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INNOVATION COMMUNICATION OF SUBMERGENCE TOLERANT RICE VARIETY AND EFFECT OF FARMER'S EXTERNAL FACTORS ON INNOVATION DIFFUSION

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ABSTRACT

Indonesia still in struggle to fulfil staple food needs, primarily to increase rice production. Huge potential could come from inundated land and by utilizing submergence tolerant rice varieties (SRV). However, its utilization was still low because of not optimized innovation communication especially for SRV and hampered by various external factors such as government policies, production input availability, markets absorption and culturee. Government policies determine the continuity of communications among various institutions and other stakeholders such as extension institutional, seed producers and traders. The results of the research showed that the communicator, innovation and government policies are determinants of the rate of innovation diffusion, while communication channels and family profile are not. Extension workers and fellow farmers as communicator (source = S) are very important, so that by increasing their capacities and budget to carry out their roles would improve the diffusion of innovation. The innovations, as message (M), which are introduced must have traits required and desired by farmers, so it will guarrante the high rate of adoption. Communication media and modes as communication channel (R). Improving the ability of farmers as receiver (R) must be continued so that there will be improvements in farmers' insight in receiving agricultural development messages such as SRV. Government policies in agricultural extension needed to be modified in order that farmers could get benefit from it as much as possible.

Keywords: communication, innovation diffusion, submergence tolerant rice variety, external factors

I. INTRODUCTION

Indonesia is still struggling to meet the basic food needs for 95 percent of the people, who have high levels of rice consumption / capita / year high compared to most neighboring countries (Wiryawan, 2012 and Suswono, 2013). In Indonesia, rice farming provides employment for about 20 million households in the rural areas (Center for FCRD, 2012). Rice production may come from irrigated land (irrigated lowland), dry land (upland and rain fed) and wetland. The wetlands consist of tidal swamp, lowland swamp and other waterlogged land.

Losses of rice farming due to submerged crops flooded could be reduced by replacing rice varieties are planted with rice varieties tolerant to submergence or SRV (submergence tolerant / Sub-1). This variety was developed in International Rice Research Institute (Mackill *et al*., 1993). The rice varieties could survive in water submerged or flooding up to 14 days (Adnyana *et al*., 2009 and Nugraha *et al*., IJAS, *under-reviewed*). This fact is supported by Peñalba and Elazegui (2013) which concluded that farmers in Laos whose lands prone to flooding and landslides require submergence tolerant rice varieties. Yield losses due to floods

in West Java is 1,005 kg / ha, while the yield losses due to drought ad ne of 273 kg / ha (Adnyana *et al*., 2009). In South Sumatra, the loss reached 570 kg / ha if it is submerged for less than seven days, whereas if submerged for more than seven days, the loss of yield could reach 1,606 kg / ha.

However, the availability of submergence tolerant rice seed as well as the awareness and willingness of farmers to use it is still questionable. For instance, in Central Sulawesi Province, farmers still use local swamp rice varieties, which productivity is low (1.27 tons / ha). If farmers use submergence tolerant rice seeds, the potential for higher productivity, namely 7.5 to 10.17 tons / ha (Basrum *et al*. 2012).

Pre-harvest activities, especially land preparation up to planting rice in paddy rice farming, taking the proportion of the cost is quite high. According to the Central Statistics Agency (BPS 2008), farming costs more than Rp 10 million / ha. The proportion of costs for seed and land preparation until ready for planting is around 30-35 percent. If farmers use SRV seeds, they will not perform the land preparation and planting as the crops survive from the submergence condition or flood. Figure 1 shows a comparison between SRV and Non SRV crops during vegetative phase (courtesy of Nugraha, 2015, personal communication). Following the 14-day submerged, SRV crops survived, while the non-SRV crops died.

In the 2007 - 2009, Center for Food Crops Research and Development (Center for FCRD) in collaboration with the International Rice Research Institute (IRRI) and the support of the Government of Japan has distributed rice varieties tolerant to submergence to farmers in various flood-prone areas and areas swamp / tidal of Indonesia, such as northern coast of Java's, tidal swamp area in South Kalimantan and lowland swamp in southern Sumatra. Deployment of submergence tolerant varieties has reached all over Indonesia, but the utilization was very low (Basrum *et al*. 2012). As Sayaka *et al*. (2006) states that traditional seed supply systems that are not in the formal system is still widely practiced by farmers, most farmers do not buy seeds for the next cultivation, they rather do exchange seeds they possess. This is consistent with research conducted by Tatlonghari *et al*. (2012) that the adoption of new rice varieties decision was strongly influenced by family/relatives and fellow farmers. That is why fellow farmers play a very important role in seeds utilization.

In Indonesia, the period of time required for the diffusion of innovation of rice seeds is relatively long. For example, the case of Ciherang rice variety needed at least six years to get into a well diffusion of innovation or it problems for instance is no longer resistant to pests and major diseases of rice such as brown plant hopper had been released in 2001, but well-deployed since in 2007 until today (interview with staff of the agricultural service office of West Java Province, 2015). Likewise, the Inpari 30 rice variety that had been released in 2012, it is not yet well-deployed. Whereas Inpari 30 rice variety has huge potential to replace Ciherang variety, which has already got deprived its advance traits, such as resistant to blast disease.

The above problems is assumed having something to do with dissemination work, which is presumed still not optimal, especially in urging farmers to apply research results as such as submergence tolerant rice varieties. Communication plays crucial roles in dissemination work, and communication is certainly not going to be separated from dissemination, which is held by several levels from the central / national, regional / provincial, district, sub-district down to the household level.

2. RESEARCH PURPOSES

Based on the above mentioned background, the objective study aims to analyze the communication elements of innovation (communicator, SRV seed innovation, media communication, of farmer's family profile), and external factors affecting the diffusion of innovation rate of SRV seed of rice farmer's family in Indramayu, Subang and Karawang Districts of West Java Province.

3. THEORETICAL BASIS

In the communication model of Berlo (1960), it is known that the communication consists of four main processes that Source, Message, Channel, and Receiver (SMCR) and another three secondary processes, namely Feedback, Effects, and Environment. Diffusion of innovation theory, which was put forward by Rogers (2003) stated that innovation is spread through certain channels over time and in a particular social system. Every

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human being has a different level of desire to adopt innovations.

Rice farmers who perform rice farming in the inundated land generally do not grow SRV, usually they plant local submergence rice variety, however its productivity is low (Septiningsih *et al*., 2009 and Bhowmicket al., 2014). The IAARD through the Indonesian Center for Rice Research (ICRR) Sukamandi has anticipated the adverse effects of flooding and submergence condition. Therefore the ICRR has produced technology in the form of new advanced rice varieties adaptive to inundated condition or submergence tolerant during vegetative phase.

4. RESEARCH METHODS

The research applied a quantitative approach, using method of descriptive explanatory survey, especially to analyze the communication variables SRV seeds innovation and the influence of the farmer's external factors on the diffusion of innovation. Research sites were in three districts of rice production centers in West Java Province, namely Indramayu, Subang and Karawang Districts. The mentioned districts are relatively vulnerable to flooding or inundated condition. The research was carried out for two months, which was between May 2015 and June 2015.

The population in this study was family farmers who in the period 2007-2009 got SRV seeds allotment, which was then cultivated in submerged-prone or flood-prone irrigated lowland areas of Indramayu, Subang and Karawang Districts, West Java, and, as presented in Table 1. Furthermore, this population called SRV farmers or participants program. Not all members of the population could be found and interviewed for various things such as dead, sick or has moved. Getting divorced from the spouse was the most found reasons. They were only 58 persons out of 119 persons from these three districts. For a comparison data also collected from other farmers who did not get the SRV seeds allotment (hereinafter referred to as non-SRV farmers or non-participants). Number of non-SRV farmers taken comparable to the study population, which amounted to 62 families, so that the whole sample was 120 households.

In addition, the subject of research as a key informant assigned 10 people in each location selected districts, which includes actors in (1) decisive government agencies and implementing policies and programs, and other concerned parties; (2) the rice seed providers, and (3) the merchant input-output production. Key informant total there are about 30 people.

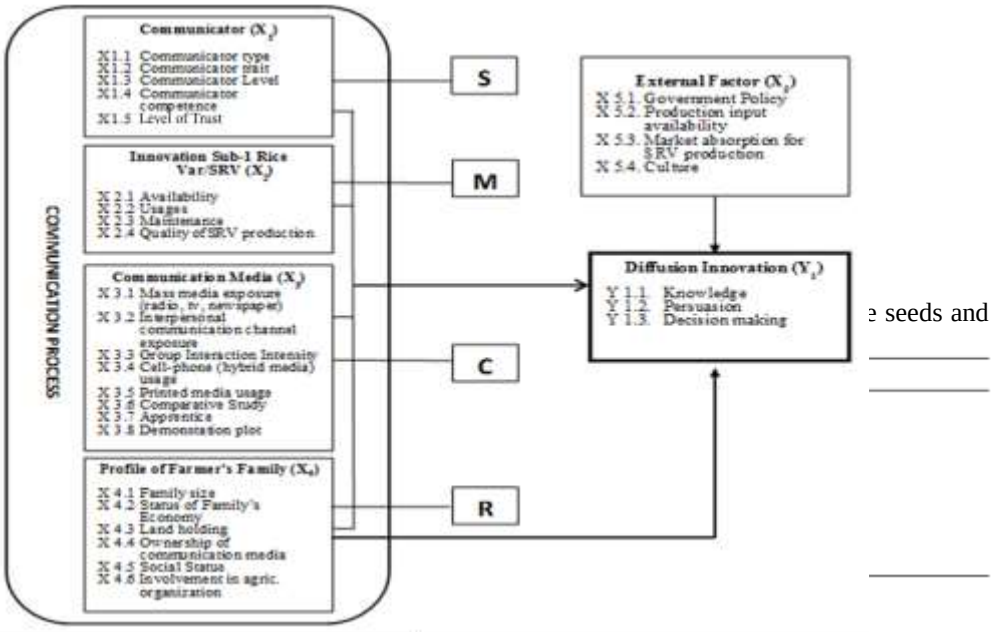

Figure 2. Framework of research on innovation communication of submergence tolerant rice variety and effect of afrmer's external factors on diffusion innovation

Table 2. I e seeds and t

X1	C
X2	Ir
X3	C
X4	P
X5	E
Y1	D

Structural Equation Modeling (SEM) with SmartPLS was applied to process research data. The SEM is a multivariate analysis that could be applied to analyze the complexity of the relationship between research variables thoroughly (Hair *et al*., 1998). In addition, SEM could be also used to examine and justify a model. The main requirement is to build a model using SEM hypothesis consists of the structural model and the measurement model in the form of the path diagram. SEM is a collection of various statistical techniques that allow testing of a series of simultaneous relationships (Santoso, 2007). The complexity of the relationships between the variables of the study requires the use of SEM as quantitative data analysis methods. Definitions of study variables are presented in Table 2.

Table 1. Framework of the study population of research on innovation communication of submergence tolerant rice seeds and the influence of farmer's external factors on the diffusion of innovation

Population Criterion	Sites of the research (district level)			
	Indramayu	Subang	Karawang	Total
SRV Farmers (Research population in 2009)	76	16	27	119
SRV Farmers (Research population in 2015)	38	7	23	58
Non-SRV Farmers (2015)	48	3	11	62

RESULTS AND DISCUSSION

General description of research sites and population

The research sites were coastal areas and the place of final disposal of irrigation water. There was also some influences tidal flood. Flood frequency was 0-5 times per year. Although it was still in the range of productive age, the average age of the respondents was more than 50 years, so it seemed that aging phenomenon had occured in the research sites. According to Setiawan *et al*. (2013), older age could hamper the adoption of livestock waste innovative management. Then it could be stated that the adoption of SRV at the research sites might be threaten by the fact that the farmer's age tent to be old. Family size was relatively small, at about five persons for each family, while each family dependant was about three persons. Average submerged land for SRV farmers was 89 percent while for non-SRV farmers was 99 percent. Yearly average frequency of submerged condition were more than once. Both SRV farmers and non-SRV farmers got less then 6 years of formal education attainment. In other

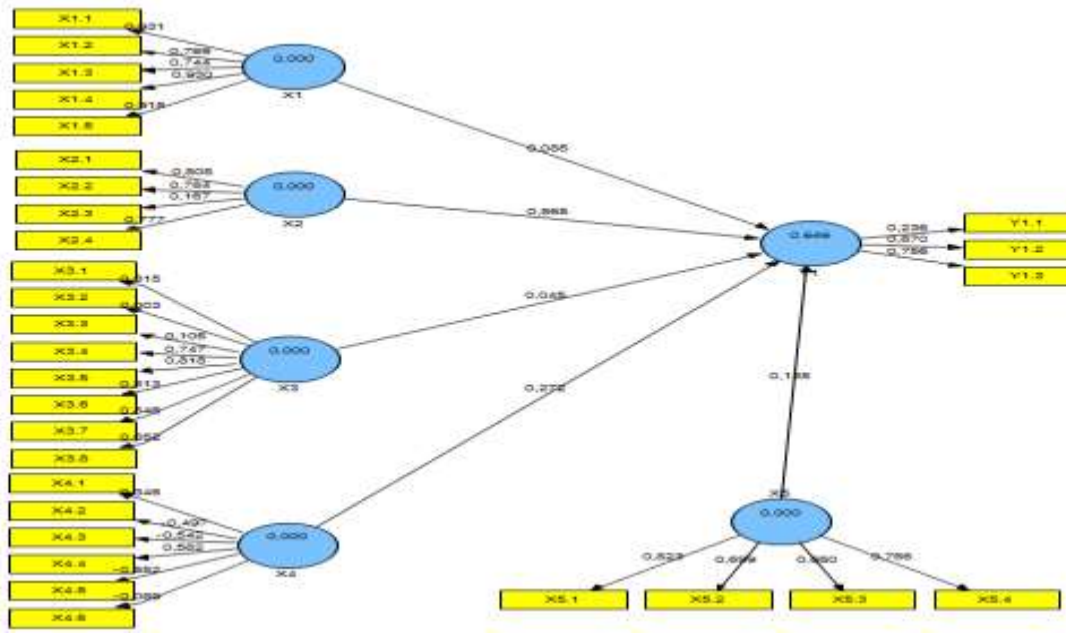

Figure 3. Output following several indicator were dropped

Table 3. Validity test on indicators on the SRV innovation communication models and the influence of external factors on the diffusion of innovation

Variable	Indicator	*Outer Loadings*	T test	Notes
X1: communicator	X1.1 Communicator types	0.931	171.25	Valid and significant
	X1.2 Communicator traits	0.770	37.99	Valid and significant
	X1.3 Communicator levels	0.742	31.53	Valid and significant
	X1.4 Communicator competences	0.931	133.83	Valid and significant
	X1.5 Trustt level	0.915	125.10	Valid and significant
X2:SRV innovation	X 2.1 Availability	0.804	52.88	Valid and significant
	X 2.2 Usages	0.780	44.94	Valid and significant
	X 2.3 Quality of SRV production	0.783	32.05	Valid and significant
X3: comm. media	X3.4: Hybrid media usage	0.761	22.58	Valid and significant
	X3.5: Printed media usage	0.808	30.53	Valid and significant
	X3.6: Comparative study	0.821	45.62	Valid and significant
	X3.7: Apprentice	0.849	45.52	Valid and significant
	X3.8: Demontration plot	0.655	16.23	Valid and significant
X4: SRV farmer's profile	X4.3: Land holding	0.446	10.83	Valid and significant
	X4.4: Comm. media ownership	-0.643	10.23	Valid and significant
	X4.5: Social status	0.647	11.04	Valid and significant
X5: external factors	X5.1: Goverment policy	0.828	43.55	Valid and significant
	X5.2: Production input availability	0.696	20.07	Valid and significant
	X5.3: Production absorption	0.851	64.03	Valid and significant
	X5.4: Culture	0.774	31.66	Valid and significant
Y1: diffusion of innovation	Y1.2: Persuasion	0.863	71.03	Valid and significant
	Y1.3: Decision making	0.777	27.11	Valid and significant

Description: If the t-statistic> t table (1.96) then it is valid and significant

words the community's educational backgrounds was less then Elementary School Level (6 years), which was 73 percent for SRV farmers and 53 percent for non-SRV farmers. Respondents who got formal educational for 7-9 years or Junior High School Level was less than 15 percent and those who got educational background 10-12 years or Senior High School Level were respectively 10 and 24 percent. Finally respondents with length of formal education more

than 12 years (more than Senior High School Level) were four and nine percent respectively, each for SRV farmers and non-SRV farmers. Unlike the research results of Sumarno (2010), that the level of education significantly affect the rate of technology adoption, most respondents at the research sites immediately used the seeds they got from the allotment. The reason was that they trusted the one who gave them the SRV seeds.

Evaluation of Innovation Communication Measurement of SRV Model and Influence Factors external to the Diffusion of Innovations (Outer Model)

The measure of reflexive individual is considered valid if it has a loading value (λ) of latent variables to be measured ≥ 0.5, if one indicator has a value of loading (λ) <0.5, then the indicator should be dropped or discarded because it indicates that the indicator is not good enough to accurately measure latent variables.

According to the above table it could be concluded that the value of loading (ë) of the indicator variable relationship with each construct ≥ 0.5, and has a T-statistic values> 1.96 at significance level á = 0.05. Thus the indicator variables X1, X2, X3, X4, X5 and Y1 could be said to be valid to measure each construct.

Reliability Test

In this research, a variable is said to be reliable enough if the variable has composite reliability value greater than 0.7 and has an AVE value greater than 0.5. Table 4. shows the reliability test results each latent variable by using SmartPLS software.

Based on the above table, it could be concluded that the latent exogenous variables X1, X2 and X3, X4, X5 has a value AVE> ρ_c ≥ 0.5 and 0.7 as well as the endogenous latent variable Y1 has a value of RD> 0.5 and ρ_c ≥ 0.7 it could be concluded that the indicators used are the variables have a fairly good reliability or able to measure the constructs. The R square also shows a quite good enough result. It shows us that the indicators of the variables could describe more than 65 percent of the model, while the other 35 could not be described by the mentioned indicators.

Table 4. Results of reliability tests of the model

Variable	AVE	*Composite Reliability*	*R square*	*Cronbach's Alpha*	*Communality*
X1	0.74282	0.93466		0.91064	0.74282
X2	0.62303	0.83214		0.69990	0.62303
X3	0.61155	0.88652		0.84077	0.61155
X4	0.34365	0.09333		0.48862	0.34365
X5	0.62351	0.86818		0.80357	0.62351
Y1	0.67404	0.80486	0.65678	0.52073	0.67404

Evaluation Structural Model (Inner Model)

Structural model could be evaluated by looking at the value of R2 on endogenous variables and parameters of the path coefficients (path coefficient parameter). The following hypotheses were raised in this study are:

H1(Hypothesis 1): Variable of communicator (X1) has a direct and positive influence to the SRV diffusion of innovation (Y1). T-test results in the output of SEM showed that the coefficient was 0.173 and t-test was 3.175, which was greater than t-table (1.96). It means that the hypothesis was accepted, X1 gave a direct and positive impact on the Y1. If communicator's condition was improved, it would lead to a better diffusion of innovation. Communicators played important roles in developing the SRV, characteristics, competences and confidences of communicators' were very decisive. There was a case that a creative Village-Level Extension Worker (VEW) brought chiefs of farmer groups within her guide

Structural model could be evaluated by looking at the value of R2 on endogenous variables and parameters of the path coefficients (path coefficient parameter). The following hypotheses were raised in this research are:

Hypothesis		*Original Sample* (O)	*Sample Mean* (M)	*Standard Deviation* (STDEV)	*Standard Error* (STERR)	*T Statistics* (|O/STERR|)
H1	X1 -> Y1	0.173	0.184	0.055	0.055	3.175
H2	X2 -> Y1	0.546	0.541	0.034	0.034	16.265
H3	X3 -> Y1	0.008	0.011	0.024	0.024	0.360
H4	X4 -> Y1	-0.259	-0.070	0.244	0.244	1.060
H5	X5 -> Y1	0.094	0.085	0.040	0.040	2.353

region to visit the Indonesian Center for Rice Research in Sukamandi, Subang District. The chiefs of the farmer's groups were interested in SRV introduction, so that they bought SRV seeds. In planting rainy season of 2014/2015 they cultivated the seeds, and the yields was very high (11-13 tons/ha). Farmers in surrounding areas have seen the planted rice crops and were interested to grow SRV. The surrounding the farmers then bought or exchange the SRV paddy rice with other rice seeds. In order to improve the diffusion of innovation, it needed some improvements for bot communicators and farmers. For communicators, improvement could be on their characteristics, competence and level of confidence. For farmers, their capacity building must be enhanced. Specifically for communicator's level indicator, the most important was the level of districts and villages, because these extension workers were the most frequent in making contact (interpersonal communication) with the farmers.

H2 (Hypothesis 2): Innovation of SRV (X2) has a direct and positive influence with Y1. T-test results in the output of SEM showed the coefficient of 0.546 and t-test (16.265) was greater than t-table (1.96) means that the hypothesis was accepted, X2 gave a direct and positive impact on the Y1. If the SRV's traits as innovation and its availability were improved, it would boost diffusion of innovation (Y1). The aavailability of seed will be related to the manufacturer or seed and seed traders of various levels. Besides "trait" rice varieties preferred by farmers was rice taste good, resistant to pests and diseases and the production of high, so the breeder should be able to create varieties that meet these three requirements. As a feed back from farmers (Receiver) to rice breeders (Source), naming for varieties should also be reconsidered. The rice variety's name should not the same name and differed only by number at the end. For example, Inpari 10 got a white point stuff at middle of the rice making it broken during milling and ended up in lower rendement. The other one was Inpari 13, which was quite hard to threshed. Inpari 30, on the other hand, having good traits such high productivity, besides submergence tolerant, it was also a bit drought tolerant, so farmers called it amphiby variety. However, because of the same name of "Inpari" farmers might be traumatized and they would not use the Inpari 30. In other words, farmers would be affected by the failure of the previous varieties.

H3 (Hypothesis 3): Media communication (X3) has a direct and positive influence on Y1. T-test results in the SEM output showed that the coefficient was 0.008 and t test (0.360) was smaller than t-table (1.96). It means that the hypothesis was rejected, X3 gave no direct effect on Y1. In this research, communication media such as the use of hybrid media (HP), printed media, demonstration plots, apprentice or internships and comparative study had not been specifically and intensively used to communicate the benefits of SRV utilization, so it could not increase the diffusion of innovation.

H4 (Hypothesis 4): Profile family of respondents (X4) has a direct and positive influence with Y1. T-test results in the output of SEM showed the coefficient of -0.259 and t-test (1,060) was smaller than t-table (1.96), which means that the hypothesis was rejected, X4 no direct effect on Y1. Although land tenure, ownership of communications media and social status of respondents repaired, will not improve the diffusion of innovation.

H5 ((Hypothesis 5): The government's policy (X5) has a direct and positive influence with Y1. T-test results in the output of SEM showed the coefficient of 0.094 and t test (2.353) was greater than t-table (1.96) means that the hypothesis was accepted, X5 direct and positive impact on the Y1. Government policies in terms of providing inputs recognized by respondents were good enough. Moreover, if there were improvements to the marketing SRV. This requires cooperation between stakeholders.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Family profiles such as age and education level both for submergence-tolerant rice variety 9SRV0of the head of family influence on the level of diffusion of innovation. Determinant factor in the diffusion of innovation SRV was (1) communicator that extension agents, researchers, fellow farmers, merchants and community leaders; (2) innovation SRV covering availability, use and quality of the results; and (3) external factors farmers' government policies including: government policies, the availability of agricultural inputs, production and cultural absorption. Extension at district and village levels was an important communicator, so as to improve

the capacity and budget to carry out its role will improve the diffusion of innovation. Fellow farmer ccommunicators also have a good chance as a messenger, as fellow farmers usually already in a state of "homophile" enabling perception and mutual uunderstanding could be achieved in a short time. Innovations are introduced should have a "trait" or the properties required of farmers. Government policies in agricultural extension need to be changed in order that farmers could get benefit as much as possible.

Suggestions

The Government needs to conduct a review to establish a policy on agricultural extension in connection with its implementation in the region. SRV naming particular varieties that will be introduced to the farmers do not use the same name, for example Inpari, but wear varieties preferred by farmers for example Ciherang Plus or Ciherang Super. Media and modes of communication most appropriate to be sought to provide substantial benefits to the farmers, especially farmers SRV mostly rice farmers, to conduct advanced research. Improving the ability of farmers and facilitation should be done so that messages could be received agricultural development and well applied by farmers.

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