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Farmer Preference to High Elevation Rice Technological Packages for Accelerating Technological Dissemination (A case Study in Humbang Hasundutan Regency)

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ABSTRACT
Accelerating the introduction of a new technological package is needed to increase the productivity of high elevation puddled rice in Humbang Hasundutan. The objectives of the study are to find out the perception of the existence of technological packages and farmers' preference for a new technological package. The study used a survey method with primary data gathered using questionnaires. The criteria of locations and respondents were used to obtain relevant respondents and data concerning their knowledge of high elevation puddled rice cultivation. The collected data were processed by using Importance Performance Analysis in order to find out the level of Importance and Satisfaction of the indicators and the valued aspects in the technological package components. The results of the study showed that the socio-economic aspects had to be heeded in organizing the technological package. Indicators having a high level of importance and a low level of satisfaction consisted of production cost, quality of seeds, farmer groups empowerment, technology information institution, capital cost, agricultural tools and machines, pest control, sales price, irrigation canals, and farm roads. On the other hand, introducing new superior seeds, productivity attribute and planting age were important indicators for local farmers as to improve the quality of existing seeds. Farmers group expected that the technological package had a high level of productivity, better access to input, low cost, and good user-friendliness in its application.
Keywords : dissemination, perception, preference, high elevation of rice.

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INTRODUCTION

Humbang Hasundutan Regency ranks the-10 out of the 33 regencies in North Sumatra in producing rice. It produced 68,288.15 tons of rice in 2019 or 4.1% compared to North Sumatra productivity. The agricultural, forestry, and fishery sectors also give the most contribution to the domestic regional income of average 43.41% than to other sectors. Among the sub-sectors of agriculture, forestry, and fisheries, food crops are a source of GDP growth in the second after fishery subsector, which amounted to 144.7% in 2019. It means that agricultural sector, especially rice commodity, is an important factor in the economy of Humbang Hasundutan Regency (BPS, 2020b). At the provincial level, Humbang Hasundutan regency contributed 4.1% to the province rice production compared to 32 other regency.

The regency is situated on the high elevation puddled rice which has variety of altitutes from 330 until 2,075 meters above the sea level (m.a.s.l). The area of the altitude of 500-1,000 m.a.s.l. accounted for 36% of total areas, while the area of 1,000 – 1,500 m.a.s.l. and above 1,500 m.a.s.l. contributes 48% and 3% respectively. The areas producing rice in the high elevation puddled soils were Doloksanggul, Pollung, Paranginan, Onanganjang Regencies, and some parts of Pakkat and Parlilitan Regencies (BPS, 2020a).

The land characteristic of high elevation is that it has low temperature. Its position and altitude can influence the condition of climate such as rainfalls, temperature, humidity, and solar radiation. An area with the altitude of <700 m.a.s.l. has the maximum temperature of <20°C (Haryati, 2014). This condition highly influences the types of commodity and cultivation technology implemented even though better rice growth and production are ideally at the range of temperature from 68^0C to 100^0C (Adri et al., 2018).

According to Gunarsih & Sitaresmi (2017) and Hasanuzzaman et al. (2019), the grip of cold temperature becomes the main inhibiting factor of crops' growth in the phases of sprouting, vegetative growth, and reproduction. The phenomena of rice plants damage is caused by low temperature due to the lateness of sprout and unfilled rice from microsporogenesis. As a result, it lower the rice production and causes long harvest intervals due to the lack photosynthetic process. The loss of harvest ranging from 0.5 to 2.5 tons hectare is caused by the grip of cold temperature (da Cruz et al., 2013).

The attempt to increase the production of high elevation rice plants has been made by providing superior varieties, adaptive test, and dissemination of rice technology. Some superior varieties which are resistant to high elevation condition were developed by Indonesian Center for Rice Research such as Inpari 13, Inpari 16, Inpari 23, Inpari 24, Inpari 27, Inpari 28 (Gunarsih & Sitaresmi, 2017). The program of assembling the varieties used gen and crossbreeding of local varieties by selecting and screening them in order to evaluate their tolerance to the grip of low temperature. The result showed that the varities could potentially produce up to 7.7 tons of harvested dry grain ha^{-1}.

In addition to the availability of high yielding varieties, efforts to test high yielding varieties in the high elevation have been carried out in North Sumatra. Chairuman (2013) integrated plant management approach based-adaptive test in South Tapanuli at the altitude of 943 - 950 m.a.s.l. The results indicated that Inpari 3, Inpari 10 and Inpari 13 were adaptive to the altitude and potentially produced up to 8.4 tons ha^{-1}. Hardyani (2019) did an adaptive study on upland rice variety at the highland of Karo Regency with Batutegi, Inpago 8, and Inpago 9. Furthermore, all varieties were appropriate to be developed on the highland of Karo Regency which would potentially produce of 7.36 tons ha^{-1}.

Rice technology dissemination was done by Musfal (2019) through socialization and farming technical guidance and field farming conseling to farmers. Three methods applied were rice cultivation-*jarwo super* technology in irrigation lowland rice, *largo super* technology on dry land, and *raisa* technology on tidal land. The application of *largo super* technology produced 2.65 tons of harvested dry grain ha^{-1}. Rice dissemination technology on the high elevation of Humbang Hasundutan Regency was done by making a demonstration plot in Baktiraja Regency.

Some efforts made by government to increase the productivity seem unequally adopted by the farmers in Humbang Hasundutan Regency. The dissemination of varieties, which was based on field survey in February 2020, only used local varieties. The varieties such as Siangkat, Sigembira, Sicantik Manis, Sitalibolon, Siboras, Sibirong have been existed for generations; Farmers can compare them easily with the other superior varieties with high level of productivity. The farmers using superior varieties are generally the farmers or cooperators of superior varieties dissemination program. According to Luo et al. (2016) technological innovation will be easily accepted when it has some characteristics such as relative costs, risks, compatibility, complexity, trialability and observability. Meanwhile Himire et al. (2015) point out that the process of technological adoption is influenced by external variables such as potential yield and increasing productivity, counseling frequency, and access to seeds.

Based on the explanation, it is necessary to study farmers' preference on technological innovations that have been disseminated in order to find out the perceptions on innovation package and the appropriateness of technological package with farmers' needs. This will help accelerate the diffusion of technological diffusion for being accepted widely. There have been many studies on the preferences of rice farmers towards technology, but research on the preferences of rice farmers in the high elevation of puddled soils is still few. This paper is expected to provide information on the preferences and perceptions of high elevation puddled rice farmers.

METHODS

The study used a survey method with questionnaires as device for gathering the data. The samples were taken by using purposive sampling technique with the criteria of respondents were farmers and location. Farmers had experience for more than ten years; they would be expected to have experience in rice field cultivation and had a good perception on several technological packages that introduced by Ministry of Agriculture, local government, and private sector. The technology in the form of integrated plant management such as superior varieties, quality seeds, fertilization, and others. The location should have been in the latitude of 800-1,000 m.a.s.l. to show that the rice plants had the characteristic of high elevation irrigated rice. Based on these criteria, the Regencies of Pakkat, Pollung, Dolok Sanggul, Bakti Raja, and Parlilitan were selected.

Primary data were gathered in February 2020 when the farmers were harvested and cultivated the land. The idea was that farmers would provide complete information on farming by the end of planting season.

The questionnaire consisted of four aspects—technical, socio-economic, institutional, and accessibility. They were determined based on technical, social, and economic feasibilities of technological packages in the pre-dissemination (Perera & Nanthakumaran, 2015). The addition of accessibility aspect was intended to explain the convenience of the institutional access to resources and product distribution as the agricultural regional development (Farida, 2013). Meanwhile, the institutional aspect was used to explain farmers' perceptions on the organization of agricultural resources in groups toward adopting a technology.

Seed quality regarding seed attributes is the magnitude of seed growth rate; replacement of variety is the number of the varieties used in a year; crop rotation is the change of plant species on the same land in a period of a year; the use of fertilizer is the type and amount of fertilizer used; pest control is an effort to control pests by farmers, and agriculture mechanization is the use of mechanization during rice cultivation.

Technical aspects comprised six indicators that seeds quality, varieties rotation, crop rotation, application of fertilizers, pest control, and agriculture tools and machinery. The socio-economic aspect consists of four indicators—production costs, capital costs, farmers' sales price, and post-harvesting value-added. The Institutional aspect consisted of six indicators non-formal financial institution, formal financial institution, technology information institution, farmer groups empowerment, partnership pattern, and nurseries. The aspect of accessibility comprised five indicators—agribusiness, road condition, transportation, source of information media, and irrigation canals. Production costs consist of variable and farm depreciation costs, fixed costs consist of capital costs; farmer level price is the price received by farmers; post-harvest value addition is an increase in the selling value of secondary products from primary products; non-formal financial institution is training received by farmers outside of formal education; farmer groups empowerment is the effort of farmer groups in overcoming problems in each of its members;

partnership pattern is the cooperation of farmers with other institutions through farmer groups; nurseries is an institution that is part of farmer groups that guarantees the quality of seeds and produces seeds.

Agribusiness is a system consisting of upstream, primary, downstream subsystems, and supporting services; road condition is the quality of road infrastructure from farm roads to market access; transportation is a tool used to transport input or output materials from or to the market; source of information media is the type of media used by farmers in accessing information; irrigation canals are primary, secondary, and tertiary irrigation conditions. All of these indicators are measured based on farmers' perceptions with a non-parametric measurement scale (Likert scale).

Primary data were gathered by conducting the survey and analyzed by using quadrant analysis by comparing the levels of satisfaction in each dimension or indicator in it. This analysis is commonly referred to as Importance Performance Analysis. This analysis is usually called Importance Performance Analysis which is able to find critical factors in the strategy of developing activities (Wang et al., 2019). The indicators and aspects were divided into four areas (1) first priority, an area which had high level of interest with low level of satisfaction, (2) maintaining performance, an area which had high level of interest and satisfaction, (3) low priority, an area which had low level of interest and satisfaction, (4) exaggeration, an area which had low level of interest but high level of satisfaction.

RESULTS AND DISCUSSION

Existing Condition of Rice Culture

According to Kami et al. (2012), there is a criterion should be fulfilled before doing technological dissemination; it is the evaluation of technical, social, and economic feasibilities considering that a technology can be appropriate or effective when it is done easily (technically), beneficially (economically), and acceptable and indestructible (socially and environmentally). Institutional aspects are farmers' recepacle in organizing resources in groups consist of social and behavioral norms of the members in it. A farmer group is an institution which has a structure, task and function organized by members. Beside functioning as the communication connector with other agencies, farmer groups are usually used to disseminate a technology such as counseling and demonstration plots.

Figure 1 explains that the socio-economic aspect is in quadrant 1 (main priority), accessibility and technical aspect is in the quadrant 2 (maintaining performance), and institutional aspect is in the quadrant 3 (low priority). Based on observation and survey, it was found that most of the farmers cultivated rice to meet their daily needs (they did not sell them to the market), with an average productivity of 4.2 tons/ha. The rice crops are produced in two harvest seasons anually, which were stored to meet their need in one year. Farmers only hired their own family members (wives and children) to do the farming.

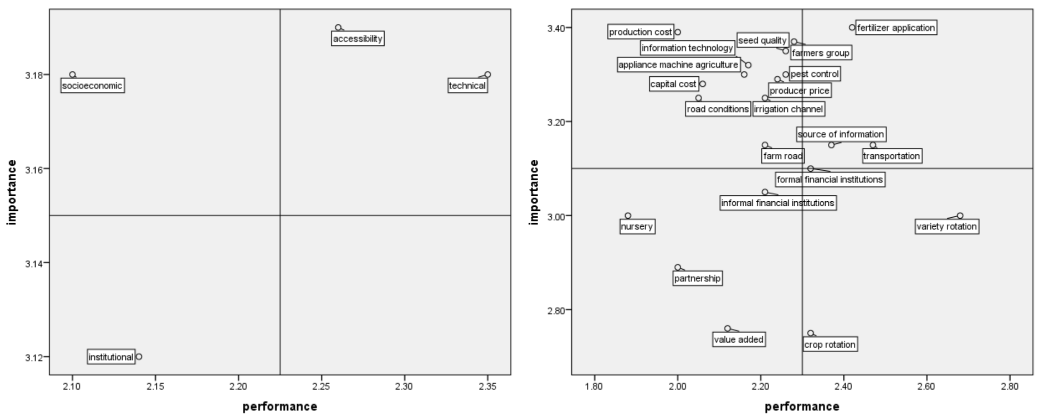

Figure 1. Perception of farmers on aspects of the technology components (left) and the indicator (right) based on performance levels and interests.

Table 1. Rice farming analysis on high elevation puddled rice in Humbang Hasundutan Regency

Component	Amount (IDR)	Proportion (%)
Cost	**17,300,000**	**100.00**
Land Rent	1,500,000	8.67
Seeds	400,000	2.31
Fertilizers	2,000,000	11.56
Pesticides	4,700,000	27.17
Labor	8,700,000	50.29
Revenue	**23,287,000**	
Production (milled dry grain)	4,234	
Price (Rp/kg)	5,500	
Income (Rp)	5,987,000	
R/C	1.35	

Source: primary data analysis

Plowing, harvesting, and planting were done manually since the activity was somewhat step so that it was impossible to use tractors.

This condition has lasted from generation to generation. Basically, the purpose of farming was to meet farmer's basic needs. Farmers never thought to attain profit financially from the farming (let alone agribusiness). Besides that, based on Table 1 the analysis of farming high elevation rice plants, it was found that the productivity of rice was 4,234 kg/ha which indicated low productivity compared to province (5,032 kg/ha) and national productivity (5,114 kg/ha). It was not able to optimize the development of rice business. Beside that, the ownership of high elevation of paddy fields was around 0.46 hectares.

Based on analysis on the farming in Table 1, it was found that the component of manpower had the highest proportion (about 50.29%). Since the majority of them came from the family members, the costs included non-cash form. It means that the farmers could save the cost since they do not directly pay their wages. This condition is in accordance with the research done by (Akahashi & Arrett, 2013) which stated that labor is the highest cost in rice cultivation. The second component was pesticides (about 27.17%) since most of the farmers depended on inorganic pesticides. Most of them uneffectively and unsimultaneously treated biological control on the attack of vectors.

In the component of income, the average of farmers had the productivity of 4.2 tons ha^{-1} with the price of IDR with 5,500/kg of milled dry grain (MDG). This number was below the national average productivity reaching at 5.11 tons/ha (BPS, 2020c). Farmers received only the value of R/C ratio of 1.35 indicating that in each one rupiah expended in rice farming, farmers get in return of 1.35 rupiahs.

Some indicators which should be improved in the socio-economic aspects can be seen in Figure 1 showing the indicators in quadrant 1: production costs, seed quality, farmer groups empowerment, pest control, sales price, irrigation canals, farming roads, road condition, capital cost, and agricultural tool and machinery cost. Almost all socio-economic indicators were in quadrant 1, except post-harvest value-added indicator which was different from those in quadrant three (low level of interest and satisfaction).

Indicators which should be improved in the technology of high elevation rice cultivation related to socio-economic aspects were seed quality, production cost, capital cost, sale price, and farmer group empowerment. Empowerment of farmer groups was expected to be able to increase bargainning position to get better price. Based on Rashid, Islam, & Quamruzzaman (2016), empowerment of farmers can be increased through the use of e-agriculture. Farmers can exchange information and be actively involved in groups related to the use of e-agriculture. In addition, group empowerment could also accommodate jointly the problems of vectors. For example, controlling of rat pests that need to be done simultaneously so as to break the chain of these pests.

In the component of costs, technology

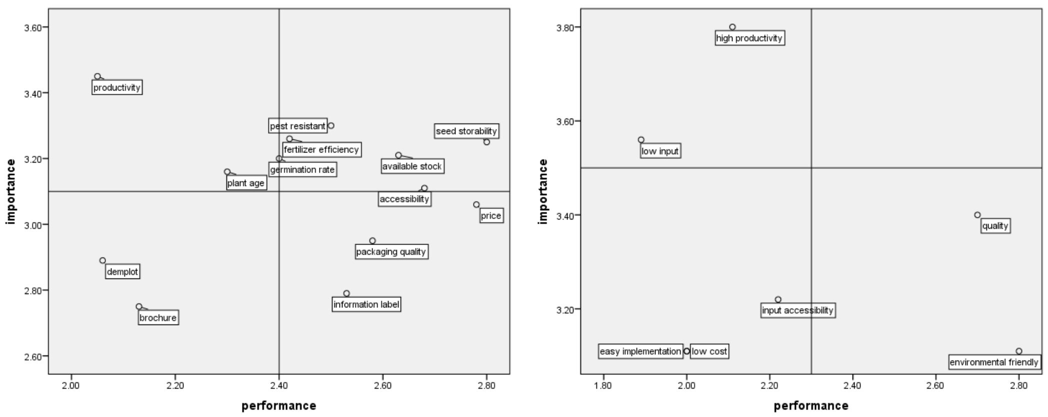

Figure 2. Farmers' preferences for seed attributes based on level of performance and importance (left) The level of importance and performance of farmers to the package technology (right)

should be efficient for labor. Pesticide became the largest component in the cost of farming. Meanwhile, the increase in seed quality could increase the productivity of land. Hence, higher income and capital (R/C Ratio) turnover could be acquired.

The improvement of rice quality should consider the farmers' preference to rice plant seeds which are disseminated (Suvi, Shimelis, & Laing, 2020). This explains why farmers prefered to select local varieties rather than superior varieties. Since there was a failure in varieties of demonstration plot due to the factors of temperature and climate, they also had other indicators such as fertilizer efficiency, pest resistance, shelf life, plant age, and other attributes attached to the seeds.

Farmers' perception on the preference to seed attributes can be seen in Figure 2. Seed attributes included in quadrant 1 is productivity and plant age; while quadrant 2 consisted of growing power, efficiency in using fertilizers, pest resistance, storing power, stock of seeds, and facility of access to seeds. Attributes of demonstration plot supply and counseling devices such as brochures/leaflets were in quadrant 3. Quadrant 4 consisted of the attributes of the seed price, quality of packages, and information on packages.

Quadrant 1 describes attributes having a high level of interest but low satisfaction. The attributes in this quadrant consist of seed productivity that the yield of milled rice in hectare units that was obtained by farmers when using these varieties. Plant age was also an attribute that should be improved because in general the local varieties used by farmers reached 6 months at harvest. Quadrant 2 (high interest and satisfaction) included attributes that were satisfactory with the use of existing seeds. The existing varieties used by farmers were considered to have good growth rates (above 85%), minim of fertilizers, resistance to pests, high storability, and easy access to the seeds. Quadrant 3 (low interest and satisfaction) consists of demonstration plots and brochures. Farmers' opinion that demonstration plots were more important than brochures. The demonstration plot had an importance value of 2.6 than the brochure only 1.8. Quadrant 4 (low importance and high satisfaction) indicates that successively high to low importance levels were seed price, packaging quality, and label information. These three attributes were considered to have met expectations because farmers were satisfied with the performance of these attributes.

Existing seeds used by the farmers today are local varieties which are highly varied. They, among others, are Siangkat, Sigeha, Sigembira, Sifransito, Sibirong, Sicantik manis, Siborutua, Sitalibolon, Siboras, Sisior, Silagabe. The seeds that they obtained through previous cultivation or exchanged with other farmers. There were no farmers specifically acting as rice seed growers. All of them had planting period of ± 6 months whereis the farmers today prefer shorter planting life which is indicated by the attribute of seed age is in quadrant 1.

Efforts to Accelerate the Technological Dissemination of High Elevation Rice Plants.

Correlation between counseling frequency and new superior varieties cultivated by the farmers is shown in Table 2. Counseling frequency significantly has correlation value of 0.477 ($p < 0.05$) with amount of new high yielding variety planted in that area. It indicates that the acceleration of technological dissemination was not only done by increasing counseling frequency but should also be done by introducing demonstration plot to the farmers technically wherein its level of production could be seen directly. Beside that, they could easily differentiate the new superior varieties from the existing varieties which were being cultivated.

Dissemination of technological packages was the last stage of a research package design composed of cultivating input and process. Before the dissemination process was done, the technological package was technically, socially, and economically tested regarding its feasibilities. The testing was done by the farmers on the existing technological package. The approach of technological package dissemination should be done by observing the farmers preference in order to eliminate the obstacles in accepting new technological package to accelerate technological diffusion. Besides considering technical, social, and economical feasibilities, the farmers should compare new technological package with the experience and information obtained before accepting the new technological package. Sometimes information was received by the farmers because they could easily believe in the information carriers even though the information is invalid.

The effort to accelerate the technological package dissemination of high elevation puddled rice in Humbang Hasundutan Regency was measured from the farmers' perception on the expectations of technological package obtained from their minimum of ten-years experience. They prefered technological package that can make them satisfied and hopeful. Figure 2 is the analytical result of the farmers' preferential quadrant toward

Table 2. The correlation of relationship extension frequency and area of new superior varieties on irrigated high elevation of puddled rice in Humbang Hasundutan Regency.

Description		Extension frequency	Area of high yielding varieties
Extension frequency	Pearson Correlation	1	.477*
	Sig. (2-tailed)		.021
	N	23	23
Area of high yielding varieties	Pearson Correlation	.477*	1
	Sig. (2-tailed)	.021	
	N	23	23

*. Correlation is significant at the 0.05 level (2-tailed).

Source: primary data analysis

technological package.

In this case, they expected that the technological package that has high level of productivity, easiness to access input, low cost and input, and easiness to apply technological package. Of all attributes, the attributes of productivity and low input had a higher priority because priority because they had the highest value of interest (situated in quadrant 1).

One of the efforts to increase the productivity can be done by doing local varieties breeding by adding lowland rice cultivars which produce high productivity (Dingkuhn et al., 2015; Saito et al., 2018). The use of local varieties as one of the source of cultivars in plant breeding is intended to enable the plants to adapt and produce varieties which are resistant to the grip of climate and to be efficient in absorbing nitrogen where it will have low input (Ranaivoson et al., 2019).

Another factor in offering a new technological package was by paying attention to the access to input and the level of easiness in applying the technology. High elevation puddled rice plants generally had a slope of 40 - 60% with terracing as the obstruction of water flow and other nutrients. This condition was clearly different from the area of lowland rice fields so that it was easy to use technology such as in seeds (Awotide et al., 2016), mechanization (Paudel et al., 2019), spacing (Moro et al., 2016), fertilizer application (Buresh et al., 2019), and pest control (Savary et al., 2012).

CONCLUSION AND SUGGESTION

Based on farmers' preference and perception, it was found that social and economic aspects have high level of interest with low level of satisfaction. It indicates that it is necessary to study these aspects before disseminating of technological packages.

Some indicators which have to be heeded in introducing new technological packages, among others, are production costs, seed quality, farmer groups empowerment, technology information institution, capital cost, agricultural machinery, pest control, sales prices, irrigation canals, and farming roads. In the case of introducing new technological package, attributes of productivity and plant age are important indicators for the local farmers as the improvement of existing seeds.

An effort to increase dissemination of new technological package can be made by doing the approach of local farmers' need and preference. The farmers expected that technological package has high level of productivity, easiness in accessing to input, low cost and input, and having the level of easiness in applying the technological package.

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REFERENCES

Adri, J., Erizon, N., Mesin, T., Padang, U. N., & Guna, T. T. (2018). Application of Appropriate Technology for Rice Weed Weeds in The River Duo Village. *Jurnal Pengabdian Masyarakat*, *1*(2), 42–49.

Akahashi, K. A. T., & Arrett, C. H. B. B. (2013). The System of Rice Intensification and Its Impacts on Household Income and Child Schooling: Evidence From Rural Indonesia. *J. Agr. Econ*, *96*(1), 269–289. doi:10.1093/ajae/aat086

Awotide, B. A., Karimov, A. A., & Diagne, A. (2016). Agricultural Technology Adoption , Commercialization and Smallholder Rice Farmers ' Welfare in Rural Nigeria. *Agricultural and Food Economics*, *4*(3), 1–24. doi:10.1186/s40100-016-0047-8

BPS. (2020a). *Humbang Hasundutan Regency in Figures* (1st ed.). Humbang Hasundutan: BPS Humbang Hasundutan.

BPS. (2020b). *Produk Domestik Regional Bruto Provinsi Sumatera Utara Menurut Lapangan Usaha* (1st ed.). Medan: BPS Sumatera Utara.

Buresh, R. J., Castillo, R. L., Carla, J., Torre, D., Laureles, E. V, Samson, M. I., … Guerra, M. (2019). Field Crops Research Site-specific nutrient management for rice in the Philippines : Calculation of field-specific fertilizer requirements by Rice Crop Manager, *239*(May), 56–70. doi:10.1016/j.fcr.2019.05.013

Chairuman, N. (2013). Adaptation Study of Paddy Varieties Based on An Integrated Crop Management in North Tapanuli Utara Provinsi Sumatera Utara. *Jurnal Pertanian Tropik*, *1*(1), 47–54. doi:10.32734/jpt.v1i1.2867

da Cruz, R. P., Sperotto, R. A., Cargnelutti, D., Adamski, J. M., de FreitasTerra, T., & Fett, J. P. (2013). Avoiding Damage and Achieving Cold Tolerance In Rice Plants. *Food and Energy Security*, *2*(2), 96–119. doi:10.1002/fes3.25

Dingkuhn, M., Rebecca, M., Laza, C., Kumar, U., Mendez, K. S., Collard, B., … Manneh, B. (2015). Improving Yield Potential of Tropical Rice: Achieved Levels and Perspectives Through Improved Ideotypes. *Field Crops Research*, *182*(2015), 1–17. doi:10.1016/j.fcr.2015.05.025

Farida, U. (2013). The Effect of Accessibility on The Socio-Economic Characteristics of Rural Communities, Bumijawa District, Tegal Regency. *Jurnal Wilayah Dan Lingkungan*, *1*(1), 49. doi:10.14710/jwl.1.1.49-66

Gunarsih, C., & Sitaresmi, T. (2017). Formation of Low Temperature Tolerant Upland Rice Varieties. *Iptek Tanaman Pangan*, *11*(2), 107–118.

Hardyani, M. A. (2019). *Growth Performance and Yield of Several Upland Rice Varieties on Upland Dry Land in Karo District*. In *Temu Teknis Jabatan Fungsional Non Peneliti* (Pp. 17–19). Malang: IAARD PRESS. Retrieved from http://repository.pertanian.go.id/handle/123456789/8499

Haryati, U. (2014). Physical

Characteristics of Soil in Upland Vegetable Cultivation Areas, Relation to Land Management Strategies. *Jurnal Sumberdaya Lahan*, *8*(2), 125–138. doi:10.2018/jsdl.v8i2.6475

Hasanuzzaman, M., Hakeem, K. R., Nahar, K., & Alharby, H. F. (2019). Temperature Extremes: Impact on Rice Growth and Development. In *Plant Abiotic Stress Tolerance: Agronomic, Molecular and Biotechnological Approaches* (pp. 1–490). doi:10.1007/978-3-030-06118-0

Himire, R. G., Wen-chi, H. U., & Hrestha, R. B. S. (2015). Factors Affecting Adoption of Improved Rice Varieties among Rural Farm Households in Central Nepal. *Rice Science*, *22*(1), 35–43. doi:10.1016/j.rsci.2015.05.006

Kami, M., Barz, M., Gheewala, S. H., & Sajjakulnukit, B. (2012). Environmental and Socio-Economic Feasibility Assessment of Rice Straw Conversion to Power and Ethanol in Thailand. *Journal of Cleaner Production*, *37*(2012), 29–41. doi:10.1016/j.jclepro.2012.06.005

Luo, L., Qin, L., Wang, Y., & Wang, Q. (2016). Environmentally-Friendly Agricultural Practices and Their Acceptance by Smallholder Farmers in China — A Case Study in Xinxiang County , Henan Province. *Science of The Total Environment*, *571*(2016), 737–743. doi:10.1016/j.scitotenv.2016.07.045

Moro, B. M., Nuhu, I. R., & Martin, E. A. (2016). Effect of Spacing on Grain Yield and Yield Attributes of Three Rice (Oryza sativa Effect of Spacing on Grain Yield and Yield Attributes of Three Rice (Oryza sativa L .) Varieties Grown in Rain-fed Lowland Ecosystem in Ghana, *9*(3), 1–10. doi:10.9734/IJPSS/2016/21911

Paudel, G. P., Bahadur, D., Bahadur, D., Justice, S. E., & Mcdonald, A. J. (2019). Scale-Appropriate Mechanization Impacts on Productivity among Smallholders : Evidence from Rice Systems in The Mid-Hills Of Nepal. *Land Use Policy*, *85*(2019), 104–113. doi:10.1016/j.landusepol.2019.03.030

Perera, K. I. M., & Nanthakumaran, A. (2015). Technical Feasibility and Effectiveness of Vermicomposting at Household Level. *Tropical Plant Research*, *2*(April), 51–57.

Ranaivoson, L., Naudin, K., Ripoche, A., Rabeharisoa, L., & Corbeels, M. (2019). Effectiveness of Conservation Agriculture in Increasing Crop Productivity in Low-Input Rainfed Rice Cropping Systems Under Humid Subtropical Climate. *Field Crops Research*, *239*(January), 104–113. doi:10.1016/j.fcr.2019.05.002

Rashid, S. M. M., Islam, M. R., & Quamruzzaman, M. (2016). Which Factor Contribute Most to Empower Farmers Through E-Agriculture in Bangladesh? *SpringerPlus*, *5*(1). doi:10.1186/s40064-016-3443-3

Saito, K., Asai, H., Zhao, D., Laborte, A. G., & Grenier, C. (2018). Progress in Varietal Improvement for Increasing Upland Rice Productivity in The Tropics. *Plant Production Science*, *21*(3), 1–14. doi:10.1080/1343943X.2018.1459751

Savary, S., Horgan, F., Willocquet, L., & Heong, K. L. (2012). A Review of Principles for Sustainable Pest Management in Rice. *Crop Protection*, *32*(2012), 54–63. doi:10.1016/j.cropro.2011.10.012

Suvi, W. T., Shimelis, H., & Laing, M. (2020). Farmers' Perceptions, Production Constraints and Variety Preferences of Rice in Tanzania. *Journal of Crop Improvement*, *00*(00), 1–18. doi:10.1080/15427528.2020.1795771

Wang, Z. L., Shen, H. C., & Zuo, J. (2019). Risks in Prefabricated Buildings in China: Importance-Performance Analysis Approach. *Sustainability (Switzerland)*, *11*(12). doi:10.3390/su10023450