.2012.06.043

Wang, J., Li, W., Haq, S. U., & Shahbaz, P. (2023). Adoption of Renewable Energy Technology on Farms for Sustainable and Efficient Production: Exploring the Role of Entrepreneurial Orientation, Farmer Perception and Government Policies. *Sustainability, 15*(7), 5611. doi:10.3390/su15075611

Yaseen, T., Abbas, A., & Rehman, A. (2022). ISSUES AND SOLUTIONS OF THE AGRICULTURE SECTOR OF PAKISTAN TO INCREASE PRODUCTIVITY. *Biological and Agricultural Sciences Research Journal, 2022*(1), 1. doi:10.54112/basrj.v2022i1.1

Yun, S., & Lee, J. (2015). Advancing societal readiness toward renewable energy system adoption with a socio-technical perspective. *Technological Forecasting and Social Change, 95*, 170-181. doi:10.1016/j.techfore.2015.01.016

Zaman, S. B., Ishaq, M., & Niazi, M. A. (2021). Contribution of Agriculture Sector in Economic Growth of Pakistan: An Empirical Analysis. *Journal of Applied Economics and Business Studies, 5*(2), 103-120. doi:10.34260/jaebs.527