Determinants of Farmers' Herbicide Use Decisions: Evidence from Jelekong Village, Baleendah District, Bandung Regency, West Java

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ABSTRACT

The use of herbicides for weed control is a common practice in rice farming. A variety of factors influences farmers' decisions to use herbicides. This study aims to analyze the factors affecting farmers' decisions to use herbicides in Jelekong Village, Baleendah District, Bandung Regency. A quantitative research design was employed using a survey technique. The respondents consisted of 115 randomly selected rice farmers. Data were analysed using logistic regression and descriptively through the top two boxes analysis. The results indicate that cost efficiency is the primary factor influencing farmers' decisions to use herbicides. Other significant factors include ease of use, product effectiveness, and the size of the cultivated land. Another key finding is that informal social networks among farmers play a substantial role in the decision-making process, outweighing the influence of extension agents or promotional efforts from herbicide producers. These findings contribute theoretically by reinforcing the importance of socio-economic variables, particularly in farmers' decisions to use herbicides. In practice, this finding highlights the need for policy interventions that prioritize community-based extension strategies as an effective means of disseminating knowledge about herbicide use. These strategies must be integrated into farmers' social networks and tailored to their socioeconomic conditions and access to information because these factors significantly impact their decisions about herbicide use.

Keywords: decision making, herbicide, influence, rice farmers

BACKGROUND

Rice is a staple food for most Indonesians, and a key component of national food security. Therefore, rice production is an important indicator when assessing the success of the agricultural sector and food security at the regional or national level. Increasing rice productivity has broad implications for maintaining stable rice supply and prices at the national level. West Java is the third-largest rice-producing region in Indonesia after East and Central Java, contributing 16.23% to the national rice production total (BPS, 2025). Rice is produced in all districts and cities in West Java Province, with Bandung Regency contributing around 4 percent of the province's total rice production. Rice productivity in Bandung Regency fluctuates annually, ranging from 5.4 to 6.1 tons per hectare (BPS Provinsi Jawa Barat, 2025). Jelekong Village, Baleendah Subdistrict, is one of the rice-producing areas in Bandung Regency, however, rice productivity in Jelekong Village remains below the average rice productivity in Bandung Regency (BPS Kabupaten Bandung, 2023). Farmers often face various challenges in rice cultivation, one of which is plant pests and diseases (PPD). Apart from pests and diseases, weeds are also potentially harmful because they can inhibit plant growth and

productivity (Yurlisa, 2021). Therefore, weed control is an important part of efforts to increase rice production.

Farmers use various strategies to control weeds, ranging from mechanical, biological, and chemical methods. One of the most widely used methods is the use of herbicides because it is considered more practical and effective compared to other weed control methods (Polansky & Guntoro, 2016). The use of herbicides is considered more efficient than other methods because it is more efficient in the use of labor and can control weeds in a larger area. However, on the other hand, the use of herbicides also poses risks to the environment and human health if not used wisely and according to existing recommendations (Espig et al., 2022; Kumar & Singh, 2015; Obiri et al., 2021).

Based on interviews, it was found that there are differences in the weed control methods used by farmers in Jelekong Village. Most farmers (82.10%) use herbicides, while only 17.90% use mechanical methods. Previous research has shown that several factors influence farmers' decisions to use herbicides. Some of the factors that are often the most important for small and medium-scale farmers include economic factors, such as the price and availability of herbicides. Research by Huang et al. (2017) in China and Kumar & Singh (2015) in India, showed that the affordable price of herbicides and their availability in the local market greatly influenced farmers' decisions to purchase these products. In the context of the cost of controlling PPD, research by Huang et al. (2017) and Rahman (2016) showed that labor costs influence farmers' decisions to use pesticides. As labor costs increase, farmers tend to choose more efficient and cost-effective PPD control methods, one of which is the use of herbicides.

Regarding farmer characteristics, several studies have shown that age, education level, and land area under control also play a role in farmers' decisions about PPD control methods (Ben Mohamed et al., 2024; Sharifzadeh et al., 2018; Wu, 2018). Farmers who are younger and have higher levels of education tend to be more open to agricultural technology innovations and have better access to information on sustainable agricultural practices. In addition, social factors also play a role in farmers' decisions, especially in farming communities with strong social ties. The role of agricultural extension workers and recommendations from fellow farmers are important factors influencing the choice of herbicides used. According to Effendy et al. (2021) and Espig et al. (2022), social interaction and communication among farmers in farming communities have a significant impact on farmers' decisions, especially regarding the introduction of new herbicides that are considered more effective. This factor is also influenced by farmers' trust in information sources they consider trustworthy.

Over time, research on pest control methods has increasingly incorporated environmental considerations. Several previous studies have shown that farmers' awareness of environmental issues, as well as their knowledge and understanding of the environmental impacts associated with chemical-based pest control, plays a role in their decision-making process (Effendi et al., 2020; Hou et al., 2020; Ismindarto et al., 2023; Obiri et al., 2021; Sharifzadeh et al., 2018; Surender et al., 2021). Farmers who are more aware of the harmful effects of chemical inputs tend to be more selective in their herbicide choices, showing a greater preference for environmentally friendly alternatives. Farmers are often faced with a wide selection of herbicides available on the market, both synthetic chemical-based and more environmentally friendly (Effendi et al., 2020). Farmers' decisions in choosing herbicides are not only based on effectiveness in controlling weeds, but are also influenced by economic, social and perceived environmental impacts

As a peri-urban area, Jelekong Village is undergoing dynamic social, economic, and environmental changes, driven in part by expanding access to information. In the context of rice production, these dynamics add complexity to understanding farmers' behavior, especially given the varying degrees of access to agricultural information. Currently, limited research has specifically examined the complexities of farmers' decision-making regarding herbicide use in rice farming in Indonesia. Therefore, it is essential to identify the key factors influencing farmers' decisions regarding herbicide use. This study's integrative approach is novel because it combines economic, socio-demographic, and environmental variables to determine farmer behavior. Unlike previous studies, which generally highlight factors separately,

The results of this study are expected to contribute to the theoretical understanding of farmer behavior when using agricultural inputs. By gaining a clearer understanding of farmers' decision-making patterns, this study aims to provide relevant recommendations for policymakers and stakeholders to support the development of more efficient and sustainable agricultural practices.

RESEARCH METHODS

The research was conducted in Jelekong Village, Baleendah Subdistrict, Bandung Regency from September to October 2024. The research site was selected based on the consideration that Jelekong village is an area with the largest rice production in Baleendah district (BPS Kabupaten Bandung, 2024). In addition, there is also an Agricultural Training and Development Research Center (SPLPP) of Universitas Padjadjaran, with the consideration that the existence of SPLPP can contribute to farmers' access to information, which can encourage farmers to be more selective in using various agricultural inputs.

This research uses a quantitative design with survey techniques. Quantitative research is an approach used to test theories objectively by ascertaining whether there is a relationship between variables. This approach views a phenomenon as an objective and measurable social reality (Creswell, 2014). The data in this study consisted of primary and secondary data. Primary data were collected through interviews with key informants, including extension workers and farmer group leaders; in addition, primary data was also obtained from interviews with rice farmers. Meanwhile, secondary data was obtained from various relevant agencies such as the Central Bureau of Statistics and the Department of Agriculture. The population of this study consisted of 160 rice farmers in Jelekong Village, Baleendah District, and Bandung Regency. Using Yamane's formula (Yamane, 1967) as follows, with a confidence level of 95%, the required sample size was determined to be 115 rice farmers.

$$n = \frac{N}{1 + N(e)^2}$$

Description:
n: Sample size
N: Population size (160 farmers)
e : *margin of error* (5%)

Sampling in this study was conducted using the simple random sampling technique. The sample of farmers was selected with the assistance of Microsoft Excel by generating random numbers and

selecting the first 115 entries based on the randomized list.

The dependent variable in this study is herbicide use (with YES and NO categories), while the independent variables are farmers' education level, economic factors (price, cost-effectiveness), psychological factors (ease of use, product effectiveness, environmental awareness), situational factors (cultivated area, availability) (Surender et al., 2021), and social factors (extension agent recommendation, promotion, and fellow farmer recommendation) (Espig et al., 2022). The independent variables were measured using a Likert scale to assess respondents' opinions on statements related to herbicide use decision-making, as described in the table below.

Table 1. Operationalization of Variables

Variable	Operational Definition	Indicator	Measurement Scale
Use of Herbicide (Y)	Farmers' decision to use herbicides	1: Yes 0: No	Dikotomis
Farmer Education (X1)	The length of time that farmers spend in formal education.		Year
Price (X2)	Farmers' perceptions of herbicide affordability	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert
Cost Efficiency (X3)	Farmers' perceptions of the cost-efficiency of herbicide use	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert
Ease of Use (X4)	Farmers' perceptions of the ease of herbicide application	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert
Promotion (X5)	Farmers' perceptions of exposure to herbicide promotion or marketing	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert
Product Effectiveness (X6)	Farmers' perceptions of herbicide effectiveness	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert
Environmental awareness (X7)	Farmers' awareness of the environmental impacts of herbicide use	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert
Farm Size (X8)	Size of rice fields cultivated by farmers		Ha
Availability (X9)	Farmers' perceptions of herbicide product availability	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert

Variable	Operational Definition	Indicator	Measurement Scale
Extension (X9)	Farmers' perceptions of agricultural extension services	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert
Peer farmer recommendation (X11)	Farmers' perceptions of peer recommendations regarding herbicide use	4: Strongly agree 3: Agree 2: Disagree 1: Strongly disagree	Likert

Data were analyzed through logistic regression analysis to determine the factors that influence farmers' decisions in the use of herbicides in Jelekong Village, Baleendah District, Bandung Regency. The regression equation used is as follows:

$$P(x) = \frac{e^{\alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \ldots\ldots\ldots + \beta_{14} x_{14} + \varepsilon}}{1 + e^{\alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \ldots\ldots + \beta_{14} x_{14} + \varepsilon}}$$

Description:

$P(x)$: Using herbicides (yes/no)

α : Constant $\qquad$ β : Regression coefficient

e : Exponent $\qquad$ ε : Error

X_1 : Farmer education $\qquad$ X_7 : Environmental awareness

X_2 : Price $\qquad$ X_8 : Farm size

X_3 : Cost efficiency $\qquad$ X_9 : Availability

X_4 : Ease of use $\qquad$ X_{10} : Extension

X_5 : Promotion $\qquad$ X_{11} : Peer farmer recommendation

X_6 : Product effectiveness

The data were also analyzed descriptively to identify general patterns, validate and complement the results of the logistic regression, and to provide a clearer picture of how to provide a clearer picture of how the analyzed variables relate to decisions on herbicide use. For Likert-scale variables, the Top Two Boxes (TTB) tabulation method was used to compare the highest two response categories "strongly agree" and "agree" as an indicator of positive perception or agreement. For ratio scale variables such as education level and farm size, the data were analyzed using cross tabulation to facilitate descriptive comparison across respondent characteristics.

RESULT AND DISCUSSION

Interview results show that the majority of farmers (82.10%) rely on herbicides for weed control, while only 17.90% use mechanical methods (Figure 1). Farmers usually use herbicides during pre-planting and crop maintenance. Results of logistic regression analysis showed that the variables of cost, ease of use, effectiveness of herbicides, cultivated area, and recommendations from fellow farmers were factors that had a significant effect on farmers' decisions to use herbicides (Table 2).
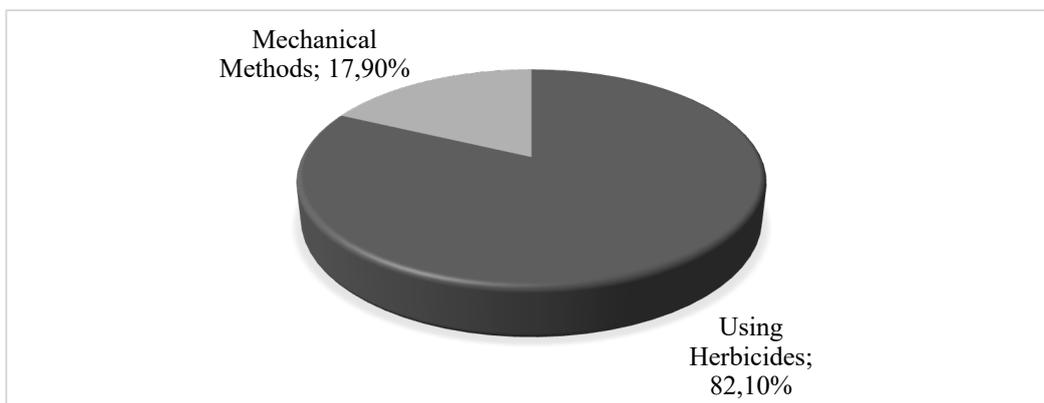
Figure 1. Weed Control Methods

The calculation of incurred costs has a positive effect on the decision to use herbicides, with an odds ratio of 4.467. This indicates that farmers who perceive herbicide use as more cost-efficient are 4.467 times more likely to use herbicides compared to those who do not (Table 2). The high value of the odds ratio indicates a strong tendency for farmers to choose products that provide economic benefits proportional to the size of their operation. This is consistent with rational choice theory, where farmers act as rational agents who make decisions based on profit-loss calculations to maximise their profits. In this perspective, any social action is seen as the result of a conscious choice based on individual preferences for the most favourable outcome, taking into account available resources, constraints, and information (Coleman, 2013). In this case, farmers consider the use of herbicides to be more efficient because it can reduce the need for labour in weeding activities. Studies by Huang et al. (2017) in China, Polansky & Guntoro (2016) in Indonesia, and Rahman (2016) in Bangladesh also shown that labour availability and wage levels influence farmers' decisions to use herbicides. For farmers who use mechanical weed control, they have to pay labour for *ngoyos* (uprooting plants that are considered to interfere with the growth of rice plants).

Ease of use and effectiveness of herbicides also had a positive effect on farmers' decision to use herbicides (Table 2). This shows that psychologically, farmers tend to avoid products that are complicated or difficult to use and the results are effective. This result is in line with the theory of diffusion of innovations proposed by Rogers (2003) that complexity and also relative advantage is one of the determining factors in the application of technology. In line with this, Ghadim & Pannell (1999); Munguia et al. (2021); and Olum et al. (2020) also explain that technology that is perceived as useful and easy to use is more likely to be widely accepted and used.

Table 2. Logistic Regression Analysis Results

Variable	B	Sig.	OR
Farmer education	0,065	0,367	1,082
Price	0,185	0,324	0,718
Cost efficiency	1,518	0,001**	4,467
Ease of use	0,23	0,003**	0,679
Promotion	0,182	0,117	0,735
Product effectiveness	1,146	0,025**	2,896
Environmental awareness	1,278	0,205	0,274

Variable	B	Sig.	OR
Farm size	0,008	0,034**	1,972
Availability	0,598	0,765	0,679
Extension	1.860	0,215	0,704
Peer farmer recommendation	0,179	0,027**	1,259

Note: ** α = 0,01

The size of the cultivated area positively influenced the decision of farmers to use herbicides, with an odds ratio = 1.972 (Table 2). Consistent with this, the data in Table 3 also show that farmers with larger land holdings are more likely to use herbicides. Economically, farmers with larger landholdings face greater labor and time efficiency challenges in weed control. Under these conditions, the use of herbicides is a more efficient alternative to mechanical weed control, which requires more labor and time. This is consistent with the findings of Kassie et al. (2013) and Surender et al. (2021) that the use of modern inputs, such as herbicides, increases significantly as land area increases due to business efficiency needs.

Table 3. Cross Tabulation of Farm Size and Herbicide Use

Farm Size	Using Herbicides (n)	Not Using Herbicides (n)	Total (n)	% Using
Small (less than 0,5 Ha)	45	12	57	78,94%
Medium (0,5-1 Ha)	29	5	34	85,29%
Large (more than1 Ha)	20	4	24	83,33%
Total	94	21	115	

Peer recommendations also emerged as a significant factor in farmers' decisions to use pesticides, with an odds ratio = 1.259 (Table 2), highlighting the influence of the social environment on decision making. Farmers consider information from fellow farmers to be more reliable in terms of controlling pests. This shows the importance of the social dimension in technology adoption by farmers. Farmers tend to rely on interpersonal networks and trust the experience of fellow farmers even more than formal sources such as extension workers. This finding confirms the findings of Bandiera & Rasul (2006), which show that social interaction and influence from other farmers play a key role in the adoption of agricultural innovations in developing countries.

Consistent with the results of the logistic regression analysis, the results of the top two boxes analysis in Figure 2 also show that cost efficiency is an important factor in farmers' decision-making processes regarding herbicide use. However, another economic variable, product price, did not show sufficient influence on the farmers' decision to use herbicides. This contrasts with the findings of Huang et al. (2017) and Kumar & Singh (2015), both of whom reported that farmers take product price into account when deciding to use pesticides This finding provides an important insight: the rational choice of farmers in Jelekong Village to use herbicides not only considers cost efficiency, but also considers the utility value of the product, which is considered to be higher than the nominal price paid.

Meanwhile, environmental awareness has not been an issue considered by farmers in the research location in using herbicides (Figure 2). In contrast to several previous studies that show that the higher the farmer's awareness of environmental issues, the farmer tends to choose environmentally

friendly methods of controlling plant pest organisms (Effendy et al., 2021; Obiri et al., 2021; Sharifzadeh et al., 2018) . This is because farmers still focus on short-term results and production efficiency, so that environmental impacts have not been the main consideration in managing farms. These results are in line with Pretty & Bharucha (2015) research, which states that environmental sustainability is often a secondary priority in subsistence or semi-commercial agricultural practices, unless it is directly linked to economic incentives or short-term risks.
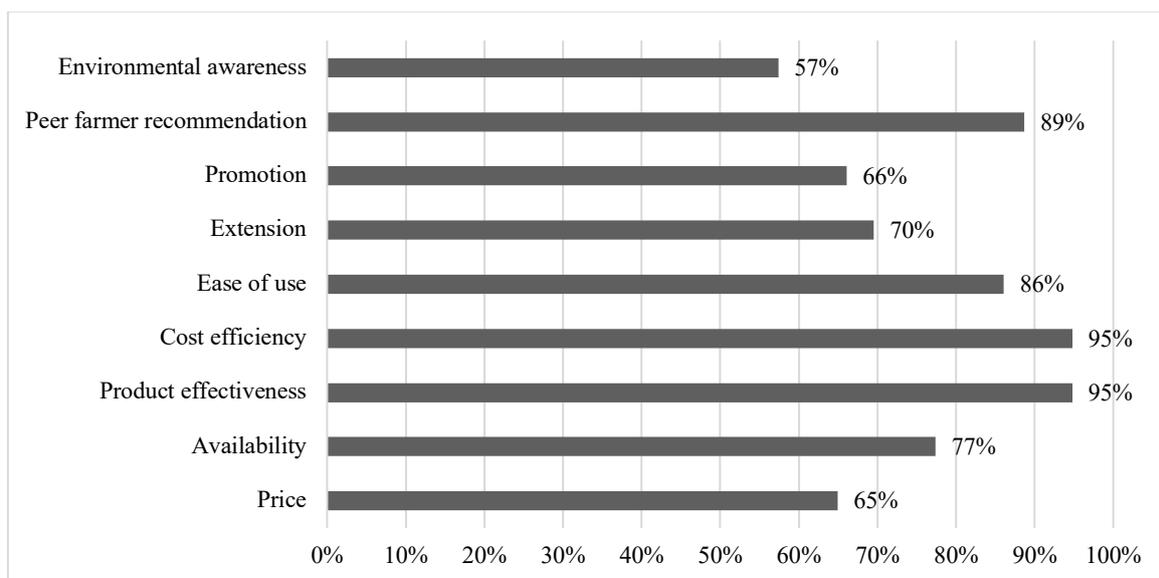

Figure 2. Results of Top Two Boxes Analysis of Factors Influencing Farmers' Decision to Use Herbicides

Herbicide availability is also not a determinant in the decision to use herbicides. This is likely because such products are generally widely accessible in the study area, making availability no longer a differentiating variable in the decision-making process. This finding is consistent with the study by Morris et al (1999), which found that availability only becomes an important issue when there are barriers in distribution or geographical conditions that cause limited access to agricultural inputs.

Regarding social factors, the analysis shows that farmers rely more on information from other farmers when considering herbicide use than on information from extension agents or herbicide company advertisements (Figure 2). Farmers often consider the direct experience of fellow farmers to be more relevant and reliable. This demonstrates the strength of informal social ties and networks in decision making. Research by Conley & Christopher (2001) and T. G. Conley & Udry (2010) shows that in agrarian societies, local knowledge and social trust play an important role in shaping perceptions of the risks and benefits of new technologies, including herbicides. Farmers tend to imitate the practices of other farmers who are perceived to be successful, especially those in geographical, social or economic proximity. This is also supported theoretically by the diffusion of innovations theory proposed by Rogers (2003), where farmers with certain characteristics act as opinion leaders who can influence the adoption decisions of other farmer groups. Farmers' decisions are not only the result of individual analysis, but also a product of social dialogue and influence in their communities. This network forms a collective norm that becomes a reference in determining which technologies are worth trying and implementing.

Table 4 shows that there is no significant variation in herbicide use trends by education level (around 81–82% in all groups). These results align with the findings of the logistic regression analysis, which suggests that farmers' education level does not have a major impact on their decision to use herbicides. This is consistent with several previous studies suggesting that practical field experience and informal learning often play a greater role in farmers' decision-making than formal education. In many agricultural contexts in developing countries, farmers acquire knowledge and skills primarily through practical experience, peer-to-peer learning, and intergenerational knowledge transfer (Asfaw & Admassie, 2004; Sohal et al., 2023; Wang & Zhang, 2025). While formal education is generally associated with improved cognitive skills and openness to innovation, in practice, decisions about the use of agricultural inputs such as herbicides tend to rely more on observation, personal experimentation, and the advice of trusted, experienced peers. Hameed & Sawicka (2023) argue that the impact of formal education on agricultural productivity is highly context dependent and often limited in the absence of effective extension services or access to supporting technologies. These findings suggest that while formal education can serve as a complementary factor, knowledge gained from direct experience remains the primary reference in farmers' daily practices. Consequently, training programs and technology dissemination strategies are likely to be more effective if they are aligned with local knowledge systems and delivered through participatory, experiential learning approaches.

Table 4. Cross-tabulation of Farmers' Educational Level and Herbicide Use

Educational Level	Using Herbicides (n)	Not Using Herbicides (n)	Total (n)	% Using
≤ 6 years (elementary school and below)	23	5	28	82,14%
7–12 years (secondary school)	54	12	66	81,81%
> 12 years (University)	17	4	21	80,95%
Total	94	21	115	

The results of this study indicate that most farmers choose to use herbicides as a method of weed control due to cost efficiency, ease of use, and recommendations from other farmers. However, environmental awareness has not yet become a primary consideration in farmers' decision-making processes. This suggests an environmental sustainability gap, as the continuous use of chemical-based herbicides without considering environmental impacts can lead to long-term risks such as soil degradation, water pollution, and weed resistance (Brühl & Zaller, 2021; Kpienbaareh et al., 2023; Parven et al., 2025). The tendency of farmers to prioritize short-term economic efficiency over environmental impacts poses unique challenges for rice farming systems. These findings align with previous research indicating that environmental sustainability is typically a secondary priority unless directly linked to economic incentives or short term risks. (Lefebvre et al., 2020; Piñeiro et al., 2020).

CONCLUSION AND SUGGESTION

The results of this study suggest that social, economic, and situational factors influence farmers' decisions to use herbicides. The findings of this study suggest that farmers' decisions to adopt herbicides are influenced by their perceptions of the products' cost-efficiency, ease of use, and effectiveness.

Another important finding is that informal social networks among farmers play a significant role in disseminating information and in the decision-making process regarding herbicide use. However, this study shows that environmental awareness is not yet a major factor in farmers' decisions about herbicide use regarding environmental sustainability issues.

Environmental changes and the need to maintain farm productivity require farmers to manage their businesses more efficiently, including in decisions related to weed control. Based on the findings of this study, policy interventions and extension programs should be adapted to farmers' decision-making patterns and local knowledge systems. Community based extension models should be strengthened by involving farmer leaders and farmer social networks. Additionally, environmental awareness campaigns should be integrated into extension activities to emphasize the long-term impacts of excessive herbicide use and promote environmentally friendly alternative methods. Input subsidy programs or incentive schemes could encourage the adoption of environmentally friendly weed control technologies. Aligning policy design with farmers' social and economic realities can lead to more effective, sustainable weed management.

REFERENCES

Asfaw, A., & Admassie, A. (2004). The role of education on the adoption of chemical fertiliser under different socioeconomic environments in Ethiopia. *Agricultural Economics*, *30*(1), 215–228. https://doi.org/https://doi.org/10.1086/451461

Bandiera, O., & Rasul, I. (2006). Social networks and technology adoption in the Zambezia province of Northern Mozambique. *The Economic Journal*, *116*(October), 869–902.

Ben Mohamed, E., Jarboui, A., Garoui, N., Ibrahim, S., Alsalman, A. M., & Abbassi, W. (2024). The determinants of the responsible use of pesticides among date farmers in Qassim region, Saudi Arabia. *Cogent Food and Agriculture*, *10*(1). https://doi.org/10.1080/23311932.2024.2314238

BPS. (2025). *Luas Panen, Produksi, dan Produktivitas Padi Menurut Provinsi, 2024*. https://www.bps.go.id/id/statistics-table/2/MTQ5OCMy/luas-panen-produksi-dan-produktivitas-padi-menurut-provinsi.html

BPS Kabupaten Bandung. (2023). Hasil Pencacahan Lengkap Sensus Pertanian 2023. In *Sensus Pertanian*.

BPS Kabupaten Bandung. (2024). *Kecamatan Balendah Dalam Angka 2024*. BPS Kabupaten Bandung.

BPS Provinsi Jawa Barat. (2025). *Produksi Beras Menurut Kabupaten/Kota (Ton), 2024*. https://jabar.bps.go.id/id/statistics-table/2/NzEzIzI=/produksi-beras-menurut-kabupaten-kota.html

Brühl, C. A., & Zaller, J. G. (2021). Indirect herbicide effects on biodiversity, ecosystem functions, and interactions with global changes. In *Herbicides: Chemistry, Efficacy, Toxicology, and Environmental Impacts* (pp. 231–271). Elsevier. https://doi.org/10.1016/B978-0-12-823674-1.00005-5

Coleman, J. S. (2013). *Dasar-dasar Teori Sosial*. Nusa Media.

Conley, T., & Christopher, U. (2001). Social learning through networks: the adoption of new agricultural technologies in Ghana. *American Journal of Agricultural Economics*, *83*(3), 668–673. https://doi.org/https://doi.org/10.1111/0002-9092.00188

Conley, T. G., & Udry, C. R. (2010). Learning about a new technology : Pineaple in Ghana. *American Economic Review*, *100*(1), 35–69.

Creswell, J. W. (2014). *Research Desain : Qualitative, Quantitative and Mixed Methods Approaches* (4th ed). SAGE.

Effendi, K., Munif, A., & Winasa, I. W. (2020). Pengetahuan, Sikap, dan Tindakan Petani Upsus dalam Mengendalikan Hama dan Penyakit Tanaman Padi (Knowledge, Attitude, and Action of Upsus Farmers in Controling Pest and Disease of Rice Plant). *Jurnal Ilmu Pertanian Indonesia (JIPI), Oktober*, *25*(4), 515–523. https://doi.org/10.18343/jipi.25.4.515

Effendy, Antara, M., Muhardi, Pellokila, M. R., & Mulyo, J. H. (2021). Identification of Factors Affecting Decisions to Adopt Pesticides at Lowland Rice Farms in Indonesia. *International Journal of Design and Nature and Ecodynamics*, *16*(6), 717–723. https://doi.org/10.18280/ijdne.160614

Espig, M., Dynes, R. A., Henwood, R. J. T., & James, T. K. (2022). The Drivers of Herbicide Use among Arable Farmers in Canterbury, New Zealand: Toward an Integrated Approach. *Society and Natural Resources*, *35*(3), 281–300. https://doi.org/10.1080/08941920.2022.2032516

Ghadim, A. K. A., & Pannell, D. J. (1999). A conceptual framework of adoption of an agricultural innovation. *Agricultural Economics*, *21*(2), 145–154. https://doi.org/10.1016/s0169-5150(99)00023-7

Hameed, T. S., & Sawicka, B. (2023). Role of Agricultural Extension in Adoption of Sustainable Agriculture Practices. *Anbar Journal of Agricultural Sciences*, *21*(1), 250–260. https://doi.org/10.32649/ajas.2023.179947

Hou, L., Liu, P., Huang, J., & Deng, X. (2020). The influence of risk preferences, knowledge, land consolidation, and landscape diversification on pesticide use. *Agricultural Economics (United Kingdom)*, *51*(5), 759–776. https://doi.org/10.1111/agec.12590

Huang, J., Wang, S., & Xiao, Z. (2017). Rising Herbicide Use and Its Driving Forces in China. *European Journal of Development Research*, *29*(3), 614–627. https://doi.org/10.1057/s41287-017-0081-8

Ismindarto, A., Pudjiastuti, A. Q., & Sumarno, S. (2023). Keputusan Petani Padi Tentang Penggunaan Pestisida Kimia dan Faktor Penentunya. *Jurnal Sosial Ekonomi Pertanian*, *20*(1), 77–92. https://doi.org/10.20956/jsep.v20i1.31614

Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., & Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. *Technological Forecasting and Social Change*, *80*(3), 525–540. https://doi.org/10.1016/j.techfore.2012.08.007

Kpienbaareh, D., Kansanga, M. M., Yiridoe, E., & Luginaah, I. (2023). Exploring the drivers of herbicide use and risk perception among smallholder farmers in Ghana. *Gender, Technology and*

Development, *27*(1), 109–135. https://doi.org/Gender, Technology and Development

Kumar, M., & Singh, N. K. (2015). Factors affecting farmer's buying decision for herbicides in relation to weed dynamics in paddy crop : A case study. *International Journal of Agricultural and Statistical Sciences*, *11*(2), 513–521.

Lefebvre, M., Midler, E., & Bontems, P. (2020). Adoption of Environment-Friendly Agricultural Practices with Background Risk: Experimental Evidence. *Environmental and Resource Economics*, *76*(2–3), 405–428. https://doi.org/10.1007/s10640-020-00431-2

Morris, M. L., Tripp, R., & Dankyi, A. . (1999). *Adoption and Impacts of Improved Ghana Grains Maize Production Technology : A Case Studyof the Ghana Grains Development Project*.

Munguia, M. O. de O., Pannell, D. J., & Llewellyn, R. (2021). Understanding the adoption of innovations in agriculture: A review of selected conceptual models. *Agronomy*, *11*(1), 1–20. https://doi.org/10.3390/agronomy11010139

Obiri, B. D., Obeng, E. A., Oduro, K. A., Apetorgbor, M. M., Peprah, T., Duah-Gyamfi, A., & Mensah, J. K. (2021). Farmers' perceptions of herbicide usage in forest landscape restoration programs in Ghana. *Scientific African*, *11*. https://doi.org/10.1016/j.sciaf.2020.e00672

Olum, S., Gellynck, X., Juvinal, J., Ongeng, D., & De Steur, H. (2020). Farmers' adoption of agricultural innovations: A systematic review on willingness to pay studies. *Outlook on Agriculture*, *49*(3), 187–203. https://doi.org/10.1177/0030727019879453

Parven, A., Meftaul, I. M., Venkateswarlu, K., & Megharaj, M. (2025). Herbicides in modern sustainable agriculture: environmental fate, ecological implications, and human health concerns. *International Journal of Environmental Science and Technology*, *22*(2), 1181–1202. https://doi.org/10.1007/s13762-024-05818-y

Piñeiro, V., Arias, J., Dürr, J., Elverdin, P., Ibáñez, A. M., Kinengyere, A., Opazo, C. M., Owoo, N., Page, J. R., Prager, S. D., & Torero, M. (2020). A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes. *Nature Sustainability*, *3*(10), 809–820. https://doi.org/10.1038/s41893-020-00617-y

Polansky, S., & Guntoro, D. (2016). Pengendalian Gulma pada Tanaman Padi Sawah dengan Menggunakan Herbisida Berbahan Aktif Campuran Bentazon dan MCPA. *Buletin Agrohorti*, *4*(1), 122–131. https://doi.org/10.29244/agrob.v4i1.15011

Pretty, J., & Bharucha, Z. P. (2015). Integrated pest management for sustainable intensification of agriculture in Asia and Africa. *Insects*, *6*(1), 152–182. https://doi.org/10.3390/insects6010152

Rahman, S. (2016). Jointness in farmers' decision to apply pesticides in multiple crops and its determinants at the farm level in Bangladesh. *International Journal of Pest Management*, *62*(2), 149–157. https://doi.org/10.1080/09670874.2016.1147621

Rogers, E. M. (2003). *Diffusion of Innovations* (5th editio). Free Press.

Sharifzadeh, M. S., Abdollahzadeh, G., Damalas, C. A., & Rezaei, R. (2018). Farmers' criteria for pesticide selection and use in the pest control process. *Agriculture (Switzerland)*, *8*(2), 1–16. https://doi.org/10.3390/agriculture8020024

Sohal, A., Pathania, A., & Sharma, C. (2023). Cultivating change: Computational strategies for enhancing adoption of agricultural technology in developing countries: A review. *Journal of Food Chemistry and Nanotechnology*, *9*(1), 375–380. https://doi.org/10.17756/jfcn.2023-s1-047

Surender, S., Balaji, P., Ashok, K., & Velavan. (2021). A study on factors influencing farmers towards the purchase of bio-fungicides in Erode district of Tamil Nadu. *The Pharma Innovation*, *10*(10), 887–891. https://doi.org/10.22271/tpi.2021.v10.i10sg.8171

Wang, H., & Zhang, L. (2025). The effect of environmental cognition on farmers' use behavior of organic fertilizer. *Environment, Development and Sustainability*, *27*(4), 9165–9185. https://doi.org/10.1007/s10668-023-04275-w

Wu, J. (2018). Individual endowment, risk preference and peasants' selection of green pesticides. *Chemical Engineering Transactions*, *65*, 745–750. https://doi.org/10.3303/CET1865125

Yamane, T. (1967). *Statistics: An Introductory Analysis, 2nd Edition*. Harper and Row.

Yurlisa, K. (2021). Review: Komposisi Vegetasi dan Keragaman Gulma di Lahan Padi Sawah. *Prosiding Seminar Nasional Pembangunan Dan Pendidikan Vokasi Pertanian*, *2*(1), 333–342. https://doi.org/10.47687/snppvp.v2i1.198