Farm-level Assessment of Rice Direct-Seeding Practices in Chonbuk Province

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ABSTRACT: The technology of direct-seeding in rice cultivation is an innovation mainly induced by factors in market economy and is rapidly diffused among individual farmhouses. Because the effect of technology can be affected by many factors under various farming circumstances, the impact and stability of the direct-seeding technology compared with transplanting was analyzed under various topographical regions. Yield in direct-seeding was higher in plains, although the farm size producing higher yield was quite different depending on the topographical regions. In the direct-seeding cultivation of rice, man-labor hours was reduced by about 38 percent and the reduction rate showed little difference among topographical regions. Fertilizer was used about 11 percent more but the increase rate varied from 3 to 17 percent depending on regions with higher rates in plains. Application of agricultural chemicals was also increased about 9 percent in direct-seeding, but the increase rate was as high as 12 percent in suburbs. More fertilizer and agricultural chemicals were used in direct-seeding cultivation by farmhouses implementing both direct-seeding and transplanting than by those implementing direct-seeding only. Use of more fertilizers and agricultural chemicals in direct-seeding in all regions may indicate its technical instability. Major problems causing the technical instability of direct-seeding cultivation should be solved by comprehensive research considering various farming circumstances such as topographical features rather than just a top-down style research and extension.

***Keywords*:** rice cultivation, technology assessment, direct seeding of rice

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). Sustainable agriculture in the future will provide economic and social opportunities for the benefits of present and future generations, while maintaining and enhancing the quality of the environment and the resource bases that support production.

The transition to sustainable growth in agricultural production will take place within the context of a transition to a stable population and a possible transition to a stable level of material consumption (NRC, 1991; Ruttan, 1994, 1995). Agricultural systems in transition recognize that farming systems have always been changing and it is this capacity to respond to and to capture market, technology, environments, and other opportunities that will ensure sustainable farming systems in the future. There are a number of technical and institutional innovations in agriculture, that could have both economic and environmental benefits. Futhermore, the design of technologies and institutions to achieve more efficient management of resources and environmentally compatible farming system will become important.

Korean agriculture has changed the pattern of its cultivation from resource-based agriculture to technology-based one through out the last three decades. At the beginning of agricultural development in 1960s, land was scarce and labor was plentiful, so that a dominant factor in Korean agriculture can only be understood as reflecting this land constraint endowment. In order to overcome this resources constraints in 1970s, technology of the high yielding varieties (HYVs) so called Tong-il was developed so as to raise land productivity and rate of self-sufficiency for food.

The technology of direct-seeding (TDS) in paddy rice cultivation, which has rapidly diffused among individual farmers in recent years, may be the similar scale-neutral technology as Tong-il type HYVs (Park *et al.*, 1995; Park and Kang, 1994; Park and Suh, 1994). It may be said that the TDS has been designed to solve the problem that results from the bottlenecks of labor shortage and high labor cost. It is also assumed that the TDS may be the technological innovation that is induced by changes in factor endowments in the market economy while Tong-il type HYVs may be the technological development that is led by the government's initiative to attain self-sufficiency of staple food.

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However, nowadays our concerns are focused on the impact of agricultural production technologies that will be employed in those areas that have made the most progress in moving toward highly intensive systems of agricultural production. These include loss of soil resources due to erosion, waterlogging, and salinization; groundwater contamination from plant nutrients and pesticides; and growing resistance of insects, weeds, and pathogens.

In this connection, the main objectives of this study are to analyze rice direct-seeding technology for improving farm management efficiency and to compare between direct-seeding and transplanting cultivation from the viewpoint of low input sustainable agriculture (LISA).

MATERIALS AND METHODS

The data used in this study came from farm survey on the inputs of direct-seeding and transplanting cultivation. The data were collected by personal interview using a questionnaire from 51 farmhouses implementing both cultivation technologies in Chonbuk province : Puan 13, Chongup 12, Iksan 7, and Kimje 19. Surveyed farmhouses were sorted into suburb, middle, and plain regions, respectively, based on their topographical locations. The number of surveyed farmhouses in suburbs, middles, and plains were 7, 17, and 27, respectively.

RESULTS AND DISCUSSION

Regional characteristics, farming scale and direct-seeding cultivation

The percentage of direct-seeding farms was higher in plains as 63%, and similar in suburbs and middles as about 54% (Table 1). The nature of land ownership types of surveyed Similar by topographical regions is that the percentage of own area was higher in plains as 77%, low in middles and suburbs as 64 and 60%, respectively. Comparing the yield of direct-seeding cultivation by farm size and topographical regions, although the yield was relatively higher in the larger scale farms as large as 3 to 5 ha in plains, it was rather lower in farms larger than 5 ha than in those as large as 3 to 4 ha. Both in suburbs and middles, however, yield was higher in farms doing direct-seeding in 1 to 2 ha thereby showing no general tendency by farm size. Compared by topographical regions, yield was higher in the order of plains, middles, and suburbs as 546, 524, and 501 kg per 10a, respectively, showing significant difference among regions (Table 2). Instability of direct-seeding technology may be a possible reason for the yield difference among regions suggesting room for improvement in the technology.

Table 2. Rice yield in direct-seeding cultivation by size and topographical regions. (Unit: kg/10a)

Farm size \ Region	Suburbs	Middles	Plains	Average
less than 1 ha	420	489	530	491
1 - 2 ha	560	540	540	541
2 - 3 ha	-	530	528	529
3 - 4 ha	504	-	559	537
4 - 5 ha	-	-	565	565
more than 5 ha	507	510	552	535
Average	501	524	546	533

Reduction in man-labor hours by direct-seeding cultivation practice

Since labor shortage and high labor cost is the main impulse of direct-seeding technology development, it is important to analyze how many man-labor hours is reduced by direct-seeding relative to transplanting practice. Direct-seeding demands much less labor because it excludes seedling, transplanting, and making-up in its working procedure.

Compared by topographical regions, more man-labor hours was required in middles as about 16 or 26 hr/10a for direct-seeding or transplanting, respectively, than in suburbs and plains, where about the same man-labor hours as 15 or 24 hr/10a was used for direct-seeding or transplanting, respec-

Table 1. Land ownership and farming scale of farmhouses practicing direct-seeding cultivation by topographical regions. (Unit: ha, %)

Classification	Suburbs	Middles	Plains	Average
samples	7	17	27	51
Own area(A)	4.99(60.5)	2.71(63.5)	5.04(77.4)	4.26(71.0)
Rented area(B)	3.31(40.1)	1.60(37.5)	1.60(24.6)	1.83(30.5)
Renting area(C)	0.05(-0.6)	0.04(-1.0)	0.13(-2.0)	0.09(-1.5)
Cultivated area(D)†	8.25(100)	4.27(100)	6.51(100)	6.00(100)
Direct-seeding area (E)	4.52	2.31	4.08	3.55
Direct-seeding ratio(G)‡	54.79	54.10	62.67	59.17

†D=A+B-C, ‡G=E/D × 100 (%).

Table 3. Man-labor hours for its working procedure in direct-seeding and transplanting cultivation by topographical regions. (Unit: hours)

Working procedure \ Region	Suburbs		Middles		Plains		Average	
	DS†	TP‡	DS	TP	DS	TP	DS	TP
Soil amendment	0.16	0.17	0.19	0.32	0.05	0.03	.011	0.16
Seed screening	0.32	0.34	0.74	0.76	0.45	0.51**	0.53	0.57
Seeding	0.32	4.15**	0.50	4.43**	0.32	3.50**	0.38	3.94**
Seedling	0.00	2.64	0.00	2.88**	0.00	2.68	0.00	2.74
Plowing	1.00	1.20	1.20	1.78	1.20	1.03	1.17	1.33**
Transplanting	0.00	1.83	0.00	2.55	0.00	1.94	0.00	2.14
Making-up	0.00	1.61	0.00	1.83	0.00	1.32	0.00	1.54
Fertilizer application	0.68	0.69	1.14	1.19	1.01	1.04	1.01	1.04
Weed control	1.26	1.10	2.12	1.58	1.29	1.22	1.56	1.33
Water management	3.26	4.07	3.46	3.75	2.58	2.54	2.97	3.21
Insect and pest control	1.79	1.89	2.92	3.54	1.94	1.95	2.25	2.54
Harvesting	3.81	2.00**	3.87	3.98	3.00	2.55*	3.40	2.98**
Drying	1.47	1.80	2.67	2.51	2.12	2.16	2.21	2.23
Hulling	0.76	0.51	0.72	0.61	0.88	0.78**	0.81	0.68**
Total	14.84	24.00	19.54	31.81	14.84	23.24	16.41	26.43*
(DS/TP) × 100	61.83		61.14		63.86		62.09	
Total labor	19.01		25.08		18.31**		20.75	

†DS(Direct-seeding cultivation), ‡TP(Transplanting cultivation)
* and ** indicate significant difference at the levels of 0.05 and 0.01, respectively.

Table 4. Quantity of fertilizer and agricultural chemicals applied in direct-seeding and transplanting cultivation by topographical regions.

Chemicals \ Region	Suburbs		Middles		Plains		Average	
	DS†	TP‡	DS	TP	DS	TP	DS	TP
Fertilizer (kg/10a)	40.1	38.8	52.0	47.9	43.9	37.5**	46.1	41.4
Std Dev	15.8	21.2	32.2	44.9	25.6	14.9	26.9	29.6
(DS/TP) × 100	103.35		108.56		117.07		111.35	
Agricultural chemicals (ml/10a)	901.2	803.7	792.9	741.8	973.6	905.1	903.4	830.9
Std Dev	368.5	277.8	333.5	278.4	378.4	310.5	364.9	296.9
(DS/TP) × 100	112.13		106.89		107.57		108.73	

†DS(Direct-seeding cultivation), ‡TP(Transplanting cultivation)
*** indicate significant to difference at 0.01 level.*

tively. The average man-labor hours was reduced by about 38% in direct-seeding practice (Table 3). Reduction rate ranged from about 36 in plains to 38% in suburbs and middles showing little difference among regions.

Increase in inputs of fertilizer and agricultural chemicals in direct-seeding cultivation

Amount of fertilizers and agricultural chemicals used in an agricultural practice is an important indicator of its environmental friendliness as well as an economical input factor. Therefore, it is important to examine the amount of fertilizer and agricultural chemicals applied in direct-seeding practice to assess its impact on environment.

Amount of fertilizer used in direct-seeding cultivation was 11% higher on average than in transplanting cultivation and ranged from about 40 to 52 kg/10a depending on topographical regions. Seventeen percent more fertilizer was applied in direct seeding than in transplanting practice in plains, but only 3 percent more in suburbs. Mean deviation between direct-seeding and transplanting cultivation indicates highly significant difference in fertilizer imput only in plains.

Amount of the average agricultural chemicals applied was 8 percent higher in direct-seeding than in transplanting cultivation. Contrary to the fertilizer use, agricultural chemicals were applied most highly in suburbs in direct-seeding cultivation (Table 4). Similar tendency in the application of fertilizer and agricultural chemicals is observed among regions regardless of cultivation practices.

Quantity of fertilizer and agricultural chemicals applied is also affected by the types of farmhouses implementing cultivation technologies. Due to the large coefficient of variation

Table 5. Comparison of quantity of fertilizer and agricultural chemicals applied in direct-seeding and transplanting cultivation by the types of farmhouses implementing cultivation technologies.

Classification	DS (I)†	DS (II)	TP	C.V.(%)
Fertilizer (kg/10a)	38.5	45.0	46.8	64.18
Std Dev	19.6	29.4	-	
Agricultural chemicals (ml/10a)	840.7	881.0	596.3	38.94
Std Dev	493.0	308.0	-	

†DS(I): Farmhouses practicing direct-seeding cultivation only DS(II): Farmhouses practicing both direct-seeding and transplanting cultivations, TP: Farmhouses practicing transplanting cultivation only. Mean deviation among the groups indicates indifference at the statistical significance levels.

among samples, statistically significant difference is not found in the amount of agrochemicals used among the types of farmhouses. In general, however, more fertilizer and agricultural chemicals tend to be used in farmhouses implementing both direct-seeding and transplanting practices than in those implementing direct-seedling only who applied less amount than in those practicing transplanting only (Table 5).

Use of more fertilizers and agricultural chemicals in direct-seeding by farmhouses implementing both technologies in all regions may indicate technical instability of the direct-seeding practice. Major factors for the technical instability could be identified through extensive empirical analysis of the technology. And measures to stabilize the technology could be devised through research and development activities considering various farming circumstances such as topographical features rather than just a top-down style research and extension.

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