DETERMINANTS OF TECHNOLOGY ADOPTION: THE CASE OF DRYLAND FARMER IN LOMBOK

Determinasi Adopsi Teknologi: Kasus Petani Lahan Kering di Lombok

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ABSTRACT

Dryland farmers in Lombok underuse the water provided through deep well irrigation pump, far below the optimum level of wateruse. Question raised in this study is what are the determinants factors explaining wateruse level of dryland farmers in Lombok. Therefore, this study aims to identify such determinants factors and by knowing the factors, it can be a valuable consideration in motivating farmers to optimize their wateruse.

This study used a two-stage cluster sampling method: (1) to choose pumps by classifying a total of 168 pumps into 23 existing pump groups and (2) to select farmers from each selected pumps. The number of farmers interviewed is 323. To investigate the factors affecting the level of wateruse, linear multiple regression was used.

This study revealed that Adopters are significantly different to non-adopters in terms of age, farming experience, hours of extension attended, holding area, farm income, farmer income, household income and cropping intensity. Land status, the frequency of operator change, the access of respondents to part time jobs, migration status and dryland problems are significant at the five percent level or lower. Determinant factors which can be used to explain the phenomenon of under use of water are: price of water, proportion of cash-cost farm income, household income, and hours of attending extension training.

Implication of this study is that attempt to motivate farmers in optimizing wateruse can be more effective if we can reduce the water price or find the in-question product market which is provide more reasonable price.

Key words: technology, adoption, farmer, Lombok
Kata kunci: teknologi, adopsi, petani, Lombok

ABSTRAK

Penggunaan air irigasi pompa artesis oleh petani lahan kering di Pulau Lombok masih jauh dibawah tingkat penggunaan optimum. Masalah yang diangkat dalam kajian ini adalah apa saja yang menjadi faktor penentu didalam menjelaskan tingkat penggunaan air oleh petani lahan kering di Pulau Lombok. Karena itu, kajian ini bertujuan untuk mengidentifikasi faktor penentu yang dimaksud yang dengan memahaminya dapat diupayakan solusi untuk mendorong petani agar mengoptimumkan penggunaan air.

Kajian ini menggunakan sampel yang ditentukan dengan metoda cluster dua langkah: (1) untuk menentukan pompa dengan mengkalisifikasikan 168 pompa kedalam 23 group and (2) untuk memilih petani dari masing-masing skim dari pompa yang terpilih. Petani yang diwawancara 323 orang. Untuk memeriksa faktor penentu digunakan regresi berganda.

Study ini mengungkapkan bahwa adopter berbeda dengan non adopter dalam hal: umur, pengalaman bertani, penyuluhan, luas areal, pendapatan usahatani, pendapatan rumah tangga dan intensitas tanam. Faktor penentu adopsi teknologi meliputi: harga air, proporsi pendapatan, pendapatan rumah tangga, dan penyuluhan.

Implikasi dari penelitian ini adalah bahwa memotivasi petani agar mengoptimumkan penggunaan airnya dapat dilakukan dengan menekan harga air atau mengusahakan pasar produk yang dihasilkan petani lahan kering

INTRODUCTION

Raising rural income requires an improved agricultural technology to increase the earning capacity of agricultural land. Therefore, transferring such a technology to the rural people is considered as a highly favourable policy given the fact that land holdings of rural people is low, the average being 52 ares (Central Bureau of Statistics, 1998). On the other hand, increasing population in an agrarian economy can lead to the decline of the farmer-land ratio and thus per capita income, unless the impact of population growth can be counteracted by increasing the earning capacity of the land or by generating off farm jobs (Mellor, 1985). At the same time, the amount of agricultural land which is converted to non-agricultural purposes perpetually increases as a direct consequence of the development process (Johnson, 1994). Many plots of fertile land have been used for office buildings, roads,

and residential developments. In Indonesia, approximately 20,000 to 35,000 hectares of agricultural land is converted to non-agricultural purposes per year (Pakpahan, Sumaryanto and Waluyo, 1993).

Being aware of this, the Indonesian government has been attempting to encourage more intensive use of drylands by introducing pump irrigation. In 1990/91 the Indonesian government through the Groundwater Development Project (P2AT) has built some 14,376 units of ground water pumps in East Java and West Nusa Tenggara with the investment of about 123.78 trillion rupiahs, about US $ 61 billion (Pakpahan, Sumaryanto and Waluyo, 1993).

Technology of groundwater pump irrigation provides water for dryland farms to enable the farmers to plant their drylands more often, not only in the wet season but also in dry seasons. However, the dryland farmers in Lombok underuse the water, far below the optimum level of wateruse (Usman, 1998). Question raised in this study is what are the determinants factors explaining wateruse level of dryland farmers in Lombok.

Therefore, this study aims to identify such determinats factors and by knowing the factors, it can be a valuable consideration in motivating farmers to optimize their wateruse.

There are many studies available in this area, but it is vary rare running for dryland which is suspected to be spesific in term of the behaviour of farmers. Susilowati and Simatupang (1990) in studying the factors affecting farmers' considerations in adopting tractors for their paddy farms used cropping intensity, farm size, use of family labour, and tractor labour cost ratio as explanatory variables. They set a dichotomous dependent variable according to whether a farmer used a tractor or not.

METHODOLOGY

Data used in this paper was collected by Usman (1997) interviewing 323 Lombok dryland farmers who held land under a P2AT pump irrigation scheme. The pumps varied in terms of the year when they started operation, pump management status and district. Considering the nature of population, this study used a two-stage cluster sampling method. This method is more appropriate than a simple random sampling method, because the target population in this study varies and is widely dispersed geographically (Bouma, 1993 and Keller, Warrack,.and Bartel,.1992).

Table 1. Number of respondents who grew and harvested their crops in normal conditions by crop and season, Lombok dryland farms

Crops	Dry Season 1			Dry Season 2		
	Grew	Harvested		Grew	Harvested	
	(Farmers)	(Farmers)	(Per Cent)	(Farmers)	(Farmers)	(Per Cent)
Onions	71	47	66.20	55	39	70.91
Chillies	33	25	75.76	37	32	86.49
Corn	40	26	65.00	28	21	75.00
Mungbeans	48	27	56.25	60	36	60.00
Peanuts	47	36	76.60	24	21	87.50
Tobacco	22	20	90.91	19	19	100.00
Total	261	181	69.35	223	168	75.34

Source: Usman, 1997

RESULTS

The first part presents the characteristics of adopters and non-adopters as background to further discussion. The investigation then focuses on identifying the factors affecting the levels of wateruse for farmers who adopted pump irrigation.

Comparison Between Characteristics of Adopters and Non-Adopters

In this study, adopters are defined as farmers who used groundwater at least once during the year of this study; other farmers are called non-adopters. As shown in Tabel 1 , the majority of respondents (258 out of 323) used groundwater. Overall, adopters are significantly different to non-adopters, at the five percent level of significance or lower, in terms of age, farming experience, hours of extension attended, holding area, farm income, farmer income, household income and cropping intensity.

The number of hours of extension attended by adopters was almost seven times as great as that of non-adopters, on average. Extension attendance thus is very likely to have an association with technology adoption.

Tabel 2. Profile comparison between adopters and non-adopters (continuous data), Lombok dryland farms

Variables	Unit of Measurement	Mean		Coef. of Variation		Prob>T
		Adopter N=258	Non-Adopter N=65	Adopter	Non-Adopter	
Age[1]	Years	36.11	59.18	24.05	10.59	0.0001
Education	Years	3.71	3.29	106.44	47.94	0.4088
Farming experience[1]	Years	15.80	36.11	53.37	26.25	0.0001
Dependants	Persons	4.03	3.62	47.47	64.26	0.1323
Distance to farm	Minutes walk	11.00	8.98	94.43	93.36	0.1489
Hours of extension[1]	Hours	6.82	0.92	119.58	162.85	0.0001
Holding area[1]	Ares	80.33	28.95	62.32	44.94	0.0001
Total-cost income[1]	XRp1000/year	226.30	124.52	159.76	158.57	0.0295
Cash-cost income[1]	XRp1000/year	349.62	164.63	110.68	127.10	0.0002
Non-dryland income	XRp1000/year	58.12	67.54	236.68	178.93	0.5860
Off-farm income	XRp1000/year	65.74	56.99	200.21	197.58	0.5902
Household income[1]	XRp1000/year	510.51	142.15	71.64	20.46	0.0001
Cropping intensity[1]	Per cent	205.16	87.42	35.64	58.41	0.0001

[1]Significant at 5 per cent level or less
Source: Usman, 1997

Household income of adopters is more than three times higher than that of non-adopters (Tabel 2). Household income consists of dryland farm, non-dryland farm and off-farm incomes. Tabel 2 shows that dryland farm incomes of adopters (both total-cost and cash-cost incomes) are significantly higher than that of non-adopters, but non-dryland and off-farm incomes between these two parties being compared were insignificantly different. This indicates that dryland farm income is responsible for the significant difference between household incomes of adopters and non-adopters (Mubyarto, 1984).

As expected, cropping intensity of adopters is significantly higher than that of non-adopters. Non-adopters only grew seasonal crops once a year, in the wet season, while adopters grew more than once. Since adopters grew more than once per year and since cash-cost income is greater than zero each season (Table 2), this means that the higher the cropping intensity, the higher the dryland farm income and thus the household income.

Holding area of adopters is almost three times greater than that of non-adopters. This is perhaps because larger farmers are more dependent on their farms for income or food, and thus are more inclined to use water to run their farms more intensively. Categorical characteristics of respondents are presented in Tabel 3 .

Tabel 3 Profile comparison between adopters and non-adopters (cathegorical data), Lombok dryland farms

Variables	Number of Respondents		Percentage		Prob. > Chi-Square
	Adopters	Non-Adopters	Adopters	Non-Adopters	
Land status[1]					
Cash rent	39	0	100.00	0.00	0.0001
Non cash rent	12	45	21.05	78.95	
Own	207	20	91.19	8.81	
House condition					
Very simple	142	43	76.76	23.24	0.3460
Simple	40	10	80.00	20.00	
Half permanent	35	6	85.37	14.63	
Permanent	40	6	86.96	13.04	
Operator change[1]					
<2 times	241	0	100.00	0.00	0.0001
>1 times	17	65	20.73	79.27	
Previous job					
Agriculture	198	52	79.20	20.80	0.5750
Non-agriculture	60	13	82.19	17.81	
Part time job[1]					
Have	125	65	65.79	34.21	0.0001
Do not have	133	0	100.00	0.00	
Marriage freq					
Once	222	57	79.64	20.36	0.7810
Other	35	8	81.40	18.60	
Migration status[1]					
Migrant	113	0	100.00	0.00	0.0001
Native	145	64	69.05	30.95	
Ijon[*]					
Involved	39	10	79.59	20.41	0.9570
Not involved	219	55	79.93	20.07	
Dryland problems[1]					
Have	183	65	73.79	26.21	0.0001
Do not have	75	0	100.00	0.00	
P3AT					
Active	70	24	74.47	25.53	0.1200
Not active	188	41	72.87	63.08	

[*]Ijon refers to marketing practices in which a farmer sells his/her crop in advance, before harvesting or even before planting. [1]Significant at five per cent level or less. Source: Usman, 1997.

Chi-square values are computed for tests of the hypothesis of whether two classifications of a population of nominal data are statistically

independent. The first classification, adopter versus non-adopter, is presented as the table headings. The second classification, the characteristic variables, are presented in the first column.

Tabel 3 shows that land status, the frequency of operator change, the access of respondents to part time jobs, migration status and dryland problems are significant at the five percent level or lower. In other words, the statistical evidence indicates that there is a relationship between each of these variables and the adoption status of the farmers.

Determinant of Technology Adoption Model Specification

To investigate the factors affecting the level of wateruse, linear multiple regression was used. The level of wateruse was employed as an independent variable, while dependent variables are water price (Wprice), time lapse (Time), age (Age), education (Educ), farming experience (Fexpr), family size (Fsize), distance to farm (Distance), proportion of cash-cost farm income (Pfmri), farmers' household income (Income), duration of attending extension training (Longext), and the acreage of formed area (Lformed) as a proxy for planted area. To catch the variations which are due to the different crops and seasons, dummy variables were employed. Output price was not included as a variable because the prices of one crop are very different to that of the other crops, ranging for 5,750 rupiahs per kilogram for chillies to 40 rupiahs per kilogram for cassava, thus incomparable. Rather, it is considered to be more appropriate to judge the effect of the output prices by examining the values of the products. Using this approach, the crop with a higher price but lower tonnage becomes comparable to the crops with a lower price but higher tonnage. Therefore, farm income was included in the model to catch the signal of the effects of output prices.

Results and Discussion

The result of the regression is presented in Tabel 4. The table shows that the signs of all parameter estimates are consistent with *a priori* expectation except for the parameter estimate for dummy dryland problem (Ddprblm). The latter variable can be disregarded as this variable is insignificant. It seems that information used in Ddprblm is not detailed enough to explain the quantity of waterused by farmers. When farmers were asked concerning the problems of dryland farmings, it was apparent that

farmers reported that they face problems and hoped that they would be granted subsidies or the like. So, the difference between farmers who really faced a problem and those who did not is vague.

Tabel 4 Results of ordinary least square (OLS) regression using wateruse (kilolitres per hectare) as dependent variable, Lombok dryland farms

Variable	Anticipated Signs	Coefficient	Standard Error	P>T
Constant[1]	?	4261.8000	2226.3000	0.0563
Wprice[1]	-	-75.2400	20.7030	0.0003
Time	-	-95.0630	91.5380	0.2997
Age	?	-36.2340	47.3790	0.4449
Educ	+	1.3428	50.5660	0.9788
Fexpr	+	41.8890	43.2430	0.3333
Fsize	?	104.6900	154.6100	0.4987
Distance	-	-26.2140	63.9340	0.6820
Pfmri[1]	+	1465.6000	697.2900	0.0362
Income[2]	+	0.0020	0.0011	0.0768
Longext[1]	+	63.3710	26.8770	0.0189
Lformed	?	-5.4229	11.1690	0.6276
Dmigrant	+	510.8800	629.0700	0.4172
Dijon	_	-439.3900	1133.9000	0.6986
Dp3a	?	-884.3400	843.8500	0.2953
Dpprblm	-	-30.0560	753.8100	0.9682
Ddprblm	-	648.5200	562.6000	0.2497
Dcn	?	1476.7000	1338.5000	0.2706
Dpn	?	1478.7000	1276.0000	0.2472
Dmb	?	691.9400	1042.4000	0.5072
Dch[2]	?	2131.2000	1217.0000	0.0807
Don[1]	?	3046.5000	1236.1000	0.0141
Dscn	?	273.9100	987.7200	0.7817
Dspn	?	-916.3600	1042.5000	0.3799
Dsmb	?	-483.6200	775.9000	0.5334
Dsch[2]	?	2149.9000	1201.4000	0.0743
Dson1	?	2290.7000	765.9400	0.0030

R-squared = 0.4505; Durbin-Watson statistic = 1.1746

[1]Siginficant at five per cent level or less; 2Significant at ten per cent level

Tabel 4 shows that seven out of twenty six parameter estimates of variables are significant. They are: Price of water, proportion of cash-cost farm income, household income, hours of attending extension training, dummy chillies (Dch), dummy onions (Don) and dummy season for chillies (Dsch). The following discussion focuses on the significant variables above.

Price of Water. This variable has a negative sign and is very significant. From an economic point of view, the price of an input (water) is a key factor influencing farmers in using water. This is consistent with the theory of demand for factor inputs discussed in the Theoretical Framework.

To assess the effects of this variable on wateruse, elasticity of wateruse on the price of water was calculated. Given the sample mean of the price of water (=27.61 rupiahs per kilolitre) and the sample mean of wateruse (=5,898 kilolitres per hectare per season), the elasticity can be calculated. The result is -0.3522. This suggests that decreasing the price of water by 1 per cent will encourage farmers to increase their wateruse by 0.35 per cent. The demand for water is relatively price inelastic.

Income and Formed Area. Both household and cash-cost incomes of farmers have a positive relationship to wateruse, the higher the income, the larger the amount of water that farmers use. This is understandable because a farmer with a higher income is able to pay more for water. The amount of money allocated for water by farmers with a higher income tends to be proportionally higher than that of those with lower income. The same explanation is true for cash-cost farm income.

The negative sign of formed land area perhaps supports the argument above, that is income influences the level of wateruse. Although the variable of formed land area is insignificant, the negative sign of its parameter suggests that the larger the area of formed land, the lower the amount of water that farmers use per hectare. This is because a larger planted area requires a larger amount of wateruse for the total planted area, thus requires a higher income. According to rural sociology, when low-income farmers earn more money, they tend to increase their expenses for their daily needs, so the remainder of their income which is normally used for financing farm, is approximately the same as those who earn less money. If this is the case, than the implication is that farmers with larger planted area tend to use less water per hectare.

Duration of Attending Extension. As expected, hours of attending extension training has a significant and positive effect on the amount of wateruse by farmers. Given the sample mean of hours of farmers attending extension training of 6.7378 hours, the elasticity of wateruse on the hours of attending extension training calculated at 0.0724. This means that increasing the number of hours to attend extension training by 10 per cent implies increasing wateruse by 0.7 per cent.

Dummy Variables and Time Lapse. Tabel 1 0 implies that wateruse by farmers for onions is different to that for the other crops. The same is true for chillies. As discussed in Chapter Six, the farmers used more water for their onions and chillies farms.

The significance and positive-sign of dummy season for chillies suggest that the amount of water that farmers used for this crop in the Dry Season 1 is larger than that in the Dry Season 2. It is hard to explain because farmers tend to use more water in the season when they expect the price of chillies to be more expensive. It seems that in the Dry Season 1, the farmers expected the price of chillies to increase as a result of advice by itinerant traders.

With regard to the insignificant effect of time lapse in explaining the level of wateruse by farmers, it can possibly be explained as follows. Once farmers decide to use water, they intend to satisfy the water requirement of their crops. Whether the farmers has used the water for years, it does not change the water requirement of the crops. The longer experience in using water may serve as a valuable lesson for the farmers, so they are provided with a better understanding about the amount of water they should use in accordance with the crops they grow and with the types of land.

CONCLUSION

Adopters are significantly different to non-adopters, in terms of age, farming experience, hours of extension attended, holding area, farm income, farmer income, household income and cropping intensity. Besides, land status, the frequency of operator change, the access of respondents to part time jobs, migration status and dryland problems are significantly different between adopters and non-adopters.

Determinant factors which can be used to explain the phenomenon of under use of water are seven out of twenty six parameter estimates of

variables. They are: price of water, proportion of cash-cost farm income, household income, hours of attending extension training, dummy chillies (Dch), dummy onions (Don) and dummy season for chillies (Dsch).

Implication of this study is that attempt to motivate famers in optimizing wateruse can be more effective if we can reduce the water price or find the in-question product market which provides more reasonable price.

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