RICE VARIETAL IMPROVEMENT AND PRODUCTION LOSS IN INDONESIA: ITS IMPLICATION FOR BIOTECHNOLOGY RESEARCH

PERBAIKAN VARIETAS DAN KEHILANGAN PRODUKSI PADI DI INDONESIA: IMPLIKASINYA UNTUK RISET BIOTEKNOLOGI

Tumari Jatileksono

Intisari

Studi ini bertujuan untuk mengestimasi kehilangan produksi padi akibat serangan hama dan penyakit, mengevaluasi kontribusi perbaikan varietas terhadap keragaan produksi padi, dan menentukan prioritas riset bioteknologi padi.

Kehilangan produksi padi diestimasi berdasarkan data agregat hasil sensus pertanian yang diterbitkan Biro Pusat Statistik, tahun 1976-90. Studi ini juga mencari taksiran petani tentang kehilangan hasil padi tahun 1990/91, yaitu dengan mewawancarai 640 petani padi yang dipilih dari 32 desa di Jawa.

Kehilangan produksi padi pada tahun 1976-79 cukup tinggi, rata-rata 1,34 juta ton per tahun, atau sekitar 5,5% dari total produksi. Kehilangan produksi ini turun sangat nyata menjadi sekitar 287 ribu ton, atau 0,7% dari total produksi, sebagai akibat adanya perbaikan varietas yang tersebar pada tahun 1980s, terutama IR36, Cisadane, Krueng Aceh, dan IR64. Kehilangan hasil ini terutama disebabkan oleh serangan hama tikus, penggerek batang, hama putih/putih palsu, wereng coklat, ganjur, walang sangit, ulat tentara, penyakit hawar daun, bercak daun, dan tungro. Taksiran petani tentang kehilangan produksi padi di seluruh desa sampel jauh lebih tinggi daripada hasil estimasi berdasarkan data agregat. Namun studi ini juga menunjukkan bahwa hama dan penyakit yang sangat merusak menurut pendapat petani ternyata mempunyai rangking yang hampir sama dengan hasil estimasi secara agregat.

Perbaikan varietas padi di Indonesia benar-benar telah mempunyai kontribusi terhadap pertumbuhan produksi padi dan peningkatan kualitas beras sekaligus. Kenyataan bahwa petani telah mendekati tingkat hasil potensial, dan kehilangan hasil pada tingkat yang sangat rendah akhir-akhir ini, memberi petunjuk bahwa riset bioteknologi padi lebih baik diprioritaskan pada usaha-usaha peningkatan angka hasil potensial daripada untuk pencegahan kehilangan hasil. Namun, kombinasi kedua usaha tersebut mungkin dapat memberikan manfaat yang lebih besar. Studi ini menyarankan agar riset bioteknologi padi segera digalakkan baik di lembaga-lembaga penelitian maupun di Universitas.

Abstract

The objectives of this study are to estimate rice production loss due to various insects and diseases, to evaluate the contribution of variety improvement on rice yield performance, and to set priority of biotechnology research on rice.

Rice production loss was estimated based on aggregate data of the annual agricultural survey published by the Central Bureau of Statistics for 1976-90. This study also derived farmers' estimate on rice yield loss in 1990/91 by interviewing 640 paddy farmers selected from 32 villages in Java.

Rice production loss was quite high in 1976-79, averaging 1.34 million ton paddy per annum, or about 5.5% of total production. This loss declined substantially to about 287 thousand ton, or 0.7% of total production, as improved modern varieties spread out in the 1980s, especially IR36, Cisadane, Krueng Aceh, and IR64. This loss was mainly due to crop damage by rat, stem borer, leaf folder/roller, brown planthopper, gall midge, stink bug, armyworm, leaf blight, blast, and tungro. The farmers' estimate of rice production loss in all sample villages were much higher than the results from the aggregate data. However, it was found that all insects and diseases that significantly contributed to rice production loss at the farm level, were also those reflected in the rank based on the aggregate data.

Rice variety improvement in Indonesia has significantly contributed to the growth of rice production and improved grain quality as well. The fact that the farmers have been approaching potential yield, and rice production loss was at low level in recent years, suggest that biotechnology research on rice should be prioritized on the effort of increasing the potential yield rather than on yield loss prevention. But, combined effort might be more beneficial too. It is suggested that biotechnology research on rice agriculture should be strengthened in both the national research institutions and Universities.

Introduction

Rice is the most important agricultural product in Indonesia, comprising around 47 percent of food crops' value added, or about 27 percent of the total agricultural value added in recent years (CBS, 1992). Rice is also the major staple food in the country, contributing around 53 and 45 percents of the total calorie and protein intakes, respectively. The share of rice in the consumption expenditure of the Indonesian household was around 17 percent, or 28 percent of the expenditure on food in 1990. Besides, rice production continues to be one of the most important source of living in the rural areas.

Increasing rice production to achieve self-sufficiency has been given high priority in Indonesia's economic development during the last two decades. Dissemination of modern varieties, heavy investment on irrigation, substantial fertilizer subsidy, credit facilities with subsidized interest rates, and establishment of proper extension service have been the major instruments of the government's rice program. As a result, rice production has increased tremendously within the last decade, and rice self-sufficiency has been achieved since 1985. Whether Indonesia will be able to maintain self-sufficiency in rice in the future is a critical policy issue.

This significant contribution of modern varieties to increased rice production in Indonesia has been widely recognized and well documented. However, in recent years, levelling-off of rice yield has been observed following an almost complete adoption of modern varieties in lowland areas. This indicates that the next generation of modern varieties with higher yield potential is required to maintain rice self-sufficiency in the future. The development in biotechnology research may be one major opportunity to be applied in rice farming, though its benefits are likely to be realized only in the long term.

The objectives of this study are (1) to estimate rice production loss due to various insects and diseases at the national level, (2) to examine rice yield loss at the farm level, (3) to evaluate the contribution of variety improvement on rice yield performance and yield loss, and (4) to set priority of biotechnology research on rice. The following section presents the progress of modern rice variety improvement, and its impact on fertilizer use and land productivity. The next section presents the results of rice production loss estimation, followed by the discussion on the implementation of IPM program. Some conclusions will be stated in the last section.

Varietal Improvement, Fertilizer Use, and Productivity

Most of the green revolution literatures have ignored the impact of the improvement of modern varieties (MVs) on the productivity and factor prices. Early MVs, such as IR5 and IR8, were highly susceptible to pests and diseases and major losses occurred occasionally due to their epidemic outbreaks. To reduce such production losses, the breeding programs in the International Rice Research Institute (IRRI) as well as the national research institutions have been designed to develop improved MVs resistant to pests and diseases (Khush, 1987). In fact, evolution of the green revolution was represented by the widespread adoption of early MVs followed by the wider dissemination of the later MVs characterized by multiple pest and disease resistance. Meanwhile, the shorter growth duration of later varieties seems to have brought about higher rice cropping intensities. Thus, the higher potential yield, smaller yield instability, and shorter growth duration are all important components of the green revolution that contributed significantly to the growth of rice production (Otsuka and Gascon, 1992).

In Indonesia, adoption of modern varieties in the lowlands has increased significantly from 11 percent of rice area in 1969/70 to 66 percent in 1979/80 and to 84 percent in 1989/90. Expansion and rehabilitation of irrigation facilities as well as improvements in the characteristics of newer modern varieties in terms of greater pest resistance, better grain quality, shorter growth duration, and more tolerance to adverse physical conditions have led to wider diffusion of modern varieties.

Modern varieties bred at both the International Rice Research Institute and the Indonesian rice research system are currently planted in the country. Those improved Indonesian varieties may be group into IMV1 and IMV2. The cross bred varieties between IR5 and Syntha, a national improved variety, are classified as MV1, i.e. Pelita I-1 and Pelita I-2. Cross bred varieties between IMV1 and other improved varieties are classified as IMV2, e.g., Cisadane, Cimandiri, Cipunegara, Citarum, Citandui, Krueng Aceh, Semeru, and Sadang.

The first generation IRRI bred varieties (IR5, IR8, and C4-63) were introduced in the late 1960s and disseminated up to 17 percent of rice area in 1975/76. IMV1 which was released in the early 1970s spread over a larger area and reached its peak in the 1975/76 covering for almost 22 percent of rice area. IRRI bred varieties released after IR8 but before IR36, i.e. IR20 to IR34, were widely grown in the late 1970s, primarily to overcome the outbreak of brown planthopper. In the 1980s, however, all of these varieties were almost completely replaced by the second generation (IR36) and the third generation (IR64) IRRI bred varieties, as well as IMV2 (Figure 1). IR36 was firstly introduced in 1976/77 wet season, and it was rapidly and more widely adopted to cover 37 percent of rice area in 1980/81, and continued to be planted over wide areas even up to the mid 1980s. IRRI varieties released after IR36 but before IR64, i.e. IR38 to IR54, accounted for around 12 percent of rice area, and mostly adopted outside Java. IMV2 which was introduced in the late 1970s, initially spread slowly, but by early 1980s adoption rate increased sharply, surpassing the area planted to IR36 by a wide margin. IR64 which was released in 1986/87 appeared to be the most promising varieties to replace IR36 in recent years. It should be noted that both IR64 and IMV2 were not only replacing IR36, but also significantly reduced the area planted with traditional varieties (TVs).

The adoption of IR5, IR8, C4-63, and IMV1 in the early 1970s was complemented by around 90 kg/ha fertilizer use (urea + TSP). Fertilizer use significantly increased in the late 1970s along with the release of IR36, and it continued to increase sharply as IMV2 and IR64 widely adopted in the 1980s (Figure 2). It is important to note that fertilizer use on upland rice also increased significantly since the early 1980s, though its level were much lower than that of the lowland rice.

Yield of the lowland rice was really stagnant at around 1.8 ton/ha during 1950s, and at around 1.95 ton/ha in the early and the mid 1960s (Figure 3). With the adoption of the first generation MVs, yield of lowland rice increased to slightly above 2 ton/ha in the late 1960s. The introduction of IMV1 in the early 1970s raised the yield to more than 2.5 ton/ha, and the release of IR36 stimulated yield to achieve more than 3 ton/ha in the late 1970s. When IMV2 was introduced in the early 1980s, rice yield sharply increased to be above 4 ton/ha. However, wide adoption of IR64 in recent years has not increased yield significantly, and it seems to be levelling off at around 4.5 ton/ha.

Yield of upland rice was also stagnant in the 1950s and 1960s at slightly above 1 ton/ha. Because no successful MVs have been developed for the upland rice, upland areas are still mostly planted with traditional rice varieties. It should be noted, however, that yield of upland rice rose from around 1.1 ton/ha in the early 1970s to about 2 ton/ha in recent years. Observed increases in yields in the lowland areas, therefore, would not have been due solely to the adoption of modern varieties, but also to other factors, such as the decline in fertilizer rice price ratios as substantial subsidies were provided over time (Jatileksono, 1987; Timmer, 1989; Heytens, 1991).

The increases in rice yield were also due to more intensive use of labor as MV adoption itself occasionally increased labor use per hectare by increasing labor requirements for crop care and harvesting (Barker and Cordova, 1978). In fact, higher yielding varieties, application of larger amounts of fertilizer, irrigation and drainage, and improved cultivation practices are all belong to labor using tecnology which have yield-increasing properties at the same time (Ishikawa, 1978).

Rice Production Loss

Rice production loss was estimated as the product of the damage intensity, area infected by various insects and diseases, and rice yield for each district. The results were aggregated and adjusted to the national level. This study utilizes the annual agricultural survey data published by the Central Bureau of Statistics which now available for the period of 1976-90, i.e. the data on production of food crops, and the data on area and damage intensity caused by insects, diseases, and calamity on paddy. Besides, farm level survey was also conducted to explore the farmers' estimate on rice yield loss in 1990/91 by interviewing 640 paddy farm households selected from 32 villages, i.e., 10 villages of West Java, 10 villages of Central Java, 10 villages of East Java, and 2 villages of Yogyakarta Special Region.

Table 1 and Figure 4 present the estimates of rice production losses as compared to the actual rice production for the period of 1976-90. Total rice production loss was quite high in 1976-79, averaging 1.34 million ton paddy per annum, or about 5.5% of total production. The average annual loss of lowland rice was around 1.32 million ton paddy in 1976-79. As shown in Table 2, this loss was contributed by the attack of brown planthopper (40%), rat (17.6%), gall midge (14.6%), stem borer (9.7%), stink bug (8.1%), leaf folder/roller (3.3%), and armyworm (1.4%).

Rice production loss declined substantially as improved modern varieties spread out in the 1980s, especially IR36, Cisadane, Krueng Aceh, and IR64. Estimates for the last five years (1986-90) show that the annual loss of the lowland rice was about 287 thousand ton paddy, or only 0.7% of total production. This loss was due to crop damage by rat (33.5%), stem borer (23.7%), leaf folder/roller (12.1%), brown planthopper (7.3%), gall midge (4.5%), stink bug (4.2%), armyworm (2.8%), leaf blight (2.3%), blast (1.5%), and tungro (1.3%).

It should be noted that upland rice production losses were very small as compared to those of the lowland rice (Table 1). Meanwhile, the most damaging insects and diseases for upland rice were almost similar to those of lowland rice with slightly different in ranking. The top ten insects and diseases causing damage on upland rice were among top 15 insects and diseases damaging lowland rice (Tables 2 and 3). We also notice that there was yearly variation of the losses by each insect and disease. But, in general, rice production losses were relatively at low level in the 1980s.

Having the time series estimates of rice production losses, we may examine the impacts of the IPM program. In November 1986, the IPM program was officially launched in Indonesia. This program has been implemented by (1) scheduling of cropping patterns with rotation of rice varieties, (2) growing high yielding varieties resistant to pests and diseases, (3) eradication and sanitation of crop damage, (4) wise use of insecticides, (5) pest monitoring, (6) supervised pest management, and (7) implementation of coordinated efforts at the national and regional levels. The most remarkable starting point with IPM was to ban 57 brands of pesticides used for rice.

In fact, rice yield continued to slightly increase in recent years (Figure 3) despite the fact that pesticides use has been significant reduced. Meanwhile, rice production loss appeared to barely increase, and it was still at low level. Hence, IPM program has been successful in reducing pesticides use without significant yield reduction. However, a special attention should be given as rice production loss due to stem borer significantly increased in 1990. From ten selected districts having highest damage intensities, the stem borer in Java clearly increased production loss in recent years (Table 4). And, the attack of stem borer seems to be concentrated in certain area, i.e. in Indramayu and Subang Districts. Total production loss in these districts was almost threefold in 1990 as compared to that in 1989.

Even though the percentage of aggregate rice production loss was very low in recent years, its occurence has been disturbing to farmers because the pest outbreak usually concentrated in certain area. The results from the farm level survey presented in Table 5 clearly indicate that farmers' estimate of rice production loss in all sample villages were much higher than what we have learned from the aggregate data. Rice production loss due to stem borer, rat, brown planthopper, or grub were really high in some villages. And there were many farmers suffered from serious attack of these pests which in turn generated negative profit. However, all insects and diseases that significantly contributed to production loss at the farm level were also those reflected in the aggregate data, except for the grub on upland rice. Therefore ranking from the most serious to the least damaging insects and diseases generated from aggregate data is still useful to prioritize research in increasing rice productivity.

The fact that the Indonesian rice farmers have been approaching potential yield, and rice production loss was at low level in recent years, suggest that biotechnology research on rice should be prioritized on the effort of increasing the potential yield rather than on yield loss prevention. Institutionalized advanced research for rice agriculture is one of the most important investment that should be taken into account. Public spending for rice research should be given high priority. And, we should realize that agricultural research in general would take relatively long time to be effective in increasing productivity. Chavas and Cox (1992) provided example that 30 year lags are required to fully capture the effects of public research expenditure on US agricultural productivity. But the internal rate of return is very high, i.e. 28 percent.

Conclusion

The experience of technological change led by variety improvement in Indonesia has significantly contributed to the growth of rice production and improved grain quality as well. Variety improvement complemented by government policy to heavily subsidize fertilizer and irrigation have contributed to remarkably rice yield increase with limited production loss, facilitating Indonesian farmers approaching the potential yield in most irrigated lowland. The Integrated Pest Management program started in 1987 seems to be successful in reducing pesticide use without significant impact on rice yield. But some preventive measures should be further developed as rice production loss due to stem borer has significantly increased in recent years.

Technological change in rice farming was able to increase efficiency and productivity, and advanced the equity objectives at the same time (Hayami and Herdt, 1977; Hayami, 1983; Jatileksono, 1993). Therefore, the development and diffusion of new technology in rice farming is a necessary condition for the national economic developing improved technology for rice sector which could be expected to improve the social welfare, especially in rural areas.

Presently, the Indonesian rice farmers are really waiting for the next technological breakthrough since the potential yield has been approached, and rice production loss was at low level in recent years. Therefore it is suggested that biotechnology research on rice in Indonesia should be prioritized on the effort of increasing the potential yield rather than on yield loss prevention. But combined effort might also be more benefecial. The most damaging insects and diseases contributing rice production loss in recent years were rat and stem borer, followed by leaf folder/roller, brown planthopper, gall midge, stink bug, armyworm, leaf blight, blast, and tungro.

Finally, searching newer technology in rice farming is the current problem which should be given first priority to solve if further increase in rice production is expected. Hence, biotechnology research on rice agriculture should be strengthened in both the national research institutions and Universities.

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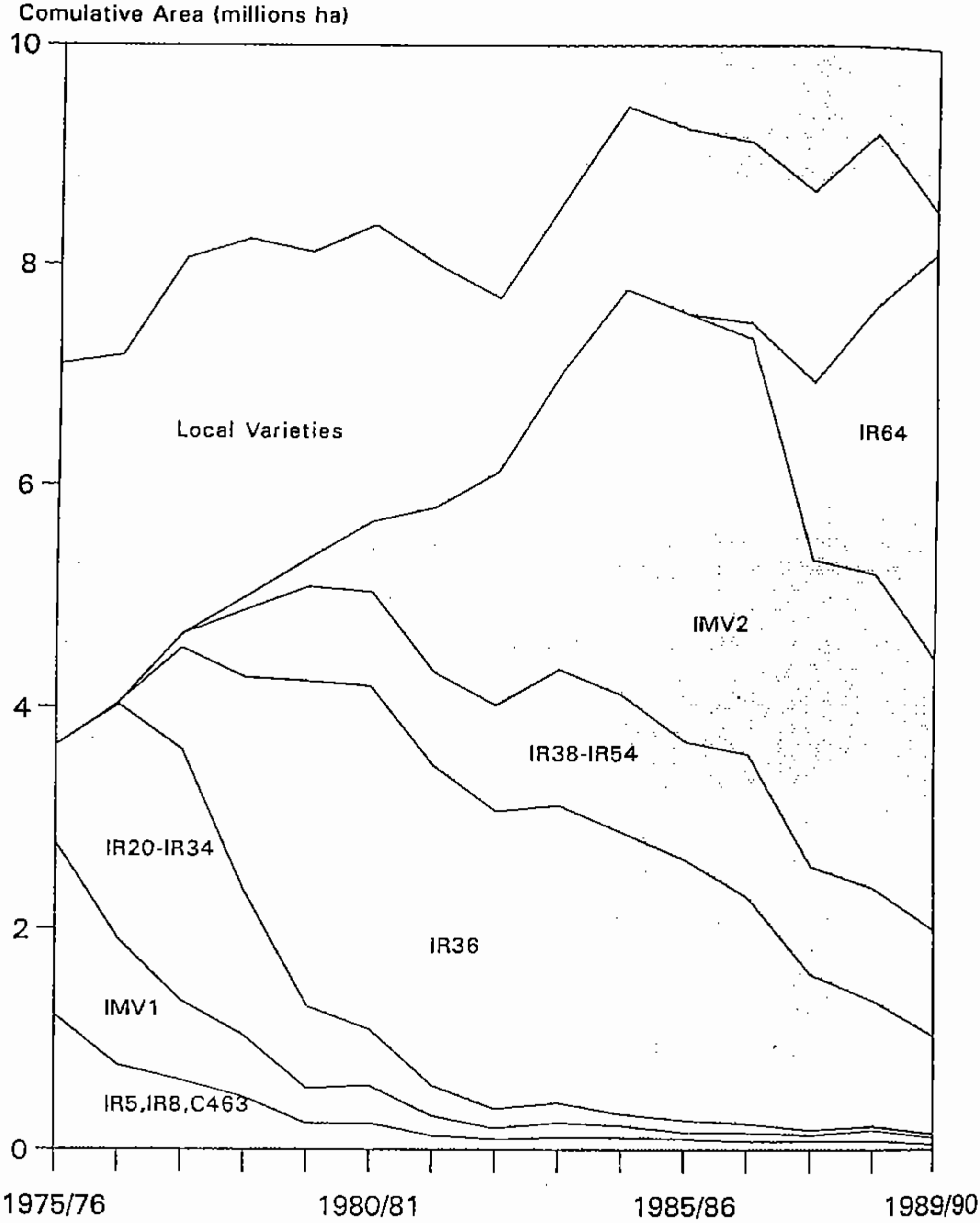
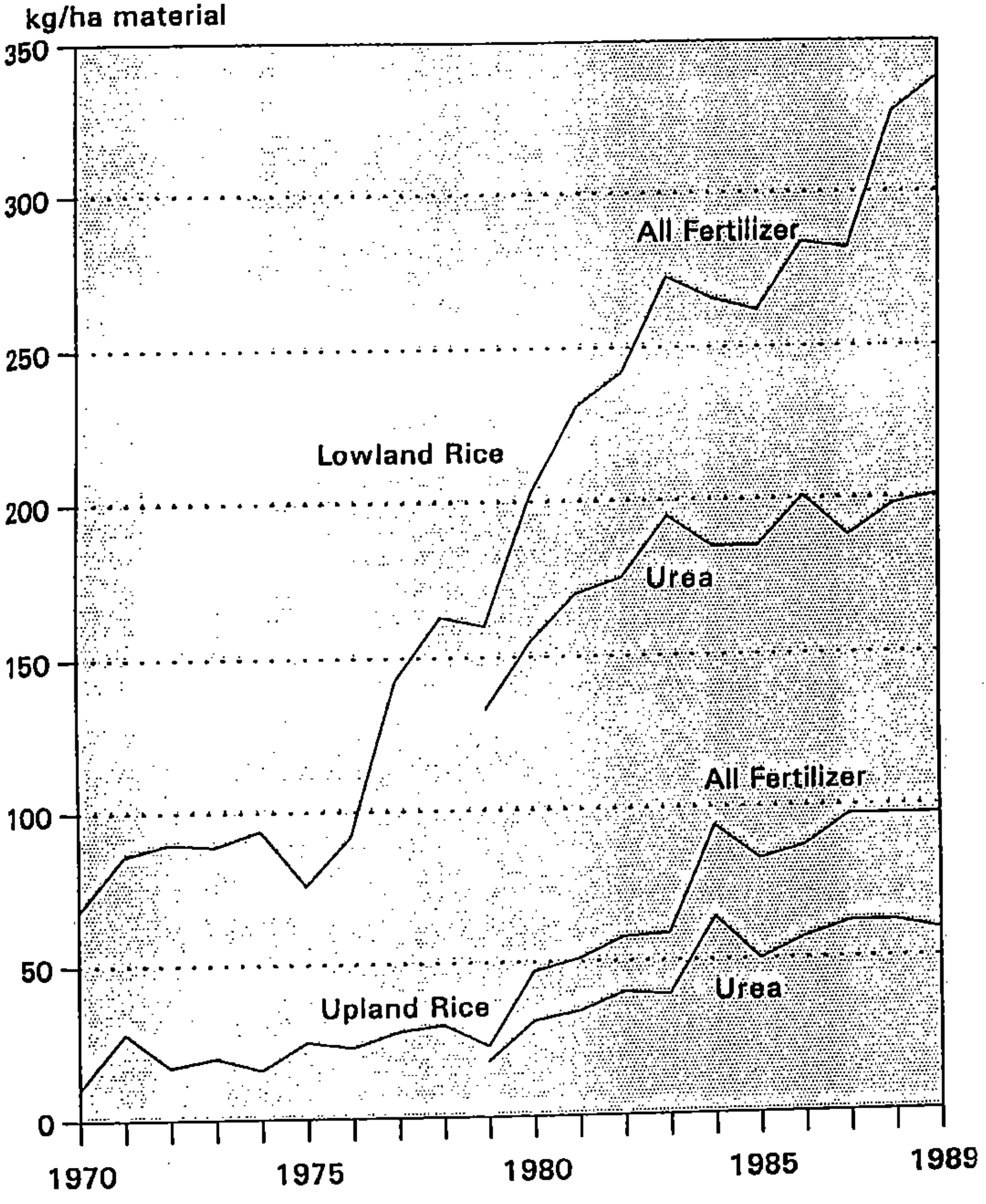
Figure 1. **The Spread of Modern Rice Varieties in Indonesia**



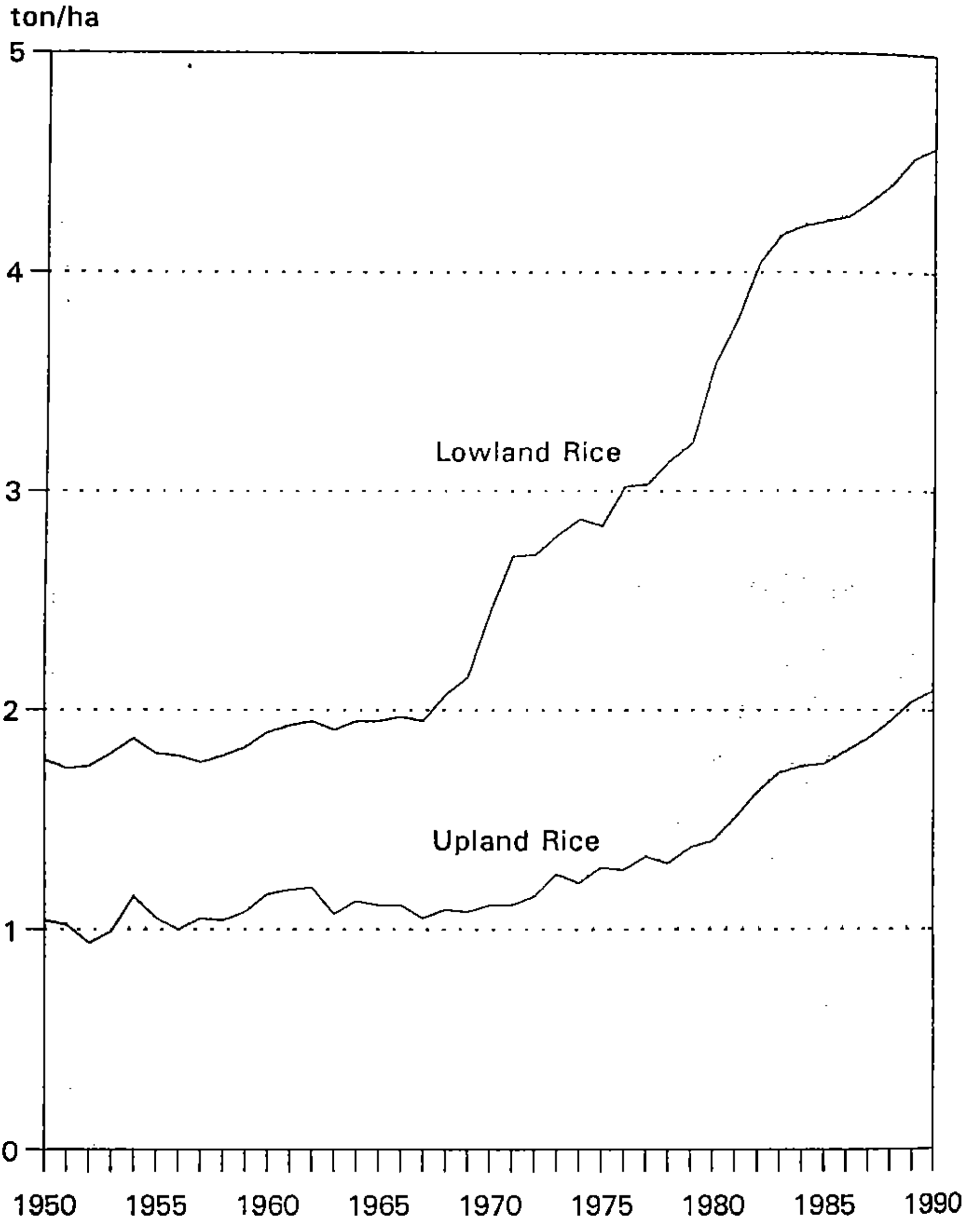
Source of data: Directorate of Food Crops Development, Dep. of Agriculture.

Figure 2. Fertilizer Use on Lowland and Upland Rice in Indonesia



Source of data: Central Bureau of Statistics.

Figure 3. **Yields of Lowland and Upland Rice in Indonesia**



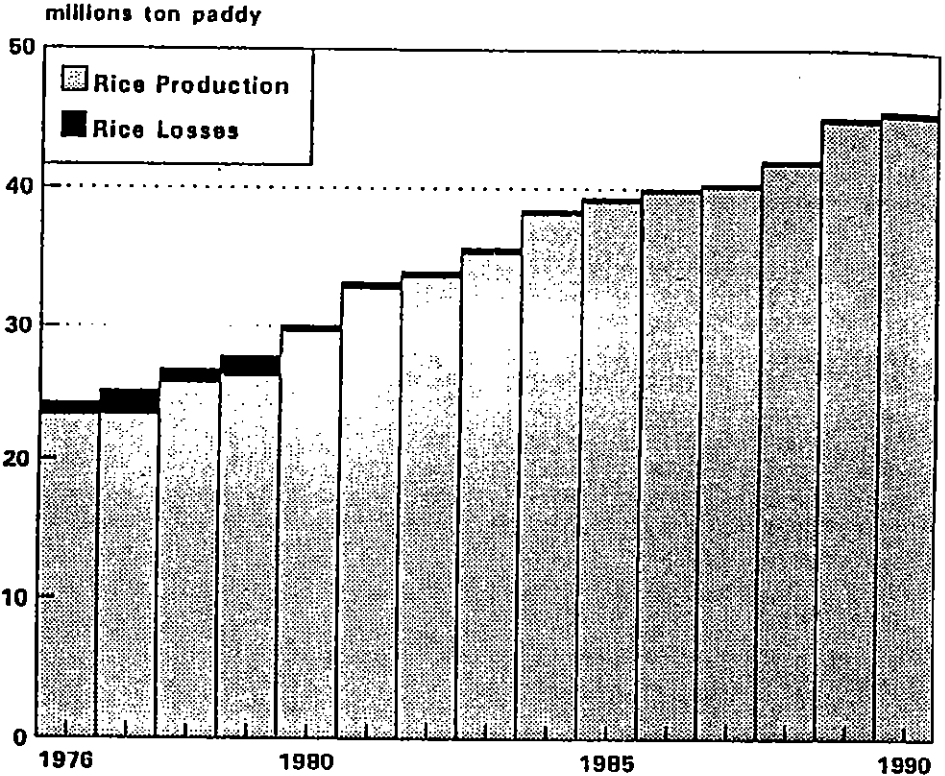
Source of data: Central Bureau of Statistics.

Table 1. **Rice production and losses in Indonesia (thousand ton paddy), 1976-90**

Year	Rice Production			Production Loss			% of Total Loss
	Lowland	Upland	Total	Lowland	Upland	Total	
1976	21852	1449	23301	960	11	971	4.17
1977	21808	1539	23347	1842	10	1852	7.93
1978	24172	1599	25772	1030	22	1051	4.08
1979	24732	1551	26283	1442	57	1499	5.70
1980	27993	1659	29652	428	10	438	1.48
1981	30989	1785	32774	484	10	494	1.51
1982	31776	1808	33584	444	7	450	1.34
1983	33294	2009	35303	421	26	448	1.27
1984	36017	2119	38136	293	15	309	0.81
1985	37027	2006	39033	304	3	307	0.79
1986	37740	1987	39727	231	4	235	0.59
1987	37970	2109	40079	198	16	214	0.53
1988	39316	2360	41676	279	8	286	0.69
1989	42371	2354	44725	296	10	305	0.68
1990	42825	2353	45178	390	8	398	0.88

Source of data: Central Bureau of Statistics.

Figure 4. **Rice Production and Losses in Indonesia**



Source of data: Central Bureau of Statistics.

Table 2. **Annual loss of lowland rice production in Indonesia (ton paddy), 1976-90**

No.	Causes of damage	1976-79	1980-85	1986-90	1976-90
1.	Brown planthopper	527396	38601	20413	162884
2.	Rat	231395	140188	93401	148914
3.	Stem borer	127472	68988	66101	83621
4.	Gall midge	192106	13138	12537	60662
5.	Stink bug	106576	26458	11815	42942
6.	Leaf folder/roller	43662	37180	33692	37746
7.	Armyworm	18542	23061	7775	16761
8.	Tungro	8711	10588	3707	7794
9.	Blast	4570	11005	4105	6989
10.	Brown spot	8925	8338	2930	6692
11.	Black rice bug	11527	2596	2165	4834
12.	Bacterial leaf blight	4199	3417	6519	4659
13.	Sheath blight	3528	4346	2434	3491
14.	Grassy stunt	9935	862	801	3261
15.	Wild Pig	5301	1335	1962	2601
16.	Green stink bug	5152	973	0	1763
17.	Yellow dwarf	3142	326	1329	1411
18.	Orange leaf	1841	227	156	634
19.	Narrow brown leaf blight	947	907	0	616
20.	Ragged stunt	182	193	958	445
21.	Rice thrips	860	409	0	393
22.	False smut	1306	32	0	361
23.	Birds	0	140	843	337
24.	Hydrellia	237	187	0	138
25.	Hedgehog beetles	422	46	0	131
26.	Others	711	2275	5067	2767
	Total annual loss	1318644	414148	261377	618014

Source of data: Central Bureau of Statistics.

Table 3. **Annual loss of upland rice production in Indonesia (ton paddy), 1976-90**

No.	Causes of damage	1976-79	1980-85	1986-90	1976-90
1.	Brown planthopper	14470	2082	275	4783
2.	Rat	2847	1160	1771	1814
3.	Stink bug	1813	1190	1045	1307
4.	Wild pig	1547	1178	1194	1281
5.	Stem borer	974	1457	733	1087
6.	Blast	326	1024	407	632
7.	Leaf folder/roller	292	590	559	500
8.	Brown spot	79	577	549	435
9.	Armyworn	289	416	212	314
10.	Black rice bug	49	355	198	221
11.	Green stink bug	73	483	0	212
12.	Narrow brown leaf spot	27	480	0	199
13.	Gall midge	239	167	165	186
14.	Sheath blight	121	164	31	108
15.	Orange leaf	253	3	0	69
16.	Bacterial leaf blight	52	76	28	54
17.	Rice thrips	53	43	0	31
18.	Tungro	7	10	41	20
19.	Grassy stunt	44	2	9	16
20.	Hedgehog beetles	45	4	0	14
21.	Yellow dwarf	15	9	8	10
22.	Hydrellia	16	13	0	10
23.	Others	568	382	1427	780
	Total annual loss	24201	11865	8651	14083

Source of data: Central Bureau of Statistics.

Table 4. Lowland rice production loss in ten districts having highest damage intensities (ton paddy), 1986-90

No.	Causes of damage	1986	1987	1988	1989	1990
Java						
1.	Stem borer	3731	8803	4832	17838	145726
2.	Rat	26724	17378	24230	31487	31312
3.	Brown planthopper	15530	1714	2922	3648	2668
4.	Leaf folder/roller	2866	4159	4457	4290	3765
5.	Gall midge	5997	2409	4862	1273	3530
6.	Bacterial leaf blight	467	4105	2258	2365	4979
7.	Brown spot	20	605	759	3723	3029
8.	Armyworn	1414	1135	1491	805	2927
9.	Stink bug	229	319	2956	1287	2709
10.	Sheath blight	121	753	1810	1436	655
11.	Blast	118	170	1685	1032	968
12.	Yellow dwarf	876	1680	11	0	0
13.	Ragged stunt	291	414	356	0	779
14.	Grassy stunt	470	775	45	287	22
15.	Tungro	476	166	232	185	99
16.	Black rice bug	374	57	456	56	182
17.	Birds	11	105	438	3	24
18.	Wild pig	1	22	340	48	10
19.	Orange leaf	6	0	4	49	22
20.	Others	0	48	497	51	11
	Total loss	59723	44817	54641	69863	203416
Outside Java						
1.	Rat	7792	8618	34596	32519	23381
2.	Leaf folder/roller	9693	13548	14757	14593	6870
3.	Stem borer	6807	8924	13108	8268	9876
4.	Brown planthopper	13421	3377	1902	1415	1331
5.	Gall midge	5028	1267	4037	629	587
6.	Stink bug	637	1982	1624	3808	2587
7.	Armyworm	707	1855	1297	2015	843
8.	Blast	190	412	825	3402	102
9.	Sheath blight	93	422	1222	647	947
10.	Bacterial leaf blight	10	1166	511	1373	222
11.	Tungro	352	823	59	417	610
12.	Wild pig	370	617	177	250	188
13.	Black rice bug	108	261	176	615	286
14.	Brown spot	154	440	255	314	7
15.	Birds	85	6	284	187	200
16.	Ragged stunt	236	150	25	204	12
17.	Yellow dwarf	292	73	102	27	24
18.	Orange leaf	328	0	17	1	0
19.	Grassy stunt	0	0	0	127	0
20.	Others	0	1560	156	358	2265
	Total loss	46303	45500	75127	71168	50339

Source of data: Central Bureau of Statistics.

Table 5. **Rice production losses based on farmers' estimate (percent), 1990/91**

Sample village number	Stem borer	Rat	Brown plant-hopper	Stink bug	Bacterial leaf blight	Grub	Others	Total loss
Irrigated areas								
1.	85.3	0.0	0.0	0.0	0.0	0.0	0.0	85.3
2.	24.4	11.3	0.6	0.0	5.6	0.0	0.0	41.9
3.	10.9	4.1	1.9	1.0	0.0	0.0	0.7	18.4
4.	8.6	5.7	1.1	0.5	0.0	0.0	0.0	15.9
5.	2.5	2.6	0.8	0.0	0.0	0.0	0.7	6.7
6.	1.7	2.2	0.3	0.0	0.0	0.0	0.0	4.2
7.	0.2	6.4	3.7	0.0	0.0	0.0	0.3	10.5
8.	1.9	6.5	2.6	0.0	0.0	0.0	0.0	10.9
9.	0.0	28.0	0.0	0.0	0.0	0.0	0.0	28.0
10.	0.0	26.9	0.0	0.0	0.0	0.0	13.2	40.0
11.	0.5	2.1	0.0	0.3	0.0	0.0	0.0	2.9
12.	1.2	12.9	0.2	0.7	0.0	0.0	0.8	15.7
13.	0.0	4.3	0.0	3.1	0.0	0.0	0.7	8.1
14.	1.3	3.5	0.2	1.0	0.0	0.0	0.0	5.9
15.	0.0	2.5	0.0	1.4	1.0	0.0	3.1	8.0
16.	0.7	6.4	0.0	0.3	1.1	0.0	0.3	8.8
17.	0.0	2.6	0.0	0.0	0.0	0.0	0.0	2.6
18.	0.3	2.2	0.8	3.6	6.5	0.0	0.2	13.6
19.	5.6	1.0	0.1	4.4	0.0	0.0	2.1	13.0
20.	12.6	0.8	0.0	4.6	0.0	0.0	0.0	17.9
Average	9.9	5.4	0.7	0.8	0.7	0.0	0.7	18.3
Rainfed areas								
21.	0.9	3.6	0.1	4.5	0.0	0.0	2.1	11.3
22.	2.3	2.9	0.2	0.3	0.0	0.0	2.3	8.0
23.	0.9	0.3	0.6	1.7	0.0	0.0	5.2	8.7
24.	1.2	0.5	0.2	2.9	0.0	0.0	4.1	8.9
25.	0.0	8.9	0.0	2.8	0.0	0.0	0.0	11.7
26.	0.0	20.3	0.0	2.8	0.0	0.0	0.0	23.2
Average	0.8	7.3	0.2	2.4	0.0	0.0	1.7	12.3
Upland areas								
27.	0.0	0.0	11.5	0.0	0.0	11.6	10.5	33.6
28.	2.9	0.0	0.0	0.0	0.0	21.8	0.7	25.4
29.	0.0	0.0	3.1	0.0	0.4	5.0	0.0	8.5
30.	0.0	0.0	6.2	0.0	9.1	13.7	0.0	29.0
31.	0.4	0.4	4.9	4.6	0.0	7.6	0.0	17.8
32.	0.0	0.0	9.8	0.6	0.0	1.4	0.0	11.8
Average	0.3	0.1	5.3	1.1	2.9	9.3	0.6	19.6