

International Journal of Agriculture Extension and Social Development

Volume 9; Issue 4; April 2026; Page No. 204-209

Received: 19-02-2026
Accepted: 23-03-2026

Indexed Journal
Peer Reviewed Journal

Barriers and drivers: Understanding the rural households and farmers knowledge on solar technology and its adoption

¹Swetha Kodali, ²R Neela Rani, ³Nomula Prathyusha, ⁴Jesse W Sunitha, ⁵Lakshmi Challa and ⁶G Swaroopa Rani

¹Scientist (FRM), AICRP-WIA., PG&RC, PJTAU-Rajendranagar, Hyderabad, Telangana, India

²Principal Scientist (EXTN), AICRP-WIA., PG&RC, PJTAU-Rajendranagar, Hyderabad, Telangana, India

³Young Professional-1, AICRP-WIA., PG&RC, PJTAU-Rajendranagar, Hyderabad, Telangana, India

⁴Scientist (FN), AICRP-WIA., PG&RC, PJTAU-Rajendranagar, Hyderabad, Telangana, India

⁵Scientist (CT), AICRP-WIA., PG&RC, PJTAU-Rajendranagar, Hyderabad, Telangana, India

⁶Scientist (CD), AICRP-WIA., PG&RC, PJTAU-Rajendranagar, Hyderabad, Telangana, India

DOI: <https://www.doi.org/10.33545/26180723.2026.v9.i4c.3472>

Corresponding Author: Swetha Kodali

Abstract

The knowledge levels of rural farm women and households on solar technology was studied to evaluate the role of solar technology in farm and household activities. Exploratory research design and Random sampling technique was used for the study. The results revealed that education level has a significant influence on awareness of solar technology. Farmers with higher levels of education were more aware of solar-based irrigation systems, government subsidies, and operational benefits compared to illiterate and primary-educated farmers. Farmers with secondary and higher education levels expressed greater satisfaction due to better understanding of system operation, maintenance, and long-term benefits. The findings emphasize the importance of educational interventions and capacity-building programs to enhance effective adoption of solar technologies among farmers. As the training programs can be extended in duration and customized to the specific needs of rural women, focusing on maintenance and practical applications of solar technology in agriculture and households. The study emphasizes the role of woman, who can make her community adopt solar technology as a logical step for economic and environmental longevity focusing on Gender specific knowledge and gaps on solar technology. The study suggest that, there is a need for progress solar technology awareness, launch of public awareness campaigns, offer government incentives like subsidies and tax benefits, and promote rooftop and community solar installations.

Keywords: Solar, technology, knowledge, rural, adoption

Introduction

Access to sustainable energy plays a crucial role in improving the quality of life in rural areas, particularly for women who are the primary managers of household energy. Solar technology offers a clean, cost-effective, and reliable alternative to conventional energy sources; however, its adoption largely depends on the level of awareness and understanding among rural women. The present study aims to assess the awareness, knowledge, and perception of solar technology among rural women and to identify factors influencing its adoption. A descriptive research design was employed, and data were collected from rural women using a structured interview schedule.

Energy is a vital component of rural development and plays a significant role in improving the living standards of households. In rural areas, women are the primary users and managers of household energy for cooking, lighting, and other domestic activities. Dependence on traditional energy sources such as firewood and kerosene not only affects women's health but also contributes to environmental degradation. Solar technology provides a clean, renewable,

and cost-effective energy solution that can reduce drudgery, save time, and improve the quality of life of rural women. However, the successful adoption of solar technology largely depends on the level of awareness, knowledge, and accessibility among rural women. Understanding their awareness and perception is essential for promoting sustainable energy practices and empowering women in rural communities.

Energy access is a key factor in rural development and women's empowerment. In Telangana, a large proportion of rural households depend on traditional energy sources such as firewood and kerosene for cooking and lighting, which places a heavy burden on women. Solar technologies such as solar lamps, solar home lighting systems, and solar pumps have the potential to reduce energy poverty, improve health conditions, and enhance livelihood opportunities for rural women. However, the adoption of these technologies remains uneven due to limited awareness, inadequate information, and socio-economic constraints. Assessing the level of awareness of solar technology among rural women in Telangana is essential for designing effective extension

strategies and ensuring inclusive and sustainable energy development.

In most of the rural areas, awareness and usage of solar energy for agriculture and reliability, and environmental advantages but adoption is quite limited due to lack of knowledge and high initial investment. Government support, better community-level education and demonstrating concrete results through pilot projects are crucial for wider adoption. Successful policies often rely on word-of-mouth and community led initiatives rather than merely on subsidies. Solar power lowers energy costs from diesel or grid electricity for pumps, processing, and lighting. Solar power provides a dependable energy source in areas where the grid is unreliable or non-existent. It is a clean, renewable alternative to fossil fuels, reducing greenhouse gas emissions and air pollution. Solar energy can automate processes like irrigation, ventilation, and post-harvest drying, which saves labour and increases efficiency. Many farmers are not aware of the available technologies, their benefits, or the potential for integration with their existing practices. A lack of local technical expertise for installation, maintenance, and repair can deter adoption. Seeing solar technology work successfully on a neighbour farm or in a local demonstration area is more convincing than a seminar alone. Integrating solar technology with traditional farming knowledge can make it more acceptable and sustainable.

Review of Literature

The review of literature relevant to the present study regarding the Awareness of Solar Technology among Rural Women in Telangana” is presented under the following sub-headings.

1.1 Energy, Gender and Rural Development

Energy plays a significant role in improving the quality of life and socio-economic status of rural households. Women are the primary managers of household energy in rural areas, and their dependence on traditional fuels such as firewood and kerosene increases drudgery and health risks. World Bank (2011) ^[13] reported that access to clean and modern energy sources significantly reduced women's workload and exposure to indoor air pollution, leading to better health and social well-being. Clancy *et al.* (2012) ^[2] emphasized that gender-sensitive energy interventions enhance women's participation in economic and social activities. Reddy and Nathan (2013) ^[10] observed that renewable energy technologies contribute to women's empowerment by saving time and improving household efficiency in rural areas.

1.2 Solar Technology Initiatives in India and Telangana

India has made considerable progress in promoting solar energy through various national applications in rural areas. And state-level initiatives. The Government of India introduced the PM-KUSUM scheme to encourage decentralized solar power generation, solar pumps, and off-grid solar.

1.3 Awareness of Solar Technology among Rural Women

Awareness is a prerequisite for the adoption of any new technology. Several studies indicate that rural women

possess limited awareness regarding solar technologies beyond basic applications.

Kumar and Rani (2017) found that rural women were aware mainly of solar lamps and solar street lights, while awareness about solar cookers and solar water heaters was low. Meena *et al.* (2019) ^[6] reported that lack of technical knowledge and inadequate demonstrations restricted the effective adoption of solar technology among rural women. Patil and Deshmukh (2020) ^[8] observed that women exposed to extension activities had higher awareness levels compared to those without extension contact.

1.4 Factors Influencing Awareness and Adoption of Solar Technology

Awareness and adoption of solar technology are influenced by various socio-economic and institutional factors. Singh *et al.* (2018) ^[11] reported that education, income, access to information sources, and training programs significantly influenced awareness of solar technology among rural women. Devi and Lal (2020) found that women's decision-making power within households played a crucial role in the adoption of solar technologies. Rao and Suresh (2021) ^[9] emphasized that availability of subsidies, credit facilities, and after-sales services positively affected adoption behaviour.

1.5 Role of Extension Agencies and Self Help Groups

Extension education and Self Help Groups (SHGs) play a vital role in disseminating information about renewable energy technologies among rural women.

Swaminathan (2016) ^[12] reported that women-centered extension programs improved awareness and skill development related to renewable energy technologies. Lakshmi and Rao (2019) ^[5] observed that SHG meetings served as effective platforms for sharing information on solar energy schemes and subsidies. Narender *et al.* (2022) ^[7] noted that training and demonstrations conducted through SHGs in Telangana significantly enhanced awareness and positive attitudes towards solar technology.

Ahmar *et al.* (2022) ^[1] found that household wealth and education levels had a highly significant positive impact on the adoption of solar energy technology in Ethiopia. The solar technology and energy development future in Rwanda and Uganda. In these two countries, solar energy sector plays an important role in supporting socio-economic development. Finally, the challenges and opportunities facing Rwanda and Uganda in development of solar energy are presented in this study (Jean Baptiste *et al.*, 2018)

Abdullah *et al.* (2017) assessed the level of awareness, adoption and barriers as related to solar PV system in Akure by assessing one hundred and fifty residential buildings randomly with a structured questionnaire administered to the occupants. The findings revealed that large percentage of the residential constructions make use of diesel or petrol generating set as an alternative to the national grid, that the level of awareness of solar photo voltaic is low, the willingness to adopt is high but it's hindered by cost implication of the system. Findings contribute to the growing literature in the adoption of renewable energy for electricity generation, highlighted the major barriers hindering this effective solution to be proffer.

Shubojit Dawn (2016) ^[19] analysed the recent trends in the

development of solar energy in India. The study proposes that climate change and its consequences of natural disasters are mainly due to increased rate of carbon emissions and its outcomes associated with greenhouse effect. The only way to overcome or to reduce this disaster is to cut down the level of greenhouse gases by using green energy resources like solar and wind mill energy resources. The encouraging fact is that Global capacity of solar photovoltaic energy generation is increased from 3.7 GW to 177 GW during the time interval of 2004 to 2014 in India.

The economic and environmental benefits of solar technology generation in developing countries explored about the problems should and created a very strong incentive to develop domestically available renewable resource. Solar energy has been a defined, as perhaps the best near indigenous resource to meet the energy needs of this great giant country by Michal *et.al* (2013)

Venkattakumar *et al.* (2009) [20] emphasized the role of improved technologies in increasing agricultural productivity. Research indicates that SPIS can significantly reduce operational costs and promote better water management techniques, such as drip irrigation, thereby conserving water resources. The Food and Agriculture Organization (FAO) has also noted the high return on investment for farmer's post-loan repayment for these systems.

Materials and Methods

Exploratory research design was adopted to conduct the study in Rangareddy District. Random sampling technique was used for the study as investigator was familiar with local language that would help to build good rapport with respondents of the study and enables to conduct the survey efficiently. A questionnaire was developed for the study and total of thirty samples were selected for the study.

Results and Discussion

This chapter highlights the findings of the investigation and their interpretation. After collecting the data with regard to the objectives, profile characteristics of respondents, awareness level in relation to solar technology. The results thus obtained are presented along with the interpretations under the following sections.

General profile of the respondents

This section deals with the findings and discussion regarding the profile characteristics of the respondents from Rangareddy district in Telangana. This refers to the information like Age, Education, Gender, Education and Occupation of the head of the family.

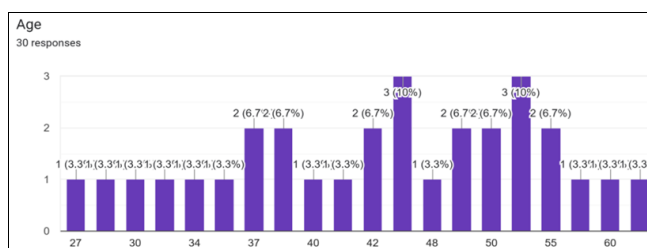


Fig 1: Distribution of respondents according to the Age

The figure.1 revealed that 10 per cent of the respondents were about 45 to 52 age group and equal amount i.e. 6.7 per cent of the respondents belongs to 37, 39,49,50,55 ages. Very negligible per cent i.e. 3.3per cent belongs to 27 to 36 age.

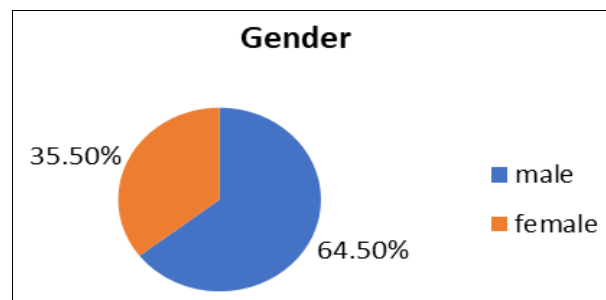


Fig 2: Distribution of respondents according to the Gender

The figure 2. shows about the distribution of respondents according to the gender. Maximum 64 per cent of the respondents were male and only 35.5 per cent were female.

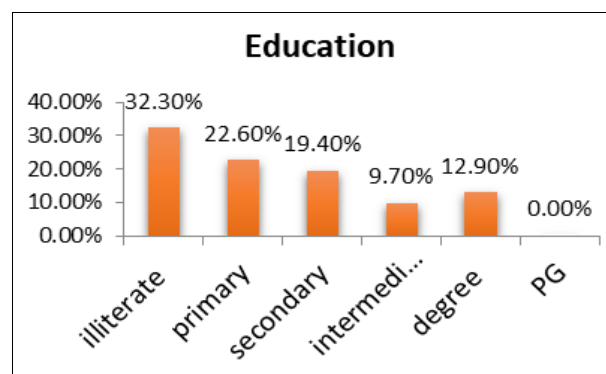


Fig 3: Distribution of respondents according to the Education

The figure 3. Explains about the distribution of respondents according to their education level. Maximum about 32 per cent of the respondents were illiterate followed by 22 per cent of the respondents i.e. 22 per cent primary level and only 4 per cent were post graduates among all the respondents.

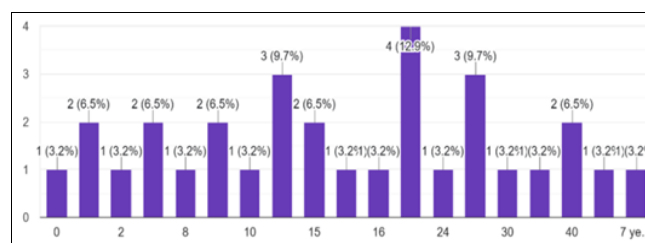


Fig 4: Distribution of respondents according to the years of experience in Agriculture

The figure 4. Revealed about the distribution of respondents according to the years of experience in agriculture. Maximum 12.9 per cent had a range of 17 to 23 years of experience and an equal per cent (9.7%) of 11 to 14 and 25 to 29 years of experience was observed among all the respondents.

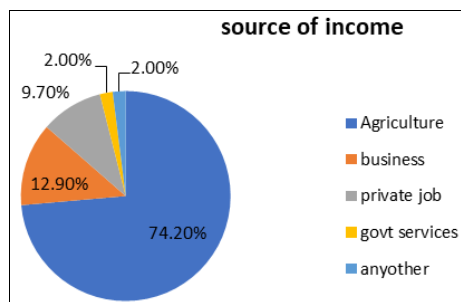


Fig 5: Distribution of respondents according to the source of income

The figure 5. Revealed about the distribution of respondents according to the source of income in the household. High proportion of respondents depended on agriculture (74.2%) followed by business (12.9%) and moved to private job only 9.7per cent. Very negligible per cent income source was government service and any other.

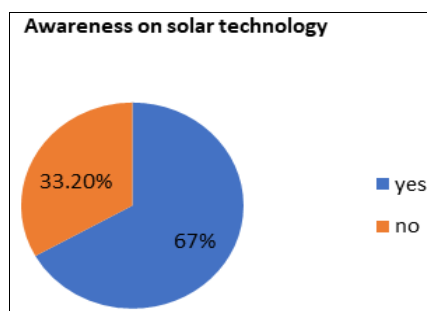


Fig 6: Distribution of respondents according to the awareness of solar technology

The figure 6. Explains about the distribution of respondents according to the awareness of solar technology. High proportion of respondent's i.e.67.7 per cent was aware of solar technology and only 32.3 per cent were not aware.

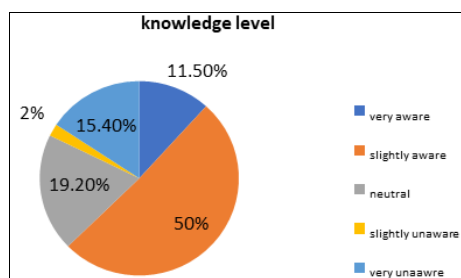


Fig 7: Distribution of respondents according to the Level of knowledge

The figure 7.explains about the knowledge level of benefits and applications of solar technology in agriculture. Half of the proportion (50per cent) were slightly aware and only 19.20per cent of the respondents were neutral. Very negligible proportion i.e.2per cent were slightly unaware about solar technology benefits.

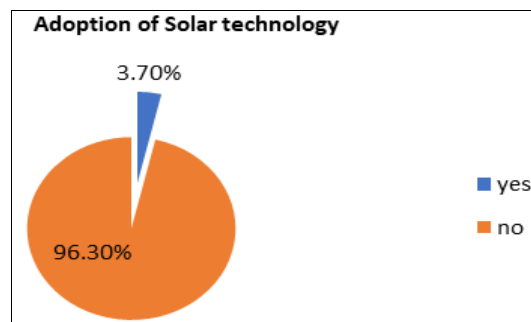


Fig 8: Distribution of respondents according to the adoption of solar technology

The figure 8.revealed that the majority (96.30per cent) of the respondents were not adopted solar technology in agriculture. Very negligible proportion i.e.3.70per cent were adopted solar technology in farming practices.

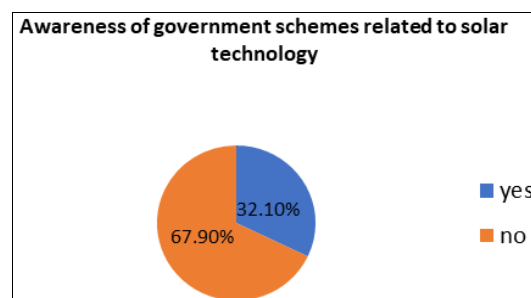


Fig 9: Distribution of respondents according to the awareness of government schemes related to solar technology

The figure 9.revealed that above half of the respondents i.e. 67.90per cent were not aware of government schemes and subsidies related to solar technology in agriculture. Low proportion i.e.32.10per cent were aware.

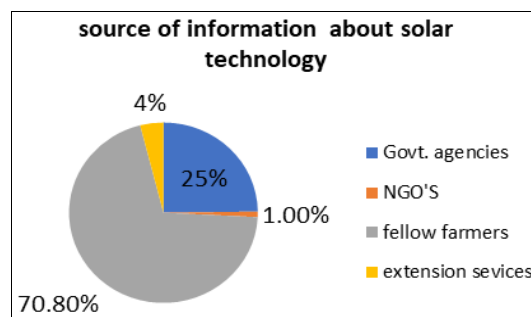


Fig 10: Distribution of respondents according to the source of information about solar technology

The figure 10.revealed that majority of the respondents i.e. 70.80per cent got the information from fellow farmers related to solar technology in agriculture and very low proportion i.e. 25per cent got the information from Government agencies. Negligible proportion only 1per cent received information from NGO's.

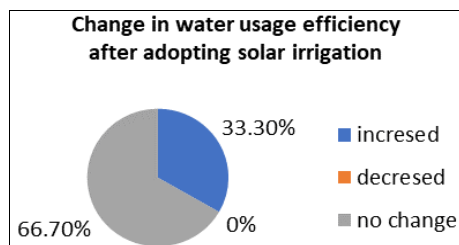


Fig 11: Distribution of respondents according to the Change in water usage efficiency after adopting solar irrigation

The figure 11.revealed that majority of the respondents i.e. 66.70per cent expressed as no change after adoption. Low proportion i.e. 33.3per cent expressed that increased water usage efficiency after adopting solar irrigation.

Chi-square test

It is used to determine if there is a statistically significant association between two categorical variables (e.g., is there a relationship between education level and knowledge level)

Level of significance: 5% ($\alpha = 0.05$)

If p-value < 0.05 → Reject H_0

If p-value > 0.05 → Accept H_0

Table 1: chi square values of variables

Variables	p-value	Result
Gender and Overall Satisfaction with Solar Technology	0.07	NS
Education Level and Awareness of Solar Technology	0.03	S
Education Level and Satisfaction with Solar Technology	0.02	S
Agricultural Experience and Awareness of Solar Technology	0.03	S

1. Gender and Overall Satisfaction with Solar Technology

The Chi-square test analysis value is 0.07 revealed that gender had no significant association with overall satisfaction towards solar technology adoption. This indicates that satisfaction levels among farmers are independent of gender, and both male and female farmers perceive solar technology in a similar manner. Gender does not influence satisfaction towards solar technology adoption.

2. Education Level and Awareness of Solar Technology

The Chi-square test analysis value is 0.03 revealed that education level had a significant influence on awareness of solar technology. Farmers with higher education levels showed better awareness compared to illiterate and primary-educated farmers. Indicating that education plays a crucial role in improving awareness of solar technology adoption.

3. Education Level and Satisfaction with Solar Technology

The Chi-square analysis value is 0.02 revealed that there is a significant association between education level and satisfaction. Farmers with secondary and higher education levels expressed greater satisfaction due to better understanding of operation, maintenance, and benefits of

solar technology.

4. Agricultural Experience and Awareness of Solar Technology

Years of Agricultural Experience and Awareness of Solar Technology Chi-square test analysis value is 0.03 revealed that there is a significant association between years of agricultural experience and awareness of solar technology. Farmers with moderate to higher years of farming experience exhibited greater awareness of solar irrigation systems, their benefits, and government support schemes compared to farmers with fewer years of experience. Experienced farmers are more exposed to extension activities, demonstrations, peer learning, and institutional support, which may enhance their awareness and understanding of renewable energy technologies in agriculture. In contrast, farmers with limited experience showed comparatively lower awareness, possibly due to reduced exposure to information sources and practical learning opportunities.

Suggestions for improvement of solar technology adoption

- Measures could be taken to promote wider adoption of solar technology
- Improve government schemes and policies related to solar in agriculture
- Recommend for overcoming technical or financial barriers
- Enhance training and awareness programmes

Conclusion

From this research study it was concluded that the maximum of the respondents (67.7%) were aware about solar technology. The results indicate that education level has a significant influence on awareness of solar technology. Farmers with higher levels of education were more aware of solar-based irrigation systems, government subsidies, and operational benefits compared to illiterate and primary-educated farmers. Farmers with secondary and higher education levels expressed greater satisfaction due to better understanding of system operation, maintenance, and long-term benefits. Lower satisfaction among less-educated farmers may be due to technical difficulties or lack of proper training. The Chi-square analysis highlights that education is the key factors influencing awareness, satisfaction, and benefits of solar technology adoption, whereas gender does not play a significant role in determining income impact. These findings emphasize the importance of educational interventions and capacity-building programs to enhance effective adoption of solar technologies among farmers. To progress solar technology awareness, launch public awareness campaigns, offer government incentives like subsidies and tax benefits, and promote rooftop and community solar installations.

Acknowledgements

The authors would like to express gratitude to the farmers and households for their participation in the study.

Disclosure statement

No potential conflict of interest was reported by the

author(s).

References

1. Ahmar S. Determinants of household adoption of solar energy technology in Ethiopia: A comprehensive analysis. *Renewable and Sustainable Energy Reviews*. 2022;95:107-120.
2. Clancy J, Oparaocha S, Roehr U. Gender equity and renewable energies. Background paper prepared for the International Conference on Renewable Energies, Bonn, Germany. 2004:40.
3. ENERGIA. Women's energy entrepreneurship: A framework for sustainable development. ENERGIA International Network on Gender and Sustainable Energy, Netherlands. 2020.
4. Johnson OW, Han JYC, Knight AL, Mortensen S, Aung MT, Boyland M. Intersectionality and energy transitions: A review of gender, social equity and low-carbon energy. *Energy Research and Social Science*. 2020;70:101774.
5. Lakshmi K, Rao S. Role of Self Help Groups in dissemination of renewable energy technologies among rural women. *Indian Journal of Extension Education*. 2019;55(3):45-49.
6. Meena ML, Singh P, Sharma R. Awareness and attitude of rural households towards solar energy utilization. *Journal of Community Mobilization and Sustainable Development*. 2019;14(2):210-215.
7. Narender R, Srinivas K, Reddy BS. Impact of SHG-based training programmes on awareness of solar technology among rural women in Telangana. *Journal of Extension Education*. 2022;34(4):6895-6901.
8. Patil SS, Deshmukh PR. Adoption behaviour of rural women towards solar energy technologies. *Maharashtra Journal of Extension Education*. 2020;39(1):72-76.
9. Rao KV, Suresh A. Factors influencing adoption of solar energy technologies in rural households. *Indian Journal of Agricultural Economics*. 2021;76(3):385-392.
10. Reddy AKN, Nathan HSK. Energy, poverty and gender: A synthesis. *Economic and Political Weekly*. 2013;48(18):51-58.
11. Singh R, Verma S, Yadav VP. Determinants of awareness of renewable energy technologies among rural women. *Indian Research Journal of Extension Education*. 2018;18(2):1-6.
12. Swaminathan MS. Empowering rural women through extension education. Indian Council of Agricultural Research, New Delhi. 2016.
13. World Bank. World development report 2012: Gender equality and development. World Bank, Washington, D.C. 2012.
14. Mutabaruka JBR, Mutabaruka A. A review of the solar energy situation in Rwanda and Uganda. *Environmental Science, Economics, Engineering*. 2018.
15. Kamalapur GD, Udaykumar RY. Feasibility assessment of photovoltaic solar home systems as a rural electrification solution in India. *International Journal of Electrical Power & Energy Systems*. 2011;33(4):579-584.
16. Omer AM. Energy and sustainable development in rural Sudan. *Renewable and Sustainable Energy Reviews*. 2007;11(5):863-895.
17. Pirasteh G, Saidur R, Rahman SMA, Rahim NA. A review on development of solar drying applications. *Renewable and Sustainable Energy Reviews*. 2014;31:133-148.
18. Sharma NK. Solar energy in India: Strategies, policies, and future potential. *Renewable and Sustainable Energy Reviews*. 2012;16(1):606-616.
19. Dawn S, Tiwari P, Goswamy AK, Mishra M. Recent development of solar energy in India: Perspectives, strategies and goals. *Renewable and Sustainable Energy Reviews*. 2016:215-235.
20. Venkattakumar R. Dissemination of improved technologies for increasing agricultural productivity. *Journal of Agricultural Extension Management*. 2009;6(1):2319-1473.