Influences of Main Factors on the Growth of Rice Production and the Adoption of Modern Varieties in Vietnam : A case study in outskirts o Hanoi

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Influences of Main Factors on the Growth of Rice Production and the Adoption of Modern Varieties in Vietnam –A case study in outskirts of Hanoi–

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Since 1986, after reformed policies were executed in "doi moi" process, Vietnam's rice production has increased considerably. That uninterrupted change has transformed Vietnam from a net importer into the world's third largest exporter by volume. As a result, food security has been achieved at the aggregate level. Rural income has increased, poverty has fallen, the overall well–being in rural has been improved (United Nations, 1999). Those achievements were gained because of not only reformed policies but also the other directed factors such as improvement in water supplies, better cultivation practices, the dissemination of new varieties and increased use of chemical fertilizer and pesticides in rice production. However, how and how much each of those factors influences on the growth of rice production has been still in the question. Therefore, this approach aims to address that fundamental problem and to identify variety adoption in a small region of Vietnam.

INTRODUCTION

Actually, the decollectivisation process in Vietnam has been implemented since 1981 after the contract system was adopted by the Government and stipulated in Directive 100–CT/TU issued on January 13th 1981. Activating that policy in agriculture, households were allocated specific plots of land for cultivation. A contract had been concluded between the farmers and the co–operative. The co–operative was supposed to provide the inputs while farmers were responsible for transplanting, weeding, harvesting and so on. The crop management had been under farmers' responsibility. All outputs beyond the contracted amount could be kept for home consumption or sold at the market (Wolz, and Axel, 2000). That renovation had stimulated farmers enhancing their labor productivity and enforcing total products, especially in rice production. Together with the renovation in 1986, total rough rice of Vietnam has considerably increased since 1981 as described in figure 1.

In 1986, Francesca Bray concluded that, "Rice yields throughout Asia have risen steadily with improvements in water supplies, better cultivation practices, the dissemination of improved varieties, increased use of chemical fertilizers and pesticides" (Francesca Bray, 1986). In Vietnam, the growth of rice production illustrated in figure 1 has been

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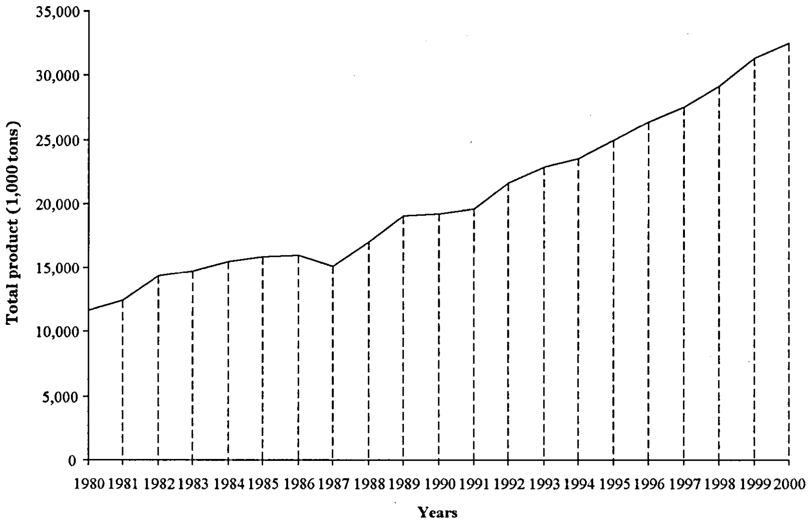

Source: World Rice Statistics published by IRRI

Fig. 1. Rice production in Vietnam since 1980

achieved on many effects, in which four main factors are the improvement in water management, the dissemination of modern varieties, the increasing utilization of chemical fertilizer and pesticide application. Thus, it is necessary to estimate how much each of those factors influences on rice production in Vietnam since 1980, aims to emphasize the importance of those factors in rice production. The objective of this paper is **to estimate the influences of modern variety, irrigation, fertilizers and pesticides on rice production in Vietnam** by an econometric model. Additionally, due to the importance of modern variety, a research on adoption of new rice varieties in three small regions has been implemented **to identify how farmers adopt the new rice varieties and how large the present varieties are cultivated** in those regions.

METHODOLOGY

Location of research survey

Socson, a suburban district of Hanoi, lies in the region between Tam Dao and Red River delta. This district is midland area comprising hills, mountains and complex topography under the gradual slope from Northwest to Southeast. The whole district is naturally divided into three different regions including hill, midland and riverside. Each of them has its own characteristic of topography as well as soil types. Because of that diversity in topography, it has characteristics of many other regions in terms of rice

[1] Modern varieties are dwarf, semidwarf, stiff-stemmed, high-tillering, nitrogen-responsive, photoperiod-insensitive, high-yielding varieties. Their characteristics are different from those of traditional varieties.

production. Additionally, the crops pattern and crop rotation in this district have been not so complicated as that of others. Almost farmers in this district had mainly grown rice only. Thus, the research survey on rice production was easy to get success when it was carried out in this district.

Sampling

In rice production, topography is an important factor to design a good irrigation system. The region locates near the rivers obviously had better irrigation for rice production than that of the region in the hill or far from rivers. Regarding to the statistic data in Socson, the rice yield illustrated in table 1 is significant difference among the regions.

Table 1. Yield of rice in each region

Unit: ton/ha

Regions	1996	1997	1998	1999
Hill	2.682	2.818	2.644	2.666
Middle	2.800	3.032	2.677	2.662
Riverside	2.960	2.954	3.218	3.370

Source: Statistic book of Socson District

Naturally, this district have been divided into three parts with the different productivity of rice caused by different topography, those are Hill, Middle land and Riverside region. In that sense, the survey was conducted over three regions respectively corresponding to the nature of different topography in this district. In order to gather the samples in the different places, stratified random sampling method was applied to take the samples based on the comparison of agriculture land and the number of farm–households among three regions.

Table 2. Agricultural land in each region

Items	Hill	Middle	Riverside
1. Number of communes	5	6	14
N°Communes in research	1	1	2
2. Agriculture land (ha)	3,220	3,395	6,348
3. Number of farm–households	9,585	12,065	24,190

Source: Socson Master plan to 2010

The description in table 2 shows that the agriculture land in the Riverside is nearly twice as larger as that of two other regions. Proportionally, the ratio of agriculture land for three regions is 1:1:2. For the number of household farms, this ratio also is 1:1:2 when compared this region to others. Totally, there are 14 communes in the Riverside. This number is over twice as many as that of the Hill and the Middle region. Thus, based on the stratified random sampling method, four communes had been selected to implement the research survey, which are one in the Hill, one in the Middle and two in the Riverside.

To secure the equivalence between regions, sample size of each also met the ratio of 1:1:2. Inferentially, sample size of each commune had the same number. In the real survey, total number of samples collected was 79 under the ratio of 20:20:39, which has qualified the above requirement.

Econometric models

In rice production, Dalrymple in 1975 had applied two different methods to disentangle the effects, which were production function and index number approach (Herdt, R. W. and Capule, C. 1983). In this approach, both of those methods will be applied. At first, all data will be converted into index number when considerate the data in 1980 equals to one. Then, a model designed based on production functions will be applied to those index numbers.

In this approach, there are four variables those are cultivated area of modern variety, irrigated paddy fields, pesticide and fertilizer utilization. Thus, the function of total rough rice will be:

$$f(Y)=f(X_1, X_2, X_3, X_4) \tag{01}$$

Where Y is total output, in this case is rough rice. X_1, X_2, X_3, and X_4 represent modern variety, pesticide, fertilizer and irrigation respectively.

In those variables, fertilizer and pesticide are the variables of inputs in production. They will response in accordance with the Cobb–Douglas production function.

$$f(X_2, X_3)=bX_2^{\alpha}X_3^{\beta} \tag{02}$$

Concerning to two other variables, if modern variety and irrigation expanding influence on the increase of total rough rice independently, then two separated functions can be estimated as following equations.

$$f(X_1)=bX_1^m \tag{03}$$
$$f(X_4)=bX_4^n \tag{04}$$

Nevertheless, both X_1 and X_4 might effect the growth of rough rice while depends on each other. The influence of each factor has the relationship with other. In this problem, the influence of modern variety might be caused by the effectiveness of irrigation expanding and vice versa. In this case, the Cobb–Douglas function could be used to check the influence of each factor. Thus, $f(X_1)$ and $f(X_4)$ can be multiplied together as following function.

$$f(X_1, X_4)=bX_1^m X_4^n \tag{05}$$

Thus, two models can be formulated under two different assumptions.

Model 1: Under assumption, that modern variety and expanding of irrigation influence independently on total product of rice, model 1 can be performed as follows:

$$Y=a+b_1X_1^m+b_2X_2^{\alpha}X_3^{\beta}+b_3X_4^n \tag{06}$$

Model 2: Under assumption, that modern variety and expanding of irrigation influences dependently on total product of rice, model 2 can be performed as follows:

$$Y=a+b_1X_1^m X_4^n+b_2X_2^{\alpha}X_3^{\beta} \tag{07}$$

Where, b_1, b_2 and b_3 represent how strong each variable influence on total rough rice. The exponents, m, n, α and β characterize the relationship between each factor and total product of rough rice.

In two models, which one is applicable for the data of Vietnam, meaning significant with those data, will be selected to analysis and differentiate how much each factors influenced to rice production in Vietnam since 1980.

INFLUENCE OF MAIN FACTORS ON THE GROWTH OF RICE PRODUCTION

Data and index numbers

Table 3. Time-series data

Years	Rough rice production (1,000 t)	Area planted modern varieties (1,000 ha)	Rice pesticide sales (million US$)	Irrigated rice area (1,000 ha)	Total consumption of fertilizer (N, P, K) (1,000 t)
1980	11,647	935	10	2,250	155
1981	12,415	962	12	2,310	219
1982	14,390	1,212	12	2,380	262
1983	14,743	1,390	12	2,430	376
1984	15,506	1,494	24	2,490	375
1985	15,875	1,623	26	2,510	386
1986	16,003	1,776	28	2,539	524
1987	15,103	1,880	31	2,564	421
1988	17,000	2,106	26	2,639	576
1989	18,996	2,642	32	3,141	563
1990	19,225	2,860	36	3,195	549
1991	19,622	3,234	38	3,336	752
1992	21,590	3,807	56	3,405	806
1993	22,837	4,144	30	3,440	923
1994	23,528	4,722	30	3,495	1,279
1995	24,964	5,153	31	3,527	1,214
1996	26,397	5,800	41	3,572	1,455

Source: World Rice Statistics published by IRRI

Table 3 presents all of factors needed, including total rough rice production, pesticide utilization in currency, increasing quantity of fertilizer, modern variety and irrigated rice in terms of expanded area.

In order to compare the increasing rate of each variable, the index numbers were estimated when considerate all data in 1980 equals to one as described in table 4.

Table 4 and figure 2 illustrate that excepting pesticide, both dependent variable Y and other respondent X are significant increased since 1980. Pesticide variable had reached the peak in 1992 but the expenditure for rice pesticide in 1996 was 4.1 times higher than that of 1980. The consumption of fertilizers has increased since 1980 but not steadily. Regarding to modern variety and irrigation, the expanding have been gradually strengthened.

Table 4. Increasing rate of each factor

Index (1980=1)

Years	Rough rice production	Modern varieties	Rice pesticide	Consumption of fertilizer	Irrigated rice
	Y	X_1	X_2	X_3	X_4
1980	1.000	1.000	1.000	1.000	1.000
1981	1.066	1.029	1.200	1.413	1.027
1982	1.236	1.296	1.200	1.690	1.058
1983	1.266	1.487	1.200	2.426	1.080
1984	1.331	1.598	2.400	2.419	1.107
1985	1.363	1.736	2.600	2.490	1.116
1986	1.374	1.899	2.800	3.381	1.128
1987	1.297	2.011	3.100	2.716	1.140
1988	1.460	2.252	2.600	3.716	1.173
1989	1.631	2.826	3.200	3.632	1.396
1990	1.651	3.059	3.600	3.542	1.420
1991	1.685	3.459	3.800	4.852	1.483
1992	1.854	4.072	5.600	5.200	1.513
1993	1.961	4.432	3.000	5.955	1.529
1994	2.020	5.050	3.000	8.252	1.553
1995	2.143	5.511	3.100	7.832	1.568
1996	2.266	6.203	4.100	9.387	1.588

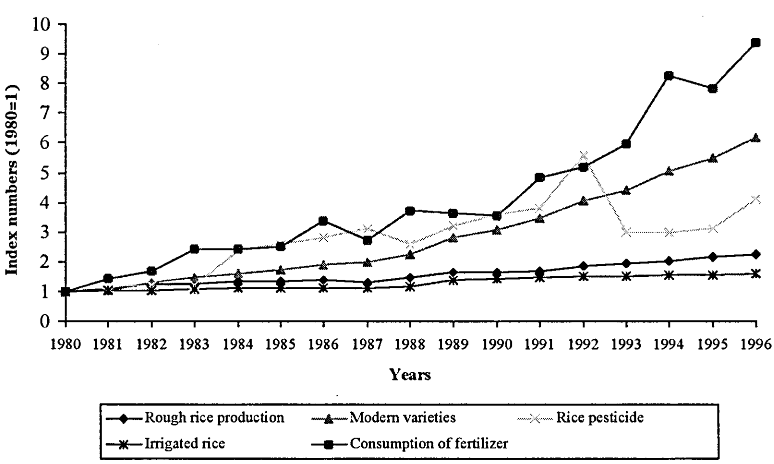

Fig. 2. Increasing rate of each factor

Function estimation

In order to estimate the influence of each factor, we had applied the index numbers in table 4 to the designed models. At first α and β were estimated by applying power function separately to each factor, rice pesticide and consumption of fertilizer.

By regression analysis, $\alpha = 0.386$; $\beta = 0.375$

Applying model 1 with $m=n=2$ into index numbers in table 4, the function can be identified as equation (08)[2]:

$$\underset{(0.08)}{Y=0.738}+\underset{(0.003)}{0.013X_1^2}+\underset{(0.051)}{0.12X_2^{0.386}X_3^{0.375}}+\underset{(0.086)}{0.232X_4^2} \tag{08}$$

Differentiation of influences from estimated function

Each independent variable in table 4 was substituted separately into estimated function (08) when others were constant at 1, meaning not increase since 1980, then the estimated influence of each independent variable, in terms of index numbers, can be calculated as demonstrated in table 5.

Table 5. Estimated influences of each independent variable
(Index numbers 1980=1)

Years	Rough rice (Estimation)	Modern varieties	Pesticide and fertilizer	Irrigated area
	Y	By X_1	By X_2, X_3	By X_4
1980	1.000	1.000	1.000	1.000
1981	1.036	1.001	1.024	1.011
1982	1.066	1.008	1.033	1.025
1983	1.103	1.014	1.054	1.035
1984	1.169	1.018	1.104	1.047
1985	1.188	1.023	1.113	1.051
1986	1.235	1.030	1.147	1.057
1987	1.234	1.035	1.136	1.063
1988	1.275	1.047	1.149	1.079
1989	1.449	1.081	1.168	1.200
1990	1.489	1.097	1.178	1.214
1991	1.600	1.128	1.221	1.252
1992	1.737	1.182	1.284	1.271
1993	1.714	1.217	1.216	1.281
1994	1.841	1.286	1.258	1.297
1995	1.904	1.342	1.256	1.306
1996	2.082	1.437	1.326	1.320

By the index numbers in table 5, the influence of each factor in both percentage and quantity can be calculated as illustration in table 6 and 7 respectively.

Table 6 shows that regardless to the effects of other factors, in 1996 the quantity of rough rice increase 108.22% compared to that of in 1980, in which achieved separately by influence of modern variety 43.68%, pesticide and fertilizer 32.57% and irrigated expanding 31.97%. The remaining quantity was gained by influence of other factors 18.42%.

[2] All of the coefficients of this function are significant at 5%. The numbers in parenthesis indicate standard errors

Table 6. Influence of each factors converted into percentage

Unit: (%)

Years	Rough rice production (estimation)	Modern varieties	Pesticide and fertilizer	Irrigated rice area	Others
1980	0.00	0.00	0.00	0.00	0.00
1981	3.61	0.07	2.41	1.14	2.98
1982	6.62	0.79	3.33	2.50	16.93
1983	10.30	1.41	5.39	3.50	16.28
1984	16.90	1.81	10.36	4.73	16.23
1985	18.76	2.35	11.27	5.14	17.55
1986	23.47	3.04	14.68	5.75	13.93
1987	23.44	3.55	13.61	6.28	6.24
1988	27.51	4.75	14.86	7.90	18.45
1989	44.86	8.14	16.77	19.95	18.24
1990	48.89	9.74	17.78	21.37	16.17
1991	60.03	12.78	22.06	25.20	8.44
1992	73.67	18.16	28.38	27.13	11.70
1993	71.44	21.73	21.59	28.12	24.64
1994	84.08	28.56	25.82	29.71	17.92
1995	90.44	34.23	25.56	30.64	23.90
1996	108.22	43.68	32.57	31.97	18.42

Table 7. Influence of each factors converted into quantity

Unit: 1.000 tons

Years	Rough rice production (estimation)	Modern varieties	Pesticides and fertilizer	Irrigated rice area	Others
1980	0	0	0	0	0
1981	421	8	280	132	347
1982	772	92	388	291	1,971
1983	1,200	164	628	408	1,896
1984	1,968	211	1,207	550	1,891
1985	2,185	273	1,313	599	2,043
1986	2,734	354	1,710	670	1,622
1987	2,729	413	1,585	731	727
1988	3,204	553	1,731	920	2,149
1989	5,225	948	1,953	2,324	2,124
1990	5,695	1,134	2,071	2,489	1,883
1991	6,992	1,488	2,569	2,935	983
1992	8,580	2,115	3,306	3,160	1,363
1993	8,321	2,531	2,514	3,276	2,869
1994	9,793	3,326	3,007	3,460	2,088
1995	10,533	3,987	2,977	3,569	2,784
1996	12,605	5,088	3,794	3,723	2,145

Graphic influences and Discussions

As illustrated in table 3, the rough rice production in 1996 increase 14,750 thousands tons comparing to that of 1980. In that amount, separately, table 7 and figure 3 show that

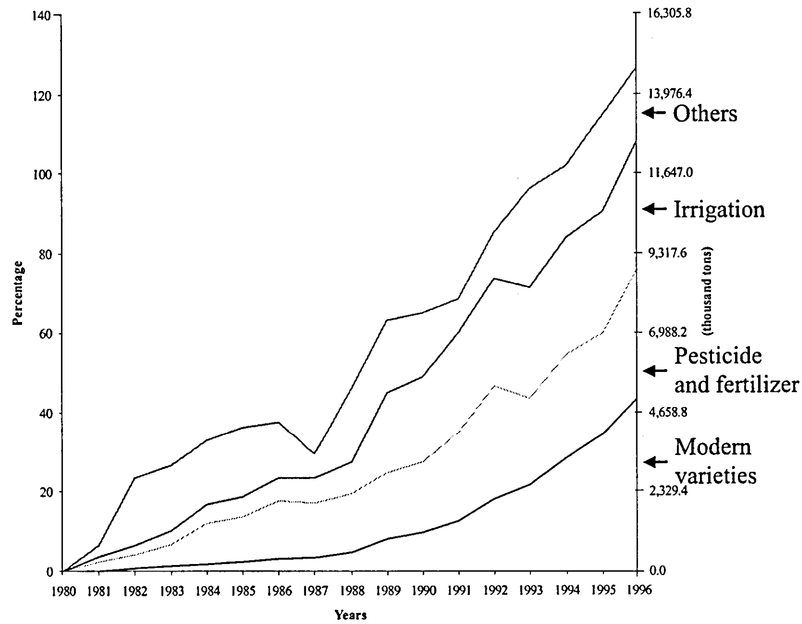

Fig. 3. Influence of each factor on rice production
(Cumulative graph)

the influence of modern varieties contributes 5,088 thousands tons, fertilizer and pesticide 3,794 thousands tons, irrigation expanding 3,723 thousands tons and others influences contribute 2,145 thousands tons respectively.

Figure 3 described the contributions from influence of each factor to the increase of rough rice production in Vietnam since 1980 to 1996. During 1980–1988, rice production in Vietnam had been strongly influenced by pesticide and fertilizer application. Since 1989 to 1994, the highest influence had belonged to the expanding of irrigated rice area. In 1995 and 1996, modern varieties had dominantly influenced to rough rice production.

RICE VARIETIES ADOPTED IN RESEARCH LOCATION

The development and spread of modern rice varieties have contributed substantially to increased rice production achieved by Asian countries since 1965 (Herdt, R. W. and Capule, C. 1983). In 1983, R. W. Herdt and C. Caplule had presented their research on the modern varieties adoption in the book "*Adoption, spread, and production impact of modern rice varieties in Asia*". In that book, they had differentiated the effects of modern varieties, fertilizers and irrigation separately for eight countries in Asian not included Vietnam during 1965–1980. In this period, rice output in those countries increased nearly 120 million tons in which modern varieties contributed 27,370 million tons. It proves that the modern varieties adoption is very important to rice production. Thus, it should be considered in this research. In this approach, modern varieties are defined as the Dwarf, semidwarf, stiff–stemmed, high–tillering, nitrogen–responsive, photoperiod–insensitive, high–yielding varieties. Their characteristics are different from those of traditional varieties[3].

On the other hand, the previous section also presented that the rough rice production in 1996 had increased 12,605 thousand tons in comparison with 1980, in which modern varieties contributed 5,088 thousand tons, the largest one among the influences of all others factors.

Due to the importance of new varieties adoption, this approach focuses on what varieties have been grown in the research location, how farmers adopt the new varieties and how large the present varieties are cultivated.

Transformation of adopted rice varieties

Generally, figure 4, 5 and 6 show that the number of rice varieties those farmers adopted has increased significantly since 1990. During the period 1998–2001, the number of adopted varieties is more than that of stage 1990–1995 in all regions. The main reason is that many new varieties were recently introduced into those regions from china and other institutes of rice improvement. The varieties named Khang dan, Boi tap son thanh, Q5, or Bac Thom Nº 7, those originated in China, were disseminated to farmers during 1998–1999.

In the Hill region, at present farmers do not cultivate DT 10 and CR203 anymore. They are cultivating C70, C71, new varieties and several local varieties. While in two other regions, farmers still cultivate DT10, CR203, C70, C71, together with new varieties. The number of varieties in the Middle and Riverside is more than in Hill region, it demonstrates that the diversification of varieties in Middle and Riverside is better than that of in

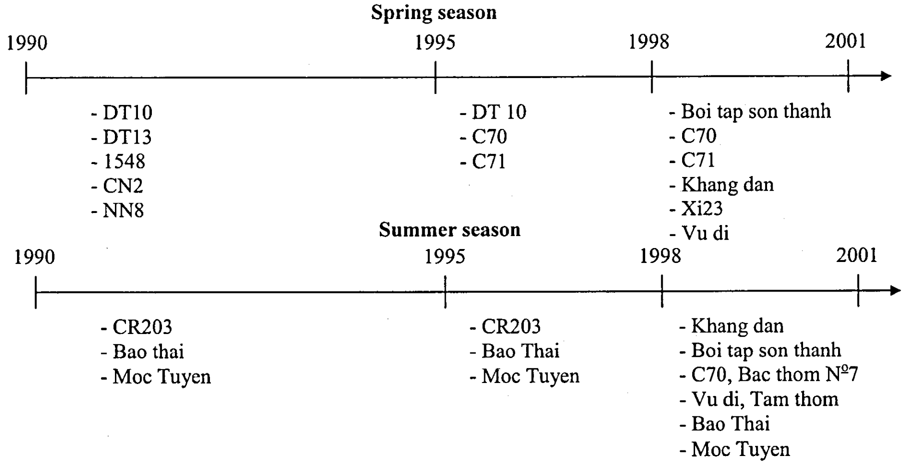

Fig. 4. Adopted rice varieties in the Hill region

[3] Acronyms and Glossary of Rice Terminology, website: http://www.knowledgebank.irri.org/glossary/

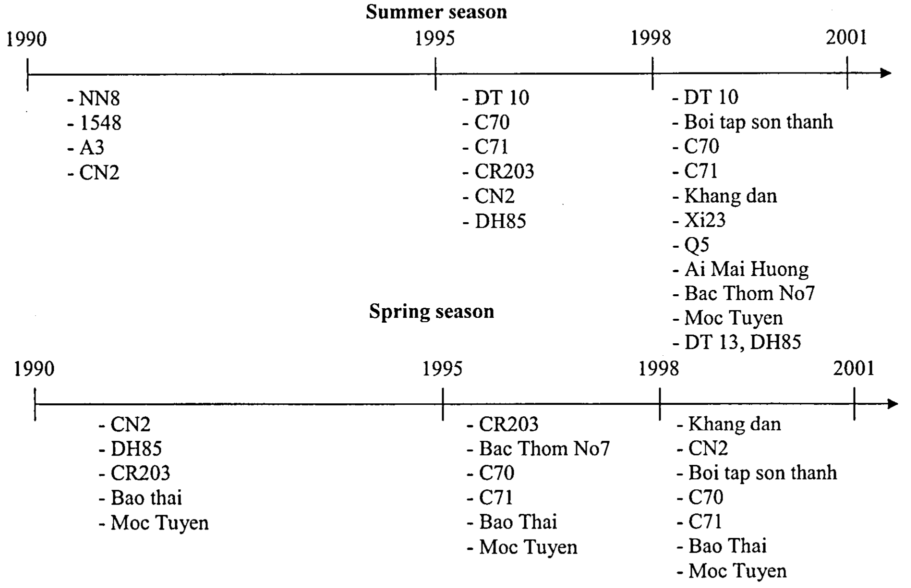

Fig. 5. Adopted rice varieties in the Middle

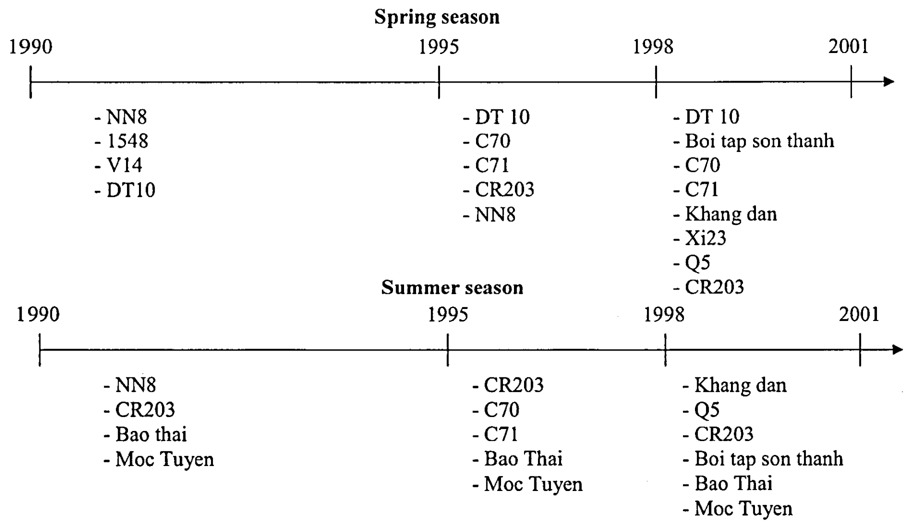

Fig. 6. Adopted rice varieties in the Riverside

Hill region. Obviously, it will be easier for farmers in Middle and Riverside to adopt a new rice variety than the farmers in the Hill region.

In the period 1998–2001, excepting Bao Thai, Moc Tuyen and Vu di, all others are modern varieties. Therefore, in the next section, will be briefly introduced the characteristics of the modern varieties presently exist in those regions.

Characteristics of the modern varieties

DT10

This variety were cultivated and recognized as national variety since 1990. It was cultivated in spring season, the growth and development periods totally are 185–195 days. The stem is around 90–100 cm height. It has good tillering, the average yield is about 5.0–5.5 ton/*ha*, the high yield can reach to 6.0–7.0 ton/*ha* (Truong Dich 1996).

Khang dan

Khang dan originated from China. It was taken into experiment since 1997 and introduced to farmers since 1999. This variety is short–duration growth. In late spring, the growth duration is 130–135 days and in early summer, it has growth duration of 105–110 days. This rice has stem of 95–100 cm height. The average yield is around 5.0–5.5 ton/*ha*, the high yield can reach to 6.0–6.5 ton/*ha* (Truong Dich 1996).

C70

C70 were recognized as the national variety since 1993. This variety can be transplanted in both spring and summer. In spring season, the growth duration is 165–175 days, in summer season 130–135 days. The seedling has cold tolerant in spring season. It has good tillering, lodge tolerant, sustainable yield. This variety is slightly affected sheath blight, bacteria leaf blight and brown plant hopper (Truong Dich 1996).

C71

This rice was recognized as the national variety since 1995. In spring season, it has growth duration of 165–175 days, in early summer the growth duration is only 125–135 days. It has 90–100 cm height of plant, good tillering, and long flowering, slightly affected rice blast and sheath blight. The average yield is about 4.5–5.0 ton/*ha*, the high average can reach to 6.0–6.5 ton/*ha* (Truong Dich 1996).

Xi23

Xi23 was recognized as the national variety since Feb. 1999. In spring season, the growth duration is 175–180 days, in summer 130–135 days. The height is 110–115 cm. This variety has good tillering, concentrated flowering, resistance to rice blast, sheath blight, brown plant hopper and cold tolerant. The average yield is about 5.5–6.0 ton/*ha*, the high yield can reach to 8.0 ton/*ha* (Truong Dich 1996).

Boi Tap Son Thanh

This variety is a hybrid imported from China, started transplanting in Vietnam since 1998–1999, now is popularizing in many Northern provinces. It is short–duration variety, high yield and good quality. It can be transplanted in both spring and summer. The growth duration is about 120–125 days in spring, 110–115 days in summer. The stem has 90–105 cm height, big and good tillering, short flag leaf, identical flowering, high ratio of effective panicle, resistance to rice blast, bacteria leaf blight, lodging and cold tolerant. The average yield is about 7.5–8.0 ton/*ha*, the high yield can reach to 10 ton/*ha* (Truong Dich 1996).

Q5

Q5 also were imported from China and recognized as the national variety since 1999. In spring season, the growth duration is about 135–140 days, in summer season 110–115 days. It has 90–95 cm height, good tillering and lodging resistance. The average yield is about 4.5–5.0 ton/*ha*, the high yield can reach to 6.0–7.0 ton/*ha* (Truong Dich 1996).

CR203

This is brown–hopper resistance variety. It was recognized as national variety since 1985. The height is 90–100 *cm*. Growth duration in late spring is 130–140 days, in early summer 115–120 days. This variety has strongly been affected sheath blight disease. When cultivating, farmers should pay attention to control rice blast and sheath blight (Truong Dich 1996).

Bac Thom №7

Originally, this variety was imported from China since 1992. It was taken into experiment and recognized as national variety since 1998. It can be transplanted in both summer and spring season. In late spring season, the growth duration is about 135–140 days, in early summer 115–120 days. The average yield is about 3.5–4.0 ton/*ha*, the high yield can reach to 4.5–5.0 ton/*ha* (Truong Dich 1996).

CN2

CN2 was recognized as the national variety since 1987. It can be transplanted in both spring and summer season. In summer, the growth duration is about 95–100 days, in spring 125–130 days. This variety has good tillering and short–duration flowering. The average yield is around 3.5–4.0 ton/*ha*, the high yield can reach to 4.5–5.5 ton/*ha* (Truong Dich 1996).

Area of each variety in research survey

Spring season

Table 8 shows that in the Hill region, at present farmers mainly cultivate Khang dan for spring rice, it was accounted for 75.75% of paddies cultivated khang dan in spring 2001. Additionally, farmers transplanted sticky rice, several new varieties such as Boi Tap son thanh and Xi23. The local variety still has been used such as Vu di. Besides, C70 and C71 were transplanted since 1995 as illustrated in figure 4.

Table 8. Rice varieties in Hill region
(Spring season–2001)

Name of varieties	Area (Sao)	% Area
Khang dan	74.4	75.75
C70	6.7	6.78
C71	4.0	4.07
Vu di	5.0	5.09
Tam Thom	0.5	0.51
Boi tap Son Thanh	3.0	3.05
Xi23	2.0	2.04
Sticky rice	2.7	2.71
Total	**98.3**	**100**

Source: Survey data–2002

In the Middle, the main variety was not only Khang dan but also DT10, a variety cultivated since 1990. The survey data in table 9 shows that 29.96% area of paddies cultivated khang dan and 39.80% area of paddies cultivated DT10 in spring 2001. Additionally, farmers cultivated other varieties for trial and diversification of rice variety.

Table 9. Rice varieties in Middle region
(Spring season–2001)

Name of varieties	Area (Sao)	% Area
Khang dan	42.3	29.96
DT10	56.2	39.80
C70	9.3	6.59
C71	1.0	0.71
DT13	4.2	2.97
Moc Tuyen	6.0	4.25
Boi tap Son Thanh	4.0	2.83
DH85	3.0	2.12
Ai Mai Huong	2.0	1.42
Bac thom No7	2.0	1.42
Xi23	5.0	3.54
Sticky rice	6.2	4.39
Total	**141.2**	**100**

Source: Survey data –2002

In the Riverside region, Xi23, one of the new varieties, which is becoming popular, accounted for 16.04% area of paddies in spring 2001. Table 10 illustrates that four rice varieties comprising Khang dan, DT10, C71 and Xi23 were considered as the main varieties in spring 2001. Remarkably, tables 8, 9 and 10 demonstrate that the number of main varieties of rice increase from the Hill to the Riverside region. In all regions, the farmers already adopted Khang dan, one of the new varieties. However, in the Middle and the Riverside farmers still cultivate the conventional varieties such as DT10 and C71.

Table 10. Rice varieties in Riverside region
(Spring season–2001)

Name of varieties	Area (Sao)	% Area
Khang dan	80.0	23.11
DT10	49.1	14.19
C70	29.8	8.62
C71	73.9	21.35
Boi tap Son Thanh	3.3	0.95
Q5	17.2	4.96
Xi23	55.5	16.04
CR203	2.0	0.58
Sticky rice	35.3	10.20
Total	**346.1**	**100**

Source: Survey data–2002

Summer season

In the summer, rice season is divided into two transplantations, early summer and late summer. In some place, farmers call late summer as the summer–autumn rice. In late summer, farmers in research location only cultivate two old varieties, namely Bao Thai and Moc Tuyen.

In Vietnam, due to crops diversification in winter season, farmers often try to transform the paddies of late summer to cultivate early summer rice. Among three regions in this research, the transformed activity in the Middle was better than two other regions with 7.57% of paddies cultivated Bao Thai Hong and 3.03% of paddies for Moc Tuyen as demonstrated in table 12. In the Hill region, the paddies cultivated Bao Thai and Moc Tuyen accounted for 14.50% and 34.63% respectively as illustrated in table 11. Table 13 shows that the area of paddies cultivated Bao Thai in the Riverside are 15.44% and 16.30% area transplanted Moc Tuyen.

There are several reasons for farmers not to transform these paddies to cultivate early summer rice. Those are paddies location, soil and water. However, the main reason is water management including irrigation and drainage systems. In the Hill region, many paddies located in the high place, the ditches cannot irrigate those paddies. Normally, farmers, who own those paddies, have to wait until late summer for raining. Then, they will possible to transplant rice. Inversely, in riverside region, there are many paddies being flooded in early summer when rice has just already transplanted in paddy fields. In this case, farmers have to transplant rice again in late summer. Many farmers, who do not have enough seedlings for re–transplantation must purchase seedling in the market.

In early summer, table 11, 12 and 13 show that Khang dan, a new variety originated in china, was significantly adopted by farmers in the Hill, the Middle and the Riverside regions. The paddies cultivated this variety in the Hill, the Middle and the Riverside accounted for 28.18%, 70.48% and 47.53% respectively. In the Middle region, this ratio is higher than in two others because the transformed activity has better performance than the Hill and the Riverside regions.

Table 11. Rice varieties in Hill region
(Summer season–2001)

Name of varieties	Area (Sao)	% Area
Khang dan	43.2	28.18
Vu di	13.0	8.49
C70	2.0	1.31
Tam Thom	2.0	1.31
Boi tap Son Thanh	13.1	8.55
Sticky rice	3.7	2.39
Bao Thai	22.2	14.50
Moc Tuyen	53.1	34.63
Bac Thom No7	1.0	0.65
Total	**153.2**	**100**

Source: Survey data–2002

Additionally, in this season farmers also transplant other varieties such as C70, C71, Boi Tap Son Thanh, sticky rice... for variety diversification. As described in table 11, 12 and 13, the diversification of variety in the Hill, the Middle and the Riverside are almost the same. In early summer 2001, in addition to Khang dan, farmers in the Riverside

Table 12. Rice varieties in Middle region
(Summer season–2001)

Name of varieties	Area (Sao)	% Area
Khang dan	93.1	70.48
DT10	7.2	5.45
C70	5.0	3.79
C71	3.0	2.27
Boi tap Son Thanh	9.5	7.19
Sticky rice	0.3	0.23
Bao Thai	10.0	7.57
Moc Tuyen	4.0	3.03
Total	**132.1**	**100**

Source: Survey data– 2002

Table 13. Rice varieties in Riverside region
(Summer season–2001)

Name of varieties	Area (Sao)	% Area
Khang dan	131.8	47.53
C71	3.0	1.08
Boi tap Son Thanh	2.5	0.90
CR203	23.0	8.29
Q5	24.1	8.70
Nu838	1.0	0.36
Sticky rice	3.9	1.39
Bao Thai	42.8	15.44
Moc Tuyen	45.2	16.30
Total	**229.2**	**100**

Source: Survey data–2002

region cultivated C71, Boi Tap Son Thanh, CR203, Q5, Nu838 and various varieties of sticky rice as demonstrated in table 13, and these area of paddies are not so large, each of them accounted for one or two percent of paddy fields in summer season excepting CR203 and Q5. CR203 has become conventional variety, which farmers cultivate on the area of 8.29% paddies, when Q5 has been gradually adopted by farmers, at present expanding on 8.70 percent of paddies as illustrated in table 13. In the Middle region, due to good performance of transformed cropping system, in addition to Khang dan, farmers transplanted DT10, C70, C71 and Boi Tap Son Thanh in the larger area, especially, Boi Tap Son Thanh, a new hybrid were planted in 7.19% of paddies area as demonstrated in table 12. In the Hill region, table 11 shows that two varieties namely Vu di, a local variety and Boi Tap Son Thanh, a new hybrid also were transplanted in the area accounted for 8.49% and 8.55% of paddies respectively. Obviously, Boi Tap Son Thanh, a new hybrid originally imported from China and started transplanting in Vietnam since 1998–1999, at present is gradually adopted by farmers.

Reasons and channels for accessing to new varieties

In order to check the reasons and channels for farmers to access to new varieties, we

Table 14. New varieties adoption–reasons and channels accessed

Unit: Percentage (%)

Items	Hill	Middle	Riverside
	Hong Ky	Tan Dan	Xuan Giang–Kim Lu
I. Reasons of new varieties cultivated			
Low price of seed	0	0	0
High yield	100	70	79
High quality of rice	15	25	13
Pest resistance ability	15	40	18
High price of output	0	0	0
Easy on cultivation	35	5	28
II. Channels access to new varieties			
Neighbors	35	30	23
Extension service	10	30	8
Relatives	0	5	3
Training course	0	5	5
Cooperative	65	10	36
Television	10	25	15
Radio	10	35	5

Source: Survey data–2002

designed in questionnaire two questions, to ask farmers why they cultivate new variety and how they know that variety. Under each question, there are several options those farmers can select freely. As a result, almost farmers cultivate new variety because of its high yield as depicted in table 14, 100% of farmers in the Hill region cultivate new variety for the high yield. The reason is that rice yield in the Hill region is low relative to that of two others, thus, farmers in this region usually desire to cultivate new variety for better yield.

In addition to high yield, farmers also selected other options, but the results were very different between the regions. In the Middle region, farmers are considerate to quality and pest resistance more than those in two others, 25% of interviewed farmers transplanted new variety for higher quality of rice and 40% of interviewed farmers cultivated new variety because of its better ability of pest resistance.

The option easy on cultivation, which 35% of interviewed farmers in the Hill and 28% of interviewed farmers in the Riverside region had selected, was formed by farmers themselves. According to their notion, a variety considered as easy on cultivation is fewer pests, less risk and easy to be adapted in their paddies compared to other varieties they had cultivated.

Regarding to access of new varieties, farmers can get information of new varieties by different channels including neighbors, extension service, cooperative and public media such as television and radio, in which cooperatives in the Hill and the Riverside is more reliable then that in the Middle region as illustrated in table 14. In the Middle region, the number of farmers can get information of new variety from cooperative accounted for only 10%. Neighbor is also very important for farmer to be able to get information of new varieties. Table 14 shows that in the Hill, the Middle and the Riverside region the number of interviewed farmers got information of new varieties from their neighbor accounted for 35%, 30% and 23% respectively. Therefore, the Government should pay attention to cooperatives and the neighborhood when introduce a new rice variety to farmers.

CONCLUSIONS

In 1996, rough rice production increased 14,750 thousands tons comparing to that of 1980. In that amount, the influence of modern varieties contributes 5,088 thousands tons, chemical fertilizer and pesticide 3,794 thousands tons, irrigation expanding 3,723 thousands tons and other influences contribute 2,145 thousands tons respectively. During 1980–1988, rice production in Vietnam had strongly influenced by pesticide and fertilizer application. Since 1989 to 1994, the highest influence belonged to the expanding of irrigated rice area. In 1995 and 1996, modern varieties had dominantly influences on rough rice production in Vietnam.

Khang dan, a new variety originated in china, was significantly adopted by farmers in the Hill, the Middle and the Riverside regions. Additionally, the farmers transplanted other varieties for diversification. Regarding to the reason of new variety cultivation, almost farmers cultivated new variety because of high yield, a part of them considered to quality, pest resistance and possibility to be adapted in their paddies. They can get information of new variety by different channels including neighbors, extension service, cooperative, and other public media.

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