International Journal of Science, Environment and Technology, Vol. 15, No 1, 2026, 47 – 57

ISSN 2278-3687 (O)
2277-663X (P)

ASSESSING THE IMPACT OF TRAINING ON POULTRY FARMING PRACTICES IN TRIBAL AND NON-TRIBAL REGIONS OF HIMACHAL PRADESH, INDIA

Devesh Thakur[1]*, Rakesh Ahuja[1], Manoj Sharma[1], Krishanender Dinesh[2], Niharika Thakur[3], Madhu Suman Sambyal[4] and Sanjay Kumar Khurana[1]

[1]Dept. of Veterinary and Animal Husbandry Extension Education, Dr. G.C. Negi College of Veterinary and Animal Sciences, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Himachal Pradesh (176 062), India

[2]Dept. of Animal Genetics and Breeding, Dr. G.C. Negi College of Veterinary and Animal Sciences, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Himachal Pradesh (176 062), India

[3]Veterinary officer Regional Research and Training Centre, Talwara, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab (144 222), India

[4]Dept. of Animal Nutrition, Dr. G.C. Negi College of Veterinary and Animal Sciences, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Himachal Pradesh (176 062), India

E-mail: drdth4@gmail.com

Abstract: The study was conducted from August 2024 to October 2024 in the districts of Kangra and Lahaul & Spiti in Himachal Pradesh, India to evaluate the impact of training programs on improving the knowledge regarding scientific poultry farming practices among tribal and non-tribal farmers. India is the world's second-largest egg producer, yet backyard poultry farming remains underdeveloped in many regions, particularly in the Himalayan state of Himachal Pradesh. Limited access to improved breeds, inadequate technical knowledge, and challenging terrains hinder the growth of backyard poultry in this state. A pre-test and post-test experimental design was adopted, and a total of 80 backyard poultry farmers (40 tribal and 40 non-tribal) were purposively selected based on their willingness to participate in the training program. The training focused on five key domains: breeding, housing, health management, feeding practices, and general management. Semi-structured interviews were conducted before and after the training to assess changes in knowledge levels. The findings revealed significant improvements in knowledge levels among both tribal and non-tribal farmers, particularly in breeding, housing, and health management practices. Despite having lower baseline knowledge, tribal farmers exhibited substantial gains post-training, highlighting the effectiveness of customized training programs in addressing geographical and socio-cultural challenges. The study concludes that well-structured training programs and scientific interventions play a crucial role in bridging knowledge gaps, enhancing productivity, improving income levels, and strengthening nutritional security, particularly in tribal and underdeveloped regions of Himachal Pradesh.

Keywords: Backyard poultry, Training impact, Knowledge adoption, Himachal Pradesh

*Received Jan 16, 2026 * Published Feb 9, 2026 * www.ijset.net*

1. INTRODUCTION

India ranks second globally in egg production, with an annual output of 142.77 billion eggs in 2023–24 (Anonymous, 2023). The poultry sector comprises an organized commercial segment, accounting for 80% of production, and an unorganized backyard poultry sector, contributing 20% (Chauhan et al., 2024). While commercial poultry has grown due to advancements in genetics, feed technology, and disease management, backyard poultry remains vital for rural livelihoods, particularly in ecologically sensitive and economically marginalized regions such as the Indian Himalayas (Singh et al., 2023).

Backyard poultry farming involves rearing native or locally adapted breeds under traditional extensive systems with minimal inputs. It plays a significant role in household nutrition (Gupta et al., 2021, Krishnaveni et al., 2020), provides economic opportunities for marginalized communities (Rajyalakshmi et al., 2023), and empowers rural women (Padhi, 2016; Rathod, 2020). Compared to commercial poultry, backyard systems have a lower environmental footprint due to reduced resource requirements and lower greenhouse gas emissions (Wong et al., 2017). Additionally, it serves as a financial safety net for rural households, offering income diversification during crop failures or economic distress (Maske, 2019; Das and Samanta, 2021).

Despite its benefits, backyard poultry farming remains underdeveloped in India, particularly in Himachal Pradesh, a Himalayan state characterized by difficult terrain, limited market access, and climatic constraints. The state's per capita egg consumption is only 12 eggs annually—12% of the national average (Anonymous, 2023). Several factors hinder its growth, including limited access to improved breeds, poor technical knowledge, inadequate disease management, and restricted extension services (Thakur et al., 2020; Dinesh et al., 2024). The mountainous landscape exacerbates these challenges, making transportation and market linkages for poultry products difficult (Saikiran et al., 2025). Given these constraints, conventional commercial poultry models, which require significant capital and infrastructure, are often unfeasible.

Advancements in poultry science provide solutions to these challenges. Improved indigenous breeds like Gramapriya, Vanaraja, and Kadaknath offer better productivity in low-input systems, creating opportunities for enhancing backyard poultry (Rajkumar, 2021; Balakrishna et al., 2023; Krishnaveni et al., 2020). When combined with modern management practices—such as improved feeding, housing, and disease control—these breeds can significantly enhance productivity and profitability (Singh et al., 2023). However, the sustainability of backyard poultry depends on farmers' access to high-quality breeding stock, veterinary care,

and extension services (Murty et al., 2016). The lack of these services leads to high mortality rates, limiting the long-term viability of backyard poultry enterprises (Sangameswaran and Sasidhar, 2019).

Empirical studies indicate that targeted training programs help bridge these gaps by enhancing technical competencies, improving management practices, and increasing productivity (Pulla et al., 2021, (Varadharajan and Gnanasekar, 2019)). Training interventions have been shown to improve flock management, reduce disease incidence, and encourage the adoption of scientific practices Kumar et al., 2019 et al., 2023; Chaturvedani et al., 2017). However, research assessing the impact of such programs in high-altitude, geographically challenging regions like Himachal Pradesh remains limited. Given the state's unique socio-economic and ecological conditions, evaluating how structured training interventions improve knowledge, adoption of best practices, and productivity in backyard poultry farming is essential.

The study evaluates the impact of training programs on the knowledge and adoption of scientific poultry farming practices among tribal and non-tribal farmers in Himachal Pradesh. Using a pre-test and post-test experimental design, it assesses whether training interventions bridge knowledge gaps, enhance poultry management skills, and improve economic outcomes. Additionally, it explores socio-economic disparities between tribal and non-tribal farmers, analysing factors such as education, experience, and access to resources that influence training effectiveness. By addressing these research gaps, this study contributes to discussions on sustainable rural livelihoods, extension strategies, and poultry-based nutritional security in mountainous regions.

2. MATERIALS AND METHODS

The study was conducted from July to September 2024 in two districts of Kangra and Lahual and Spiti districts of Himachal Pradesh, India. This study employed a pre-test and post-test experimental design to evaluate the knowledge levels of tribal and non-tribal poultry farmers in Himachal Pradesh, India, and assess the impact of training programs on knowledge gain nontribal and tribal farmers. A total of 80 farmers (40 tribal and 40 non-tribal) who showed willingness to participate in training in backyard poultry farming were purposively selected. The non-tribal farmers were identified from training programs held in August 2024 at the Department of Veterinary and Animal Husbandry Extension Education, DGCN COVAS, CSKHPKV, Palampur, Kangra. The tribal farmers were drawn from a similar training program held in September 2024 at KVK, Kukumseri. Kangra district, representing non-tribal participants, is characterized by a hilly terrain traversed by the Shivalik, Dhauladhar, and

Himalayan ranges, situated between latitudes 31˚21′ to 32˚59′ N and longitudes 75˚47′55″ to 77˚45′ E. In contrast, the Lahaul and Spiti district, home to the tribal participants, is part of the outer Himalayas with an average altitude of 10,000 feet, featuring rugged landscapes and extreme climatic conditions. Improved connectivity in the region, facilitated by the Atal Tunnel, has enhanced accessibility for training programs and research activities. Purposive sampling was employed to select 80 backyard poultry farmers, ensuring representation of both tribal and non-tribal populations. Farmers were chosen based on their active engagement in poultry farming and willingness to participate in training. Structured training programs tailored to the identified knowledge gaps were conducted, covering five critical domains of poultry farming, Breeding practices, Housing systems, Health management, feeding practices, and general management practices. Pré-training knowledge levels were assessed using a validated semi-structured interview schedule, categorized into three tiers: low, medium, and high. Post-training knowledge levels were reassessed to evaluate the effectiveness of the training in terms of change in knowledge levels in five domains of scientific backyard poultry farming. A semi-structured interview schedule was developed to capture baseline knowledge and assess change post-training. Each domain of poultry farming was scored using a pre-defined range based on class interval method (mean ± standard deviation). The interview schedule was tested to ensure validity and reliability before administration. Descriptive statistics, including frequency distributions, means, and standard deviations, were used to summarize the data. Paired t-tests were applied to evaluate the significance of changes in knowledge levels between the pre-test and post-test phases. A p-value of < 0.01 was considered statistically significant, highlighting the effectiveness of training programs. Comparisons were also made between tribal and non-tribal groups to identify disparities in knowledge levels and assess the impact of geographical and socio-cultural factors on poultry farming practices.

3. RESULTS AND DISCUSSION

3.1. Socio-personal profile of poultry farmers

Table1: provides a comparative overview of the socio-personal profile of trainee poultry farmers from non-tribal and tribal backgrounds.

Table 1: Socio-Personal profile of poultry farmers

Socio-Personal Parameters	Non-Tribal Farmers		Tribal Farmers	
	N	%	N	%
Age				
Young (Up to 35 years)	9	22.5	3	7.5

Middle (35-50 years)	19	47.5	28	70
Old (Beyond 50 years)	12	30	9	22.5
Education				
Illiterate	0	0	7	17.5
Primary	0	0	8	20
Middle	15	37.5	2	5
High School	18	45	16	40
Intermediate & above	7	17.5	7	17.5
Gender				
Male	21	52.5	26	65
Female	19	47.5	14	35
Landholding Size				
Landless Farmers	0	0	0	0
Marginal Farmers (<1 hectare)	37	92.5	39	97.5
Small Farmers (1-2 hectares)	3	7.5	1	2.5
Average Income				
Up to ₹1 Lakh	29	72.5	20	50
₹1-2 Lakhs	7	17.5	4	10
₹2-5 Lakhs	2	5	8	20
₹5-10 Lakhs	2	5	8	20
Above ₹10 Lakhs	0	0	0	0
Average Experience in Backyard Poultry Farming in Years	0.97		0.58	
Average Flock Size	13.77 birds		6.25 birds	

N: Number of Farmers

3.1.1. Age

Among non-tribal farmers, the largest proportion (47.5%) belonged to the middle-age group (35–50 years), followed by older farmers (30%) and younger participants (22.5%). On the other hand tribal farmers showed a more pronounced concentration in the middle-age group (70%, n=28), with substantially fewer young (7.5%) and older (22.5%, n=9) participants. Elamathi et al.(2020) also reported that majority of backyard poultry farmers belonged to middle aged group in Salem district of Tamil Nadu.

3.1.2. Education

Education levels were higher among non-tribal farmers.45% non-tribal farmers completed high school, and 17.5% had intermediate or higher education. None were illiterate. Tribal farmers included 17.5% illiterate and 20% with primary education; only 17.5% reached intermediate education.

3.1.3. Gender

In terms of gender, male farmers make up 52.5% of non-tribal and 65% of tribal farmers. Non-tribal farmers had near-equal gender distribution (52.5% male, 47.5% female). Tribal farmers were predominantly male (65%). The higher female participation among non-tribal farmers supports Padhi (2016) asserted that backyard poultry empowers rural women. Sakthivel (2017) also reported that backyard poultry farming is predominantly a women-oriented activity.

3.1.4. Landholding size

Both groups were primarily marginal farmers (<1 hectare): 92.5% (non-tribal) and 97.5% (tribal). Only 7.5% of non-tribal and 2.5% of tribal farmers owned 1–2 hectares. The prevalence of marginal farmers reflects Himalayan land fragmentation Therefore, backyard poultry's low space requirements make it ideal for smallholders

3.1.5. Income

72.5% of non-tribal and 50% of tribal farmers earned ≤₹1 lakh annually. Tribal farmers had higher representation in ₹2–10 lakh brackets (40% combined vs. 10% for non-tribal).

3.1.6. Experience and flock size

Non-tribal farmers had more experience (0.97 years vs. 0.58 years) and larger flocks (13.77 vs. 6.25 birds). Limited experience among tribal farmers suggests recent adoption, possibly due to government schemes. Smaller tribal flocks may reflect resource constraints or cultural preferences. Training should address breed selection and flock management for scalability

3.2. Knowledge about poultry breeding practices

Farmers' knowledge was assessed on key aspects such as understanding suitable breeds for backyard poultry farming, breed-specific egg and meat production capacities, and parameters for bird selection. Pré-training 95% of non-tribal and 100% of tribal farmers demonstrated low knowledge levels. As evident from table 2, post-training, and knowledge levels improved significantly, with 72% of non-tribal and 55% of tribal farmers attaining medium knowledge levels. About 27.5% of non-tribal farmers reached high knowledge levels. Post-training the average knowledge score on poultry breeding practices increased from 2.27 to 8.60 and from 1.57 to 5.32 for non-tribal and tribal farmers respectively. The Knowledge score was statistically significant at a 1% level post-training for both categories of farmers.

3.3. Knowledge about poultry housing practices

This domain included awareness of space requirements, seasonal modifications, predator management, and proper housing orientation. Majority (85%) of non-tribal and tribal (100%) farmers exhibited low knowledge. Post-training, knowledge scores improved significantly, with 65% of non-tribal farmers moving to medium levels, and 55% of tribal

farmers also achieving medium levels. The average knowledge scores rose from 0.15 to 7.1 for non-tribal farmers and from 0.51 to 4.25 for tribal farmers, both statistically significant at the 1% level.

Table 2: Effect of training on knowledge about scientific poultry production in regions of Himachal Pradesh				
Non-Tribal Farmers			Tribal Farmers	
Knowledge about Poultry breeding Practices				
Category	Before Training	After Training	Before Training	After Training
Low (0-5)	38 (95%)	11 (17.5%)	40 (100%)	7 (17.5%)
Medium (6-11)	2 (5%)	29 (72.5%)	0	22 (55.0%)
High (12-17)	0	0	0	11 (27.5%)
Mean±SD	2.27±1.56	8.6±3.11	1.57±0.98	5.32±4.15
"p" value"	*p*>.01		*p*>.01	
Knowledge about Poultry Housing Practices				
Low (0-5)	34 (85%)	12 (30%)	40 (100%)	18 (45%)
Medium (6-11)	6 (15%)	26 (65%)	0	22 (55%)
High (12-17)	0	2 (5%)	0	0
Mean±SD	.15±0.36	7.1±2.35	0.51±0.71	4.25±2.82
"p value"	*p*>.01		*p*>.01	
Knowledge about Poultry Health Practices				
Low (0-5)	36 (90%)	34 (85%)	40 (100%)	30 (75.00%)
Medium (6-11)	4 (10%)	6 (15%)	0	10 (25.00%)
High (12-17)	0	0	0	0
Mean±SD	4.01±0.23	4.95±1.62	.82±38	3.45±2.74
"p value"	*p*>.01			
Knowledge about Poultry Feeding Practices				
Low (0-5)	40 (100%)	32 (80%)	40 (100%)	34 (85%)
Medium (6-11)	0 (0%)	8 (20%)	0	6 (15%)
High (12-17)	0		0	0
Mean±SD	0.45±1.06	4.38±1.10	0.77±0.99	2.40±2.16
"p value"	*p*>.01		*p*>.01	
Knowledge about Poultry Management Practices				
Low (0-5)	40 (100%)	33 (82.5%)	40 (100%)	32 (80%)
Medium (6-11)	0 (0%)	7 (17.5%)	0	8 (20%)
High (12-17)	0	0	0	0
Mean±SD	1.41±0.55	2.15±2.23	0.2±0.16	3.35±2.25
"p value"	*p*>.01		*p*>.01	

3.4. Knowledge about poultry health practices

This evaluation covered biosecurity, deworming, infection control, litter management, and ammonia management. Pre-training, 90% of non-tribal and 100% of tribal farmers had low knowledge. Post-training significant improvement in post-training was observed, with 15% of non-tribal and 25% of tribal farmers moving to medium knowledge levels. Average scores increased from 4.01 to 4.95 (non-tribal) and from 0.82 to 3.45 (tribal), both statistically significant at the 1% level.

3.5. Knowledge about poultry feeding practices

Key aspects included understanding the dietary requirements of different bird categories, essential nutrients, and suitable feed ingredients. Pre-training, all farmers scored low, with averages of 0.69 (non-tribal) and 0.54 (tribal). Post-training, 20% of non-tribal and 15% of tribal farmers moved to medium knowledge levels. Average scores rose from 0.45 to 4.38 (non-tribal) and 0.77 to 2.40 (tribal), showing significant improvements at the 1% level. The observed improvements in poultry feeding practices post-training align with findings from

3.6. Knowledge about poultry management practices

This assessment included areas such as lighting requirements, litter management, scavenging practices, and addressing behavioral issues in poultry farming. Before training, knowledge levels were consistently low, with average scores of 1.41 for non-tribal farmers and 0.2 for tribal farmers. However, post-training, 17.5% of non-tribal farmers and 20% of tribal farmers progressed to medium knowledge levels. The average scores increased significantly, from 1.41 to 2.15 for non-tribal farmers and from 0.2 to 3.35 for tribal farmers, with improvements statistically significant at the 1% level. Baruah et al. (2024) reported positive impact of trainings on poultry management practices in hilly regions of Arunachal Pradesh.This aligns with the present findings, which demonstrate the importance of targeted training programs in bridging knowledge gaps and fostering sustainable poultry management practices.

4. CONCLUSION

The findings of this study emphasize that training programs significantly bridge knowledge gaps in backyard poultry farming in Himachal Pradesh, improving breeding, housing, health, and feeding practices. Their effectiveness enhances productivity and rural livelihoods. For long-term sustainability, follow-up support through extension services, community-driven models, and mobile platforms is vital. Integrating these can transform poultry farming, boosting food security, rural development, and sustainable agriculture, ensuring lasting economic and nutritional benefits for rural communities in Himachal Pradesh and beyond.

COMPETING INTERESTS

"Authors have declared that no competing interests exist."

REFERENCES

[1] Anonymous, 2023. Basic Animal Husbandry Statistics. Department of Animal Husbandry & Dairying (DAHD), Ministry of Fisheries, Animal Husbandry & Dairying, Government of India. Available at: https://dahd.gov.in/sites/default/files/2025-01/FinalBAHS2024Book14012025.pdf (Accessed on 28 March, 2025).

[2] Balakrishna, C., Lakshmi, K.B., Neelaveni, S., Kumar, V.H., Kumar, S.K., Suneetha, B., Anusha, S., Mounica, B., 2023. Poultry farming: A sustainable livelihood option for tribal and rural women in Srikakulam district, Andhra Pradesh. Journal of Krishi Vigyan 11(suppl), 192–196.

[3] Baruah, M.S., Islam, M.M., Singh, K.S., Debbarma, S., 2024. Technological interventions for impact assessment on backyard Vanaraja poultry farming in two districts of Arunachal Pradesh, India. Journal of Krishi Vigyan 12(2), 414–423.

[4] Chaturvedani, A.K., Lal, N., Dhruw, K., Jaiswal, S.K., 2017. Marketing practices and employability in traditional backyard poultry rearing in Bastar District of Chhattisgarh, India. International Journal of Bio-resource and Stress Management 8(1), 179–182.

[5] Chauhan, D.S., Jugran, H.P., Negi, G.C.S., Bisht, D.S., 2024. Income generation potential of backyard poultry in rural areas of Central Himalaya. World's Poultry Science Journal 80(4), 1225–1239.

[6] Das, P.K., Samanta, I., 2021. Role of backyard poultry in south-east Asian countries: Post COVID-19 perspective. World's Poultry Science Journal 77(2), 415–426.

[7] Dinesh, K., Sankhyan, V., Chaudhary, D.R., Bhushan, L., Kumar, P., Thakur, A., Singh, N., Murai, A.S., Sheoran, P., 2024. Backyard poultry production system for improving livelihood and nutritional security in rural areas. Indian Farming 74(10), 31–33.

[8] Elamathi, T.M., Sharma, D., Deo, C., Tyagi, P.K., Biswas, A., 2020. Current scenario of rural backyard poultry farming in selected villages in Salem district of Tamil Nadu. Indian Journal of Extension Education 56(3), 133–136. https://doi.org/10.5958/2454-552X.2020.00022.5.

[9] Gupta, M.D., Mondal, S.K., Basu, D., Pan, S., Mitra, K., 2021. Empowering rural women through backyard poultry farming: Adoption of Haringhata Black in tribal district of West Bengal. Indian Journal of Animal Sciences 91(12), 118–1121.

[10] Kumar, M., Dahiya, S. P., Ratwan, P., 2019. Backyard poultry farming in India: A tool for nutritional security and women empowerment. Biological Rhythm Research, 52(10), 1476–1491. https://doi.org/10.1080/09291016.2019.1628396

[11] Krishnaveni, D., Gurram, S., Pavan, A.D., 2020. Sustainable livelihoods for rural underprivileged women through backyard poultry as a tool. Indian Journal of Poultry Science 55(2), 165–168. https://doi.org/10.5958/0974-8180.2020.00026.4.

[12] Maske, M., Landage, S., Sayre, M., Bhavani, R.V., 2019. Nutritional and livelihood security through backyard poultry model in tribal regions of Maharashtra. Indian Journal of Poultry Science 54(2), 175–179. https://doi.org/10.5958/0974-8180.2019.00020.5.

[13] Murty, P.V.V.S., Rao, M.V., Bamji, M.S., 2016. Impact of enriching the diet of women and children through health and nutrition education, introduction of homestead gardens and backyard poultry in rural India. Agricultural Research 5(2), 210–217. https://doi.org/10.1007/s40003-016-0206-x.

[14] Padhi, M. K., 2016. Importance of indigenous breeds of chicken for rural economy and their improvements for higher production performance. Scientifica, 2016(1), 2604685.

[15] Pulla, S., Mathialagan, P., Singh, R.P., 2021. Impact of training on knowledge level of poultry entrepreneurs of Tamil Nadu. Indian Journal of Extension Education 57(1), 176–180. https://doi.org/10.5958/2454-552X.2021.00039.6.

[16] Rajkumar, U., Rama Rao, S.V., Raju, M.V.L.N., Chatterjee, R.N., 2021. Backyard poultry farming for sustained production and enhanced nutritional and livelihood security with special reference to India: A review. Tropical Animal Health and Production 53(1), 176.

[17] Rathod, P., 2020. A Guide to Backyard Poultry Farming for Sustainable Livelihoods. Hyderabad 502 324, Telangana, India: International Crops Research Institute for the Semi-Arid Tropics, 28.

[18] Saikiran, J., Rajanna, N., Shashank, J., Ganesh, G., Raju, A., Sowmya, C., Arunjyoti, R., 2025. Impact of rearing Rajasri birds on the livelihood and nutritional security of BPL families in Telangana State. International Journal of Bio-resource and Stress Management 16(1).

[19] Sakthivel, K.M., Narmatha, N., Uma, V., Jothilakshmi, M., 2017. Gender dimensions in backyard poultry rearing. Indian Journal of Poultry Science 52(2), 236–238. https://doi.org/10.5958/0974-8180.2017.00046.0.

[20] Sangameswaran, R., Sasidhar, P.V.K., 2019. Strategies for Promotion of Improved Native Chicken Strain in Rural Family Poultry. Indian Journal of Extension Education 55(2), 106–110.

[21] Singh, M., Patton, R.N., Mollier, R.T., Pongener, N., Yadav, R., Singh, V., Katiyar, R., Singh, G.D., Deori, S., Doley, S., Chaudhary, J.K., 2023. Indigenous chicken production system in different agro-ecology of Indian Himalayan Region: implication on food and economic security. Frontiers in Nutrition, 10, 1244413.

[22] Thakur, R., Sankhyan, V., Kumar, R., Mankotia, B.S., 2020. Demonstration on Himsamridhi Variety of Chicken under Rural Poultry Production in District Kangra, Himachal Pradesh. Journal of Krishi Vigyan 9(1), 351–354.

[23] Varadharajan, A., Gnanasekar, R., 2019. Sustainable rural development through backyard poultry farming in Tamil Nadu. Indian Journal of Poultry Science 54(2), 181–183.

[24] Wong, J.T., de Bruyn, J., Bagnol, B., Grieve, H., 2017. Small-scale poultry and food security in resource-poor settings: A review. Global Food Security 15, 43–52.