Journal of Agricultural Extension
Vol. 27 (1) January 2023
ISSN(e): 24086851; ISSN(Print): 1119944X
Website: http://journal.aesonnigeria.org; http://www.ajol.info/index.php/jae
Email: editorinchief@aesonnigeria.org; agricultural.extension.nigeria@gmail.com

Impact of Agricultural Extension Services on Cereal Production among Rural Farmers in Bhutan

https://dx.doi.org/10.4314/jae.v27i1.2

Shangshon, Bhakta Bdr
Corresponding author
Department of Sustainable Development, College of Natural Resources, Royal University of Bhutan, Punakha, Bhutan.
Email: bbs.cnr@rub.edu.bt
Phone no: +975 77239026
Orcid ID: 0000-0003-4753-2613

Polthanee, Anan
Department of Agronomy, Program of System Approaches in Agriculture, Faculty of Agriculture, Khon Kaen University, Thailand.
Email: panan@kku.ac.th
Phone no: +66 00 66 81 047 7800

Wongsamun, Chaicharn
Department of Agricultural Extension. Khon Kaen University, Thailand.
Email: chaicharn@kku.ac.th
Phone no: +66 0066 896199575

Suriya, Patcharee
Department of Agricultural Economics, Faculty of Agriculture, Khon Kaen University, Thailand.
Northeast Thailand Cane and Sugar Research Center, Khon Kaen University, Thailand
Email: supatch@kku.ac.th
Phone no: +66 094-363-5615
Orcid ID: 0000-0001-6016-585X

Submitted: 25th July 2021
First Request for Revision: 8th April 2022
Revisions: 10th, 11th, 13th April 2022.
Accepted: 7th May 2022
Published: 21st January 2023

Cite as: Shangshon, B.B., Polthanee, A., Wongsamun, C. (2023). Impact of agricultural extension services on cereal production among rural farmers in Bhutan. *Journal of Agricultural Extension 27*(1), 13-26 https://dx.doi.org/10.4314/jae.v27i1.2
Keywords: Extension services, cereal production, farmers' participation

Disclosure statement: The authors declare no potential conflict of interest.
Acknowledgement: Authors would like to acknowledge the Thailand International Cooperation Agency (TICA) for funding this study. The authors also wish to thank agricultural extension officers for helping to collect the data.
Funding agency: This work was supported by the Thailand International Cooperation Agency (TICA) under the Capacity Development of College of Natural Resources Project - Follow-up Phase.
Authors' contributions:
BBS: (25%) Conceptualization; Data curation; Formal analysis; Software; Methodology; Writing - original draft; Writing - review & editing
AP (25%): Conceptualization; Investigation; Methodology; Resources; Software; Supervision; Validation; Visualization.
CW (25%): Conceptualization; Data curation; Visualization; Writing - original draft; Writing - review & editing
PS (25%): Conceptualization; Data curation; Visualization; Writing - original draft; Writing - review & editing

Abstract

This study explored the impact of agricultural extension services on cereal production. Data were collected through a semi-structured questionnaire from a random sample of 262 farmers from four regions (east, west, north, and south) in Bhutan. Farmers assessed the impact of extension services on five aspects of cereal production (cereal seed, social, environmental, production, and marketing aspects). Percentages and an ordered logistic model were used to analyse the data. The study found a low level of farmers' participation in extension services. The social aspect of cereal production was the most impacted by the extension programmes, while the marketing aspect was the least impacted. The farmers' cultivated dry land (Coeff. = 0.21) and wetland (Coeff. = 0.72), their participation in extension services (Coeff. = 0.61), and

the extra labour (Coeff. = 0.24) significantly contributed to cereal production. The provision of effective and high-quality extension programs by extension agents is critical for smallholder farmers to enhance their agricultural production.

Introduction

The agriculture sector in Bhutan is imperative to the growth, balance, and stability of the nation's economy, accounting for about 19.23 percent of the gross domestic product in 2020 (National Statistics Bureau [NSB], 2021). The majority of Bhutanese farmers are small shareholders and practice subsistence farming. They mostly grow staple crops such as rice, wheat, corn, buckwheat, potatoes, barley, and minor cereals. Some farmers have diversified farming into cash crops such as cardamom and citrus. Many farmers practice mixed farming, combined with livestock and poultry, to enhance their income and livelihood. However, the limited arable land of less than 2.93% of 38.394 Km2 of the entire country poses serious challenges to agricultural development and national food security. Due to this, household landholding size is small, the average being 3.4 acres, and the majority of the land is on steep slopes (Ministry of Agriculture and Forest [MoAF], 2017). The challenge to agricultural production is further exacerbated by poor soil fertility, water stress, and human-wildlife conflict. In addition to these biophysical constraints, dependence on family labour, rural-to-urban migration, limited scope for mechanization due to the rugged terrain, and long distances to the nearest road pose significant barriers to improving agricultural productivity. Moreover, the predominance of subsistence farming has constrained the shift to commercial farming due to low levels of technology adoption and accessibility of the market.

Extension services play a critical role in increasing the agricultural productivity of the available arable land. In Bhutan, adequate infrastructural facilities and efficient extension services are indispensable for boosting the agriculture sector (Dendup, 2018). A study on the socio-economic impacts of agricultural subsidies in Bhutan indicates a large disparity in the provision of extension services between poor and non-poor populations, with poor farmers having less access to agricultural subsidies than non-poor populations (Wang et al., 2019). The study shows that none of the poor farmers received farm machinery, improved livestock such as Jersey cows and piglets, or biogas subsidies due to their inability to co-pay. Poor farmers have no access to even economically efficient agricultural inputs, for instance, only 35% of the poor received seed and sapling subsidies compared to 52% of seeds and 39% of sapling subsidies received by the non-poor population.

Although the emphasis is given to farm mechanization as a necessary input to transform peasants' farming into entrepreneurial farming in Bhutan (Dendup, 2018), farmers still lack this subsidy from the government (Wang et al., 2019). Strengthening the development of rural communities requires effective mobilization and facilitation of farmer's groups with the professional support, knowledge, and skills of well-trained competent extension agents. Thus, the challenges of farmers could be addressed by the provision of agricultural subsidy programs and projects as a package to poor smallholders, where inputs are given based on existing capacity, availability of technical support, and market accessibility (Wang et al., 2019). Diversity in extension services is critical to addressing challenges and promoting agricultural development in Bhutan. Extension facilitates agricultural services and provides technical skills to farmers. Therefore, this study determined farmers' level of participation in extension services, their impact on different aspects of cereal production, and identified factors

influencing the impact of extension services on cereal production. The results of this study would be crucial for agricultural planning on the provision of extension services to increase productivity.

Methodology

The study covered four districts: Chukha district (27.0523° N, 89.5757° E) in the west, Mongar district (27.2754° N, 91.2398° E) in the east, Tsirang district (27.0322° N, 90.1870° E) in the south-central and Punakha district (27.5921° N, 89.8797° E) in the north-western region. These four districts have 51 blocks (sub-district) out of 205 blocks in 20 districts in Bhutan. Two rural blocks from each district were considered for the study of farmers' participation in extension services and their impact on cereal production. The combined four districts have a total area of 5,568.57 km^2 and a rural population of 100,416 people (NSB, 2021). Chukha, Punakha, and Tsirang each have 11 renewable natural resources (RNR) extension centres, and Mongar has 17 RNR extension centres, respectively (NSB, 2021). These districts lie within the humid subtropical and dry sub-tropical agroecological zones of Bhutan. The humid subtropical and dry subtropical zones have an annual mean temperature of 19.5°C and 17.5°C and an annual mean rainfall of 1200-2500 mm and 850-1200 mm, respectively. Due to similar agroecological conditions, farmers in these regions grow similar cereals such as rice, maize, millet, wheat, and buckwheat. While extension personnel were interviewed from 11 districts out of 20 districts and 53 gewogs (blocks) out of 205 gewogs in Bhutan.

From the four selected districts, eight sample blocks were selected; two sample blocks each from all four districts (Darla and Phuensholing from Chukha; Mongar and Tsamang from Mongar; Lingmukha and Shelngana from Punakha; and Dunglagang and Tsirangtoe from Tsirang). A random sampling method was employed to select 300 farmers, 35-40 farmers each from the four blocks. Participation in the survey was voluntary, therefore, around 38 farmers did not participate in the survey either due to their unavailability during the survey time or because they did not want to participate. From the 262 collected samples, 251 farmers were included for the final analysis after excluding 11 farmers due to incomplete questionnaires. The data were collected through face-to-face interviews. The lead author led the interview with assistance from the extension officials. The study was conducted from September to October 2018.

A semi-structured questionnaire was used to collect the data. The questionnaire had three sections. Section one contained the socio-economic information of the farmers. Section two consisted of farmers' level of participation in extension services, which was measured on a 3- point Likert-type scale (1 = Low, 2 = Intermediate, and 3 = High). Section three covered the impact of extension services on cereal production as perceived by the farmers. The farmers were asked to indicate the impacts of extension services on cereal production based on a 5-point Likert scale (1 = very lowly impacted, 2 = lowly impacted, 3 = moderately impacted, 4 = highly impacted, and 5 = very highly impacted). The impacts of extension services on cereal farming were assessed based on five aspects: 1) cereal seed; 2) production; 3) environmental; 4) social; and 5) marketing aspect. Pre-consultation was conducted with farmers and extension officials to understand the extension services offered by the extension agents. Based on this consultation, the authors developed different aspects and attributes for the impact of extension services on cereal production. Finally, five aspects and attributes were chosen based on this discussion and consultation. Another question was asked to rate these services as a whole, to assess their overall impact, which followed the same 5-

point Likert scale used for the attributes. The reliability of the five Likert scales was tested with Cronbach's alpha. The Cronbach's value of 0.903 indicated high reliability.

Mean, percentage, and standard deviation were conducted to analyse the data. An ordered logistic model was used to determine factors affecting the impacts of extension services on cereal production. The dependent variable is the impact of extension services on cereal production and the independent variables are those hypothesized to influence cereal production (Table 1). The level of participation in extension services (Kassem et al., 2021) was measured through ten different statements rated on a 3-point Likert scale (Figure 1). Factorial analysis was conducted to obtain a composite score of multiple variables of extension services.

The ordered logit model used in the study is based on equation (1):

$$y_i^* = \beta' X_i + \epsilon \quad (1)$$

where y_i^* is the unobserved measure of the impact of extension services on cereal production (dependent variables), X_i is the vector of independent variables (i=1……n), β' is the vector of regression coefficient to be estimated, and ε is the error effect.

In R, the ordered logit model was performed by the lrm() function, which is designed to fit logistic regression model (Zhang & Kattan, 2017).

Table 1: Dependent and explanatory variables for impacts of extension services on cereal production used in ordered logit model

Variables	Measurement descriptions
	Dependent variable
Impacts	impact of extension services on cereal farming (1 = Very lowly impacted, 2 = Lowly impacted, 3 = Moderately impacted, 4 = Highly impacted, 5 = Very highly impacted)
	Explanatory variables
Age	Age of farmers (years)
Sex	Sex of farmers (dummy variable, 1=Male, 2=Female)
Education	The education level of farmers (1 = illiterate, 2=Non-formal education, 3 = primary, 4 = above secondary)
Annual income	The income of farmers in Ngultrum
Cultivated wetland	Cultivated wetland owned by farmers in acres
Cultivated dryland	Cultivated dryland is owned by farmers in acres.
Regular farmer	No. of regular farmers at home in numbers
Extra labour	Extra labour at home in numbers
Participation in extension services	Level of participation in agricultural extension services (1 = low, 2 = moderate, 3 = high)
Cost of cereal production	The cost of cereal production in the last five years (1 = decreasing, 2 = about the same, 3 = increasing).

Results and Discussion

Farmers' Level of Participation in Agricultural Extension Services

Farmers' level of participation in agricultural extension services is shown in Figure 1. Farmers had a low level of participation in agricultural extension services, with values

ranging from 1 to 1.7, with a mean value of 1.27. Farmers show a greater level of participation when extension officials visit farmers' homes to deliver extension services ($\bar{x}$ = 1.7), followed by the information shared through mobile phones ($\bar{x}$ = 1.5), and the provision of training for farmers ($\bar{x}$ = 1.5). The result indicates that farmers have access to limited extension services or that delivery of extension services is ineffective, which might have affected cereal production (Suvedi et al., 2017). Low participation could be due to the ineffectiveness of methods used to provide or disseminate the services, farmers' inability to attend meetings, or lack of awareness (Kassem et al., 2021). This could also be due to the fact that many agents are involved in providing services that do not involve the needs of the farmers.

Farmers' participation in extension programs is influenced by personal benefits, economic benefits, and agricultural production (Nahayo et al., 2017). Similarly, the effectiveness of extension services is determined by service delivery, delivery methods, and service relevancy. For instance, the privatization of agricultural extension services has limited interaction between coordinating authorities and farmers to co-produce knowledge that is relevant to their needs and has impacted the productivity and environmental performance of farms (Shlaby et al., 2017). The quality of services is affected by accessibility, relevance, diversity of services and information communication media and technologies used to conduct the services (Baiyegunhi et al., 2019; Kassem et al., 2021). Therefore, extension services must be integrative of knowledge development, economic incentives, and effectiveness of service delivery (Noga et al., 2018).

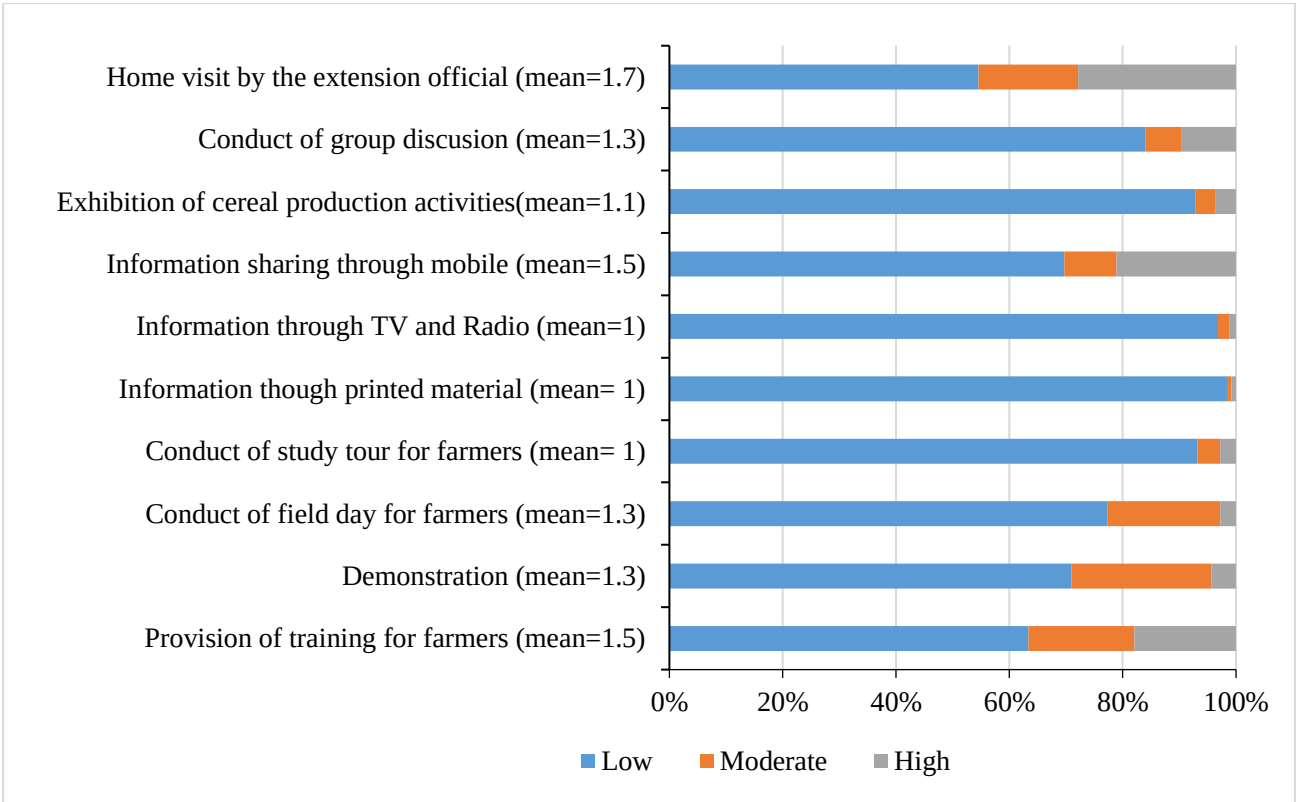

Figure 1: Farmers' level of participation in extension services

Impacts of Extension Services on Different Aspects of Cereal Production

The farmers' perceived impacts of extension services on cereal production are indicated in table 3. Overall, extension services have highly impacted farmers' cereal production ($\bar{x}$ = 3.78, SD = 0.72). Of the five aspects of cereal production, extension service has moderately impacted the marketing aspect; while other aspects such as seed, production, social, and environmental aspects are highly impacted (Figure 2).

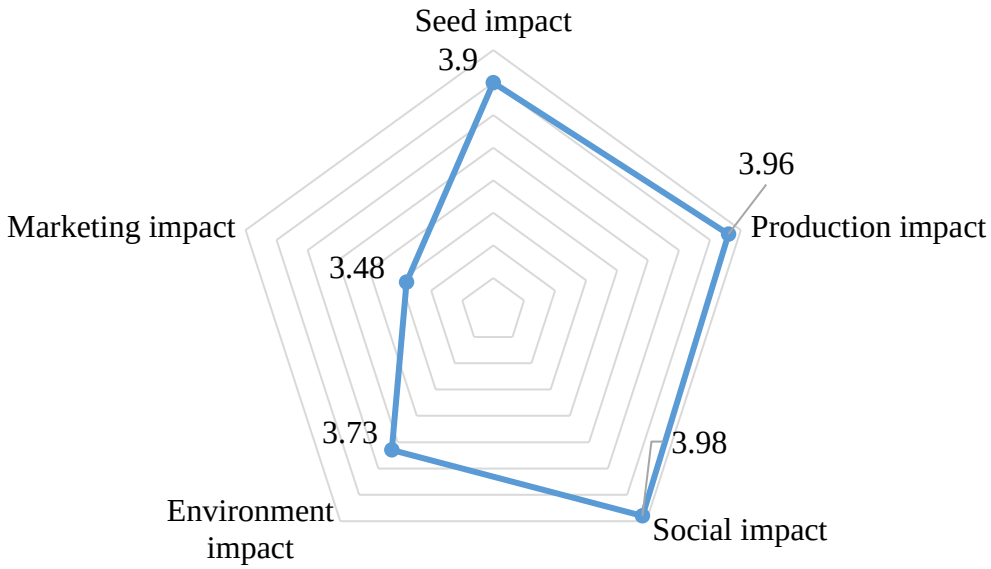

Figure 2: Impacts of extension services on different aspects of cereal production

Impacts of Extension Services on Seed Aspect of Cereal Production

The mean value of the impacts of extension services on cereal seeds ranges from 3.77 to 4.06; with an overall mean of 3.95, indicating a high impact of extension services on the cereal seeds aspect of cereal farming (Table 3). The farmers perceived that extension services have the highest impact on improving access to quality cereal seeds ($\bar{x}$ = 4.06, SD = 0.63), followed by the availability of improved varieties of cereal seeds ($\bar{x}$ = 3.88, SD = 0.77) and improving the protection of indigenous seeds ($\bar{x}$ = 3.77, SD = 0.69).

Good quality seed is important for enhancing resilience to climate shocks and pests and diseases to augment seed security, which has direct links to food security and

resilient livelihoods (Vernooy et al., 2017; Thomas et al., 2017). Extension services play a critical role in promoting the use of quality seed that enhances crop production and improves the livelihoods of farmers (Elahi et al, 2018). Improving seed quality is a focus of extension agents as well as business development services in many countries to increase productivity and promote agricultural farming (Baloch & Thapa, 2019).

Impacts of Extension Services on Cereal Production

Table 3 shows the impacts of agricultural extension services on cereal production. The finding indicates that extension services have highly impacted the production of cereal with an overall mean of 3.96 (Figure 2), with a mean impact ranging from 3.80 to 4.12 as perceived by farmers (Table 3). The finding is congruent with the previous studies (Baloch and Thapa, 2018; Ragasa and Mazunda, 2018), which indicated that extension services have significantly contributed to an increase in farm productivity and income. The result is supported by the influence of extension services on increasing yield ($\bar{x}$ = 4.08, SD = 0.62), improving plant protection ($\bar{x}$ = 4.12, SD = 0.67), improving storage of cereal grains ($\bar{x}$ = 3.80, SD = 0.76), and improving irrigation ($\bar{x}$ = 3.83, SD = 0.70).

Agricultural extension programs have facilitated and promoted farmers' knowledge and skills in terms of seed storage, plant protection, and irrigation to increase agricultural productivity (Mesterházy et al., 2020). A study shows that access to extension services had a positive impact on the adoption of integrated pest management practices and increased crop yield (Midingoyi et al., 2019). The extension has not only significantly increased the utility of improved cultivation methods but also enhanced economically efficient methods to enhance production (Pan, Smith, & Sulaiman, 2018). Inputs to crops such as fertilizer and sufficient irrigation water, supplied by the extensions, significantly determine the yield and production (Verma et al., 2021).

Impacts of Extension Services on the Environmental Aspect of Cereal Production

An environmentally sustainable approach is important to address environmental issues such as soil fertility, climate change mitigation and adaptation, and human-wildlife conflicts that impact cereal production. Farmers perceived that extension services have highly impacted environmental aspects of cereal production with an overall mean of 3.68. Among the environmental variables, farmers rated that they are more impacted by the extension services in terms of improving soil fertility ($\bar{x}$ = 3.95, SD = 0.60), followed by adoption of adaptation measures to climate change ($\bar{x}$ = 3.83, SD = 0.67), minimizing disturbance of wildlife habitats to reduce crop damage by wildlife ($\bar{x}$ = 3.61, SD = 0.66), and adoption of mitigation measures to climate change ($\bar{x}$ = 3.53, SD = 0.66).

Extension agents have recognized the integration of climate change mitigation and adaptation measures into agricultural extension programs to boost production and the local economy. This has played an instrumental role in advocating farmers' adoption of farming systems such as intercropping and crop rotation that have mitigated soil erosion and increased yields (Pan et al., 2018). Feliciano (2019) noted that the increasing diversity and quality of extension services, including land and soil management, have shown a positive contribution to crop production and farming.

Diverse services such as the improvement of the fertilizer and tillage systems, the adoption of technology for soil fertility management, and integrated soil fertility management have significantly contributed to the agricultural yield (Danso-Abbeam et al., 2019; Zhang et al., 2021).

Impacts of Extension Services on the Social Aspect of Cereal Production

The overall mean of impacts of extension services on social aspects was 3.98, indicating a high impact on cereal farming as perceived by farmers (Figure 2). There is no large variation in the impact of extension services on social aspect variables as the mean ranges from 3.93 to 3.99 (Table 3). The social aspect is an integral part of agricultural farming to address societal challenges, which entails social interactions for the management of labour, coordination, and partnership among farmers. Extension agents have recognized the importance of networking and building relationships among farmers and increasing and managing farmer groups (table 3). The networking of peer farmers influences the motivation to participate in agricultural extension services to increase crop production (Kerr et al., 2017; Niu et al., 2022). The formation of groups has reduced extension costs per farmer, enhanced access to loans from micro-finance institutions through group guarantee systems, and availed price discounts resulting from joint input procurement from manufacturers (Porter & Kramer, 2019; Mayoux, 2020).

Impacts of extension services on the marketing aspect of cereal production

The mean and standard deviation of the impacts of extension services on the marketing of cereals are shown in table 3. The extension services had a moderate impact on marketing aspects, with an overall mean of 3.48. Relatively, farmers have benefitted from extension services provided by extension agents in increasing income ($\bar{x}$ = 3.67, SD = 0.88), finding markets ($\bar{x}$ = 3.43, SD = 0.87), setting prices ($\bar{x}$ = 3.27, SD = 0.86), and negotiating prices ($\bar{x}$ = 3.27, SD = 0.81).

Extension services have an influence on the market participation of farmers and market orientation, such as the commercialization of their farms, setting and negotiating the price, and finding markets (Jerop et al., 2018). Extension programs are critical in enhancing farm productivity and income by identifying the markets and pre-negotiating the farm produce (Danso-Abbeam, Ehiakpor, & Aidoo, 2018).

Table 3: Impacts of extension services on different aspects of cereal production

	Mean	SD
Cereal seed		
Improve access to quality cereal seeds	4.06	0.63
Improve protection of indigenous seeds	3.77	0.69
Availability of improved varieties of cereal seeds	3.88	0.77
Production		
Increase yield	4.08	0.62
Improve plant protection	4.12	0.67
Improve storage of cereal grains	3.8	0.76
Improve irrigation for farming	3.83	0.7
Social		
Improve networking among farmers	3.98	0.7
Increase farmers' groups in the community	3.99	0.83

Improve farmers' group management	3.93	0.78
Improve relationship among farmers	4.02	0.64
Environment		
Improve soil fertility for cereals	3.95	0.6
Adoption of adaptation measures to climate change	3.83	0.67
Adoption of mitigation measures to climate change	3.53	0.66
Minimize disturbance of wildlife habitats to reduce crop damages by wildlife	3.61	0.66
Marketing		
Increase income	3.67	0.88
Set a price for grains	3.27	0.86
Negotiate a price for cereals	3.27	0.81
Find a market for cereals	3.43	0.87
Overall impact	3.79	0.73

Factors Influencing the Impact of Extension Services on Cereal Farming.

The socio-economic characteristics of the farmers were considered in determining the factors influencing the impacts of extension services on cereal production. From the ordered logit model, the chi-squared value of 71.23 shows highly significant likelihood ratio statistics ($p<0.01$), indicating a large variation in the impacts of extension services on cereal production. The pseudo-R^2 of 0.26 indicates that independent variables contributed 26% of the variation in the impacts of extension services on cereal production. The result in table 4 shows that cultivated wetland, cultivated dryland, extra labour, and participation in extension services significantly influenced the impacts of extension services on different aspects of cereal production. While age, sex, education, annual income, number of regular farmers, and cost of cereal production were not significant predictors of the impacts of extension services on cereal production.

Table 4: Factors determining the impacts of extension services on cereal production

Factors	Coeff.	S.E	Odd ratio
Age	0.02	0.01	1.02
Sex	-0.08	0.26	0.93
Education	0.09	0.13	1.09
Annual income	-0.02	0.10	0.98
Cultivated wetland size	0.72*	0.15	2.06
Cultivated dryland size	0.21*	0.08	1.23
No. of working farmer	0.07	0.07	1.07
No. of extra labor	0.24*	0.09	1.27
Participation in extension services	0.61*	0.24	1.85
Cost of production	-0.06	0.19	0.94
R^2	0.26		
Chi-square	71.23*		
Df	10		

**P<0.05

Farmers' cultivated wetland and dryland significantly influenced the likelihood of the impacts of extension services on cereal production. For every one unit increase in wetland and dryland, the odds are likely to impact on cereal production increase by 2.06 and 1.23, respectively, when farmers participated in extension services where all other variables are kept constant.

The wetland and dryland serve as important agricultural farms for cereal cultivation as well as other cash crops. Farmers with larger farms are more likely to have been impacted by the extension services, which have significantly impacted all aspects of cereal production. This could be due to the fact that larger farm sizes demand higher participation of farmers in the extension programs and have higher adoption rates of technology to increase productivity. Scores of studies (Ragasa & Mazunda, 2018; Kassem et al., 2021) have found that farmers' satisfaction with extension services associated with farm size has influenced agricultural productivity and food security.

The result of a number of extra labor shows a significant contribution to the impact of extension services on cereal production. For every one unit increase in extra labor, the odds are likely to impact the cereal production increases by 1.27, holding constant all other variables. This means that additional labour will increase the probability of the impact of extension services on cereal production by 27%. Having additional labour will increase the likelihood of their participation in extension services to gain agricultural information, knowledge, and skills, which in turn will influence agricultural production. Moreover, extra manpower will be distributed to different household chores and farming activities, which helps to maintain spontaneity and eschew the disruption of agricultural activities. The result is similar to the previous studies (Suvedi et al., 2017) that found an increase in household members increases farmers' participation in agricultural extension services, thereby increasing productivity.

The result shows that farmers' participation in extension services significantly impacted cereal production. One unit increase in farmers' participation in extension services was associated with 85% of the odds of impacts on cereal production when all other variables are kept constant. Every block (sub-district) in Bhutan has an extension services center, which is an important agent in providing agricultural innovation and information to farmers. Farmers' participation has been not only a significant determinant of their satisfaction with extension services, but also of increasing agricultural performance to meet the economics of scale (Danso-Abbeam, Ehiakpor, & Aidoo, 2018; Ragasa, & Mazunda, 2018).

The result indicates that age, sex and education are insignificant indicators of cereal production influenced by the extension services. This could be due to the low participation of the farmers that lacked enough farming information from the extension services. Only 12.4% (Table 2) of farmers had education levels above secondary school, which might have hindered their understanding of the extension services. In this context, extension services must be provided with the most comprehensive and accessible methods to disintegrate the idea and convince the farmers to adopt new agricultural practices. The finding aligned with previous studies that confirmed age, education (Kassem et al., 2021), and gender (Suvedi et al., 2017) are not significant determinants of farmer satisfaction and participation with extension services. People at home and the number of full-time farmers also did not contribute significantly to the cereal farming involved with agricultural extension services. This could be due to a lack of information and awareness about the services among farmers and the provided

services are poor. Therefore, service providers must address farmers' interests and motivations to enhance the effectiveness of the services.

The finding also reveals that the cost of production of cereal and annual income did not significantly influence impacts on cereal production with agricultural-extension services. Although there are extension recommendations, there is no provision of farm machinery by external agents to the farmers in Bhutan (Wang et al., 2019). Some farmers also experience labor costs due to unstable labor and financial status, which ultimately impacts the yield of the cereal. With regard to income, farmers must have grown cereal for self-consumption and not for commercial purposes- that has not impacted income due to extension services. This could also explain why the financial crisis hinders the adoption of new technology or the expenses required for expensive inputs to start commercial farming and increase income from the cereal. In fact, the intent of farmers' participation in agricultural extension services was economic interests (Wąs et al., 2021) indicating the need for financial support. Therefore, where financial support is inadequate, extension services must focus on cost-effective input measures to boost productivity.

Conclusion and Recommendation

Among the five aspects of cereal production, the marketing aspect was moderately impacted, while all other aspects were highly impacted. This suggests that extension services must equally focus on enhancing the marketing aspect of cereal farming. Farmers' participation in extension services, availability of extra labour, and size of cultivated wetland and dryland significantly impacted cereal production with agricultural extension services.

A low level of farmers' participation in agricultural extension services implies that existing extension approaches have not been particularly effective, indicating a weak coordination and connection between the service providers and farmers. This also indicates a need for decentralized extension services involving farmers in the planning and decision-making process to meet demand-driven services. The extension agents must address innovative systems approaches, integrating traditional farming and modern technology, to improve crop yield and achieve food security. The innovation approaches help transform current subsistence farming into more business and market-oriented farming to increase the household income. The result might be useful for extension service providers and policymakers to understand the needs of farmers for better farming productivity and income to achieve food security.

References

Agarwal, B. (2020). Does group farming empower rural women? Lessons from India's experiments. The Journal of Peasant Studies, 47(4), 841-872. https://doi.org/10.1080/03066150.2019.1628020

Baiyegunhi, L. J. S., Majokweni, Z. P., & Ferrer, S. R. D. (2019). Impact of outsourced agricultural extension program on smallholder farmers' net farm income in Msinga, KwaZulu-Natal, South Africa. Technology in Society, 57, 1-7. https://doi.org/10.1016/j.techsoc.2018.11.003

Baloch, M. A., & Thapa, G. B. (2018). The effect of agricultural extension services: Date farmers' case in Balochistan, Pakistan. Journal of the Saudi Society of Agricultural sciences, 17(3), 282-289. https://doi.org/10.1016/j.jssas.2016.05.007

Baloch, M. A., & Thapa, G. B. (2019). Review of the agricultural extension modes and services with the focus to Balochistan, Pakistan. Journal of the Saudi Society of Agricultural Sciences, 18(2), 188-194. https://doi.org/10.1016/j.jssas.2017.05.001

Danso-Abbeam, G., Dagunga, G., & Ehiakpor, D. S. (2019). Adoption of Zai technology for soil fertility management: evidence from Upper East region, Ghana. Journal of Economic Structures, 8(1), 1-14.https://doi.org/10.1186/s40008-019-0163-1

Danso-Abbeam, G., Ehiakpor, D. S., & Aidoo, R. (2018). Agricultural extension and its effects on farm productivity and income: insight from Northern Ghana. Agriculture & Food Security, 7(1), 1-10. https://doi.org/10.1186/s40066-018-0225-x

Dendup, T. (2018). Agricultural transformation in Bhutan: From peasants to entrepreneurial farmers. Asian Journal of Agricultural Extension, Economics & Sociology, 23(3), 1-8. https://doi.org/10.9734/AJAEES/2018/40289

Elahi, E., Abid, M., Zhang, L., Ul Haq, S., & Sahito, J. G. M. (2018). Agricultural advisory and financial services; farm level access, outreach and impact in a mixed cropping district of Punjab, Pakistan. Land use policy, 71, 249-260. https://doi.org/10.1016/j.landusepol.2017.12.006

Feliciano, D. (2019). A review on the contribution of crop diversification to Sustainable Development Goal 1 "No poverty" in different world regions. Sustainable development, 27(4), 795-808. https://doi.org/10.1002/sd.1923

Jerop, R., Dannenberg, P., Owuor, G., Mshenga, P., Kimurto, P., Willkomm, M., & Hartmann, G. (2018). Factors affecting the adoption of agricultural innovations on underutilized cereals: The case of finger millet among smallholder farmers in Kenya. African Journal of Agricultural Research, 13(36), 1888-1900. https://doi.org/10.5897/AJAR2018.13357

Kassem, H. S., Alotaibi, B. A., Muddassir, M., & Herab, A. (2021). Factors influencing farmers' satisfaction with the quality of agricultural extension services. Evaluation and Program Planning, 85, 101912. https://doi.org/10.1016/j.evalprogplan.2021.101912

Kerr, J. M., Lapinski, M. K., Liu, R. W., & Zhao, J. (2017). Long-term effects of payments for environmental services: Combining insights from communication and economics. Sustainability, 9(9), 1627. https://doi.org/10.3390/su9091627 https://doi.org/10.3390/su9091627

Ma, W., Grafton, R. Q., & Renwick, A. (2020). Smartphone use and income growth in rural China: Empirical results and policy implications. Electronic Commerce Research, 20(4), 713-736. https://doi.org/10.1007/s10660-018-9323-x

Mayoux, L. (2020). Women's Empowerment Versus Sustainability? Towards a New Paradigm in Micro-finance Programmes 1. In Women and Credit (pp. 245-269). Routledge. https://doi.org/10.4324/9781003103233-19

Mesterházy, Á., Oláh, J., & Popp, J. (2020). Losses in the grain supply chain: Causes and solutions. Sustainability, 12(6), 2342. https://doi.org/10.3390/su12062342

Midingoyi, S. K. G., Kassie, M., Muriithi, B., Diiro, G., & Ekesi, S. (2019). Do farmers and the environment benefit from adopting integrated pest management practices? Evidence from Kenya. Journal of Agricultural Economics, 70(2), 452-470. https://doi.org/10.1111/1477-9552.12306

Ministry of Agriculture and Forest. (2017). RNR Agricultural Census Data, Ministry of Agriculture and Forests, Royal Government of Bhutan, Thimphu

Nahayo, A., Omondi, M. O., ZHANG, X. H., LI, L. Q., PAN, G. X., & Joseph, S. (2017). Factors influencing farmers' participation in crop intensification program in Rwanda. Journal of integrative agriculture, 16(6), 1406-1416. https://doi.org/10.1016/S2095-3119(16)61555-1

Niu, Z., Chen, C., Gao, Y., Wang, Y., Chen, Y., & Zhao, K. (2022). Peer effects, attention allocation and farmers' adoption of cleaner production technology: Taking green control techniques as

an example. Journal of Cleaner Production, 130700. https://doi.org/10.1016/j.jclepro.2022.130700

National Statistics Bureau (2021). National Accounts Statistics 2021. National Statistics Bureau of Bhutan. Royal Government of Bhutan. Thimphu, Bhutan. Accessed December 2 2021 https://bit.ly/3tis1ry

National Statistics Bureau. (2021). Statistical Yearbook of Bhutan 2021. National Statistics Bureau of Bhutan Royal Government of Bhutan. Thimphu, Bhutan. Accessed February 9 2022 https://bit.ly/3MXYVpd

Pan, Y., Smith, S. C., & Sulaiman, M. (2018). Agricultural extension and technology adoption for food security: Evidence from Uganda. American Journal of Agricultural Economics, 100(4), 1012-1031. https://doi.org/10.1093/ajae/aay012 https://doi.org/10.1093/ajae/aay012

Pan, Y., Smith, S. C., & Sulaiman, M. (2018). Agricultural extension and technology adoption for food security: Evidence from Uganda. American Journal of Agricultural Economics, 100(4), 1012-1031. https://doi.org/10.1093/ajae/aay012 https://doi.org/10.1093/ajae/aay012

Porter, M. E., & Kramer, M. R. (2019). Creating shared value. In Managing sustainable business (pp. 323-346). Springer, Dordrecht. https://doi.org/10.1007/978-94-024-1144-7_16

Ragasa, C., & Mazunda, J. (2018). The impact of agricultural extension services in the context of a heavily subsidized input system: The case of Malawi. World Development, 105, 25-47. https://doi.org/10.1016/j.worlddev.2017.12.004 https://doi.org/10.1016/j.worlddev.2017.12.004

Suvedi, M., Ghimire, R., & Kaplowitz, M. (2017). Farmers' participation in extension programs and technology adoption in rural Nepal: a logistic regression analysis. *The Journal of Agricultural Education and Extension*, 23(4), 351-371. https://doi.org/10.1080/1389224X.2017.1323653

Thomas, E., Alcazar, C., Moscoso Higuita, L. G., Osorio, L. F., Salgado Negret, B., Gonzalez, M., ... & Ramirez, W. (2017). The importance of species selection and seed sourcing in forest restoration for enhancing adaptive potential to climate change: Colombian tropical dry forest as a model. CBD Technical Series.

Verma, D. K., Singh, H., & Meena, G. L. (2021). Factors Affecting Production of Cereal Crops in Rajasthan: The Cobb-Douglas Analysis. *Economic Affairs*, 66(2), 195-200. https://doi.org/10.46852/0424-2513.2.2021.3

Vernooy, R., Sthapit, B., Otieno, G., Shrestha, P., & Gupta, A. (2017). The roles of community seed banks in climate change adaption. *Development in Practice*, 27(3), 316-327. https://doi.org/10.1080/09614524.2017.1294653

Wang, S. W., Manjur, B., Kim, J. G., & Lee, W. K. (2019). Assessing socio-economic impacts of agricultural subsidies: A case study from Bhutan. *Sustainability*, 11(12), 3266. https://doi.org/10.3390/su11123266

Wąs, A., Malak-Rawlikowska, A., Zavalloni, M., Viaggi, D., Kobus, P., & Sulewski, P. (2021). In search of factors determining the participation of farmers in agri-environmental schemes-Does only money matter in Poland?. Land Use Policy, 101, 105190. https://doi.org/10.1016/j.landusepol.2020.105190

Yazdanpanah, M., & Feyzabad, F. R. (2017). Investigating Iranian farmers' satisfaction with agricultural extension programs using the American customer satisfaction index. Journal of Agricultural & Food Information, 18(2), 123-135. https://doi.org/10.1080/10496505.2017.1285240

Zhang, W., Qian, C., Carlson, K. M., Ge, X., Wang, X., & Chen, X. (2021). Increasing farm size to improve energy use efficiency and sustainability in maize production. Food and Energy Security, 10(1), e271. https://doi.org/10.1002/fes3.271

Zhang, Z., & Kattan, M. W. (2017). Drawing Nomograms with R: applications to categorical outcome and survival data. Annals of translational medicine, 5(10). https://doi.org/10.21037/atm.2017.04.01