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The drivers of technology adoption on tobacco agribusiness in West Nusa Tenggara

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ABSTRACT

West Nusa Tenggara (NTB) is the third-largest tobacco-producing province in Indonesia. However, the dynamics of tobacco production tend to decline, one of which is due to its productivity and land area, which also tends to stagnate. Technology is one of the levers of productivity and the efficiency and effectiveness of supply chain management. The objectives of this research are to assess the level of technology adoption, analyze the factors influencing farmers' decisions to adopt technology, and develop policy recommendations based on the findings. This research uses mixed methods, namely qualitative and quantitative. The qualitative approach uses an in-depth interview approach and Focus Group Discussion (FGD) with farmers and stakeholders of the tobacco industry. The quantitative approach uses the Partial Least Square Structural Equation Modeling (PLS-SEM) method. The results showed that farmers who used tractors, ovens, tobacco pressing, power weeder, and combine harvester technology were 42%, 71%, 46%, 21%, and 2%, respectively. The results of PLS-SEM analysis showed that the variables of education and age had a positive and significant effect on the adoption of tobacco farmer technology. In contrast, the variables of length of farming and land area did not have a significant effect. The variables of land area, length of farming experience, and farmers' age do not significantly affect technology adoption. Based on the results of this study, several strategies to increase technology adoption for tobacco farmers are institutional strengthening to facilitate socialization and counseling related to technology, the establishment of financing schemes that are friendly to farmers, and the development of research and innovation related to appropriate technology to economic, social, cultural, and environmental aspects.

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INTRODUCTION

Agricultural technology is related to increasing productivity and economic efficiency, including minimizing agricultural risk and uncertainty (Gallardo dan Sauer, 2018; Oyetunde-Usman et al., 2021). Indonesia has a history of adopting agricultural technology that began to be promoted during the Industrial Revolution 4.0 in the agricultural sector. Good agricultural development will impact a stable economy (Puspitasari 2019). The government wants to strengthen the status of food security, one of which is through technology. However, agricultural technology adoption among Indonesian smallholders is still relatively low (Priest et al. 2015, Suprehatin 2021). The low adoption of technology in agriculture is caused by various things, including the readiness of human resources, geographical, infrastructure, institutional, socio-economic, and cultural factors (Feyisa 2020, Kilmanun et al. 2022).

Tobacco is one of the agricultural industries contributing to considerable state revenue, namely 10.11% in 2022 (Ministry of Industry 2022). West Nusa Tenggara (NTB) is Indonesia's third largest tobacco-producing provincefter East Java and Central Java Provinces (Badan Pusat Statistik 2015). However, tobacco productivity tends to stagnate in 2014-2018, besides being caused by weather and climate factors (Nazam et al. 2022). Tobacco also contributes to the most significant inflation in NTB (Bank Indonesia 2022).

Agriculture, such as seeds, fertilizers, and pesticides, which are scarce and tend to be expensive, also have an effect (Hidayat et al. 2021). In addition, other crucial factors are the lack of dissemination and the unaffordability of technology. Adopting technology in agricultural systems can promote rural economic growth and reduce poverty rates (Muzari et al. 2012, Habtemariam et al. 2017, Zegeye et al. 2022, Akumbom et al. 2023). Technology adoption can also overcome the problem of agricultural workers whose costs are increasingly high and limited in number (Abdullah and Samah 2013).

Indonesia lags far behind in adopting agricultural technology (Kuntariningsih and Mariyono 2013), but there are still opportunities to catch up. Technology is an essential factor that determines the sustainability of Indonesian agribusiness, so the direction of agricultural development policy should include technology adoption as one of the levers of competitiveness.

Tobacco agribusiness is no exception and requires technology from upstream to downstream agriculture. Adopting technology in tobacco agribusiness is essential to increase productivity and profits and ensure that the tobacco industry can adapt to various challenges, such as climate change and more sustainable products.

Two types of technology are used to streamline the agribusiness system, namely on-farming and postharvest. On-farming technology is directly related to agricultural cultivation, such as optimization of tillage, fertilization, irrigation, pest and disease control. The technology used varies from machine-based to Artificial Intelligence (AI). In addition to *on-farming* technology, tobacco farmers use postharvest technology to improve the performance of tobacco-added value, including oven dryers, choppers, and pressing machines.

The level of technology adoption by tobacco farmers, both on-farming and postharvest, needs to be identified. In addition, it is also necessary to analyze the determinants that influence farmers in adopting technology. Some literature states that several factors affect the level of technology adoption in farmers, including farmer education, household size, land size, access to credit, land tenure, access to extension services, and organization membership (Ruzzante et al. 2021). Feyisa (2020) explained that technology adoption is also influenced by distance from the market because it is related to the storage of agricultural products. Belay and Mengiste (2023) added that gender, frequency of contract with extension agents, access to climate information, and income are core determinants of agricultural technology adoption. Muzari et al. (2012) assert that vulnerability, awareness, labor, and innovativeness by smallholder farmers are factors that influence technology adoption. Farm size determines technology adoption (Mwangi and Kariuki 2015).

In addition to identifying determinants that influence technology adoption, this study also identifies whether the length of farming affects the land area. This condition is related to other investments made by farmers in addition to technology. After analyzing these determinants, policy implications for accelerating technology adoption in tobacco agribusiness will be formulated. The policy of accelerating technology adoption is expected to increase the competitiveness of tobacco agribusiness and the welfare of farmers in particular.

METHOD

Research approach and data sources.

This paper uses quantitative and qualitative data to identify the determinants of technology adoption among tobacco smallholders in West Nusa Tenggara. Quantitative data were collected by surveying 100 smallholders. West Nusa Tenggara was selected because it is one of Indonesia's top three tobacco producers (BPS 2021). Data were collected through a survey using questionnaires. To follow up on important and interesting issues that had arisen during the survey, the study went further by conducting in-depth interviews with a few selected smallholders and stakeholders, such as the local government and the Tobacco Industry Association. The sampling method is purposive sampling. This research also uses literature reviews to obtain information about tobacco agribusiness.

Procedure and data processing

Partial Least Square-Structual Equation Modeling (PLS-SEM) is employed to analyze the relationship between exogenous and endogenous variables and test the model's characteristics. The number of samples in this study was 100 respondents. The minimal number of samples is five to ten multiplied by the number of core questions in the questionnaire (Hair 2014). This study's number of core questions was 9, 9x5=45 respondents, more than enough to meet the required recommendations. This study's technology used as indicators are tractors, ovens, tobacco-pressing machines, and power weeders. The variables that determine the level of farmer technology adoption are education, age, land area, and length of farming. Education variables are one of the crucial factors influencing technology adoption (Pierpaoli et al. 2013, Shita et al. 2018, Feyisa 2020, Ruzzante et al. 2021, Zegeye et al. 2022). Age is one of the socio-demographic variables that is a core factor in adopting technology (Kumar et al. 2018; Pierpaoli et al. 2013). Furthermore, land area is also one of the main variables in consideration of technology adoption (Kumar et al. 2018; Ruzzante et al. 2021; Zegeye et al. 2018; Suprehatin 2021; Shita et al. 2018; Feyiza 2020; Milkias and Abdulahi 2018). Likewise, farming experience influences farmers in adopting technology (Challa and Tilahun 2014, Kumar et al. 2019). Table 1 shows the full extent of questions asked, characteristics, and scales for each construct used in the PLS-SEM analysis.

Figure 1 is a structural model of PLS-SEM in this research. Based on the literature reviews explained before, to achieve our research objectives, we will test five hypotheses as follows

H1: Education has a positive and significant effect on technology adoption
H2: Farmer age has a positive and significant effect on technology adoption
H3: The land area has a positive and significant effect on technology adoption
H4: Long time of farming has a positive and significant effect on technology adoption
H5: The length of farming has a positive and significant impact on land area

RESULTS AND DISCUSSION

This study measured how much tobacco farmers in West Nusa Tenggara adopted agricultural technology. The survey results showed that farmers who used tractors, ovens, tobacco pressing machines, power weeder, and combine harvester technology were 42%, 71%, 46%, 21%, and 2%, respectively. Agricultural technology adoption rates below 50% also occur in various countries in the adoption of improved varieties. Smale and Mason (2014) reported that the adoption rate of hybrid maize in Zambia was 37.4% in 2002/2003 and 42.6% in 2006/2007. Asfawi et al. (2019) also identified that only 32% of farmers in Tanzania and Ethiopia adopted chickpeas and pigeonpea. The same condition also occurs in the Philippines, as Villano and Fleming (2006) reported, where only 30% of farmers adopt certified rice seeds. Furthermore, the adoption rate of drought-tolerant maize was only 5% of maize area in 2006 in Angola, 15% in Benin, 19% in Ethiopia, 25% in Ghana, 72% in Kenya, 15% in Mali, 22% in Malawi, 11% in Mozambique, 25% in Nigeria, 18% in Tanzania, and 35% in Uganda (Kostandini et al. 2013). Technology adoption increases revenue and reducesroduction costs (Michler et al. 2019). Furthermore, adopting agricultural technology can also reduce poverty rates (Kostandini et al. 2013).

Table 1 Indicator variables

Constructs	Indicators	Symbol	Characteristics	Scale
Technology adoption (Y1)	Technology Use: Tractor (soil processing machine)	Y11	Not using, using	1, 2, respectively
	Technology Usage: Oven	Y12	Not using, using	1, 2, respectively
	Technology Usage: Tobacco pressing machine	Y13	Not using, using	1, 2, respectively
	Use of technology: Power weeder (weed or nuisance plant cleaner)	Y14	Not using, using	1, 2, respectively
Education (X1)	Education Level of farmers	X11	Not finished/graduated from elementary school/equivalent	1
			Junior High School/equivalent	2
			High school/equivalent	3
			Diploma, Undergraduate, and Postgraduate	4
Age (X2)	Age of the farmer	X21	≤30 years	1
			31-40 years	2
			41-50 years	3
			≥ 51 years	4
Land (Y2)	Farmer’s land area		≤ 5000	1
		Y21	5001-10000	2
			10001-15000	3
			15001-20000	4
			20001-100000	5
Farming experiences (X3)	Long-time farmers do farming	X31	0 - 5	1
			6 - 10	2
			11 - 15	3
			16 - 20	4
			≥ 21	5

The analysis results show that ovens are the most widely adopted postharvest technology by tobacco farmers in NTB compared to other technologies. Two methods of handling tobacco postharvest are bachelor and oven tobacco. Most tobacco farmers prefer to invest in oven machinery and technology because the selling price of oven tobacco tends to be higher than display tobacco. Tobacco pressing machines are the second most widely adopted postharvest technology by farmers. Farmers use pressing machines to supply cigarette companies in large quantities so as not to need large volumes.

Furthermore, the third most common technology adopted by farmers is a tractor, which is an on-farming technology used to cultivate agricultural land. The next technology that farmers have adopted the least is the power weeder and combine harvester, an on-farming technology. Technology and machinery, both on-farming and postharvest, aim to increase agricultural productivity and farm efficiency.

Furthermore, to identify the relationship between variables and determinants that affect the rate of technology adoption, it will be analyzed using the PLS-SEM model. However, previously descriptive statistical indicators will be presented in each construction. Table 2 describes each indicator's mean, median, minimum value, maximum value, standard deviation, excess currency, and skewness. From these results, it can be seen that the value of each indicator spreads from the smallest value to the largest.

Before testing the path coefficient relationship, it is necessary to analyze the concurrent and determinant validity tests. The loading factor value on each indicator is more than 0.7, so it can be stated that all the indicators tested are valid. Furthermore, the overview of algorithm test results, namely Cronbach alpha, rho_A, composite reliability, and average variance extracted (AVE) have exceeded the rule of thumbs, namely Cronbach alpha > 0.6, rho A > 0.7, composite reliability > 0.6, AVE more than 0.5 (Abdullah and Hartono 2014).

Furthermore, determinant validity testing was carried out based on the AVE square root value between constructs and the cross-loading value of each indicator. Based on the results of the determinant validity test, it can be stated that the model formed is valid because the value has met the rule of thumbs, namely, the value of the AVE square root between constructs is more than the correlation of latent variables (discriminant validity) and the cross-loading value is more than 0.7 in one variable (Table 4 and Table 5). Furthermore, the results of the R-square test show that the R-square and R-square adjusted values of the technology adoption construct are 0.124 and 0.088, respectively, while for the land area construct are 0.061 and 0.051, respectively.

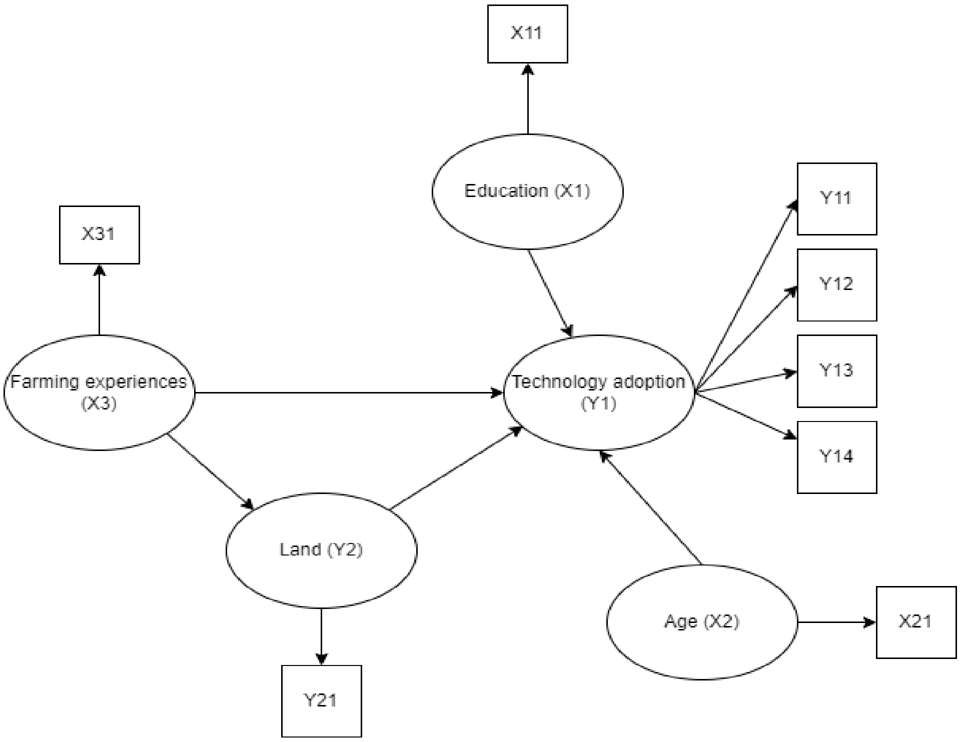

Figure 1 PLS-SEM structural model

Table 1 Descriptive statistics

Construct	Indicator	Mean	Median	Min	Max	Standard Deviation	Excess Kurtosis	Skewness
Technology adoption (Y1)	Y11	1.420	1.000	1.000	2.000	0.494	-1.931	0.329
	Y12	1.710	2.000	1.000	2.000	0.454	-1.140	-0.940
	Y13	1.460	1.000	1.000	2.000	0.498	-2.014	0.163
	Y14	1.210	1.000	1.000	2.000	0.407	0.092	1.446
Education(X1)	X11	2.570	3.000	1.000	4.000	1.079	-1.266	-0.087
Age (X2)	X21	2.530	2.000	1.000	4.000	0.888	-0.756	0.299
Farming experiences (X3)	X31	3.030	3.000	1.000	5.000	1.323	-1.135	0.023
Land (Y2)	Y21	2.860	2.000	1.000	5.000	1.364	-1.198	0.354

Table 2 Convergent validity test

Construct	Item	Factor loading (>0,7)	AVE (>0,5)	Rho-A (>0,7)	Cronbach's Alpha **(> 0,6)**	Composite reliability (>0,6)
Technology adoption	Y11 Y14	0.856 0.930	0,799	0,815	0,755	0,888
Education	X1	1.000	1.000	1.000	1.000	1.000
age	X2	1.000	1.000	1.000	1.000	1.000
Farming experiences	X3	1.000	1.000	1.000	1.000	1.000
Land	Y2	1.000	1.000	1.000	1.000	1.000

Table 3 Root value of AVE square between constructs

construct	Technology adoption	Farming experiences	Land	education	age
Technology adoption	0,894				
Farming experiences	0,034	1,000			
Land	0,112	0,246	1,000		
education	0,215	-0,446	-0,007	1,000	
age	0,199	0,650	0,028	-0,221	1,000

Table 4 cross-loading value of each indicator

Construct	Technology adoption	Farming experiences	Land	education	age
X1	0,215	-0,446	-0,007	**1,000**	-0,221
X2	0,199	0,650	0,028	-0,221	**1,000**
X3	0,034	**1,000**	0,246	-0,446	0,650
Y11	**0,856**	0,011	0,117	0,208	0,085
Y14	**0,930**	0,044	0,089	0,183	0,245
Y2	0,112	0,246	**1,000**	-0,007	0,028

Table 6 presents the results of the path coefficient, which shows that three results match the hypothesis, namely H1, H2, and H5, while the other three test results do not match the hypothesis. The level of education has a positive and significant effect on technology adoption, which indicates that the higher the level of education, the greater the chance of farmers adopting technology. Age has a positive and significant effect on technology adoption. The older the farmer, the more likely the farmer to adopt technology. The long farming period has a positive and significant effect on land area. The more extended farmers farm, the more they tend to have more agricultural land. Farmers prefer to invest in agricultural land.

Furthermore, land area and length of farming do not have a significant effect on technology adoption. As farming experience progresses, farmers tend to prefer investing in land areas rather than technology. Likewise, the area of land, the larger the land area, it does not necessarily change the behavior of farmers in investing in technology. Based on the test results, it can be stated that two variables influence the adoption of tobacco technology in NTB, namely education and age.

The results showed that tobacco farmers in NTB tend to use postharvest technology more than on-farming technology. However, coverage also tends to be low. It is not only experienced by tobacco farmers in Indonesia, but technology options also occur in various other countries. Research conducted by Simtowe et al. (2008) reported that technology adoption in groundnut varieties in Malawi is relatively low. Mwangi and Kariuki (2015) explained that the adoption of technology by smallholder farmers in several developing countries is also relatively low. Various things cause the low level of technology adoption in various countrie both institutional readiness and the ability of farmers (Suprehatin 2021). In addition, socio-cultural factors are also one of the factors that play a significant role in the technology transfer process in the agribusiness value chain (Curry et al. 2021).

The results of path coefficient testing in PLS-SEM show that two determinants positively and significantly affect the technology adoption of tobacco farmers in NTB: education and age. The test results show that education and age are the main variables in adopting agricultural technology. The higher the farmers' education level, the more aware farmers are that using technology can increase farm efficiency. Education, including the agricultural sector, is an important pillar in human resource development. Ruzzante et al. (2021) explained that investment in education is significant because it can improve farmers' ability to understand and make informed decisions about new technologies.

The results of this study are consistent with the findings of Maguza-Tembo et al. (2017), Manyumwa et al. (2013), and Massresha et al. (2021a) found that greater years of schooling is a key determinant influencing agricultural technology adoption in Ethiopia. Similarly, Manyumwa et al. (2013) also stated that educational status affects farmers' decisions to adopt floating tray technology in tobacco farming. Maguza-Tembo et al. (2017) revealed that the level of education is a significant factor influencing farmers' adoption decisions regarding climate-smart technologies.

There is a fundamental problem: farmers' education level in Indonesia is relatively low.Badan Pusat Statistik (2022) reports that the proportion of informal employment is only 16.87% who complete their education at the university level, the rest is dominated by workers who are not in school. The results of this study show that farmers who completed education at the elementary, junior high, high school, and tertiary levels were 21%, 26%, 28%, and 25%. The majority of farmers completed their education at the high school level. In addition, a relatively large percentage of 25% of farmers complete their education at university. The results of the research observations indicate that there are groups of people who have two livelihoods at once: those working in the formal sector and those who are tobacco farmers. The community claimed that tobacco farming was profitable, so educated people pursued it. Economic benefits are one of the driving factors for the agricultural sector to be attractive. Therefore, the policy implication in improving the competitiveness of tobacco agribusiness is an attractive economic profitability scheme while also considering other sustainability aspects, such as social and environmental aspects.

The age variable is an essential variable in the adoption of tobacco farmer technology in NTB. The longer the age of farmers turned out to be correlated with the rate of technology adoption. Older farmers tend to apply technology more compared to younger farmers. This study is also consistent with the research conducted by Maguza-Tembo et al. (2017), Massresha et al. (2021), and Manyumwa et al. (2013), which found that age is a significant determinant influencing farmers' decisions to adopt agricultural technologies.

Table 5 Path coefficient

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
H1: Education -> technology adoption	**0,244**	**0,243**	**0,126**	**1,941**	**0,053*** **
H2: > of technology adoption	**0,306**	**0,306**	**0,150**	**2,040**	**0,042** **
H3: Land area -> technology adoption	0,126	0,131	0,115	1,102	0,271
H4: Farming experience -> Technology Adoption	-0,087	-0,096	0,178	0,491	0,623
H5: Farming experiences -> land area	**0,246**	**0,247**	**0,087**	**2,822**	**0,005***

Note: ***(10%), **(5%), *(1%)

Feyisa (2020) explained that older people are better aware of the benefits of agricultural technology based on life experience. In addition, older age also tend to be more established in terms of capital, so they can invest in machinery and technology to make their farming activities more effective and efficient. On the other hand, young farmers tend not to have the capital to invest in machinery and technology because the amount of capital is limited and has been used to pay for agricultural inputs, such as land, seeds, fertilizers, pesticides, and so on. The policy implication that can be applied to this case is formulating environmentally friendly financing schemes through banking and non-banking, such as cooperation between corporate partners and cooperatives.

Furthermore, the variable length of farming is positively and significantly correlated with land area, while the variable length of farming is not significantly correlated with technology adoption. The results of a similar study conducted by Panikkai et al. (2017) stated that tobacco cultivation and postharvest methods have been carried out for generations so that farmers already have their concepts or ways of farming. The test results indicate that farmers tend to prefer investing in land area rather than agricultural technology. Farmers prefer increasing the profitability of agricultural extensification over agricultural intensification through optimizing land resources. Through agricultural land extensification, farmers can expand their farming. The agricultural extensification strategy will be profitable following the procedure, namely clearing untapped land. Agricultural intensification strategies also have the potential to increase profitability, and it is recommended that ecological aspects be paid attention to to support sustainability (Marita et al. 2021).

Land area variables were not significantly correlated with technology adoption. The test results indicate that more land farmers own does not necessarily apply more technology adoption. The increase in agricultural land area is not matched by the adoption of technology, both on-farming and postharvest. The results of the same study were reported by Setiyowati et al. (2022), which stated that the attitude of farmers who are unable to face the risks of farming and fear of failure if they have invested in technology is the reason the land area factor does not significantly affect technology adoption. In addition to optimizing profitability, technology can minimize the impact of agricultural risks, which will cause the wider the land, the greater the risk will be. Awareness of the use of technology does not seem to have been fully experienced by tobacco farmers in NTB. Technology is also one of the keys to increasing the competitiveness of agricultural agribusiness. Therefore, a comprehensive strategy is needed so that farmers can feel the impact of technology that can increase the effectiveness and efficiency of farming.

Based on the analysis results, formulating a strategy to accelerate technology adoption in tobacco farmers in NTB should prioritize the education sector. The government and other stakeholders should invest in education for smallholder farmers (Ruzzante et al. 2021, Zegeye et al. 2022). It is also essential for farmers to provide counseling and guidance on understanding the importance of appropriate technology. Technology can reduce fixed costs for the sustainability of tobacco agribusiness, particularly the economic dimension (Zegeye et al. 2022). The results of this study also show that age variables are positively and significantly correlated with technology adoption, so it is essential to integrate financing schemes that are friendly to smallholder farmers. Local and central governments should formulate credit access policies that provide optimal services for smallholder farmers both to public and private financial institutions, such as banks, cooperatives, and so on (Yigezu et al. 2018, Massresha et al. 2021b, Ruzzante et al. 2021, Zegeye et al. 2022).

In addition, Kumar et al. (2019) emphasized that it is essential to emphasize the element of economic advantage in the technology used. Institutional strengthening needs to be done because technology development is related to the social and cultural aspects of the local community. Therefore, the government needs to develop research related to appropriate technology that meets economic, social, cultural, and environmental sustainability aspects. Stakeholders must develop institutional innovations such as farmer corporations to encourage farmers' adoption and understanding of technology (Mwangi and Kariuki 2015, Suprehatin 2021). The synergy between stakeholders, such as researchers, farmers, and governments, both locations and regions, is essential to increase farmers' access to technology (Achmad et al. 2022).

CONCLUSION

The level of technology adoption among tobacco farmers in NTB in this study showed low value. Most farmers do not adopt technology for their agribusiness activities in the cultivation and postharvest processes. The results of the path coefficient test in PLS-SEM show that the variables of education and age are positively and significantly correlated with the variables of technology adoption. At the same time, the length of farming and land area do not have a significant effect. The analysis results also show that the longer they farm, the more likely farmers are to like investing in agricultural areas rather than technology. Although the land area has increased, farmers do not immediately adopt technology.

Technology is one of the keys to agribusiness sustainability because it can increase the efficiency of farming costs and improve the welfare of farmers. Therefore, it is necessary to formulate a strategy to increase technology adoption. The results of this study emphasize the importance of several aspects that need to be considered in increasing technology adoption, including 1) dissemination of technology for both tobacco cultivation and postharvest, 2) development of research and innovation related to appropriate technology for tobacco agribusiness that pays attention to various aspects, including economic, social, cultural, and environmental, 3) training and mentoring farmers on the benefits and use of technology, 4) more manageable and optimal financing schemes for tobacco agribusiness sustainability, 5) strengthening agricultural institutions and corporations to facilitate socialization and coordination, and 6) strengthening cooperation with tobacco company partners for technology supply and facilitation.

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REFERENCES

Abdullah, F. A., and Samah, B. A. 2013. Factors impinging farmers' use of agriculture technology. *Asian Social Science*. 9(3): 120–124. https://doi.org/10.5539/ass.v9n3p120

Abdullah, W., and Hartono, J. 2014. Partial least square (PLS). Penerbit Andi.

Achmad, B., Sanudin, B., Siarudin, M., Widiyanto, A., Diniyati, D., Sudomo, A., Hani, A., Fauziyah, E., Suhaendah, E., Widyaningsih, T. S., Handayani, W., Maharani, D., Suhartono, D., Palmolina, M., Swestiani, D., Sulistiadi, H. B. S., Winara, A., Nur, Y. H., Diana, M., … Ruswandi, A. 2022. Traditional subsistence farming of smallholder agroforestry systems in Indonesia: A review. *Sustainability (Switzerland)*. 14(14): MDPI. https://doi.org/10.3390/su14148631

Akumbom, P., Bime Egwu, M. J., and Shillie, P. N. 2023. Agricultural technology adoption, productivity, and poverty reduction in Cameroon: A mediating analysis. *Journal of Enterprise and Development (JED)*. 5(2):

Asfawi, S., Probandari, A., Setyono, P., and Hartono. 2019. Economic valuation of horticulture organic farming in Getasan, Semarang Regency. *IOP Conference Series: Earth and Environmental Science*. 1. 12029. https://doi.org/10.1088/1755-1315/328/1/012029

Badan Pusat Statistik. 2015. Produksi tembakau per provinsi di Indonesia.

Badan Pusat Statistik. 2022. Komposisi jumlah pekerja formal dan informal di Indonesia.

Bank Indonesia. 2022. Laporan perekonomian provinsi NTB November 2022.

Belay, M., and Mengiste, M. 2023. The ex-post impact of agricultural technology adoption on poverty: Evidence from north Shewa zone of Amhara region, Ethiopia. International *Journal of Finance and Economics*. 28(2): 1327–1337. https://doi.org/10.1002/ijfe.2479

Challa, M., and Tilahun, U. 2014. Determinants and impacts of modern agricultural technology adoption in West Wollega: The case of Gulliso District. International *Journal of Education and Research*. 4(3): www.iiste.org

Curry, G. N., Nake, S., Koczberski, G., Oswald, M., Rafflegeau, S., Lummani, J., Peter, E., and Nailina, R. 2021. Disruptive innovation in agriculture: Socio-cultural factors in technology adoption in the developing world. *Journal of Rural Studies*. 88: 422–431.

https://doi.org/10.1016/j.jrurstud.2021.07.022

Feyisa, B. W. 2020. Determinants of agricultural technology adoption in Ethiopia: A meta-analysis. *Cogent Food and Agriculture*. 6(1): https://doi.org/10.1080/23311932.2020.1855817

Gallardo, R. K., and Sauer, J. 2018. Adoption of labor-saving technologies in agriculture. *Annual Review of Resource Economics*. 10: 185–206. https://doi.org/10.2307/26773486

Habtemariam, L. T., Kassa, G. A., and Gandorfer, M. 2017. Impact of climate change on farms in smallholder farming systems: Yield impacts, economic implications and distributional effects. *Agricultural Systems*. 158: 58–66. https://doi.org/10.1016/j.agsy.2016.12.006

Hidayat, A., Mardialina, M., and Safitri, P. 2021. Analisa fair trade dalam rantai perdagangan tembakau di Lombok Nusa Tenggara Barat. LPPM Universitas Mataram, 3.

Kilmanun, J. C., and Dwi Wahyu Astuti, B. 2022. Potensi dan kendala revolusi industri 4.0 di sektor pertanian. *Prosiding Seminar Nasional Kesiapan Sumber Daya Pertanian dan Inovasi Spesifik Lokasi Memasuki Era Industri 4.0.* https://www.wartaekonomi.co.id/read215598/begini-revolusi-industri-40-di-sektor-

Kostandini, G., La Rovere, R., and Abdoulaye, T. 2013. Potential impacts of increasing average yields and reducing maize yield variability in Africa. *Food Policy*. 43: 213–226. https://doi.org/10.1016/j.foodpol.2013.09.007

Kumar, A., Kumari, A., and Lal, A. 2019. Design and economic evaluation for the precision farming of tomato crop at Pusa (Bihar). International *Journal of Chemical Studies*. 7(3): 5123–5128. https://doi.org/10.22271/chemi.2019.v7.i3ce.6312

Kuntariningsih, A., and Mariyono, J. 2013. Socio-economic factors affecting adoption of hybrid seeds and silvery plastic mulch for chili farming in Central Java. *SEPA*. 9(2): 297–308.

Maguza-Tembo, F., Edriss, A.-K., and Mangisoni, J. 2017. Determinants of climate smart agriculture technology adoption in the drought prone districts of Malawi using a multivariate probit analysis. *Asian Journal of Agricultural Extension, Economics and Sociology*. 16(3): 1–12. https://doi.org/10.9734/ajaees/2017/32489

Manyumwa, D., Mafuse, N., Matovore, M., Musara, J., Munyati, V. T., Chimvuramabwe, J., Chagwiza, G., Zivenge, E., and Dudu, V. 2013. Extent and adoption determinants of floating tray technology by smallholder tobacco farmers: A case of Zimbabwe. *Journal of Development and Agricultural Economics*. 5(10): 416–424. https://doi.org/10.5897/JDAE2013.0491

Marita, L., Arief, M., Andriani, N., and Wildan, M. A. 2021. Strategi peningkatan kesejahteraan petani Indonesia, review manajemen strategis. *Agriekonomika*. 10(1): 1–18. https://doi.org/10.21107/agriekonomika.v10i1.9391

Massresha, S. E., Lema, T. Z., Neway, M. M., and Degu, W. A. 2021a. Perception and determinants of agricultural technology adoption in North Shoa Zone, Amhara Regional State, Ethiopia. *Cogent Economics and Finance*. 9(1): https://doi.org/10.1080/23322039.2021.1956774

Michler, J. D., Tjernström, E., Verkaart, S., and Mausch, K. 2019. Money matters: The role of yields and profits in agricultural technology adoption. *American Journal of Agricultural Economics*. 101(3): 710–731. https://doi.org/10.1093/ajae/aay050

Ministry of Industry. 2022. Pengembangan inovasi dan teknologi industri hasil tembakau. Ministry of Industry.

Muzari, W., Gatsi, W., and Muvhunzi, S. 2012. The impacts of technology adoption on smallholder agricultural productivity in Sub-Saharan Africa: A review. *Journal of Sustainable Development*. 5(8): 69–78. https://doi.org/10.5539/jsd.v5n8p69

Mwangi, M., and Kariuki, S. 2015. Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. *Journal of Economics and Sustainable Development*. 6(5): www.iiste.org

Nazam, M., Hadiawati, L., and Suriadi, A. 2022. Perspective of increasing value added of waste in integrated rice-livestock system on irrigated land agroecosystem. *IOP Conference Series: Earth and Environmental Science*. 1107(1). https://doi.org/10.1088/1755-1315/1107/1/012013

Oyetunde-Usman, Z., Olagunju, K. O., and Ogunpaimo, O. R. 2021. Determinants of adoption of multiple sustainable agricultural practices among smallholder farmers in Nigeria. *International Soil and Water Conservation Research*. 9(2): 241–248. https://doi.org/10.1016/j.iswcr.2020.10.007

Panikkai, S., Nurmalina, R., Mulatsih, S., and Purwati, H. 2017. Analisis Ketersediaan Jagung Nasional menuju Pencapaian Swassembada dengan Pendekatan Model Dinamik. *Informatika Pertanian.* 26(1): 41–48.

Pierpaoli, E., Carli, G., Pignatti, E., and Canavari, M. 2013. Drivers of precision agriculture technologies adoption: A literature review. *Procedia Technology*. 8: 61–69. https://doi.org/10.1016/j.protcy.2013.11.010

Priest, S. H., Greenhalgh, T., Neill, H. R., and Young, G. R. 2015. Rethinking diffusion theory in an applied context: Role of environmental values in adoption of home energy conservation. *Applied Environmental Education and Communication*. 14(4): 213–222. https://doi.org/10.1080/1533015X.2015.1096224

Puspitasari, R. D. 2019. Pertanian berkelanjutan berbasis revolusi industri 4.0. Retno Dwi Puspitasari. https://id.wikipedia.org/wiki/Sukorame,_Lamongan

Ruzzante, S., Labarta, R., and Bilton, A. 2021. Adoption of agricultural technology in the developing world: A meta-analysis of the empirical literature. *World Development*. 146. https://doi.org/10.1016/j.worlddev.2021.105599

Setiyowati, T., Fatchiya, A., and Amanah, S. 2022. Pengaruh karakteristik petani terhadap pengetahuan inovasi budidaya cengkeh di Kabupaten Halmahera Timur. *Jurnal Penyuluhan*. 18(02): 208–218. https://doi.org/10.25015/18202239038

Shita, A., Kumar, N., and Singh, S. 2018. Agricultural technology adoption and its determinants in Ethiopia: A reviewed paper. *Asia Pacific Journal of Research.* www.apjor.com

Simtowe, B., Simtowe, F., Asfaw, S., Diagne, A., and Shiferaw, B. 2008. Determinants of agricultural technology adoption: The case of improved groundnut varieties in Malawi.

Smale, M., and Mason, N. 2014. Hybrid seed and the economic well-being of smallholder maize farmers in Zambia. *Journal of Development Studies.* 50(5): 680–695. https://doi.org/10.1080/00220388.2014.887690

Suprehatin, S.-. 2021. Determinants of agricultural technology adoption by smallholder farmers in developing countries: Perspective and prospect for Indonesia. *Jurnal Penelitian dan Pengembangan Pertanian*. 40(1): 21. https://doi.org/10.21082/jp3.v40n1.2021.p21-30

Villano, R., and Fleming, E. 2006. Technical inefficiency and production risk in rice farming: Evidence from Central Luzon Philippines. *Asian Economic Journal.* 1: 29–46. https://doi.org/10.1111/j.1467-8381.2006.00223.x

Yigezu, Y. A., Mugera, A., El-Shater, T., Aw-Hassan, A., Piggin, C., Haddad, A., Khalil, Y., and Loss, S. 2018. Enhancing adoption of agricultural technologies requiring high initial investment among smallholders. *Technological Forecasting and Social Change.* 134: 199–206. https://doi.org/10.1016/j.techfore.2018.06.006

Zegeye, M. B., Fikire, A. H., and Meshesha, G. B. 2022. Determinants of multiple agricultural technology adoption: Evidence from rural Amhara region, Ethiopia. *Cogent Economics and Finance.* 10(1). https://doi.org/10.1080/23322039.2022.2058189