A STUDY OF FARM-LEVEL INPUT DEMANDS WITHOUT SEED SELECTIVITY ADJUSTMENT ON RICE FARMS IN THE CIMANUK RIVER BASIN, JAWA BARAT

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Abstract

This paper is an attempt to analyze how a rice farmer responds to economic stimulus through allocating his resources reflected in elasticities of input demands. Specifically, in the model seed selectivity adjustment is not taken into account, that is, modern and traditional variety farmer elasticities are separately computed and then compared. The sample farmers were drawn from six *desas* in the area of the Cimanuk River Basin, Jawa Barat, which has been and still is currently dominated by rice farming. The results show that the own-price elasticities of demand for nitrogen fertilizer of TV (traditional variety) farmers are higher than that of MV (modern variety) farmers. These elasticities tend to decline over time.

Introduction

Since the introduction of the BIMAS program launched in the early 1960s and until the period of the late 1970s, research on farm-level response to economic environment in Indonesia is very scarce, even though this type of research is very important because it can provide information needed for formulating agricultural economic policy. Particularly, we sure would like to know how farmers behave to the "new green-revolution" technology that swept most of South and Southeast Asia which is reflected in elasticities of demand.

This study is one of an attempt in that direction conducted in the rice-dominant areas of six *desas* of Jawa Barat from two separate periods of surveys of 1977 and of 1983. This paper is planned as follows. Section 2 introduces the methodology and Section 3 summarizes the model of estimation. Finally, Section 4 provides the results and discussion.

Methodology

The data for the study were collected by Survey Agro Economy (SAE) located in Bogor, Jawa Barat. They were part of the Rural Dynamic Study in the paddy production area of the Cimanuk River Basin, Jawa Barat.

The locations of the survey are characterized by dominant rice farms implying having a good water supply and almost identical agroclimatic environment. In 1977, the survey was conducted twice, that is, at the beginning and at the end of the year. The first survey associated with farming practice covering the rainy (wet)

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season of 1975/1976 and the dry season of 1976. The second survey covered data specifically on household activities in the rainy season of 1976/1977. In 1978, the visit to the survey area was done to cover farm management activities at the dry season of 1977. However, this study did not use the data of the first survey due to insufficient information on farm-level input use.

To make comparison of elasticities of input demand possible, the resurvey to the same area and the same farmers was conducted in 1983. Not surprisingly, during the five-year period there are tremendous changes prevailing in labor allocations, sources of labors, land and asset holding, land tenure arrangements. At any rate, some data from the survey could still be secured for the study.

Sample farmers were drawn from six desas by multi-stage stratified random sampling from the upper level of **kecamatans** in such manner that those desas should come from six different kecamatans. And these kecamatans were picked randomly from five **kabupatens** (see Hutabarat, 1985). From each desa, 60 farmers were selected as respondents representing all farmers in the desa community (Table 1).

Table 1. Number of rice farms and percentage of irrigated sawah in the area selected for the survey by residency.

Residency	Wet season			Dry season			Percentage of irrigated sawah in the desa
	1976	1977	1983	1976	1977	1983	
1. Wargabinangun[a], Gegesik[b], Cirebon[c]	60	60	52	60	60	52	90
2. Lanjan, Lohbener, Indramayu	60	59	53	60	60	53	40
3. Gunungwangi, Argapura, Majalengka	60	60	50	60	60	50	96
4. Malausma, Bantarujeg, Majalengka	60	60	55	60	59	55	33
5. Sukaambit, Situraja, Sumedang	60	60	49	60	60	49	71
6. Ciwangi, Blubur Limbangan, Garut	60	61	53	60	59	53	96
Total	360	360	312	360	358	312	—

[a]Desa.
[b]Kecamatan.
[c]Kabupaten.

The variables to the interest of the study are classified as follows: (1) observation on gross paddy yield (kg); (2) total expenditure for harvesting yield (kg); (3) net paddy yield (kg); (4) value of net paddy yield (Rp); (5) hectareage of land operated by farmer household (ha); (6) amounts of seed applied (kg) and its value (Rp); (7) amounts (kg) and values (Rp) of nitrogen fertilizer applied; (8) value of pesticide (Rp); (9) total value of production inputs (Rp); (10) seed type dummy, 1 for MV (modern variety) or HYV (high yielding variety) and O for TV (traditional variety) or LV (local variety); (11) man, woman, and animal labor input used in production process either from family or hired.

Model

The study employed the translog cost function below (see Hutabarat, 1985),

$$\ln C = a_o + \sum_{i=1}^{m} a_{oi} \ln P_i + a_y \ln Y + \sum_{k}^{r} b_{ok} \ln Z_k$$

$$+ 1/2 \sum_{i}^{m} \sum_{j}^{n} a_{ij} \ln P_i \ln P_j + \sum_{i}^{m} a_{iy} \ln P_i \ln Y + 1/2\, a_{yy} (\ln Y)^2$$

$$+ \sum_{i}^{m} \sum_{k}^{r} b_{ik} \ln P_i \ln Z_k + 1/2 \sum_{k}^{r} \sum_{l}^{s} d_{ki} \ln Z_k \ln Z_i$$

$$+ \sum_{k}^{r} d_{ky} \ln Z_k \ln Y$$

where C is variable cost, P is a vector of variable input prices, Z is a vector of fixed inputs, and Y is the output level. This cost function must satisfy the following restrictions:

1. **Symmetry:** (a) $a_{ij} = a_{ji}$,
   (b) $a_{iy} = a_{yi}$, and
   (c) $d_{ki} = d_{ik}$ (2a)

2. **Homogeneity:**

(a) $\sum_{i}^{m} a_{oi} = \sum_{k}^{r} b_{ok} = 1$, and

(b) $\sum_{j}^{m} a_{ij} = \sum_{i}^{m} a_{iy} = \sum_{i}^{m} b_{ik} = \sum_{k=1}^{r} d_{ki} = \sum_{k}^{r} b_{ik} = \sum_{k}^{r} d_{ky} = 0$ (2b)

By employing Shephard's lemma, a specification for factor shares (S_i) can be obtained as follows:

$$S_i = \frac{\ln C}{\ln P_i} = a_i + \sum_{j}^{n} a_{ij} \ln P_j + a_{iy} \ln Y + \sum_{k}^{r} b_{ik} \ln Z_k \qquad (3)$$

where S_i is the ratio of variable expenditure for the i-th input with farm production expenses. Therefore, elasticities of demand for inputs can be estimated from the estimation of parameters in equation (3). The estimation technique was done by the seemingly unrelated multivariate regression technique developed by Zellner (1962) in order to utilize as much information as is available. Specifically, knowing that input share function is derived by taking partial derivative of total cost function with respect to price of particular input, there is a very high probability that the disturbances from each of the total cost and input share equations are to be correlated because errors in cost minimization which result in overstating on input share will symmetrically affect other input shares. Therefore, greater efficiency in estimation can be achieved by this technique. In addition, iteration of the Zellner's estimation procedure will converge the results into maximum likelihood estimates.

Results and Discussion

The results of the estimation are presented in Tables 2 and 3. Note, however, that the estimates for the total cost function are not included due to the fact that by applying Shephard's lemma, everything there is to know about the total cost function is already captured in input share equations.

Estimates on Table 2 are the results from 1977 data and estimates on Table 3 are the results from 1983 data. Incidentally, upper halves of Tables 2 and 3 show estimates for TVs and bottom halves are the results for MV of 1977 and 1983, respectively.

Turning first to the upper half of Table 2, it shows that only 2 out of 12 coefficients are statistically significant on seed share equations, and 3 in nitrogen and 1 in human labor share equations, respectively. On the bottom half of Table 2, we see that 5 out of 12 coefficients are statistically significant on each seed and nitrogen share functions, and 4 in human labor share. For 1983, Table 3 exhibits that 4 out of 12 coefficients are statistically significant on seed share equations, 8 in each nitrogen fertilizer and human labor share functions. The lower half of Table 3 reports that 5 out of 12 coefficients are significant on seed share equations, 6 and 7 on nitrogen and human labor share equations, respectively.

Table 2. Estimated coefficients of input share equations for TVs and MVs without adjustment for seed selectivity bias, 1977.

Equations Exogenous Variables[a]	Share of seed		Share of nitrogen		Share of human labor	
	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]
			TV Farmers Group			
Intercept	0.0658	1.8565*	0.1601	2.6089***	0.7513	9.4107***
D(.)[d]	0.0480	0.9400	-0.0359	-0.4032	-0.0287	-0.2550
$LnPM_{sa}$	-0.0555	-1.4434	0.0314	0.7979	-0.0356	-1.0273
D(.)	0.0954	2.1146**	-0.0332	-0.6962	0.0042	0.1167
$LnPM_{nfa}$	0.0314	0.7979	0.0486	0.6735	-0.0387	-0.5807
D(.)	-0.0332	-0.6852	-0.0716	-0.8546	-0.0199	-0.2857
$LnPM_{hla}$	-0.0356	-1.0273	-0.0387	-0.5807	0.0926	1.0723
D(.)	0.0042	0.1167	-0.0199	-0.2857	0.0604	0.6770
LnY	-0.0055	-0.9942	0.0211	2.1212**	-0.0139	-1.0861
D(.)	-0.0033	-0.4256	-0.0173	-1.2472	0.0132	0.7397
LHMIP	0.0050	1.2548	-0.0078	-1.1114	0.0089	0.9743
D(.)	-0.0004	-0.0923	0.0181	2.1191**	-0.0088	-0.7946
			MV Farmers Group			
Intercept	0.0354	1.4239	0.2153	3.0883***	0.6721	8.6304***
D(.)[d]	0.0331	0.8793	0.0219	0.1991	-0.0064	-0.0556
$LnPM_{sa}$	0.0424	3.2395***	-0.0351	-2.1571**	-0.0416	-2.1786**
D(.)	-0.0072	-0.3768	-0.0003	-0.0112	0.0418	1.4626
$LnPM_{nfa}$	-0.0351	-2.1571**	0.0979	1.8466*	-0.0566	-1.0344
D(.)	-0.0003	-0.0112	-0.0782	-0.7721	0.0359	0.3983
$LnPM_{hla}$	-0.0416	-2.1786**	-0.0566	-1.0344	0.1187	1.8397*
D(.)	0.0418	1.4626	0.0359	0.3983	-0.0896	-0.9172
LnY	0.0004	0.1084	0.0151	1.3781	-0.0044	-0.3607
D(.)	-0.0016	-0.3328	-0.0270	-1.7942*	0.0118	0.7069
LHMIP	0.0065	3.6844***	0.0019	0.3526	-0.0044	-0.7267
D(.)	-0.0055	-2.2730**	-0.0125	-1.6456*	0.0173	2.0649**

[a]Complete description of variables is available upon request.

[b]Coefficients.

[c]Asymptotic t-ratios.

[d]D(.) represents D*Variable right above it, where D = 1 for rainy season and D = 0 for dry season.

*Significant at $\alpha_{0.10} = 1.645$.

**Significant at $\alpha_{0.05} = 1.960$.

***Significant at $\alpha_{0.01} = 2.576$.

However, those coefficients cannot themselves show directly the sign and magnitude of the input elasticity of demand we are concerned with. These elasticities must be derived from mathematical combinations of the coefficients and the value of input shares[1]. These derived elasticities appear in Tables 4 to 7 for each data set.

Table 3. Estimated coefficients of input share equations for TVs and MVs without adjustment for seed selectivity bias, 1983.

Equations / Exogenous Variables[a]	Share of seed		Share of nitrogen		Share of human labor	
	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]
			TV Farmers Group			
Intercept	0.0575	4.1079***	0.1731	4.3318***	0.8597	14.0460***
D(.)[d]	-0.0316	-1.5925	-0.1149	-2.0147**	-0.0479	-0.5298
$LnPM_{sa}$	0.0057	1.0433	0.0150	2.1881**	-0.0184	-4.7138***
D(.)	0.0016	0.2129	0.0055	0.6051	-0.0148	-2.9536***
$LnPM_{nfa}$	0.0150	2.1881**	0.0884	5.2374***	-0.0596	-5.2803***
D(.)	0.0055	0.6051	0.0033	0.1549	-0.0622	-4.3074***
$LnPM_{hla}$	-0.0184	-4.7138***	-0.0596	-5.2803***	0.0950	4.9907***
D(.)	-0.0148	-2.9536***	-0.0622	-4.3074***	0.0702	2.9528***
LnY	-0.0008	-0.5079	0.0110	2.2362**	-0.0127	-1.5855
D(.)	0.0027	1.0604	0.0048	0.6400	0.0004	0.0293
LHMIP	-0.0005	-0.5509	-0.0077	-0.30801***	0.0192	4.6359***
D(.)	-0.0000	0.0324	-0.0004	-0.1090	-0.0085	-1.5848
			MV Farmers Group			
Intercept	0.0358	1.4661	0.0658	1.5390	0.8701	16.3320***
D(.)[d]	-0.0230	-0.6052	0.1445	2.1952**	-0.1352	-1.5877
$LnPM_{sa}$	0.0810	10.4460***	0.0102	1.0322	-0.0637	-5.7339***
D(.)	-0.0209	-2.0903**	0.0046	0.3510	0.0059	0.3795
$LnPM_{nfa}$	0.0102	1.0322	0.0807	3.3937***	-0.1231	-6.4620***
D(.)	0.0046	0.3510	0.0225	0.6448	0.0218	0.7501
$LnPM_{hla}$	-0.0637	-5.7339***	-0.1231	-6.4620***	0.2047	6.8137***
D(.)	0.0059	0.3795	0.0218	0.7501	-0.0354	-0.8021
LnY	0.0078	2.6238***	0.0137	2.9747***	-0.0247	-3.6881***
D(.)	0.0004	0.0847	-0.0146	-1.9902**	0.0207	1.9209*
LHMIP	-0.0031	-2.9606***	-0.0045	-2.7745***	0.0073	3.1296***
D(.)	-0.0003	-0.2020	-0.0023	-0.9384	-0.0026	-0.7442

The most obvious feature observed in those tables is that most of the own-price elasticities of demand have correct negative signs on all data sets except on demand for seed and human labor on MV group of dry season 1983 which have positive signs. Also, the elasticity of animal labor wage on animal labor demand function in this data set is positive. The same thing also seems to be true in rainy season data 1983. Moreover, these elasticities also show a tendency to decline, when we compare data sets of 1977 and 1983 in the same season. This phenomenon might be resulted from the fact that over time, farmers also learn their perceived distribution of technical parameters and gather more and more information about adoption. This is illustrated by the data where more farmers are using MVs from 30.16 (35.79) percent of the farmer samples in rainy (dry) season 1977 to 55.08 (57.60) percent in rainy (dry) season 1983.

Table 4. Estimated elasticities of input demands evaluated at sample means, rainy and dry season 1977.

Exogenous Variables		Demand for: Seed	Nitrogen	Human Labor	Animal Labor
		Rainy season			
Seed price	TV	-0.20	0.02	-0.53	-0.07
	MV	-0.36	-0.52	0.06	0.06
Nitrogen price	TV	0.23	-0.86	-0.02	0.59
	MV	0.13	-0.66	0.19	0.19
Wage rates					
Human labor	TV	0.56	0.52	-0.14	0.51
	MV	0.66	0.63	-0.30	0.65
Animal labor	TV	1.38	0.95	-4.65	-1.04
	MV	0.01	2.45	-0.56	-2.84
Output level	TV	-2.00	-1.82	-1.83	-1.92
	MV	-4.16	-4.19	-4.17	-2.18
Landholding	TV	6.81	6.77	6.73	6.58
	MV	6.91	6.86	6.92	6.67
Insecticide or Pesticide expense	TV	6.64	6.68	6.73	6.88
	MV	6.88	6.94	6.88	7.12
		Dry season			
Seed price	TV	-1.48	0.42	-0.26	0.72
	MV	-0.43	-0.32	-0.39	0.48
Nitrogen price	TV	0.37	-0.56	0.08	0.07
	MV	0.17	-0.37	0.09	0.27
Wage rates					
Human labor	TV	0.57	0.57	-0.22	0.60
	MV	0.53	0.50	-0.20	0.56
Animal labor	TV	1.95	-1.30	-0.56	-0.97
	MV	1.22	-0.19	-0.68	-1.24
Output level	TV	-1.86	-1.71	-1.82	-1.86
	MV	-2.38	-2.12	-1.83	-2.78
Landholding	TV	6.05	5.97	5.98	5.81
	MV	6.74	6.67	6.66	6.52
Insecticide or Pesticide expense	TV	5.95	6.03	6.02	6.20
	MV	6.59	6.66	6.67	6.80

Table 5. Estimated elasticities of input demands evaluated at sample means, rainy and dry season 1983.

Exogenous Variables		Demand for Seed	Nitrogen	Human Labor	Animal Labor
Rainy season					
Seed price	TV	-0.77	0.57	-0.83	0.18
	MV	-0.01	0.29	-0.83	2.07
Nitrogen price	TV	0.21	-0.23	-0.68	0.21
	MV	0.25	-0.17	-0.51	0.01
Wage rates					
Human labor	TV	0.71	0.59	-0.03	0.74
	MV	0.65	0.59	-0.04	0.74
Animal labor	TV	0.15	0.22	-0.11	1.23
	MV	-0.25	-0.25	-0.13	-0.15
Output level	TV	-2.30	-2.24	-2.36	-2.44
	MV	-3.16	-3.30	-3.30	-3.35
Landholding	TV	6.81	6.28	6.82	6.77
	MV	8.18	8.19	8.24	8.34
Insecticide or Pesticide expense	TV	6.81	7.33	6.79	6.84
	MV	8.29	8.28	8.23	8.14
Dry season					
Seed price	TV	-0.82	0.39	-0.39	-0.48
	MV	0.20	0.21	-0.82	0.01
Nitrogen price	TV	0.25	-0.26	-0.25	-0.14
	MV	0.23	-0.35	-0.56	0.31
Wage rates					
Human labor	TV	0.75	0.69	-0.11	0.75
	MV	0.63	0.55	0.00	0.70
Animal labor	TV	-0.03	-1.16	-0.43	0.76
	MV	-0.62	0.82	-0.39	-0.64
Output level	TV	-2.14	-2.05	-2.13	-2.05
	MV	-2.65	-2.68	-2.79	-2.68
Landholding	TV	6.43	5.93	6.47	6.14
	MV	7.58	7.60	7.63	7.70
Insecticide or Pesticide expense	TV	6.46	6.98	6.42	6.75
	MV	7.67	7.65	7.61	7.55

For the data sets of 1977 and 1983, own-price elasticities of demand for seed are -0.20 (-0.36) and -0.77 (-0.01) for TV (MV) group of rainy season data and -1.48 (-0.43) and -0.82 (0.20) for TV (MV) group of dry season data. It appears that the absolute elasticities of dry season are higher than that of the rainy season data which somewhat suggests that the farmers are more responsive to price change of seed during the dry season. Comparison of elasticities between groups, TV and MV farmers are quite mixed. In 1977 rainy season data the absolute elasticity of demand for seed by TV group is less than that of by MV group but for dry season data it is the reverse. So it appears that a 1 percent increase in seed price, ceteris paribus, will cause a reduction in demand for seed by 0.20 (0.36) and 0.77 (0.01) percent during rainy season of 1977 (1983). And for dry season of 1977 and increase in seed price by 1 percent, other things remaining the same, will cause 1.48 (0.43) percent reduction in demand for seed by TV (MV) group. However, for dry season of 1983, an increase in seed price by 1 percent, keeping everything constant, there will be a decrease in demand for seed by TV group by -0.82 percent and an increase by MV group by 0.20 percent.

Comparing to Sumodiningrat's (1982) study, this result has a wider range assuming that positive elasticities such as 0.20 percent are ruled out. He found on his data set of rice farmers in Jawa-Bali in the period of 1979-80 that seed price elasticities of demand was -0.14 (-0.58) for TV (MV) rice farmers group.

Regarding the own-price elasticities of demand for nitrogen fertilizer, surprisingly enough, TV farmers group have a higher value in all data set except in dry season of 1983. The values are -0.86 (-0.66) and -0.23 (-0.17) for rainy season data of 1977 and 1983 of TV (MV) group and -0.56 (-0.37) and -0.26 (-0.35) for dry season data of 1977 and 1983 of TV (MV) group. This says, then, that in rainy season data of 1977 and 1983, a 1 percent increase in nitrogen fertilizer price will tend to decrease demand for fertilizer by 0.86 (0.66) percent and 0.23 (0.17) percent in TV (MV) group, given that everything else remains the same. It then suggests that traditional variety rice farmers are relatively more sensitive to change in fertilizer price than modern variety rice farmers. This might be true if we assume on one hand, that most MV farmers were members of BIMAS program and on the other hand, that most TV farmers were not. Hence, while MV farmers could only attain their fertilizer need through BIMAS package, TV farmers could only acquire the fertilizer from the local market. Based on Philippines data in 1975, Barker and Anden (1975) found that the fertilizer demand elasticity was about -0.50 and Pitt[2], in his study of the 1973 agricultural census data, found elasticity was -0.50 in Jawa rice farmers. Sumodiningrat's result was -0.47 (-0.42) for TV (MV) rice farmers group.

With respect to the own-price elasticity of demand for human labor, TV farmers have no different elasticities with that of MV farmers group which is in the neighborhood of -0.30 to 0.00. In contrast with the demand for animal labor, the absolute own-price elasticities are higher in MV group for data of 1977. The opposite is true for data 1983, where the own-price elasticities of labor of TV farmer group is higher than that of MV group. Note that, the elasticities are positive for TV group and negative for MV group. These result are quite different with Sumodiningrat's results. He found that TV rice farmers had a higher animal labor elasticity of demand than MV group. One conjecture that there seems to be true on 1977 data is that MV farmers do not rely much on animal labor for certain farm chores as opposed to TV farmers. Hence, any percentage change in animal wage rate will induce MV farmers to make more percentage change in demand for animal labor.

Tables 4 to 7 also show that for any percentage increase in output level, ceteris paribus, there will be a decline in demand for all inputs in all data sets. It appears that the absolute value of elasticities are always higher in the MV group than the TV group. Furthermore, regarding the elasticities with respect to landholding, it also appears that the values of for the MV group are always higher than the TV group.

In Tables 4 to 7, it can also be observed the estimates of the cross-price elasticities among input, that is, a percentage change in demand for particular input due to a percentage change in other input prices and the degree of substitutability, is measured by the coefficient of elasticities of substitution[3] (These elasticities are available upon request). The signs of cross-price elasticities are mixed, either within a particular data set or among particular data sets. However, four remarks can be summarized from the tables that: 1) signs of cross-price elasticities of demand for seed with respect to nitrogen fertilizer price or wage rate of human labor are always positive which appears to be suggesting that for any price increase in fertilizer price or wage rate, everything else is equal, there will be an increase in demand for seed, 2) cross-price elasticities of demand for nitrogen fertilizer with respect to wage rate of human labor are always positive, 3) cross-price elasticities of demand for human labor with respect to animal labor are always negative, and 4) cross-price elasticities of demand for animal labor with respect to human labor are always positive. This is a bit puzzling. It appears to be indicating, on one hand, a direction of complementary rather than substitutability of human labor and animal labor. In this sense, it confirms the hypothesis that human labor and animal labor each performs specialized and diverse activities that cannot be interchanged. On the other hand, for an increase in wage rate of human labor there will be an increase in demand for animal labor.

Conclusions

For the data sets of 1977 and 1983, own-price elasticities of demand for seed are -0.20 (-0.36) and -0.77 (-0.01) for TV (MV) group of rainy season data and -1.48 (-0.43) and -0.82 (0.20) for TV (MV) group of dry season data. It appears that the absolut elasticities of dry season data are higher than corresponding elasticities of rainy season data.

The own-price elasticities of demand for nitrogen fertilizer for TV group in rainy season of 1977 and of 1983 are higher than that of MV group. This is also shown by data set of dry season 1977 but not by data set of dry season 1983. The values for rainy season 1977 and 1983 are -0.86 (-0.66) and -0.23 (-0.17) for TV (MV), respectively. For dry season 1977 the values are -0.56 and -0.37 for TV and MV, respectively. It then suggests that traditional variety rice farmers are relatively more sensitive to change in fertilizer price than modern variety rice farmers.

With respect to the own-price elasticity of demand for human labor, TV farmers have no different elasticities with the corresponding elasticities of MV farmers which is in the neighborhood of -0.30 to 0.00. This is contrary to the absolute own-price elasticities of demand for animal labor. For data of 1977 (rainy and dry season), MV farmer group's are higher than that of TV farmers group's. The values are -1.04 (-0.97) and -2.84 (-1.24) for TV and MV group of rainy (dry) season, respectively. The opposite is true for data set of 1983, where the own-price elasticities of labor of TV farmer group is higher than that of MV group. In addition, the elasticities are positive for TV group and negative for MV group. One conjecture for this case seems to be that MV farmers do not rely much on animal labor for certain farm chores as opposed to TV farmers. Hence, any percentage change in animal wage rate will induce MV farmers to make more percentage change in demand for animal labor. This phenomenon might not happen for TV group.

Observation upon and comparison of all elasticities of 1977 data and of 1983 data seems to show that there is a tendency that absolute values are declining. This proposition might be resulted from the fact that over time, farmers also learn their perceived distribution of technical parameters and gather more and more information about adoption. This will then influence their respons to the prices and application of inputs.

Notes

1. The own-price (ϵ_{ii}) and cross-price elasticities (ϵ_{ij}) of demand are calculated through,

$$\epsilon_{ii} = S_{ii} - 1 + \frac{a_{ii}}{S_i}$$

$$\epsilon_{ij} = S_j + \frac{a_{ij}}{S_j}$$

where S and a are share value of an input and a coefficient from the estimation, respectively.

2. See Sumodiningrat (1982).
3. Elasticities of substitution are derived from the relationship as follows:
   a) own-elasticity of substitution

$$\delta_{ii} = 1 - \frac{1}{S_i} + \frac{a_{ii}}{S_i S_i}$$

   b) cross-elasticity of substitution

$$\delta_{ij} = 1 + \frac{a_{ij}}{S_j S_j}$$

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