

FARMERS WILLINGNESS TO ACCEPT (WTA) FOR SUBMERGENCE RICE VARIETIES AT FLASH FLOOD AND FLOOD PRONE AFFECTED RICE AREA

Keinginan Petani untuk Menerima Varietas Padi Toleran Rendaman pada Lahan Rawan Banjir dan Lahan Rawa Lebak

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ABSTRACT

Farmers are rational in decision making process with respect to any introduced agricultural technology. Farmers may consider the economic sacrifices in term of additional cost and potential benefit or additional income before they accept and adopt the introduced technology. This study aimed to analyze farmer's criteria and determine explanatory variables affecting farmer's decision to accept or to adopt submergence tolerant (Sub-1) rice varieties at flash flood and flood prone affected rice area. The study was conducted in Indramayu District, West Java, and Kayu Agung District, South Sumatra. Contingent Valuation Method (CVM) that derived Willingness to Accept (WTA) approach was exercised to analyze explanatory variables that influence farmers' willingness to accept introduced rice varieties. The results showed that the economic cost of flooding that damaged rice was about US\$7.63 million in Kayu Agung and US\$11.25 million in Indramayu in every wet season planting. Farmer's criteria used in submergence tolerant varietal evaluation varied and location specific in nature. Most of explanatory variables used in the model were significantly influenced farmers' WTA for submergence tolerant rice varieties such as: (1) availability of seed, (2) submergence tolerant for more than 14 days, (3) high yield, (4) proffer rice taste, (5) households' income during normal year, (6) area planted during normal year, and (7) age of farm household head. The only indicator that did not significantly influence the farmers' WTA for the Sub-1 rice varieties was farm household income during the flood year cropping.

[**Keywords:** Willingness to accept, submergence tolerant rice varieties, flash flood, flood prone]

ABSTRAK

Petani cukup rasional dalam mengambil suatu keputusan yang terkait dengan teknologi introduksi. Petani selalu mempertimbangkan korbanan ekonomi yang mereka keluarkan sebagai konsekuensi tambahan biaya dan potensi tambahan pendapatan sebelum mereka menerima dan mengadopsi suatu teknologi introduksi. Studi ini dimaksudkan untuk menganalisis faktor yang memengaruhi keinginan petani untuk menerima atau meng-

adopsi varietas padi tahan rendaman (Sub-1) pada lahan yang mengalami banjir musiman atau lahan rawa lebak. Penelitian dilaksanakan di Kabupaten Indramayu, Jawa Barat, dan Kayu Agung, Sumatera Selatan. Contingent Valuation Method (CVM) yang menggiring keinginan petani untuk menerima atau menolak suatu teknologi introduksi, diterapkan untuk menganalisis peubah penjelas yang memengaruhi keinginan petani untuk menerima atau menolak padi tahan rendaman. Hasil penelitian menunjukkan bahwa biaya ekonomi yang ditimbulkan oleh kedua jenis rendaman pada lahan sawah sekitar US\$7,63 juta di Kayu Agung dan US\$11,25 juta di Indramayu pada setiap tanam padi di musim hujan. Kriteria yang digunakan petani dalam mengevaluasi varietas padi tahan rendaman bervariasi dan bersifat spesifik lokasi. Sebagian besar peubah penjelas yang digunakan dalam model secara nyata dan positif mampu menjelaskan keinginan petani untuk menerima dan mengadopsi varietas padi tahan rendaman, seperti: (1) ketersediaan benih, (2) varietas padi toleran rendaman sampai 14 hari, (3) hasil tinggi, (4) rasa sesuai dengan selera konsumen, (5) pendapatan rumah tangga petani pada tahun normal (tidak banjir), (6) area tanam pada tahun normal, dan (7) umur kepala rumah tangga petani. Satu-satunya peubah bebas yang tidak berpengaruh nyata terhadap keinginan petani untuk mengadopsi varietas padi Sub-1 adalah pendapatan rumah tangga petani pada tahun munculnya banjir dan merendam lahan sawah.

[**Kata kunci:** Keinginan untuk menerima, varietas padi tahan rendaman, banjir kiriman, lahan rawa]

INTRODUCTION

The lowland rice-producing areas of the world may be classified first by water regime, namely those with a reliable and controlled external supply of water and a drainage system, the irrigated rice lands, and those depending solely on rainfall and runoff, the rainfed lowlands. The later are diverse and range from drought-prone lands to those subjected to flooding in excess of several meters during the growing season. Rice production in these areas has not really bene-

fited from the technological advances that were so successful for irrigated rice, yet hundreds of millions of Asia's poorest people depend upon the rainfed lowlands for their livelihood (Zeigler and Puckridge 1995).

Flooding is a major stress constraint to rice production, especially in rainfed lowland areas of the tropics. The flooding of the major river basins and deltas of Asia has provided the sustenance for the rice production that has been a prominent feature of the region for millennia. However, flooding is also a cause of yield fluctuations because of erratic rainfall patterns and poor drainage of many rice fields. This results in excess water in these fields for varying depths and durations (Ismail *et al.* 2010). For convenience, this flooding can be classified into four types depending on the plant traits and varietal types adapted to the conditions, namely: (1) flooding during germination (anaerobic germination, a problem when direct seeding is practiced and heavy rains result in submergence before germination; (2) flash flood (submergence), plants are completely submerged for up to two weeks thus submergence tolerance is required for this condition; (3) stagnant flooding (medium deep or semi-deep), flooding occurs for a longer duration, more than two weeks and often several months, at depths up to 50 cm thus it requires varieties tolerant to stagnant flooding conditions; and (4) deeper stagnant flooding (deepwater or floating rice), in which water depth increases throughout the season to depths of above 50 cm and often a meter or more. Varieties with tall plant height or rapid internodes elongation are required (MacKill *et al.* 2010).

Submergence is a recurring problem in the rice-producing rainfed lowlands of South and South-East Asia. Developing rice cultivars with tolerance submergence and with agronomic and quality traits acceptable to farmers is a feasible approach to address this problem. In areas where high-yielding but submergence-intolerant rice varieties have been cultivated, farmers suffer from crop losses caused by periodic flash floods during the monsoon season (Septiningsih *et al.* 2009). Recently, the extent of submergence stress has increased due to extreme weather events such as unexpected heavy rains that have inundated wider areas across many regions in Asia such as Indonesia. More sustainable solutions are needed to overcome this problem. One of the most promising solutions is to develop high-yielding varieties that are submergence tolerant and likely to be adopted by the farmers in the target regions.

Through collaborative research led by the International Rice Research Institute (IRRI) with National

Agricultural Research (NARs), a flood-tolerant local rice variety was investigated to isolate the gene responsible for flood resistance. Using a technique known as marker-assisted backcrossing, scientists transferred the water tolerant trait of interest into commercially valuable local rice varieties without losing useful characteristics which make them popular with farmers. Identification of the genetic code of the *SUB1* gene controlling submergence tolerance enabled breeding of new, high-yielding Sub-1 mega-varieties, with popular characteristics such as high yield, good grain quality and local pest and disease resistance (IRRI 2011). Fortunately, local rice landraces cherished by farmers include accessions adapted to extremes in water availability, including tolerance to progressive flooding or rapid submergence that can be the source of genetic variation to be used to improve the adaptability of rice to extreme environmental stresses such as submergence (Serres *et al.* 2010).

Indonesia is one of the country participants based on characteristics and targeted output of the project, Until present condition, not much effort has been implemented to fully understand farmers' production constraints and challenges both institutional and technological factors. Thus, this may hinder the adoption of the varieties to be disseminated at each area as well as other impact areas. Farmers may take into consideration the balance between added cost and potential benefit and return before they will to accept and adopt an introduced technology (Manikmas *et al.* 2009).

Willingness to Accept (WTA) approach is a measure of the economic scarifies in terms of income or other goods a person is willing and able to forgo gain or maintain a resource, good, or service. Net WTA, which is the difference between WTA and actual action for introduced technology and its impact to the ecological services, is usually used for cost-benefit analysis. Whether WTA is actually collected as cash is largely irrelevant from the standpoint of economic efficiency. While it may be important for political reasons to transfer a portion of the user's WTA to actual cash flow, any financial returns are just a transfer of benefits from user to recipient. The total economic value received by society does not change, only the distribution of the economic value among members of society (Willing 1976).

Technology adoption is governed by farmer perceptions regarding advantages and disadvantages of new technology compared with the existing technology. Yet farmer perceptions are not adequately documented and analyzed in adoption studies. In this

paper, farmer perceptions regarding traditional and improved rice varieties in a rainfed village in Orrisa are used as a basis for explaining the low adoption of improved varieties and the high degree of varietal diversity. The results indicate that quality characteristics loom very large in farmers' choice of rice varieties (Kshirsagar *et al.* 2002). Quality characteristics such as seed purity, grain and milled rice quality, yield potential of submergence tolerant rice varieties depend upon its genetic background.

This study aimed to determine the economic cost and farmer's criteria in evaluating introduced varieties and analyze the determining explanatory variables that potentially affecting farmer's decision to accept or to adopt submergence tolerant rice varieties at flash flood and flood prone affected rice area.

METHODOLOGY

Locations and Respondents

The study was conducted in Indramayu District, West Java, and Kayu Agung District, South Sumatra. Indramayu District was selected as a key site representing flash flooding areas along the North Coast of Java. Meanwhile, Kayu Agung District was selected to represent flood prone area as a satellite site. Direct and face-to-face individual interview was conducted in both districts. Participatory varietal selection (PVS) was exercised to derive farmers' WTA for newly introduced submergence tolerance rice varieties.

Stratified random sampling was applied to cluster the farm household samples. The cluster was based on few indicators such as income class, size of land holding and level of flooding. The number of respondents was 100 farmers in Indramayu and 60 farmers in Kayu Agung for a total of 160 respondents that covered two cropping season, i.e. 2007 dry season (March-July) and 2007/2008 wet season (November to February). Year 2006 was treated as flood year and year 2007 was a normal year.

Data Collection

Baseline surveys was exercised to collect data and relevant information at farm household level at targeted study areas. This type of survey aimed to establish initial or ex-ante condition against which the effects of a finished project can be compared or ex-post condition. These study efforts are used to

provide a quick snap shot of the sector and to understand processes where a project would be involved in and serve as benchmark against which the impact of a project will be measured (NB Ideas 2007).

In both cases, some of the data required to measure the impacts of any new technology innovation at aggregate level can be directly observed, and other data must be estimated indirectly from other evidence. Choosing and using data are most important skill required in baseline study. The difference between successful and unsuccessful of ex-ante assessment typically rest on the judgment of the researcher in collecting and interpreting their data (Master *et al.* 1996).

Well structured questionnaire was used to record all possible factors affecting WTA for introduced Sub-1 rice varieties, included: 1) availability of seed, (2) submergence tolerance at most 14 days, (3) high yield, (4) suitable rice taste, (5) household income at normal year, (6) on-farm income at flood year, (7) area affected by flood, (8) paddy price, (9) age of household head, (10) education of household head, and (11) number of household members. Economic cost of flooding and farmer's criteria in evaluating new rice varieties were other considerably important factors in evaluating the adoption opportunity of newly introduced rice varieties.

Approach

Contingent Valuation Method (CVM) has been widely used in agricultural research and development. In this method, farmers can be directly interviewed individually by asking how they would be willing to pay or to accept for the improvements of their practices or the environmental impact which agriculture technology brings (Yoshida *et al.* 1997; Yoshida 1999). CVM uses surveys in which people are asked how they are willing to accept (WTA) for a certain level of agricultural technological change through introduction or improvement of the existing technology. The basic notion underlying CVM is that a realistic but hypothetical condition for targeted group to accept a certain technological change can be described to an individual. Key features of the hypothetical change include: (1) description of the resource being valued; (2) means of acceptance, such as an increase in yield and quality; and (3) the value of elicitation. The means of acceptance level must be realistic and emotionally neutral for the respondents. To improve realism, the means of acceptance must be appropriate for the technology.

In principal, application of CVM is based on potential behavior, which is not based on actual behavior (Munasinghe 1992). The application of CVM is basically assessing the farmers' technological preferences with respect to the observable benefit through investigation of farmer's WTA. CVM has been shown to be reliable, especially for estimating user values. CVM is generally consistent with axioms of revealed choice at least for familiar goods and services. CVM typically has been shown to compare very favorably with other non-market resource valuation techniques (Cummings *et al.* 1986; Mitchell and Carson 1989).

CVM is the most widely exercised approach for determining the value of non-market goods and agricultural technological impact to the end users. CVM has been shown to produce benefit estimates close to the true benefit and is also reliable in re-testing at least for user values (Loomis 1987). Introduction of agricultural technology often produces both costs and benefits that may not be valued totally. In addition, some government agricultural programs not yet initiated may have unknown cost that cannot be summarized from the program activity. This approach is also intensively exercised to evaluate the willingness of community living along the Citarum watershed area to the programs offered by government to conserve the environment such as reforestation, alley cropping, terracing, water reservoir and household well, irrigation and drainage system, and agroforestry (Manikmas and Fahmudin 2003). Other study also applied CVM to evaluate the WTA of farmers with respect to newly introduced food crop varieties such as red rice, quality protein maize (QPM), pulut maize and sweet potato. In aggregate, similar variables exercised in this study were able to explain 70-90% of farmers WTA to those introduced varieties (Adnyana *et al.* 2007).

Contingent Valuation Model

Assumes that unobserved WTA could be expressed as:

$$WTA_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \dots + \beta_k X_{ki} + \epsilon_i \dots \dots \dots (1)$$

Where ϵ_i is independently and identically distributed $(0, \delta^2)$, and the X_i 's are the explanatory variables. In this study the mathematical equations of farmers' WTA for flash flood affected rice areas in Indramayu are as follow:

1. WTA during normal year

$$WTA_{imn} = \beta_0 + \beta_1 SEED_{1i} + \beta_2 SUBR_{2i} + \beta_3 HYD_{3i} + \beta_4 SRT_{4i} + \beta_5 INC_{5i} + \beta_6 ANYN_{6i} + \beta_7 AGE_{7i} + \beta_8 EDUC_{8i} + \epsilon_i \dots \dots \dots (2)$$

$\beta_i > 0; i = 1, 2, \dots 8$

2. WTA during flood year

$$WTA_{imf} = \alpha_0 + \alpha_1 SEED_{1i} + \alpha_2 A SUBR_{2i} + \alpha_3 HYD_{3i} + \alpha_4 SRT_{4i} + \alpha_5 PRICE_{5i} + \alpha_6 INC_{6i} + \alpha_7 ANYF_{7i} + \alpha_8 AGE_{8i} + \alpha_9 EDUC_{9i} + \alpha_{10} NHHM_{10i} + \epsilon_i \dots \dots \dots (3)$$

$\alpha_i > 0; i = 1, 2, \dots 10$

where:

- WTA_{imn} = WTA of respondents in Indramayu District in normal year
- WTA_{imf} = WTA of respondents in Indramayu District in flood year
- SEED = available seed
- SUBR = submergence tolerant rice varieties for 14 days
- HYD = high yield
- SRT = suitable rice taste
- INC = total household's income (Rp000)
- PRICE = price of rice (Rp kg⁻¹)
- ANYN = area in normal year
- ANYF = area in flood year
- AGE = age of farm household head
- EDUC = education level of farm household head
- NHHM = number of farm household member

For the case of flood prone affected rice areas in Kayu Agung District, mathematical equation of farmers' WTA for the introduced submergence tolerant rice varieties are as follow:

1. WTA during normal year

$$WTA_{kan} = \beta_0 + \beta_1 HYD_{1i} + \beta_2 INC_{2i} + \beta_3 ANYN_{3i} + \beta_4 AGE_{4i} + \beta_5 EDUC_{5i} + \beta_6 NHHM_{6i} + \epsilon_i \dots \dots \dots (2)$$

$\beta_i > 0; i = 1, 2, \dots 6$

2. WTA during flood year

$$WTA_{kanf} = \alpha_0 + \alpha_1 SEED_{1i} + \alpha_2 A SUBR_{2i} + \alpha_3 HYD_{3i} + \alpha_4 SRT_{4i} + \alpha_5 INC_{5i} + \alpha_6 ANYF_{6i} + \alpha_7 AGE_{7i} + \alpha_8 EDUC_{8i} + \epsilon_i \dots \dots \dots (3)$$

$\alpha_i > 0; i = 1, 2, \dots 8$

where :

- WTA_{kan} = WTA of respondents in Kayu Agung District in normal year

WTA_{kaf}	= WTA of respondents in Kayu Agung District in flood year
SEED	= available seed
SUBR	= submergence tolerant rice variety for 14 days
HYD	= high yield
SRT	= suitable rice taste
INC	= total household's income (Rp000)
PRICE	= price of rice (Rp kg ⁻¹)
ANYN	= area in normal year
ANYF	= area in flood year
AGE	= age of farm household head
EDUC	= education level of farm household head
NHHM	= number of farm household member

varieties are presented in Tables 1 and 2. Meanwhile, all estimated parameters of explanatory variables to explain WTA for introduced Sub-1 rice varieties included: (1) availability of seed, (2) submergence tolerant at most 14 days, (3) high yield, (4) suitable rice taste, (5) household income at normal year, (6) on-farm income at flood year, (7) area affected by flood, (8) paddy price, (9) age of household head, (10) education of household head, and (11) number of household members. The WTA model was estimated to explain factors or explanatory variables that influenced farmers in decision process with respect to the introduced submergence tolerant rice varieties. The outputs of WTA analysis are presented in Tables 3 and 4.

Data Analysis

Ordinary least square (OLS) was used to estimate the parameters for each respondent's WTA. Since OLS has given quite efficient parameter estimate in term of coefficient of determination and magnitude of the estimates, no other technique was exercised. Responsiveness of respondents to the change of explanatory variables was also computed in term of elasticity value since the model used is double log equation.

Four WTA equations were estimated with pre-condition all sign of parameter estimates are positive except area planted during the flood year. In other words, all explanatory variables included in the model positively influence the variability of farmers' WTA for the introduced submergence tolerant rice varieties. The explanatory variables included in the model were based on the continuous estimation process until the most suitable variables were fit to the model.

RESULTS AND DISCUSSION

Results of the study related to economic cost of flooding and farmer's criteria in evaluating new

Economic Cost of Flooding

Economic cost of flooding that damaged rice areas at aggregate level was counted based on average price of paddy during the baseline study was conducted. The on-farm price of paddy in Kayu Agung was about US\$210.2/t, while price of paddy in Indramayu was accounted at US\$235.6/t. On the other hand, price of paddy at national level was about US\$226.9/t.

Based on these paddy prices and average production loss, therefore the total economic cost of flooding was accounted for about US\$7.63 million in Kayu Agung and US\$34.02 million at provincial level of South Sumatra. On the other hand, cost of flooding in Indramayu was about US\$11.25 million and US\$38.54 million at provincial level of West Java. Meanwhile, nationally economic cost of flooding was estimated at least US\$288.60 million in average per year within last 12 years (Table 1).

In Viet Nam for example, every year, resource-poor rice farmers in the Mekong Delta experience varying types of flooding causing yield loss of about 20-100%. Since rice is the main source of livelihood in the rural areas, frequent floods have contributed to increased poverty (Ngoc Chi *et al.* 2011b). To avert

Table 1. Economic cost of flooding at the aggregate level, Indonesia 2008.

Province/district	Eq. total damaged area (ha)	Average production loss (t)	Average price of paddy (US\$/t)	Total economic cost (US\$ 000)
South Sumatra	40,458	161,834	210.2	34,019
Ogan Komering Ilir	9,075	36,298	210.2	7,630
West Java	40,895	163,578	235.6	38,536
Indramayu	11,940	47,759	235.6	11,251
Indonesia	317,917	1,271,669	226.9	288,602

this impact of flooding, farmers need submergence-tolerant rice varieties with desired traits and appropriate management practices. Along with the breeders' selection, farmers' preferred traits are also important in defining breeding goals for wider acceptability of new varieties.

More precisely, impact of flash flood to rice production in flood year in Mekong Delta, Viet Nam, was relatively lower than those in normal year of about 15%. The rice yield in the flood year also reduced from 4 to 3.73 t ha⁻¹. The gross household income in the flood year was relatively lower than those in the normal year (about 18%). Of which, the reduction in rice income was 19%. This caused reduction in the net income from rice production in the flood year (Ngoc Chi *et al.* 2011a).

In addition, submergence caused by typhoons and floods is one of the major reasons for production losses. Because of the complexity of these ecosystems, the breeding framework necessitates adequate feedback and a more in-depth understanding of the ecological and socioeconomic conditions in these flood-prone areas (Manzanilla *et al.* 2011; Mariano *et al.* 2012). Within this purview, this study validated the performance in farmers' fields of lines with the *SUB1* gene that confers tolerance of submergence for up to two weeks. The evaluation was conducted through participatory approaches to gain understanding of the risks as well as farmers' preferences for these varieties (Manzanilla *et al.* 2011).

Farmers' Criteria in Evaluating New Varieties

The farmers' perceptions with respect to the criteria they use to select the existing varieties at flood affected rice areas in Indonesia were grouped into five priorities (rank) such as most important (rank 1), important (rank 2), quite important (rank 3), less important (rank 4) and not important (rank 5). Study on submergence tolerant rice adoption showed that about 19.61% of farmers at key site in Indramayu said that available seed was the most important criteria, important criteria 29.41%, quite important 13.73%, less important 17.65%, and about 19.61% farmers said that available and quality seed was not important. On the other hand, about 50%, 17.31% and 23.08% farmers in Kayu Agung said that the availability of seed was not very important, important and quiet important, respectively. Only about 7.69% and 1.92% farmers considered that availability and quality of seed was less important and not important, conse-

cutively. In average for both sites, most of farmers said that seed quality and availability criteria were relatively very important and important or about 29.87% and 25.32%, respectively (Table 2).

The benefits of developing and releasing submergence salinity-tolerant and phosphorous-deficiency-tolerant rice in Bangladesh, India, Indonesia and the Philippines are estimated for marker-assisted breeding (MAB) and for conventional breeding (CB) using economic surplus analysis. Marker-assisted breeding is estimated to save at least 3-6 years in the breeding cycle and result in incremental economic benefits over 25 years in the range of US\$50-900 million compared to CB, depending on the country, stress and time lags. Saline and phosphorus-deficient soils are difficult problems to address through CB because of undesirable traits that accompany desirable ones during the breeding process. Marker-assisted breeding enabled by advances in genomics and molecular mapping is more precise and time-saving. Costs are estimated at US\$3.4 million for MAB and US\$2.5 million for CB, and hence the additional net benefits of MAB in rice far exceed those for CB (Alpuerto *et al.* 2009).

Study conducted in the Philippines showed that varying conditions of submergence can influence farmers' criteria and preferences for rice cultivars. Depending on the timing of flood with respect to growth stage, shorter duration and shallow flash-floods result in less than 10% production losses while deeper and stagnant water with two weeks duration and >100 cm depth cause damage ranging from 40% to 77%. Major findings of PVS trials and preference analysis indicated that farmers prefer rice cultivars that are tolerant to submergence, have early to medium maturity relative to their commonly grown varieties, and are resistant to pests, diseases and lodging, among other traits. To enhance adoption, male and female farmers should be involved in the evaluation process. The results of this study can contribute to enhancing breeding programs to develop appropriate varieties that reduce production losses, improve income and ultimately reduce poverty incidence in submergence-prone areas (Manzanilla *et al.* 2011).

Indramayu District

The overall performance of estimated farmers' WTA for Sub-1 rice varieties in Indramayu during the normal year was statistically acceptable. This was shown by the coefficient of determination (R^2) that

Table 2. Farmer's criteria in choosing rice varieties at key site in West Java and satellite site in South Sumatra during Flood year, 2008.

Rank of reasons for growing submergence tolerant rice varieties	Absolute values of household heads number			Percentage values of household heads		
	West Java	South Sumatra	Total	West Java	South Sumatra	Total
Available seed						
Rank 1: Very important	20	26	46	19.61	50.00	29.87
Rank 2: Important	30	9	39	29.41	17.31	25.32
Rank 3: Quite important	14	12	26	13.73	23.08	16.88
Rank 4: Less important	18	4	22	17.65	7.69	14.29
Rank 5: Not important	20	1	21	19.61	1.92	13.64
All	102	52	154	100.00	100.00	100.00
Submergence-tolerant up to 14 days						
Rank 1: Very important	55	12	67	53.92	23.08	43.51
Rank 2: Important	21	34	55	20.59	65.38	35.71
Rank 3: Quite important	9	4	13	8.82	7.69	8.44
Rank 4: Less important	13	1	14	12.75	1.92	9.09
Rank 5: Not important	4	1	5	3.92	1.92	3.25
All	102	52	154	100.00	100.00	100.00
High yield						
Rank 1: Very important	22	13	35	21.57	25.00	22.73
Rank 2: Important	36	5	41	35.29	9.62	26.62
Rank 3: Quite important	29	17	46	28.43	32.69	29.87
Rank 4: Less important	14	15	29	13.73	28.85	18.83
Rank 5: Not important	1	2	3	0.98	3.85	1.95
All	102	52	154	100.00	100.00	100.00
Suitable rice taste						
Rank 1: Very important	0	1	1	0.00	1.92	0.65
Rank 2: Important	8	3	11	7.84	5.77	7.14
Rank 3: Quite important	23	7	30	22.55	13.46	19.48
Rank 4: Less important	13	12	25	12.75	23.08	16.23
Rank 5: Not important	58	29	87	56.86	55.77	56.49
All	102	52	154	100.00	100.00	100.00
Price						
Rank 1: Very important	5	0	5	4.90	0.00	3.25
Rank 2: Important	7	1	8	6.86	1.92	5.19
Rank 3: Quite important	27	12	39	26.47	23.08	25.32
Rank 4: Less important	44	21	65	43.14	40.38	42.21
Rank 5: Not important	19	18	37	18.63	34.62	24.03
All	102	52	154	100.00	100.00	100.00

accounted for about 0.819 and 0.841 during the normal year and flood year, respectively. The accuracy of estimated WTA model was also quite high with coefficient of variation 0.145 for normal year and 0.215 for flood year. The estimated parameters showed that most of explanatory variables used in the model were significantly influenced the farmers WTA such as: (1) availability of seed, (2) submergence tolerant, (3) high yield, (4) rice taste, (5) households' income during normal year, (6) area planted during normal year, and (7) age of household head. The only indicator that did not significantly influence the farmers' WTA for Sub-1 rice varieties was household income during the normal year.

Rice planted area during flood year in Indramayu negatively influenced the farmers' decision in determining their WTA. In other words, if household income increased during the normal year then farmers tend to reduce their WTA for the submergence tolerant rice varieties. This condition was because the introduced Sub-1 rice varieties were not well tested during the flood year or farmers are waiting for the real on-farm performance of these varieties. The estimated parameters of explanatory variable are presented in Table 3.

Availability of seed and the submergence tolerance of introduced Sub-1 rice can be improved at least by 10% then the farmers' WTA will increase at least by

Table 3. Farmers willingness to accept (WTA) for flash flood submergence tolerant rice varieties at key site in Indramayu, West Java, 2008.

Variable	Label	DF	Parameter estimate	Standard error	t -value	Pr > t
Normal year						
Intercept	Intercept	1	7.4548	0.0810	92.09	<.0001
SEED	Available seed	1	0.0438	0.0096	4.55	<.0001
SUBR	Submergence-tolerant for 14 days	1	0.0894	0.0084	1.07	0.0291
HYD	High yield	1	0.0258	0.0077	3.37	0.0016
SRT	Suitable rice taste	1	0.0163	0.0054	3.00	0.0045
INC	Income in normal year	1	0.0046	0.0041	1.12	0.2681
ANYN	Area in normal year	1	-0.0210	0.0035	-5.91	<.0001
AGE	Age of farm household head	1	0.0664	0.0068	9.80	<.0001
EDUC	Education of farm household head	1	0.0172	0.0028	6.21	<.0001
R-Square			0.8194			
Adj R-Sq			0.7858			
CV			0.1451			
10% increase of each explanatory variable			2.4260			
Flood year						
Intercept	Intercept	1	8.5699	0.6944	12.34	<.0001
SEED	Available seed	1	0.2306	0.0961	2.40	0.0353
SUBR	Submergence-tolerant for 14 days	1	0.1435	0.0861	1.67	0.1233
HYD	High yield	1	0.1286	0.0643	2.00	0.0710
SRT	Suitable rice taste	1	0.1356	0.0525	2.58	0.0255
PRICE	Price or rice	1	0.0773	0.0392	1.97	0.0740
INC	Income in flood year	1	0.0061	0.0140	0.44	0.6695
ANYF	Area in flood year	1	-0.0188	0.0155	-1.21	0.2505
AGE	Age of farm household head	1	0.0297	0.0251	1.18	0.2620
EDUC	Education of farm household head	1	0.0297	0.0063	4.73	0.0006
NHHM	Number of household members	1	0.0321	0.0149	2.15	0.0547
R-Square			0.8406			
Adj R-Sq			0.6956			
CV			0.2148			
10% increase of each explanatory variable			7.9445			

0.438% and 0.894%, consecutively. In addition, the 10% improvement of rice yield and rice taste will also improve the farmers' WTA at least by 0.258% and 0.163%, respectively. In general, if all explanatory variables used in the WTA model improved by 10% each, then farmers' WTA will also increase at least by 2.426% during the normal year wet cropping season. This condition indicates that farmer's response that expressed in WTA is quite slow since farmer may wait for better varieties field performance in relation to availability of seed, submergence tolerance level on introduced varieties, yield, rice taste and on-farm price of harvested paddy during the normal year.

Similar to WTA model used to estimate parameter of variables that influence farmers WTA during the normal year, the WTA model used to explain the farmers WTA during the flood year was also statistically valid and significant. About 84.06% of farmers' WTA variability was able to be explained by the model with coefficient of determination (R^2)

0.8406 and coefficient of variation (CV) 0.2148. This indicated that the accuracy of estimated parameters was quite high. In other words, the WTA model used in this study was able to represent the farmer's response to the introduced submergence rice varieties planted during flood year.

More factors influenced farmers' WTA during flood year compared with normal year since more problems were encountered by farmers during the flood year. Factors that significantly affected the farmers WTA for submergence tolerant Sub-1 rice varieties during flood year were (1) availability of seed, (2) submergence tolerant up to 14 days, (3) high yield, (4) suitable taste, (5) price of paddy, (6) level of education of household head and (7) number of household member. However, on-farm crop income during flood year, planted area, and age of household head did not significantly affect farmers' WTA.

Four important farming indicators such as seed availability, submergence tolerant up to 14 days, high

yield, suitable rice taste, and price of rice exhibited significant influence to farmer WTA with estimated parameter of about 0.2306, 0.1435, 0.1286, and 0.1356, respectively. In other words, a 10% increase of each variable will improve the farmers WTA by 2.306%, 1.435%, 1.286%, and 1.356%, respectively. Even though the planted area during the flood year did not significantly affect the farmers' WTA, it showed negative trend. If the planted area during flood year increases then farmers' WTA tend to decline. This indicated farmers are trying to find out further coping mechanism during the flood year if the availability of introduced submergence tolerant rice varieties is limited.

Nevertheless, level of education and number of household members also affected farmers' WTA for introduced Sub-1 rice varieties with estimated parameter of about 0.0297 and 0.0321 during the flood year respectively. In addition, an overall increase of each indicator or explanatory variable by 10% will increase farmers' WTA during flood year by 7.945%. This figure was almost four times higher compared with farmers' WTA during normal year (Table 3). This indicates that farmers are more responsive to accept the introduced Sub-1 rice varieties during the flood year as one of the coping mechanisms for the crop damage due to flash flood during wet season cropping.

The discussion about farmers WTA for Sub-1 rice varieties in Indramayu conclude that farmer's response to these introduced varieties was relatively higher during the flood year compared with normal year. This indicates that more problems and challenges are faced by farmers during flood year compared with normal year. This high response also indicates that farmers are trying to find out more coping mechanisms during flood year.

To compare, outputs of similar study conducted in Viet Nam showed that there was also moderate to strong WTA between the farmers' preferences and the researchers' good performing varieties. The traits crucial to the farmers included resistance to pests and diseases, high yield, stiff/sturdy stem for lodging tolerance, good eating quality, tolerance to acid sulfate soils, good seed vigor, short duration, high tillering capacity, longer stalks, appropriate for existing cropping systems and less fertilizer requirement. This study employed needs-based and participatory approaches to ensure that breeding programs are well-targeted and can contribute to fast track dissemination of submergence-tolerant rice varieties. The ultimate goal is increasing rice productivity and reducing poverty in flood-prone ecosystems (Ngoc Chi *et al.* 2011b; Mariano *et al.* 2012).

Kayu Agung District

Overall performance of estimated farmers' WTA at Kayu Agung was also statistically acceptable with coefficient of determination (R^2) of about 0.8456 and 0.8694 during the normal and flood year, respectively. In other words, about 84.56% and 86.94% of farmers' WTA variability with respect to submergence tolerant Sub-1 rice varieties was well explained by the model either during normal or flood year (Table 4).

The accuracy of estimated WTA model was also quite high with coefficient of variation (CV) 0.2355 for normal year and 0.3294 for flood year. Most of explanatory variables used in the model were significantly influenced the farmers' WTA except farmers' income during the normal year. However, during the flood year out of eight explanatory variables estimated in the WTA model only three variables that significantly influenced the farmers' WTA for the introduced submergence tolerant rice varieties such as submergence-tolerance on 14 days, high yield, and suitable rice taste.

In general, farmers showed higher response to the introduced submergence-tolerant rice varieties that expressed into WTA during the normal year compared with flood year. This indicates that farmers remain uncertain during the flood year about the opportunity of submergence tolerant rice to overcome problems at the flood prone affected rice areas in Kayu Agung.

In more detail, indicators significantly affected the farmers' WTA during the normal year in Kayu Agung were: (1) high yield, (2) planted area during normal year, (3) age of household head, (4) level of education, and (5) number of household's members with estimated parameter of 0.0324, 0.0163, 0.0756, 0.0495 and 0.0603, consecutively. In other words, 10% increase of each indicator will improve farmers' WTA to submergence tolerant Sub-1 rice varieties at least by 0.324%, 0.163%, 0.756%, 0.495% and 0.603%, consecutively (Table 4).

An overall increase of indicators or explanatory variables used in the WTA model by 10% will increase farmers' WTA for submergence tolerant rice varieties in Kayu Agung by 2.4434%. This response may not as high as farmers response during the flood year, however this figure remains in an increasing trend for Kayu Agung case. Meanwhile, only few indicators that significantly affected farmers' WTA during flood year in Kayu Agung, including: (1) submergence tolerant up to 14 days, (2) high yield, and (3) suitable rice taste with estimated parameter of

Table 4. Farmers willingness to accept (WTA) for flash flood submergence tolerant rice varieties at satellite site in Kayu Agung, South Sumatra, 2008.

Variable	Label	DF	Parameter estimate	Standard error	t-Value	Pr > t
Normal year						
Intercept	Intercept	1	6.9960	0.1874	37.32	<.0001
HYD	High yield	1	0.0324	0.0104	3.11	0.0067
INC	Income in normal year	1	0.0102	0.0111	0.92	0.3726
ANYN	Area in normal year	1	0.0163	0.0095	1.72	0.1044
AGE	Age of farm household head	1	0.0756	0.0145	5.22	<.0001
EDUC	Education of farm household head	1	0.0495	0.0165	3.01	0.0084
NHHM	Number of household members	1	0.0603	0.0185	3.25	0.0050
R-Square			0.8456			
Adj R-Sq			0.788			
CV			0.2355			
10% increase of each explanatory variable			2.4434			
Flood year						
Intercept	Intercept	1	7.9198	0.5802	13.65	<.0001
SEED	Available seed	1	0.0665	0.0795	0.84	0.4349
SUBR	Submergence-tolerant for 14 days	1	0.0829	0.0371	2.23	0.0669
HYD	High yield	1	0.1556	0.0603	2.58	0.0419
SRT	Suitable rice taste	1	0.1118	0.0367	3.05	0.0226
INC	Crop income in flood year	1	0.0047	0.0318	0.15	0.8876
ANYF	Area in flood year	1	-0.0142	0.0449	-0.32	0.7631
AGE	Age of farm household head	1	0.0465	0.0616	0.76	0.4784
EDUC	Education of farm household head	1	0.0801	0.0592	1.35	0.2247
R-Square			0.8694			
Adj R-Sq			0.6952			
CV			0.3294			
10% increase of each explanatory variable			5.3394			

0.0829, 0.1556 and 0.1118, respectively. Most of indicators did not significantly influence farmers' decision in determining their WTA for Sub-1 rice varieties during flood year, such as availability of seed, crop income in flood year, planted area in flood year, age of household's head and level of education. This response indicated that for rice cropping practices during flood year, farmers tend to use their local varieties. They remain wait for the field performance in a bigger scale.

The overall increase of 10% of each indicator during flood year will influence farmers' WTA for submergence tolerance Sub-1 rice varieties and increase by 5.3394% or more than double compared with normal year. Once again this finding showed that farmers in Kayu Agung are also more respond during the flood year compared with normal year. Need to be taken into account that farmers in Kayu Agung only grow rice once a year. Farmer faced problems and constraints during the flood year due to long flood prone submergence compared to normal year.

In addition, outputs of a study conducted in the Philippines showed that estimated factors influencing

farmers willingness to accept or to adopt modern rice technology and good management practices are reasonably consistent, particularly with respect to soil deficiencies and risk aversion. Results were also consistent between models in terms of the positive impacts on the adoption of certified seed technology and integrated crop management practices of farmers' education, machinery ownership, irrigation water supply, capacity-enhancement activities and profit-oriented behavior. Conversely, soil and nutrient deficiencies are impediments to their adoption. Extension-related variables have the biggest impact on technology adoption (Mariano *et al.* 2012).

CONCLUSION AND POLICY IMPLICATION

Conclusion

Two types of submergence rice area during the wet season planting have created crop damage and significant economic loss to the farmers in Indramayu and Kayu Agung District. Meanwhile, farmer's criteria

in relation to the selection, adoption and acceptance of newly introduced submergence tolerant rice varieties are location specific in nature.

Farmers are more responsive to the introduced submergence tolerant rice varieties especially during the flood year as part of their coping mechanism to the crop damage due to the flash flood or flood prone. Farmers are willing to accept or to adopt submergence tolerant Sub-1 rice varieties to reduce crop risk at flash flood rice area in Indramayu and flood prone rice affected areas in Kayu Agung as long as:

1. Seed is available when farmers need in a good quality and right amount.
2. Introduced submergence tolerant rice varieties either at flash flood or flood prone rice affected areas should more than 14 days submerge.
3. Introduced varieties produce higher yield and proffer taste such as soft texture for Indramayu and harder for Kayu Agung.
4. Higher farm households' income and planted rice areas during normal year cropping, especially wet season.
5. Age of farm household head is other factor that determines farmers' willingness to accept submergence tolerant rice varieties.

Policy Implication

1. There should be a more central government direct targeted submergence rice ecosystem and farmers group to anticipate the increasing trend of this area.
2. Expansion of irrigation canal rehabilitation program should include the most submergence affected area especially those belong to highly susceptible and nearly susceptible areas.
3. The government should focus the rehabilitation program to submergence affected rice areas due to flash flood for better drainage system.
4. Rehabilitation of up-stream area is vitally important to increase the water catchment area and reduce the flood at downstream area where rice is the main crop grown by farmers.
5. The budget is needed to construct the canal. In this regards, the local government should put the budget in the development planning for drainage construction and rehabilitation.
6. The government should consider short-term strategies that offset environmental adversities such as drought and submergence.
7. Government interventions to improve the educational status of farming households, overcome the

effects of small farm size and encourage more profit-oriented behavior by farmers are necessary to enhance farmer willingness to accept or adopt introduced rice production technology particularly submergence tolerant rice varieties.

REFERENCES

- Adnyana, M.O., K. Kariyasa, S.D. Indrasari, Jumali, F. Rozi, I. Sutrisno, Bahtiar, I G.M. Subiksa, dan Soeprapto. 2007. Identifikasi dan analisis komoditas tanaman pangan untuk menciptakan peluang pasar. Pusat Penelitian dan Pengembangan Tanaman Pangan, Bogor.
- Alpuerto, V.E.B, G.W. Norton, J.A., and A.M. Ismail. 2009. Economic impact analysis of marker-assisted breeding for tolerance to salinity and phosphorous deficiency in rice. *Appl. Econ. Perspect. Pol.* 31(4): 779-792.
- Bhisop, R.C. and T.A. Hebertstein. 1979. Measuring values of extra-market goods: Are indirect measure based? *Am. J. Agric. Econ.* 61(5): 926-930.
- Cummings, R.G., D.S. Brookshire, and W.D Schulze. 1986. Valuing Environmental Goods: An assessment of the contingent valuation method. Rowman and Allanheld, NJ.
- IRRI. 2011. Scuba rice: breeding flood-tolerance into Asia's local mega rice varieties. IRRI in collaboration with UK-Aid, Department for International Development.
- Ismail, A.M, M.J. Thomson, G.V. Vergara, M.A. Rahman, R.K. Singh, G.B. Gregorio, and D.J. Mackill. 2010. Designing resilient rice varieties for coastal deltas using modern breeding tools. pp. 154-165. *In* C.T. Hoanh, B. Szuster, K.S. Pheng, A. Nobel, A.M. Ismail (Eds.). *Tropical Deltas and Coastal Zones: Food production, communities and environment at the land-water interface.* CAB International, UK.
- Kshirsagar, K.G., S. Pandey, and M.R. Bellon. 2002. Farmer Perceptions, Varietal Characteristics and Technology Adoption: A rainfed rice village in orissa. *Economic and political weekly.*
- Loomis, J.B. 1987. Expanding contingent value sample estimates to aggregate benefit estimates: Current practices and proposed solutions. *Land Econ.* 63(4): 396-402.
- Mackill, D.J, A.M. Ismail, A.M. Pamplona, D.L. Sanchez, J.J. Carandang, and E.M. Septiningsih. 2010. Stress tolerant rice varieties for adaptation to a changing climate. *Crop, Envir. Bioinform.* 7: 250-259.
- Manikmas, M.O.A., R.S. Soeganda, A. Heirmansyah, Widyantoro, and Supartopo. 2009. Economic costs of flooding and farmers' coping mechanisms in rice farming communities in Indonesia: Implementation plans to disseminate submergence tolerant rice varieties and associated new production practices to southeast Asia (IRRI-JAPAN No. DPPC2007-22).
- Manzanilla, D.O., T.R. Paris, G.V. Vergara, A.M. Ismail, S. Pandey, R.V. Labios, G.T. Tatlonghari, R.D. Acda, T.T.N. Chi, K. Duoangsil, Siliphouthone, M.O.A. Manikmas, and D.J. Mackill. 2011. Submergence risks and farmers' preferences: Implications for breeding Sub1 rice in Southeast Asia. *Agric. Syst.* 104(4): 335-347.
- Mariano, M.J., R. Villano, and E. Fleming. 2012. Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines. *Agric. Syst.* 110: 41-53.

- Master, W.A., A. Williams, and M. Sidibe. 1996. *The Economic Impact of Agricultural Research: A Practical Guide*. Department of Agriculture Economics. Purdue University, West Lafayette, IN. 55 pp.
- Mitchell, R. and R. Carson. 1989. *Using Surveys to Value Public Goods. The Contingent Valuation Method*. Washington, DC: Resources for the Future.
- Munasinghe, M. 1992. Environmental economics and sustainable development, Paper presented at the UN Earth Summit, Rio de Janeiro, and reprinted by the World Bank, Washington D.C.
- N.B. Ideas. 2007. Southern Africa trust monitoring and evaluation baseline survey report. South Africa, April 2007.
- Ngoc Chi, T.T., D. Manzanilla, S. Pandey, T.T. Ngoc Mai, T. Quang Tuyen, L. Velasco, O. Velarde, N. Thi Lang, and R. Labios. 2011a. Characterizing flood events and its impacts on rice production in the Mekong Delta, Viet Nam. *Omonrice* 18: 149-156.
- Ngoc Chi, T.T., T.R. Paris, D.O. Manzanilla, G.T. Tatlonghari, R.V. Labios, T. Quang Tuyen, and N. Thi Lang. 2011b. Understanding farmers' preferences through the participatory varietal selection (PVS) in the flood-prone rice areas of the Mekong Delta, Viet Nam. *Omonrice* 18: 167-181.
- Septiningsih, E.M., A.M. Pamplona, D.L. Sanchez, C.N. Neeraja, G.V. Vergara, S. Heuer, A.M. Ismail, and D.J. Mackill. 2009. Development of submergence-tolerant rice cultivars: the Sub1 locus and beyond. *Ann. Bot.* 103(2): 151-160.
- Serres, J.B., T. Fukao, P. Ronald, A. Ismail, S. Heuer, and D. Mackill. 2010. Submergence Tolerant Rice: SUB1's journey from landrace to modern cultivar. *Rice* 3:138-147, DOI 10.1007/s12284-010-9048-5.
- Willing, R. 1976. Net benefit without apology. *Am. Econ. Rev.* 66: 589-97.
- Yoshida, K., J. Kinoshita, and M. Goda. 1997. Valuing the environmental benefits of farmland and forests by the contingent valuation method. *Quarterly J. Agric. Econ.* 51(1): 1-58.
- Yoshida, K. 1999. Contingent valuation approach to the environmental benefits from agriculture in the less favored areas. *Quarterly J. Agric. Econ.* 53(1): 45- 87.
- Zeigler, R.S. and D.W. Puckridge. 1995. Improving sustainable productivity in rice-based rainfed lowland systems of South and Southeast Asia. *Geo J.* 35(3): 307-324.