The Relationship of Health Status, Fatigue Level, and Pesticide Exposure on Work Productivity Among Female Farmers

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Abstract. Women farmers are a vital pillar of global food security (up to 43% of the agricultural workforce in developing countries) but face an overlooked dual burden of household and occupational risks.The purpose of this study was to analyze the relationship between health status, fatigue level, and pesticide exposure to the work productivity of farm women. This cross-sectional study surveyed 70 women farmers in Loa Janan District, Kutai Kartanegara, using standardized instruments: the SF-12, SOFI, and a questionnaire on pesticide exposure (health problems and PPE use) The results showed that SF-12 correlated with 0.040, SOFI did not correlate with 0.065, and pesticide exposure was associated with health problems by 0.030 and did not correlate with PPE use by 0.578. The study recommends boosting women farmers' productivity by improving their health through regular check-ups and implementing health interventions, specifically managing pesticide exposure risks.

Keywords: Farmer productivity, Pesticide exposure, Fatigue, Female farmers, Health status

1 Introduction

Women farmers play a crucial role as a pillar of global food security. However, their participation is often burdened by the double burden of domestic duties and the risks of work on farmland. This condition can affect their health and ultimately their work productivity [1][2] . This study aims to analyze the relationship between health status, fatigue level, and use of Personal Protective Equipment (PPE) on the work productivity of women farmer groups in Loa Duri Seberang, Kutai Kartanegara.

Previous research has consistently shown that good health status is a fundamental prerequisite for optimal working capacity and high productivity in various sectors, including agriculture [3][4]. Exposure to occupational risk factors, such as pesticides, has been extensively documented to have adverse effects on farmers' health, including neurological disorders,

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respiratory problems, and decreased cognitive function [5]. These health impacts can in turn reduce farmers' ability to work effectively and productively

Although the relationship between health and productivity has been extensively researched, there is still a gap in the specific understanding of how fatigue levels and PPE use directly affect the work productivity of women farmers in local contexts such as Loa Duri Seberang. Some previous studies have identified fatigue as a major factor in decreased productivity, but it is not yet clear whether this correlation is universally applicable across all farmer populations, especially considering the dual burden faced by women farmers[6]. Similarly, while the use of PPE is essential for preventing health problems from pesticide exposure, its direct impact on work productivity has not been fully demonstrated consistently in the literature.

This study seeks to fill this knowledge gap by specifically examining the complex relationship between the primary factors affecting women farmers' capacity: fatigue levels, health status (including the effect of pesticide exposure), and PPE use with their overall work productivity. While farmer productivity is influenced by various elements (such as land access, market prices, and technology), this research focuses narrowly on these three variables because they represent the manageable, health-related inputs that are directly tied to the dual burden faced by women on the farm. By understanding these specific correlations, we can identify key, actionable factors—related to well-being and risk management—that significantly affect the productivity of women farmers in the study area. The rationale behind this study was to provide more specific and contextual empirical evidence regarding the productivity challenges faced by women farmers, who are often underrepresented groups in the research

The urgency of this research lies in the vital role of women farmers in food security and family welfare. By identifying the factors that affect their productivity, the results of this study can be the basis for the development of more targeted interventions. By understanding these correlations, the findings of this study are expected to provide an evidence-based foundation for developing future strategies and policies. Such an understanding is crucial for identifying key, actionable factors that can ultimately improve the quality of life and economic contribution of women farmers in the study area. Increasing the productivity of women farmers not only impacts household income but also directly contributes to the achievement of sustainable development goals related to food security and gender equality.

2 Methods

This study is quantitative research with a *Cross Sectional* approach. The research was conducted in Loa Duri Seberang Village, Kutaikartanegara Regency in March 2025. The study involved 70 respondents. Sampling uses the total sampling technique, according to the criteria that have been set This study employed a total sampling technique, including all participants who met the predefined inclusion criteria. Data were collected using a questionnaire consisting of: questions about respondent characteristics, health status using the SF-12 questionnaire, Fatigue level using the SOFI questionnaire, and use of PPE at work questionnaire. The questionnaire was completed directly by the respondents. For those who had difficulty reading or writing, the researcher assisted by reading the questions aloud and recording their responses. The collected data were then processed and analyzed using computer software. To describe each variable, a distribution table is used and then described in the form of a narrative, for SF-12 and SOFI using kendall tau-C bivariate analysis because it is used to measure the strength and direction of the relationship between 2 variables based on their ranking on an ordinal scale, for kendall tau-C is designed for rectangular contingency tables (2x3, 2x4 etc.) and for pesticide exposure using kendall tau-B bivariate analysis because Used to measure thestrength and direction of the relationship between 2 variables with the ordinal data scale when the data does not normally distributed.

3. Results

A descriptive analysis of the demographic characteristics of the farmers who were the subject of this study was conducted to understand the profile of the respondents. Table 1 shows the distribution of the respondents' characteristics based on four main aspects: age, marital status, education level, and tenure.

Table 1. Characteristics of respondents

Variable	Farmer	
	n	Percentage (%)
Age		
<25 y.o.	0	0
26-45 y.o.	42	60
>45 y.o.	28	40
Marital Status		
Unmarried	0	0
Married	65	93
Widowed	5	7
Educational Level		
No Formal Education	4	6
Primary School	19	27
Junior High School	19	27
Senior High School	25	36
College	3	4
Work experience/length of service		
1-3 years	36	51
4-6 years	6	9
7-9 years	1	1
≥10 years	27	39

Table 1 shows farmer demographic data offers a thorough summary of the 70 farmers that participated in the survey. Sixty percent of farmers are between the ages of 26 and 45, which is the most productive age group. Forty percent of farmers are above 45 y.o. Remarkably, there were no farmers under the age of 25, underscoring the younger generation's minimal involvement in the industry. The majority of farmers (93%) are married, followed by widows (7%) and single farmers (none). This would suggest that farming is a more steady or appropriate source of income for married people.

Farmers with a senior high school education make up the majority (36%) in terms of education level. At 27% each, the primary and junior secondary schooling groups are also noteworthy. It's interesting to note that only 4% of farmers have completed college, while 6% have no formal education. This implies that although farmers frequently have formal education up to the secondary level, highly educated people might not find agriculture appealing.

Not the least, work experience or length of service data reveals a distinctive trend: over half of the farmers (51%) have a comparatively short tenure of 1-3 years, suggesting that they are new or just getting started. On the other hand, a sizable percentage (39%) of farmers have ten years or more of experience. The limited size of the medium tenure group (4–6 and 7-9 years) suggests a divide between new and highly experienced farmers. All things considered, the data shows that the majority of farmers are middle-aged and older married people with a moderate degree of education, as well as a mix of new and seasoned farmers.

Table 2 shows distribution of respondents by productivity level (high, medium, or low) in relation to four main health aspects: general health status (SF-12), fatigue level (SOFI), health problems due to pesticide exposure, and use of personal protective equipment (PPE). Statistical tests were performed to determine the significance of the relationships between the variables.

Table 2. Relationship of Health Indicators (SF-12, SOFI, Pesticide Exposure, PPE) with Farmer Productivity Levels

Variabel	**Category**	**Productivity Levels**			Total	*p-value*
		High Productivity	**Medium productivity**	**Low Productivity**		
SF-12	Better Health	6 (8.5%)	7 (10%)	2 (2.9%)	15 (21.4%)	0.040 (correlated)
	Same as average health	2 (2.9%)	1 (1.4%)	1 (1.4%)	4 (5.7%)	
	Below-average health	5 (7.1%)	35 (50%)	11 (15.7%)	51 (72.9%)	
SOFI	Not tired	1 (1.4%)	0	0	1 (1.4%)	0.065 (uncorrelated)
	Mild Fatigue	2 (2.9%)	4 (5.7%)	1 (1.4%)	7 (10%)	
	Moderate Fatigue	8 (11.4%)	29 (41.4%)	7 (10%)	44 (62.6%)	
	Severe Fatigue	2 (2.9%)	10 (14.3%)	6 (8.6%)	18 (25.7%)	
Pesticide Exposure (Health Issues)	No	0	9 (12.9%)	4 (5.7%)	13 (18.6%)	0.030 (correlated)
	Yes	13 (18.6%)	34 (43.6%)	10 (14.3%)	57 (81.4%)	
Pesticide Exposure (Use of PPE)	Yes	12 (17.1%)	39 (55.7%)	12 (17.1%)	63 (90%)	0.578 (uncorrelated)
	No	1 (1.4%)	4 (5.7%)	2 (2.9%)	7 (10%)	

Table 2 shows the relationship between productivity levels and health status were found to be significantly correlated (p=0.040) by analysis of the SF-12 (health indicator). 72.9 percent of respondents said they were in below-average health, and most of them (50% of the sample as a whole) were at a moderate level of productivity. Interestingly, though, individuals who were in better health were more likely to be in the high (8.5%) to medium (10%) productivity range.

This suggests that although there is a positive tendency, improved health does not always equate to high productivity, even when bad health is linked to moderate or low production.

In contrast, there was no significant relationship between productivity levels and the SOFI (fatigue indicator) values (p=0.065). The majority of responders (41.4%) had moderate productivity, whereas the majority (62.6%) had moderate fatigue. Similarly, the moderate productivity group (14.3%) also included respondents who reported feeling extremely tired (25.7% of the total). Although the trend indicates that moderate or poor productivityis frequently associated with fatigue, the non-significant p value raises the possibility that this association is not statistically significant in this particular group.

There was a strong association (p=0.030) between productivitylevel and pesticide exposure (health issue). The vast majority of respondents (81.4%) said they had been exposed to pesticides, and the majority of them (43.6%) were at a moderate level of productivity. Furthermore, increased productivity was reported by 18.6% of all respondents who had been exposed to pesticides. This could indicate that although there is a statistically significant correlation between pesticide exposure and productivity, the effects may vary or not always be linear.

On the other hand, there was no significant correlation (p=0.578) between productivity level and the usage of Personal Protective Equipment (PPE) during pesticide exposure. The majority of respondents (55.7% of the sample as a whole) had modest productivity, and 90% of them reported utilizing PPE. Just 10% of those surveyed said they didn't utilize PPE. This finding suggests that, despite PPE's significance for workplace health and safety, its use has little direct impact on productivity levels in the context of this data.

4 Discussions

The results of this study highlight the complex relationship between farmers' health, work practices [7], and their work productivity levels. The analysis showed that general health (assessed through SF-12) was significantly correlated with productivity levels (p=0.040). These findings are in line with various studies showing that good health status is a fundamental prerequisite for optimal work capacity and high productivity in various sectors, including agriculture [3,4]. Research has consistently demonstrated that farmers' health has a considerable impact on productivity. Studies indicate that poor health leads to reduced technical efficiency, owing to the impairment of work capacity, which in turn decreases both management and supervision effectiveness among farmers [8][9]. Work ability is significantly influenced by aspects of physical health, as evidenced by studies employing the SF and Work Ability Index among agricultural workers. These studies demonstrate that physical functioning, vitality, and the absence of bodily pain are crucial factors in the assessment of work ability [10]. Moreover, increases in sickness lead to measurable inefficiencies in production. Studies in Ethiopia and other countries demonstrate that more days lost to sickness substantially reduce labor input and farm productivity [11]. The predominance of suboptimal health among the majority of respondents, particularly within the moderate-productivity group, underscores the health challenges that farmers may encounter, which can directly or indirectly impact their work efficiency.

The significant correlation between pesticide exposure (which causes health problems) and productivity levels (p=0.030) further strengthens the argument about the health impact on productivity. Many studies have documented the adverse effects of pesticide exposure on farmers' health, including neurological disorders, respiratory problems, and decreased cognitive function, which in turn can reduce their ability to work effectively and productively [12][13]. A systematic review has identified a significant association between occupational exposure to pesticides and a range of health problems, including hematological alterations, respiratory issues, endocrine dysfunction, neurotoxicity, and an increased risk of cancer. These health complications can hinder farmers' work ability and reduce agricultural productivity [14][15]. A multitude of studies conducted in various geographical locations have reported that farmers who are exposed to pesticides frequently manifest a constellation of symptoms, including headaches, skin disorders, dizziness, shortness of breath, and fatigue, at notably elevated rates compared to those who are not exposed. This heightened prevalence of symptoms has been associated with increased absenteeism and diminished capacity for prolonged work [14][16][17]. A substantial body of research has identified neurological effects resulting from acute and chronic exposure to pesticides. These effects include cognitive and psychomotor dysfunction, an elevated risk for neurodegenerative diseases (e.g., Parkinson's and Alzheimer's), headaches, dizziness, and depression. Many of these effects directly impair work efficiency and the capacity for productive labor [16][18]. Although a small percentage of farmers exposed to pesticides showed high productivity, this may be due to other compensatory factors such as higher experience or use of work aids that are not covered by this data. Overall, however, our data show that pesticide exposure is a risk factor that affects productivity.

On the other hand, the findings regarding fatigue (SOFI) that did not correlate significantly with productivity (p=0.065) deviated slightly from initial expectations [19]. Some previous studies have often identified fatigue as a major factor in decreased productivity [20]. However, in the context of this study, a p-value approaching the significance limit (0.05) suggests that there may be a weak relationship trend or that the sample size (n=70) may not be large enough to detect a statistically significant correlation. Alternatively, farmers may have developed coping mechanisms against chronic fatigue, or the definition of "productivity" in this context does not fully capture the impact of fatigue.

Similarly, the use of Personal Protective Equipment (PPE) that was not significantly correlated with productivity (p=0.578) was also interesting. Although the use of PPE is essential for preventing health problems due to pesticide exposure, these results suggest that the use of PPE itself does not directly affect the productivity levels measured in this study. This could mean that the positive effects of PPE are more visible on long-term disease prevention than direct impacts on daily productivity, or that farmers who use PPE may already have higher health awareness and safer work practices in general. A large-scale study in Peruvian agriculture showed that while about a third of farmers do not use any PPE, intensity of PPE use varies depending on education, credit access, and training, with PPE adoption being more closely linked to risk perception and health protection strategies than to observed productivity increases [21]. Some intervention studies have shown that farmers who consistently used PPE had better health biomarker profiles over time, indicating the protective benefits against toxic exposure, without necessarily showing productivity changes within the study period [22]. Other research also shows that compliance with PPE use is not necessarily directly proportional to increased productivity, but rather to the prevention of health risks. Other research also shows that compliance with PPE use is not necessarily directly proportional to increased productivity, but rather to the prevention of health risks [23].

5 Conclusion

This study concluded that farmers' exposure to pesticides and general health have a significant impact on their output levels.. Farmers that are exposed to pesticides and have poorer health typically have moderate levels of productivity. However, in this group, there was no statistically significant relationship between productivity and fatigue levels and PPE used. These results highlight the importance of health interventions and risk management for pesticide exposure in preserving and enhancing farmers' ability to produce. This highlights the necessity of providing farmers with continual training and assistance so they can improve their productivity and be aware of safest practices. Future studies could examine other elements like resource availability or environmental conditions that might affect productivity. Conduct longitudinal research to track changes in farmers' health status and productivity over time, as well as the long-term impacts of pesticide exposure. Agricultural policy must consider farmer health factors as a key component in the strategy to increase national productivity.

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References

[1] N. Menon, Y. van der M. Rodgers, and N. Tanjeem, "The Agricultural Marketplace and Women's Work," *SSRN Electron. J.*, 2023, doi: 10.2139/ssrn.4316602.

[2] Rosihan Khalik and Yossi Permata, "Women's Double Burden: Environmental Responsibility and Gender Inequality," *J. Sumatera Sociol. Indic.*, vol. 3, no. 2, pp. 318–324, 2024, doi: 10.32734/jssi.v3i2.18718.

[3] M. Marmot, "The Health Gap: The Challenge of an Unequal World: The argument," *Int. J. Epidemiol.*, vol. 46, no. 4, pp. 1312–1318, 2017, doi: 10.1093/ije/dyx163.

[4] W. N. Burton, D. J. Conti, C. Y. Chen, A. B. Schultz, and D. W. Edington, "The role of health risk factors and disease on worker productivity," *J. Occup. Environ. Med.*, vol. 41, no. 10, pp. 863–877, Oct. 1999, doi: 10.1097/00043764-199910000-00007.

[5] R. J. Buralli *et al.*, "Occupational exposure to pesticides and health symptoms among family farmers in Brazil," *Rev. Saude Publica*, vol. 54, pp. 1–12, 2020, doi: 10.11606/S1518-8787.2020054002263.

[6] B. R. O'Shaughnessy, A. D. O'Hagan, A. Burke, J. McNamara, and S. O'Connor, "The prevalence of farmer burnout: Systematic review and narrative synthesis," *J. Rural Stud.*, vol. 96, pp. 282–292, Dec. 2022, doi: 10.1016/J.JRURSTUD.2022.11.002.

[7] S. Mohebi, M. Parham, G. Sharifirad, and Z. Gharlipour, "Relationship between the status of occupational health management and job satisfaction among farmers: A health promotion approach," no. January, pp. 1–6, 2018, doi: 10.4103/jehp.jehp.

[8] H. Zhang, Z. Yang, Y. Wang, M. Ankrah Twumasi, and A. A. Chandio, "Impact of Agricultural Mechanization Level on Farmers' Health Status in Western China: Analysis Based on CHARLS Data," *Int. J. Environ. Res. Public Health*, vol. 20, no. 5, 023, doi: 10.3390/ijerph20054654.

[9] T. A. R. Mary E. Kelley, Claire Ramsay Wan, Beth Broussard, Anthony Crisafio, Sarah Cristofaro, Stephanie Johnson, "Envisioning the future of work to safeguard the safety, health, and well-being of the workforce: A perspective from the CDC's National Institute for Occupational Safety and Health," *Schizophr. Res.*, vol. 171, no. 1–3, pp.

62–67, 2016, doi: 10.1002/ajim.23183.Correspondence.
[10] A. Morado, G. Jr, R. Mark, and A. Ambong, “Health-related quality of life and work ability of smallholder rice farm workers in San Jose, Occidental Mindoro, Philippines,” *Makara J. Heal. Res.*, vol. 24, no. 2, 2020, doi: 10.7454/msk.v24i2.1203.
[11] M. L. Loureiro, “Farmers’ health and agricultural productivity,” *Agric. Econ.*, vol. 40, no. 4, pp. 381–388, Jul. 2009, doi: 10.1111/J.1574-0862.2009.00385.X.
[12] M. C. R. Alavanja, J. A. Hoppin, and F. Kamel, “Health effects of chronic pesticide exposure: Cancer and neurotoxicity,” *Annu. Rev. Public Health*, vol. 25, pp. 155–197, 2004, doi: 10.1146/ANNUREV.PUBLHEALTH.25.101802.123020.
[13] M. D. Sanborn, D. Cole, A. Abelsohn, and E. Weir, “Identifying and managing adverse environmental health effects: 4. Pesticides,” *C. Can. Med. Assoc. J.*, vol. 166, no. 11, pp. 1431–1436, 2002.
[14] M. P. De-Assis, R. C. Barcella, J. C. Padilha, H. H. Pohl, and S. B. F. Krug, “Health problems in agricultural workers occupationally exposed to pesticides,” *Rev. Bras. Med. do Trab.*, vol. 18, no. 3, pp. 352–363, 2021, doi: 10.47626/1679-4435-2020-532.
[15] C. Shekhar *et al.*, “A systematic review of pesticide exposure, associated risks, and long-term human health impacts,” *Toxicol. Reports*, vol. 13, no. November, pp. 0–3, 2024, doi: 10.1016/j.toxrep.2024.101840.
[16] I. Ali, “Occupational exposure to pesticides and health symptoms among farmers in Palestine,” *Afr. Health Sci.*, vol. 24, no. 4, pp. 373–382, 2024, doi: 10.4314/ahs.v24i4.46.
[17] R. Pengpan, K. Y. Kopolrat, S. Srichaijaroonpong, N. Taneepanichskul, P. Yasaka, and R. Kammoolkon, “Relationship Between Pesticide Exposure Factors and Health Symptoms Among Chili Farmers in Northeast Thailand,” *J. Prev. Med. Public Heal.*, vol. 57, no. 1, pp. 73–82, 2024, doi: 10.3961/jpmph.23.353.
[18] R. K. Kori, M. K. Singh, A. K. Jain, and R. S. Yadav, “Neurochemical and Behavioral Dysfunctions in Pesticide Exposed Farm Workers: A Clinical Outcome,” *Indian J. Clin. Biochem.*, vol. 33, no. 4, pp. 372–381, 2018, doi: 10.1007/s12291-018-0791-5.
[19] A. Suparman, S. Wibowo, A. Kekalih, M. Ilyas, and A. Agustina, “Indonesian Version of Swedish Occupational Fatigue Inventory (SOFI): Validity and Reliability Test of Worker’s Fatigue Assessment Instrument,” *Indones. J. Community Occup. Med.*, vol. 2, no. 2, pp. 89–95, 2022, doi: 10.53773/ijcom.v2i2.36.89-95.
[20] E. Grandjean, *Fitting the Task to the Man: An Ergonomic Approach*. Taylor & Francis, 1980. [Online]. Available: https://books.google.co.id/books?id=bltRAAAAMAAJ
[21] S. Lari *et al.*, “The impact of the use of personal-protective-equipment on the minimization of effects of exposure to pesticides among farm-workers in India,” *Front. Public Heal.*, vol. 11, 2023, doi: 10.3389/fpubh.2023.1075448.
[22] A. Garrigou *et al.*, “Critical review of the role of PPE in the prevention of risks related to agricultural pesticide use,” *Saf. Sci.*, vol. 123, no. April 2019, p. 104527, 2020, doi: 10.1016/j.ssci.2019.104527.
[23] M. H. Taghdisi, B. A. Besheli, T. Dehdari, and F. Khalili, “Knowledge and practices of safe use of pesticides among a group of farmers in Northern Iran,” *Int. J. Occup. Environ. Med.*, vol. 10, no. 2, pp. 66–72, 2019, doi: 10.15171/ijoem.2019.1479.