

Table 4.4 Change in the Extent of Contribution of Harvested Area and Yield to Production of Lowland Paddy in 1991 as to 1980

Province	Production Log P91/P80	Contribution	
		Harvested Area Log H91/A80	Yield Log Y91/Y80
11. D.I. Aceh	4.270	2.158	2.112
12. Sumatera Utara	4.264	2.161	2.103
13. Sumatera Barat	4.207	2.094	2.113
14. Riau	4.280	2.139	2.141
15. Jambi	4.092	2.021	2.071
16. Sumatera Selatan	4.178	2.098	2.080
17. Bengkulu	4.284	2.195	2.089
18. Lampung	4.335	2.226	2.110
Sumatera	4.241	2.137	2.104
31. D.K.I. Jakarta	3.651	1.449	2.201
32. Jawa Barat	4.172	2.023	2.150
33. Jawa Tengah	4.165	2.041	2.124
34. Yogyakarta	4.104	1.997	2.107
35. Jawa Timur	4.123	2.034	2.088
Jawa	4.152	2.030	2.122
51. Bali	4.057	1.951	2.106
52. Nusatenggara Barat	4.235	2.092	2.143
53. Nusatenggara Yimur	4.311	2.219	2.093
54. Timor Timur	n.a	n.a	n.a
Bali & Nusa Tenggra	4.166	2.058	2.108
61. Kalimantan Barat	4.073	1.981	2.091
62. Kalimantan Tengah	4.171	2.091	2.079
63. Kalimantan Selatan	4.141	2.092	2.049
64. Kalimantan Timur	4.211	2.093	2.118
Kalimantan	4.129	2.058	2.071
71. Sulawesi Utara	4.273	2.168	2.105
72. Sulawesi Tengah	4.401	2.264	2.137
73. Sulawesi Selatan	4.242	2.097	2.145
74. Sulawesi Tenggara	4.662	2.480	2.182
Sulawesi	4.270	2.134	2.136
81. Maluku	5.101	2.993	2.108
82. Irian Jaya	5.210	3.058	2.152
Maluku & Irian Jaya	5.178	3.040	2.138
Indonesia	4.179	2.068	2.111

Source: JICA-FIDP team calculation based on Agricultural Survey Production of Cereals 1980 and 1991, CBS

Table 4.5 Change in the Extent of Contribution of Field Area and Crpping Intensity to Harvested Area of Lowland Paddy in 1991 as to 1983

	Harvested Area Log H91/Log H83	Contribution	
		Field Area Log F91/F83	CIh Log CIH91/CIH83
11. D.I. Aceh	4.069	2.069	2.000
12. Sumatera Utara	4.154	2.005	2.149
13. Sumatera Barat	4.063	2.032	2.031
14. Riau	4.129	2.129	2.000
15. Jambi	3.987	2.085	1.902
16. Sumatera Selatan	4.012	1.999	2.013
17. Bengkulu	4.121	2.078	2.043
18. Lampung	4.125	2.155	1.970
Sumatera	4.088	2.050	2.038
31. D.K.I. Jakarta	3.782	1.806	1.976
32. Jawa Barat	4.033	1.991	2.042
33. Jawa Tengah	4.051	2.008	2.043
34. Yogyakarta	3.984	1.991	1.993
35. Jawa Timur	4.023	2.000	2.023
Jawa	4.033	1.998	2.035
51. Bali	3.979	1.970	2.009
52. Nusatenggara Barat	4.057	2.014	2.043
53. Nusatenggara Timur	4.107	2.190	1.917
54. Timor Timur	n.a.	n.a.	n.a.
Bali & Nusatenggara	4.038	2.047	1.991
61. Kalimantan Barat	4.027	2.016	2.011
62. Kalimantan Tengah	4.072	2.384	1.688
63. Kalimantan Selatan	4.081	2.175	1.906
64. Kalimantan Timur	4.217	2.395	1.822
Kalimantan	4.072	2.174	1.898
71. Sulawesi Utara	4.116	2.098	2.018
72. Sulawesi Tengah	4.219	2.131	2.088
73. Sulawesi Selatan	4.104	2.030	2.074
74. Sulawesi Tenggara	4.400	2.286	2.114
Sulawesi	4.129	2.064	2.065
81. Maluku	n.a.	n.a.	n.a.
82. Irian Jaya	n.a.	n.a.	n.a.
Maluku & Irian Jaya	n.a.	n.a.	n.a.
Indonesia	4.058	2.046	2.013

Source: JICA-FIDP team calculation based on Agricultural Survey Production of Cereals and Land Area by Utilization, 1983 and 1991, CBS

Table 4.6 Trend Growth Projection on Harvested Area of Lowland Paddy by Province until Year 2020

unit: 000 ha

Province	1980	1985	1990	1995	2000	2005	2010	2015	2020
11 D.I. Aceh	211	268	291	306	317	326	334	341	347
12 Sumatera Utara	400	542	601	640	671	696	717	735	752
13 Sumatera Barat	270	328	350	365	358	385	392	398	404
14 Riau	77	92	98	102	105	107	109	110	112
15 Jambi	133	140	143	144	145	146	147	148	148
16 Sumatera Selatan	238	312	342	361	377	389	399	408	416
17 Bengkulu	43	63	72	78	83	87	90	93	95
18 Lampung	139	221	259	286	306	324	339	352	364
Sumatera	1,511	1,967	2,155	2,282	2,361	2,459	2,527	2,586	2,639
31 D.K.I. Jakarta	21	10	7	6	6	5	5	4	4
32 Jawa Barat	1,706	1,870	1,930	1,967	1,995	2,017	2,035	2,051	2,065
33 Jawa Tengah	1,266	1,406	1,456	1,489	1,513	1,532	1,548	1,561	1,573
34 Yogyakarta	105	101	100	99	99	98	98	97	97
35 Jawa Timur	1,374	1,469	1,502	1,523	1,538	1,551	1,561	1,569	1,568
Jawa	4,471	4,855	4,995	5,084	5,151	5,203	5,247	5,283	5,307
51 Bali	172	165	162	161	160	159	158	158	157
52 Nusatenggara Barat	204	233	244	251	256	260	264	267	270
53 Nusatenggara Timur	47	63	69	71	73	77	79	83	85
54 Timor Timur	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bali & Nusa Tenggara	423	460	475	483	489	496	502	508	512
61 Kalimantan Barat	184	181	181	180	180	180	179	179	179
62 Kalimantan Tengah	67	81	87	91	93	96	98	99	101
63 Kalimantan Selatan	256	303	321	333	341	348	354	359	364
64 Kalimantan Timur	35	39	41	42	42	43	43	44	44
Kalimantan	541	604	630	645	657	667	674	681	687
71 Sulawesi Utara	51	67	73	77	81	84	86	88	90
72 Sulawesi Tengah	57	91	106	117	126	133	139	145	150
73 Sulawesi Selatan	499	649	710	750	781	806	827	845	862
74 Sulawesi Tenggara	10	26	37	46	53	60	66	72	78
Sulawesi	616	833	926	991	1,041	1,082	1,119	1,150	1,179
81 Maluku	0	2	3	4	5	6	6	7	8
82 Irian Jaya	1	3	6	8	10	12	15	17	19
Maluku & Irian Jaya	1	5	8	12	15	18	21	24	27
Indonesia	7,563	8,725	9,190	9,497	9,714	9,925	10,089	10,234	10,352

Source: Projected by JICA-FIDP team

**Table 4.7 Trend Growth Projection on Lowland Paddy Yield by Province
until Year 2020**

Province	unit: ton/ha									
	1980	1985	1990	1995	2000	2005	2010	2015	2020	
11 D.I. Aceh	3.08	3.68	3.90	4.05	4.16	4.25	4.32	4.38	4.44	
12 Sumatera Utara	3.15	3.75	3.97	4.12	4.23	4.32	4.40	4.46	4.52	
13 Sumatera Barat	3.47	4.22	4.51	4.70	4.84	4.95	5.05	5.13	5.21	
14 Riau	2.29	2.92	3.17	3.34	3.46	3.57	3.65	3.73	3.79	
15 Jambi	2.68	3.06	3.21	3.30	3.36	3.42	3.46	3.50	3.53	
16 Sumatera Selatan	2.84	3.23	3.37	3.46	3.53	3.58	3.63	3.67	3.70	
17 Bengkulu	2.97	3.37	3.52	3.62	3.69	3.75	3.79	3.83	3.87	
18 Lampung	3.38	3.99	4.22	4.37	4.48	4.57	4.65	4.72	4.77	
Sumatera	3.08	3.66	3.88	4.02	4.13	4.22	4.29	4.35	4.41	
31 D.K.I. Jakarta	2.78	4.03	4.57	4.94	5.23	5.46	5.67	5.84	6.00	
32 Jawa Barat	3.59	4.61	5.02	5.28	5.49	5.65	5.79	5.92	6.02	
33 Jawa Tengah	3.92	4.81	5.16	5.38	5.55	5.69	5.81	5.91	6.00	
34 Yogyakarta	4.24	5.05	5.36	5.56	5.71	5.83	5.93	6.02	6.10	
35 Jawa Timur	4.43	5.05	5.28	5.43	5.54	5.63	5.70	5.77	5.82	
Jawa	3.95	4.81	5.14	5.36	5.52	5.66	5.77	5.86	5.95	
51 Bali	4.02	4.76	5.04	5.22	5.36	5.47	5.56	5.64	5.71	
52 Nusatenggara Barat	3.25	4.02	4.32	4.52	4.67	4.79	4.89	4.98	5.06	
53 Nusatenggara Timur	2.65	3.00	3.13	3.21	3.27	3.32	3.36	3.39	3.43	
54 Timor Timur	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Bali & Nusa Tenggara	3.50	4.15	4.39	4.55	4.67	4.76	4.84	4.91	4.97	
61 Kalimantan Barat	2.29	2.57	2.67	2.74	2.79	2.83	2.86	2.89	2.91	
62 Kalimantan Tengah	2.03	2.15	2.19	2.22	2.24	2.25	2.26	2.27	2.28	
63 Kalimantan Selatan	2.48	2.74	2.83	2.89	2.94	2.97	3.00	3.03	3.05	
64 Kalimantan Timur	2.13	2.50	2.63	2.72	2.79	2.84	2.89	2.93	2.96	
Kalimantan	2.34	2.59	2.69	2.75	2.79	2.83	2.85	2.88	2.90	
71 Sulawesi Utara	3.33	3.98	4.23	4.39	4.51	4.61	4.69	4.76	4.82	
72 Sulawesi Tengah	2.40	3.02	3.27	3.43	3.56	3.66	3.74	3.81	3.88	
73 Sulawesi Selatan	3.20	3.99	4.29	4.49	4.65	4.77	4.88	4.97	5.05	
74 Sulawesi Tenggara	2.31	3.08	3.40	3.62	3.78	3.91	4.02	4.12	4.21	
Sulawesi	3.12	3.85	4.13	4.32	4.46	4.57	4.67	4.75	4.82	
81 Maluku	2.20	2.60	2.75	2.85	2.92	2.98	3.03	3.07	3.11	
82 Irian Jaya	1.96	2.46	2.65	2.78	2.88	2.96	3.03	3.09	3.14	
Maluku & Irian Jaya	2.03	2.51	2.70	2.82	2.91	2.99	3.05	3.10	3.15	
Indonesia	3.57	4.27	4.54	4.71	4.84	4.94	5.03	5.10	5.17	

Source: Projected by JICA-FIDP team

Table 4.8 Trend Growth Projection on Lowland Paddy Production by Province until Year 2020

unit: 000 ton

Province	1980	1985	1990	1995	2000	2005	2010	2015	2020
11 D.I. Aceh	650	986	1,135	1,238	1,319	1,386	1,444	1,495	1,541
12 Sumatera Utara	1,259	2,032	2,389	2,640	2,839	3,005	3,150	3,278	3,394
13 Sumatera Barat	937	1,385	1,580	1,714	1,819	1,906	1,980	2,046	2,104
14 Riau	176	269	311	340	362	381	397	412	425
15 Jambi	356	429	457	475	489	500	509	517	524
16 Sumatera Selatan	676	1,007	1,151	1,251	1,329	1,393	1,449	1,498	1,541
17 Bengkulu	128	213	253	282	305	324	341	356	369
18 Lampung	470	883	1,094	1,248	1,374	1,481	1,576	1,662	1,740
Sumatera	4,652	7,203	8,370	9,189	9,836	10,377	10,846	11,263	11,638
31 D.K.I. Jakarta	58	39	34	31	29	28	27	26	25
32 Jawa Barat	6,131	8,625	9,680	10,397	10,949	11,404	11,793	12,113	12,438
33 Jawa Tengah	4,956	6,761	7,510	8,014	8,400	8,717	8,987	9,223	9,433
34 Yogyakarta	446	512	536	552	563	572	580	587	593
35 Jawa Timur	6,082	7,420	7,936	8,273	8,527	8,731	8,903	9,052	9,184
Jawa	17,673	23,356	25,696	27,266	28,469	29,452	30,290	31,001	31,672
51 Bali	691	783	818	840	856	869	880	890	898
52 Nusatenggara Barat	662	938	1,056	1,136	1,197	1,248	1,292	1,330	1,364
53 Nusatenggara Timur	125	188	216	235	250	263	274	283	292
54 Timor Timur	na	na	na	na	na	na	na	na	na
Bali & Nusatenggara	1,479	1,910	2,090	2,211	2,304	2,381	2,446	2,502	2,553
61 Kalimantan Barat	420	466	483	493	501	507	513	517	521
62 Kalimantan Tengah	135	175	191	201	209	215	221	226	230
63 Kalimantan Selatan	633	830	909	962	1,003	1,036	1,064	1,088	1,110
64 Kalimantan Timur	74	98	107	113	118	122	125	128	131
Kalimantan	1,263	1,569	1,690	1,770	1,831	1,881	1,923	1,959	1,991
71 Sulawesi Utara	169	265	309	340	365	385	402	418	432
72 Sulawesi Tengah	137	275	348	403	448	487	521	553	581
73 Sulawesi Selatan	1,594	2,587	3,047	3,372	3,629	3,844	4,031	4,197	4,347
74 Sulawesi Tenggara	22	81	126	165	201	235	267	298	328
Sulawesi	1,922	3,208	3,830	4,280	4,642	4,951	5,222	5,466	5,688
81 Maluku	1	4	7	11	14	17	20	23	25
82 Irian Jaya	1	8	15	22	29	37	44	52	60
Maluku & Irian Jaya	2	12	22	33	43	53	64	75	85
Indonesia	26,990	37,257	41,699	44,749	47,125	49,095	50,790	52,265	53,629

Source: Projected by JICA- FIDP team

Table 4.9 Trend Growth Projection on Upland Paddy Production by Province until Year 2020

Province	unit: 000 ton									
	1980	1985	1990	1995	2000	2005	2010	2015	2020	
11 D.I. Aceh	20	18	17	17	16	16	16	16	16	
12 Sumatera Utara	188	167	161	157	154	152	151	149	148	
13 Sumatera Barat	10	23	30	35	40	44	48	51	54	
14 Riau	54	77	87	94	99	103	107	110	113	
15 Jambi	16	47	69	87	103	118	131	144	156	
16 Sumatera Selatan	151	176	185	191	195	199	202	204	207	
17 Bengkulu	34	37	38	39	39	40	40	40	40	
18 Lampung	174	226	247	261	271	280	287	294	299	
Sumatera	647	771	834	881	919	952	982	1,008	1,033	
31 D.K.I. Jakarta	0	0	0	0	0	0	0	0	0	
32 Jawa Barat	155	297	370	424	469	506	540	570	597	
33 Jawa Tengah	63	126	159	184	205	222	238	252	265	
34 Yogyakarta	51	83	98	109	117	124	130	135	140	
35 Jawa Timur	98	187	233	266	294	317	338	357	374	
Jawa	367	694	860	984	1,084	1,170	1,246	1,314	1,376	
51 Bali	9	5	4	4	4	3	3	3	3	
52 Nusatenggara Barat	26	28	28	29	29	30	30	30	30	
53 Nusatenggara Timur	87	98	101	104	106	107	108	109	110	
54 Timor Timur	0	0	0	0	0	0	0	0	0	
Bali & Nusatenggara	122	130	134	136	139	140	141	142	143	
61 Kalimantan Barat	134	166	179	187	193	198	203	206	210	
62 Kalimantan Tengah	52	69	76	81	85	88	90	92	94	
63 Kalimantan Selatan	41	55	60	64	67	70	72	73	75	
64 Kalimantan Timur	50	82	98	108	117	124	131	136	141	
Kalimantan	276	372	413	441	462	480	495	508	520	
71 Sulawesi Utara	19	21	22	22	22	22	23	23	23	
72 Sulawesi Tengah	66	35	29	25	23	21	20	19	18	
73 Sulawesi Selatan	42	33	31	29	28	27	27	26	26	
74 Sulawesi Tenggara	36	29	27	25	25	24	23	23	23	
Sulawesi	164	118	107	101	98	95	93	91	90	
81 Maluku	28	12	9	7	7	6	5	5	5	
82 Irian Jaya	1	2	3	3	4	4	5	5	6	
Maluku & Irian Jaya	29	14	11	11	10	10	10	10	10	
Indonesia	1,604	2,098	2,360	2,553	2,711	2,847	2,966	3,074	3,173	

Source: Projected by JICA-FIDP team

Table 4.10 Trend Growth Projection on Paddy Production by Province until Year 2020

Province	unit: 000 ton								
	1980	1985	1990	1995	2000	2005	2010	2015	2020
11 D.I. Aceh	670	1,004	1,152	1,255	1,335	1,402	1,460	1,511	1,557
12 Sumatera Utara	1,447	2,199	2,550	2,797	2,993	3,157	3,301	3,427	3,542
13 Sumatera Barat	947	1,408	1,610	1,749	1,859	1,950	2,028	2,097	2,158
14 Riau	230	346	398	434	461	484	504	522	538
15 Jambi	372	475	526	562	592	618	640	661	680
16 Sumatera Selatan	827	1,183	1,336	1,442	1,524	1,592	1,651	1,702	1,748
17 Bengkulu	162	250	291	321	344	364	381	396	409
18 Lampung	644	1,109	1,341	1,509	1,645	1,761	1,863	1,956	2,039
Sumatera	5,299	7,974	9,204	10,069	10,755	11,329	11,828	12,271	12,671
31 D.K.I. Jakarta	58	39	34	31	29	28	27	26	25
32 Jawa Barat	6,286	8,922	10,050	10,821	11,418	11,910	12,333	12,683	13,035
33 Jawa Tengah	5,019	6,887	7,669	8,198	8,605	8,939	9,225	9,475	9,698
34 Yogyakarta	497	595	634	660	680	696	710	722	733
35 Jawa Timur	6,180	7,607	8,169	8,539	8,821	9,048	9,241	9,409	9,558
Jawa	18,040	24,050	26,556	28,250	29,553	30,622	31,536	32,315	33,049
51 Bali	700	789	822	844	860	873	883	893	901
52 Nusatenggara Barat	688	966	1,084	1,165	1,226	1,278	1,322	1,360	1,394
53 Nusatenggara Timur	212	286	317	339	356	371	382	392	402
54 Timor Timur	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bali & Nusa Tenggara	1,600	2,040	2,224	2,347	2,442	2,521	2,587	2,645	2,697
61 Kalimantan Barat	554	632	662	680	694	705	716	723	730
62 Kalimantan Tengah	187	244	267	282	294	303	311	318	324
63 Kalimantan Selatan	674	885	970	1,026	1,070	1,106	1,136	1,161	1,185
64 Kalimantan Timur	124	180	204	222	235	247	256	264	272
Kalimantan	1,539	1,941	2,103	2,210	2,293	2,360	2,418	2,467	2,511
71 Sulawesi Utara	188	286	331	362	387	408	425	441	455
72 Sulawesi Tengah	203	310	377	428	471	508	541	572	599
73 Sulawesi Selatan	1,636	2,620	3,078	3,401	3,657	3,871	4,058	4,223	4,373
74 Sulawesi Tenggara	58	110	153	190	225	259	290	321	351
Sulawesi	2,086	3,326	3,938	4,381	4,740	5,046	5,314	5,557	5,778
81 Maluku	29	16	16	18	21	23	25	28	30
82 Irian Jaya	2	10	18	25	33	41	49	57	66
Maluku & Irian Jaya	30	26	34	44	53	63	74	85	95
Indonesia	28,593	39,357	44,059	47,302	49,836	51,941	53,756	55,340	56,802

Source: Projected by JICA-FIDP team

Table 4.11. Categorization of Provinces by Production and Environment of Lowland Paddy (1/2) - Basic Data for Ranking

Province	Yield (kg/ha)	Yield rate (kg/ha/year)	Contribution to Production		Contribution to Harvested area		Increased field area		Ratio of Irr. Field Fertilizer (kg/ha)	Amount of Fertilizer (kg/ha)	Ratio of Int. area
			Harvested area	Yield	Field area	Clh Area (ha/year)	Ratio				
11 D.I. Aceh	4.033	71	2.158	2.112	2.069	2.000	52.9	19.6%	47.4%	162.4	81.3%
12 Sumatera Utara	4.002	70	2.161	2.103	2.005	2.149	16.6	3.2%	51.7%	287.0	95.3%
13 Sumatera Barat	4.637	94	2.094	2.113	2.032	2.031	5.0	2.3%	71.0%	367.4	99.9%
14 Riau	3.232	75	2.139	2.141	2.129	2.000	59.1	38.7%	12.8%	156.7	81.3%
15 Jambi	3.291	48	2.021	2.071	2.085	1.902	49.6	30.4%	14.2%	77.5	75.7%
16 Sumatera Selatan	3.487	46	2.098	2.080	1.999	2.013	35.0	8.3%	16.0%	238.2	88.6%
17 Bengkulu	3.611	40	2.195	2.089	2.078	2.043	10.9	18.0%	69.3%	173.2	87.2%
18 Lampung	4.286	68	2.226	2.110	2.155	1.970	48.6	29.1%	61.6%	356.3	99.5%
Sumatera	3.974	69	2.137	2.104	2.050	2.038	277.6	14.0%	41.0%	250.4	91.8%
31 D.K.I. Jakarta	4.757	174	1.449	2.201	1.806	1.976	0.0	0.0%	71.6%	n.a.	100.0%
32 Jawa Barat	5.188	126	2.023	2.150	1.991	2.042	-8.5	-0.7%	75.8%	434.0	100.0%
33 Jawa Tengah	5.241	106	2.041	2.124	2.008	2.043	17.8	1.8%	69.1%	388.7	100.0%
34 Yogyakarta	5.467	95	1.997	2.107	1.991	1.993	-0.2	-0.3%	84.5%	365.1	100.0%
35 Jawa Timur	5.393	72	2.034	2.088	2.000	2.023	14.8	1.3%	77.1%	426.3	99.7%
Jawa	5.271	103	2.030	2.122	1.998	2.035	23.9	0.7%	74.5%	417.7	99.9%
51 Bali	5.236	93	1.951	2.106	1.970	2.009	-4.7	-4.8%	98.6%	358.9	100.0%
52 Nusatenggara Barat	4.482	93	2.092	2.143	2.014	2.043	5.7	3.0%	79.8%	382.1	96.5%
53 Nusatenggara Timur	3.107	31	2.219	2.093	2.190	1.917	42.3	55.4%	49.7%	25.8	40.9%
54 Timor Timur	na	na	na	na	na	na	na	na	na	na	na
Bali & Nusatenggara	2.726	77	2.058	2.108	2.047	1.991	43.2	11.8%	75.3%	305.4	89.0%
61 Kalimantan Barat	2.375	29	1.987	2.091	2.016	2.011	55.5	14.8%	16.0%	148.4	60.9%
62 Kalimantan Tengah	2.904	11	2.091	2.079	2.348	1.688	98.0	78.9%	14.2%	45.7	71.5%
63 Kalimantan Selatan	2.748	32	2.092	2.049	2.175	1.906	150.7	47.6%	5.6%	182.3	98.2%
64 Kalimantan Timur	2.771	43	2.093	2.118	2.395	1.822	105.7	189.4%	6.1%	57.6	74.6%
Kalimantan	4.232	29	2.058	2.071	2.174	1.898	410.0	47.0%	10.7%	119.3	81.0%
71 Sulawesi Utara	3.308	70	2.168	2.105	2.098	2.018	12.8	23.7%	75.8%	279.4	98.2%
72 Sulawesi Tengah	4.353	75	2.264	2.137	2.131	2.088	9.7	8.9%	77.7%	165.2	82.7%
73 Sulawesi Selatan	3.427	89	2.097	2.145	2.030	2.074	35.6	6.4%	55.3%	254.8	98.0%
74 Sulawesi Tenggara	4.161	80	2.480	2.182	2.286	2.114	27.3	91.9%	61.3%	118.8	81.6%
Sulawesi	4.1	82	2.134	2.136	2.064	2.065	85.3	11.4%	61.1%	242.4	95.6%
81 Maluku	na	na	na	na	na	na	na	na	na	na	na
82 Irian Jaya	na	na	na	na	na	na	na	na	na	na	na
Maluku & Irian Jaya	na	na	na	na	na	na	na	na	na	na	na
Indonesia	4.617	82	2.068	2.111	2.046	13.000	840.0	11.4%	54.0%	337.9	95.7%

Source: JICA-FIDP team estimation based on BIMAS, Agricultural Survey Production of Cereals in Indonesia 1980-1991 and Land Area by Utilization 1983-1991, CBS

Table 4.12 Present Situation of Factors for Increasing Paddy Production by Province

Province	Yield(ton/ha)			Yield increase potential (ton/ha)			Yield Inc. rate	Cult. Irr. area	Whole A. field area	Increased field area	Ratio	Ratio of Amount of	
	Irrig.	Rainfed	Others	Irrig.	Rainfed	Others						Irr. field	fertilizer
11 D.I. Aceh	4.42	3.60	3.29	4.03	1.40	0.21	72	1.030	0.905	52.9	19.6%	45.0%	162.4
12 Sumatera Utara	4.18	3.74	2.92	4.00	1.26	0.58	83	1.566	1.106	16.6	3.2%	50.4%	287
13 Sumatera Barat	5.08	3.11	2.96	4.64	1.89	0.55	97	1.762	1.334	5.0	2.3%	70.2%	367.4
14 Riau	3.86	3.13	2.99	3.23	1.87	0.51	79	1.649	0.453	59.1	38.7%	10.9%	156.7
15 Jambi	4.06	3.70	2.70	3.29	1.30	0.80	51	1.638	0.640	49.5	30.3%	19.2%	77.5
16 Sumatera Selatan	4.13	4.29	2.93	3.49	0.71	0.57	67	1.669	0.746	35.0	8.3%	12.9%	238.2
17 Bengkulu	3.61	4.17	2.79	3.61	0.83	0.71	35	1.345	0.952	10.9	18.0%	62.0%	173.2
18 Lampung	4.51	3.59	2.67	4.29	1.41	0.83	75	1.368	1.151	48.6	29.1%	59.5%	356.3
Sumatera	4.42	3.62	2.89	3.97	1.38	0.61	75	1.484	0.941	277.6	14.0%	38.6%	250.4
31 D.K.I. Jakarta	4.78	2.85	2.33	4.76	2.15	1.18	191	2.040	1.226	-1.4	-16.9%	67.0%	n.a.
32 Jawa Barat	5.43	4.00	3.13	5.19	1.00	0.37	119	1.719	1.652	-7.7	-0.6%	74.6%	434
33 Jawa Tengah	5.57	4.44	2.53	5.24	0.56	0.97	118	1.590	1.479	18.7	1.9%	65.4%	388.7
34 Yogyakarta	5.72	3.84	0.00	5.47	1.16	3.50	100	1.661	1.623	-0.7	-1.1%	81.4%	365.1
35 Jawa Timur	5.51	4.83	2.51	5.39	0.17	0.99	74	1.356	1.298	4.8	0.4%	75.6%	426.3
Jawa	5.49	4.40	2.89	5.27	0.60	0.61	110	1.555	1.480	13.6	0.4%	72.4%	417.7
51 Bali	5.26	3.17	2.51	5.24	1.83	0.99	90	1.843	1.834	-4.7	-4.8%	98.7%	358.9
52 Nusatenggara Barat	4.58	3.71	0.00	4.48	1.29	3.50	93	1.341	1.270	5.6	2.9%	77.3%	382.1
53 Nusatenggara Timur	3.17	2.48	2.07	3.11	2.52	1.44	37	0.864	0.570	42.3	55.4%	53.4%	25.8
54 Timor Timur	na	na	na	na	na	na	na	na	na	na	na	na	na
Bali & Nusatenggara	4.59	3.46	2.32	2.73	1.54	1.18	70	1.394	1.197	43.2	11.8%	75.3%	305.4
61 Kalimantan Barat	4.55	2.14	1.92	2.38	2.86	1.58	15	0.940	0.464	55.5	14.8%	22.6%	143.4
62 Kalimantan Tengah	0.72	1.36	3.08	2.90	3.64	0.43	50	0.469	0.395	98.0	78.9%	21.0%	45.7
63 Kalimantan Selatan	5.71	2.78	2.56	2.75	2.22	0.94	36	1.277	0.670	150.7	47.6%	8.0%	182.3
64 Kalimantan Timur	2.77	2.56	2.91	2.77	2.44	0.59	37	1.000	0.243	105.7	189.4%	3.8%	57.6
Kalimantan	4.14	2.44	2.61	4.23	2.56	0.89	29	0.892	0.499	409.9	47.0%	14.6%	119.3
71 Sulawesi Utara	4.43	3.26	2.98	3.31	1.74	0.52	83	1.399	1.074	12.8	23.7%	66.6%	279.4
72 Sulawesi Tengah	3.33	2.55	2.23	4.35	2.45	1.27	88	1.020	0.909	9.7	8.9%	81.0%	165.2
73 Sulawesi Selatan	4.62	3.81	2.56	3.43	1.19	0.94	102	1.576	1.309	35.6	6.4%	53.6%	254.8
74 Sulawesi Tenggara	3.49	2.82	2.62	4.16	2.18	0.88	104	1.091	0.708	27.3	91.9%	52.3%	118.8
Sulawesi	4.31	3.76	2.58	4.10	1.24	0.92	96	1.420	1.192	85.2	11.4%	58.5%	242.4
81 Maluku	na	na	na	na	na	na	na	na	na	na	na	na	na
82 Irian Jaya	na	na	na	na	na	na	na	na	na	na	na	na	na
Maluku & Irian Jaya	na	na	na	na	na	na	na	na	na	na	na	na	na
Indonesia	5.07	3.84	2.76	4.62	2.24	0.74	88	1.486	1.136	829.5	11.2%	52.7%	337.9

Source: JICA-FIDP team estimation based on BIMAS, Agricultural Survey Production of Cereals in Indonesia 1980-1991 and Land Area by Utilization 1983-1991, CBS

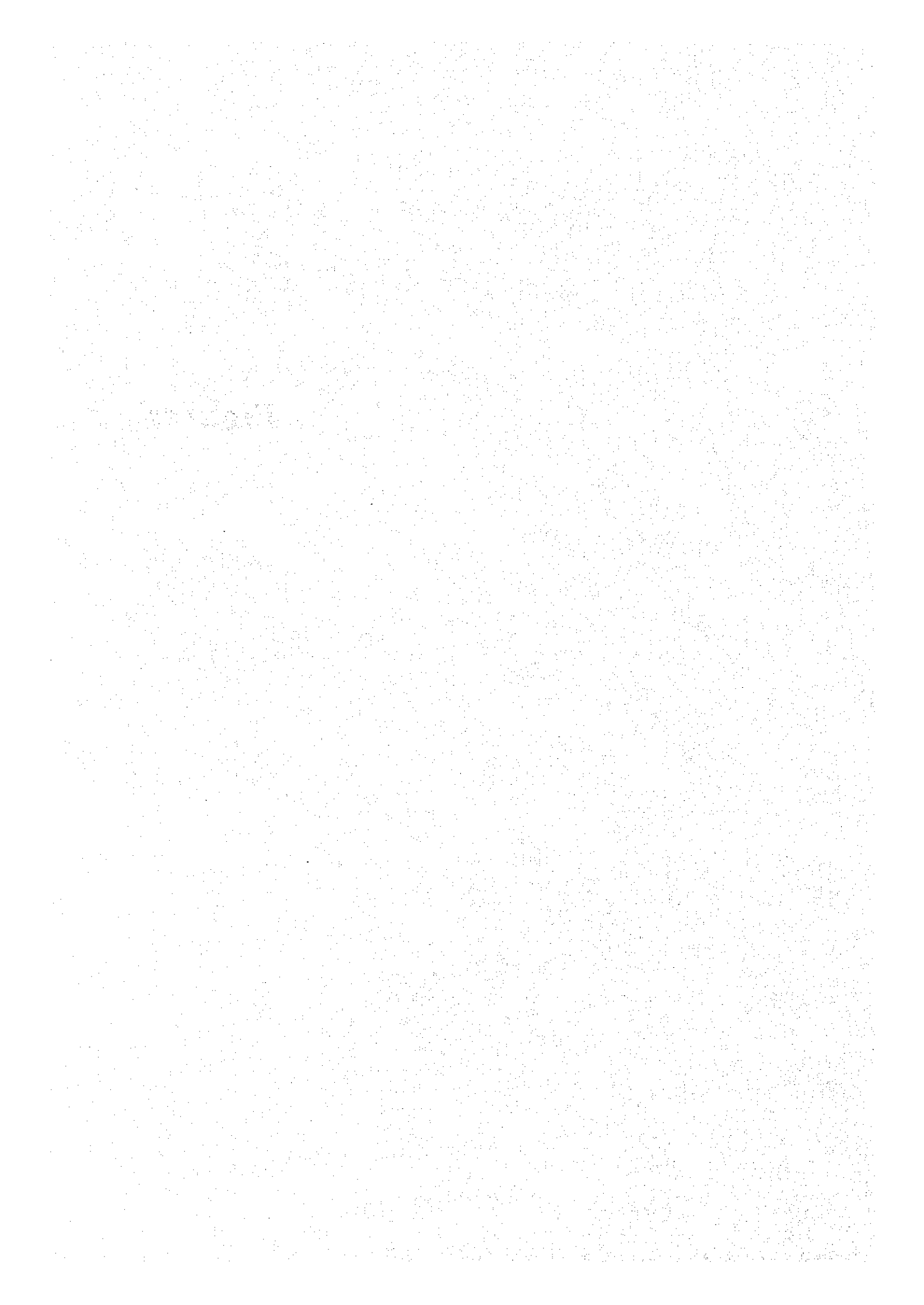
Table 4.13 Categorization of Provinces by Production and Environment of Lowland Paddy (2/2) - Ranking -

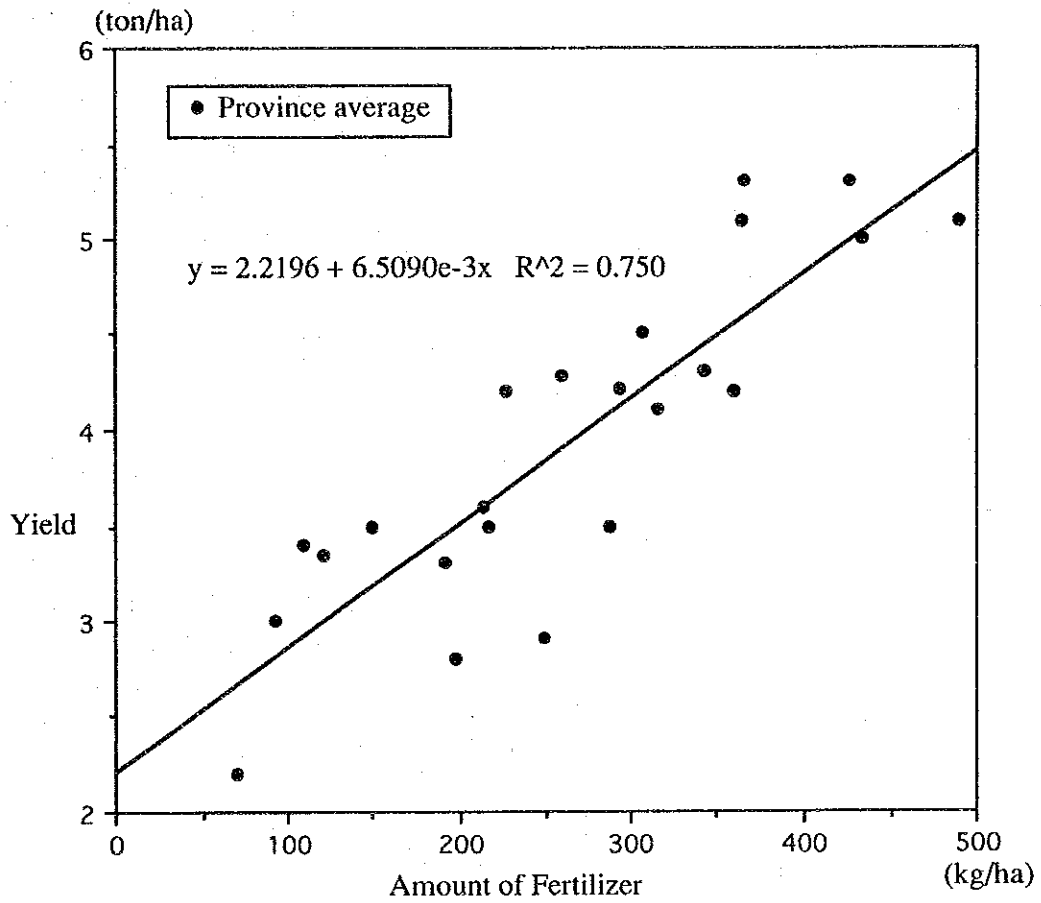
Province	Yield		Yield rate		Contribution to Production		Contribution to Harvested area		Increased field area		Ratio		Amount of Fertilizer		Ratio of Int. area	Category type
	Yield	Rate	Harvested area	Yield	Field area	CH	Area	Area	Area	Area	Irr. Field	Fertilizer	Int. area			
11 D.I. Aceh	4	3	1	2	3	5	2	3	3	3	4	4	2			
12 Sumatera Utara	4	3	1	2	4	2	4	3	3	3	2	1	2			
13 Sumatera Barat	2	2	3	2	4	4	5	1	4	2	1	1	1			
14 Riau	5	3	3	1	1	5	2	3	1	5	4	4	3			
15 Jambi	5	5	5	3	2	3	1	5	2	1	5	5	3			
16 Sumatera Selatan	5	4	1	3	4	4	3	3	4	5	3	3	3			
17 Bengkulu	5	5	1	3	3	5	4	3	4	2	4	3	3			
18 Lampung	3	3	1	2	2	4	3	2	2	2	2	1	2			
Sumatera	3	3	3	3	3	4	3	3	3	4	3	2	n.a.			
31 D.K.I. Jakarta	2	1	5	1	5	4	5	5	2	2	n.a.	1	1			
32 Jawa Barat	1	1	3	1	5	3	5	1	2	2	1	1	1			
33 Jawa Tengah	1	1	1	2	4	3	4	4	2	2	1	1	1			
34 Yogyakarta	1	1	5	2	5	5	5	5	1	1	1	1	1			
35 Jawa Timur	1	3	3	2	4	4	4	4	2	2	1	1	1			
Jawa	1	1	3	1	4	3	4	4	2	2	1	1	n.a.			
51 Bali	1	2	5	2	5	3	5	5	1	2	2	1	1			
52 Nusatenggara Barat	3	2	4	1	4	3	4	4	2	1	1	1	2			
53 Nusatenggara Timur	5	5	1	1	5	2	1	3	5	3	5	5	3			
54 Timor Timur	na	na	na	na	na	na	na	na	na	na	na	na	na			
Bali & Nusatenggara Tintim	3	3	3	2	3	5	3	3	2	2	3	3	n.a.			
61 Kalimantan Barat	5	5	4	3	3	5	2	3	4	4	4	5	3			
62 Kalimantan Tengah	5	5	2	5	1	5	1	1	4	5	5	5	3			
63 Kalimantan Selatan	5	3	3	4	1	5	1	1	1	4	3	1	3			
64 Kalimantan Timur	5	5	4	2	5	1	1	1	2	5	5	5	3			
Kahmantan	5	5	3	3	1	5	1	1	1	5	4	4	n.a.			
71 Sulawesi Utara	3	3	2	2	1	5	4	2	2	2	3	1	2			
72 Sulawesi Tengah	5	2	1	1	4	2	4	4	1	4	4	4	2			
73 Sulawesi Selatan	3	1	1	1	4	1	3	4	3	3	1	2	2			
74 Sulawesi Tenggara	5	1	1	1	1	2	3	1	1	3	4	4	2			
Sulawesi	3	2	1	1	3	2	3	3	3	3	3	1	n.a.			
81 Maluku	na	na	na	na	na	na	na	na	na	na	na	na	na			
82 Irian Jaya	na	na	na	na	na	na	na	na	na	na	na	na	na			
Mahuku & Irian Jaya	na	na	na	na	na	na	na	na	na	na	na	na	na			
Indonesia	3	2	3	2	3	4	3	3	3	3	2	1	n.a.			

Source: JICA-FIDP team estimation, based on BIMAS, Agricultural Survey Production of Cereals and Land Area by Utilization, CBS

Rank	Yield	Yield/Contribution to Production		Contribution to Harvested area		Increased field area		Ratio of Amount of Fertilizer		Ratio of Int. Area
		Rate	Harvested area	Field Area	CH	Area	Area	Irr. Field	Fertilizer	
1	>5.0	>100	>2.12	>2.12	>2.12	>60	>30	80-100	>360	95-100
2	4.5-5	85-100	2.08-2.12	2.08-2.12	2.08-2.12	40-60	20-30	60-80	280-360	90-95
3	4.0-4.5	70-85	2.04-2.08	2.04-2.08	2.04-2.08	20-40	10-20	40-60	180-280	85-90
4	3.5-4.0	55-70	2.00-2.04	2.00-2.04	2.00-2.04	0-20	0-10	20-40	100-180	80-85
5	-3.5	-55	-2.00	-2.00	-2.00	-0	-0	0-20	0-100	-80

Figures





Source : Table 3.23

Figure 3.1 Relationship between Applied amount of Fertilizer and Paddy Yield under Intensification Program

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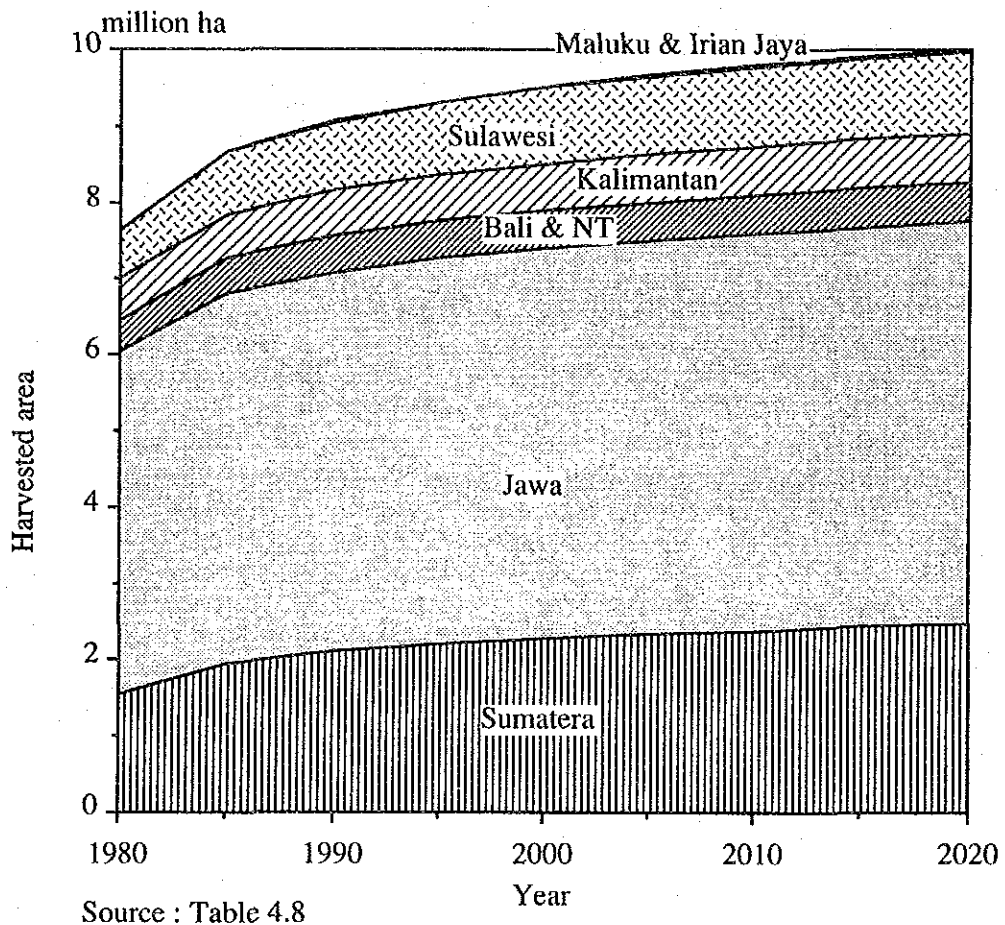


Figure 4.1 Trend Growth Projectin on Harvested Area of Lowland Paddy until Year 2020

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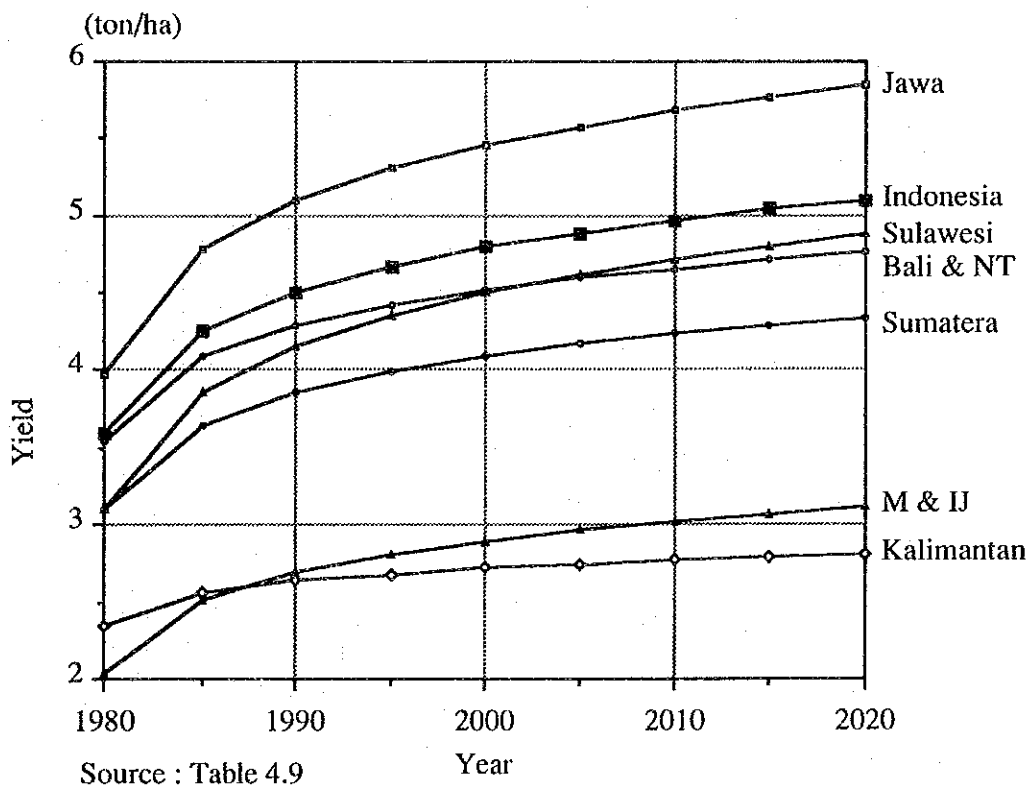
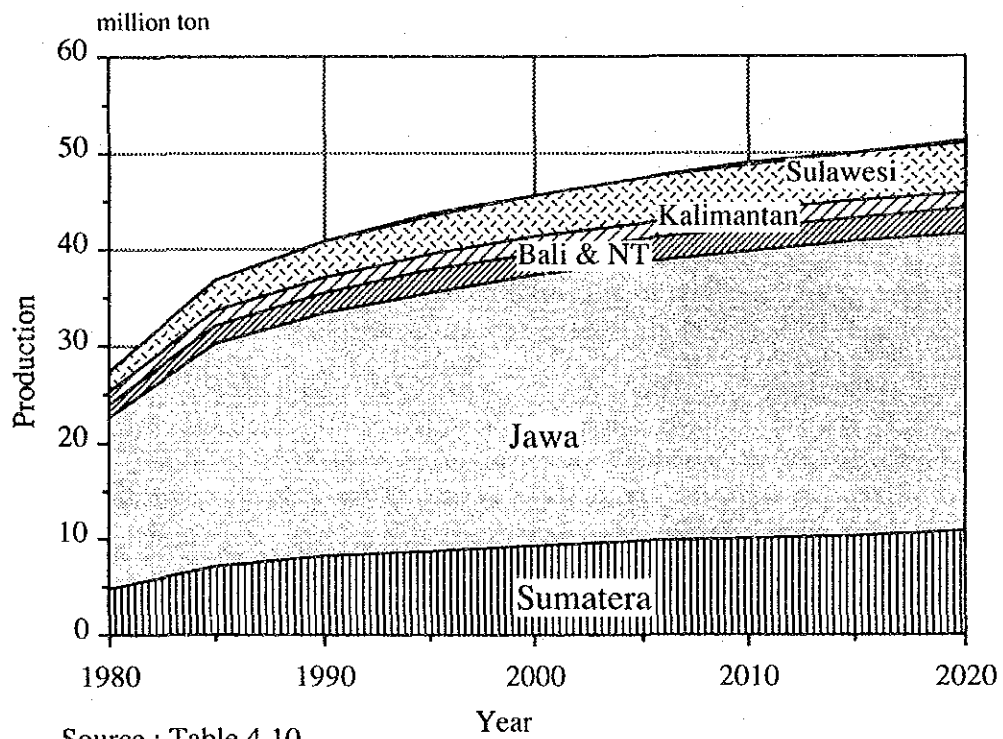


Figure 4.2 Trend Growth Projection on Yield of Lowland Paddy until Year 2020

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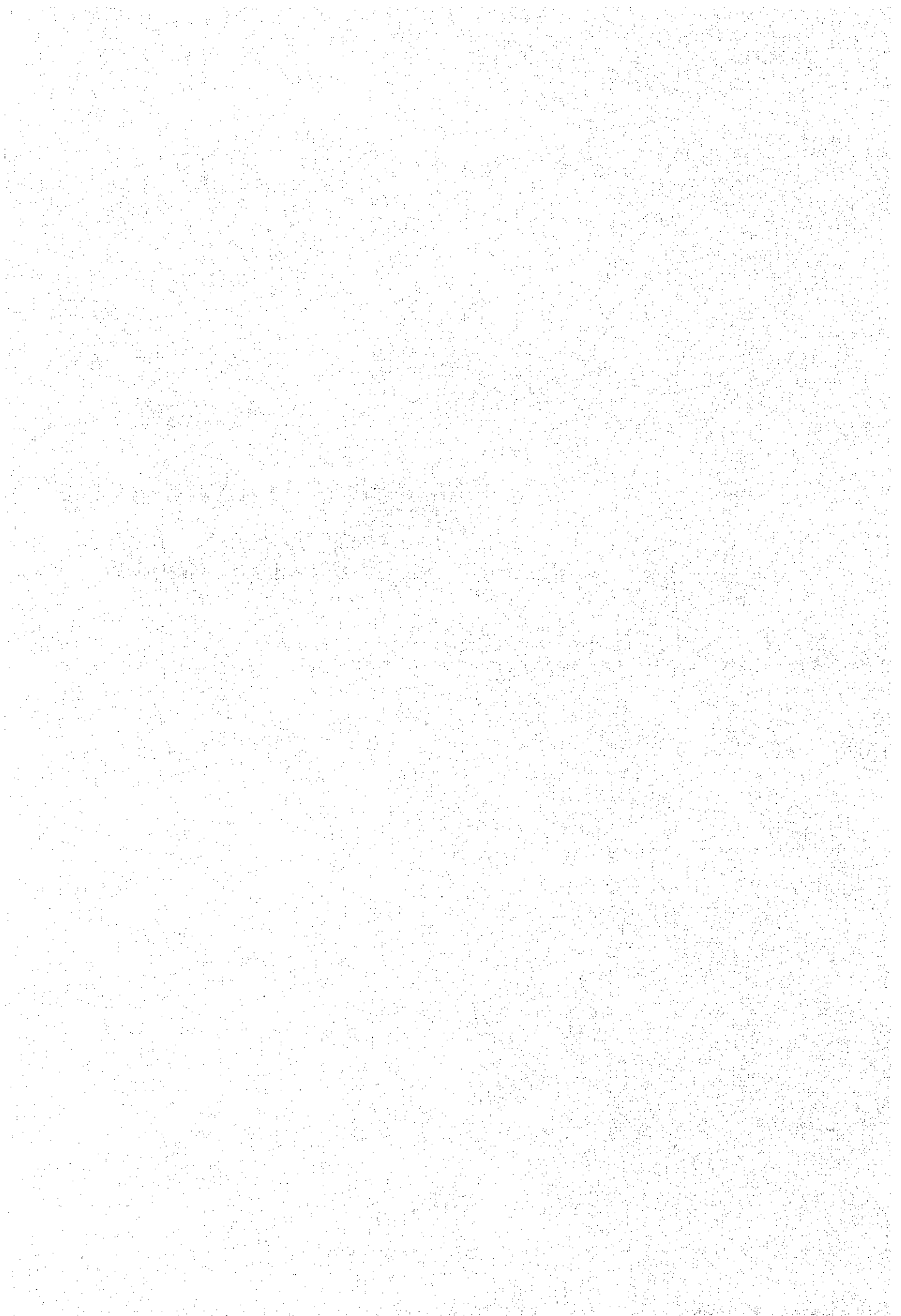
Source : Table 4.10

Figure 4.3 Trend Growth Projection on Production of Lowland Paddy until Year 2020

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Appendix

Statistical Analysis for Crop Cutting Test of LowLand Paddy



Appendix: Statistical Analysis for Crop Cutting Test of LowLand Paddy

Everybody wants to increase the yield of paddy and also to know which factor is a key factor for increasing paddy yield, namely irrigation or fertilizer. But is it true and what type of irrigation is the most favourable for increasing yield and how much amount of fertilizer application is the most effective for increasing yield ? To solve and to make clear the question, a many data of field experiment and analysis of these data are required.

Fortunately enough data of crop cutting test of lowland paddy covering whole Indonesia are now available for analysis of the effect of irrigation and fertilizer application on the paddy yield. Followings show the procedure of statistical analysis of the data of crop cutting test to make clear the contribution of each type of irrigation system and that of the amount of fertilizer application to the paddy yield, and the interaction effect of the type of irrigation facility and the amount of fertilizer application to the paddy yield.

Data source

Central Bureau of Statistics (CBS) has carried out a crop cutting survey of paddy for the first crop season in 1991 with assistance of Ministry of Agriculture and stored those data into micro computer, but not all of them. JICA-FIDP team requested CBS the sample data of the crop cutting test on May 1992 and received 11,261 records of the complete data of the crop cutting test by several diskettes on early July 1992. Many information such as province, kabupaten, kecamatan, irrigation type, fertilizer name and quantity, pesticide name and quantity, intensification programme and grain weight per unit area (kg per 6.25m²) are recorded in the data.

Data Screening and Preprocessing

Before processing the data, each sample was assessed by following criteria and discard extraordinary or insufficient data.

1. data which has not complete information are omitted
2. samples in which grain weight of paddy per plot under each intensification programme are more than following standard, are eliminated

Programme	weight (kg/6.25m ²)
INSUS	6.30
INMUM	5.50
Non program	4.50

3. samples in which total quantity of fertilizer is more than 800 kg/ha should be eliminated

By application of above criteria, 8,981 samples were selected for further statistical analysis.

In addition to the two factors, irrigation and fertilizer, the province code, intensification programme and yield are extracted from the selected samples and then each data were arranged as shown below, for example;

Province Code	Irrigation Type	Total Fertilizer (kg/ha)	Intensification Program	Yield (ton/ha)
12	1	465	Is	5.65
31	2	120	Im	4.75
52	5	50	N	3.52
⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮

[Yield] is converted from the data of the crop cutting test (kg/6.25 m²) to the grain weight per one hecter (ton/ha).

[Irrigation Type] shows the type of irrigation as tabulated below

No.	Type
1	Technical irrigation
2	Semi-technical irrigation
3	Simple irrigation
4	Village irrigation
5	Rainfed (no irrigation)

Following table shows the [Province Code] and its province name.

Code	Province Name	Code	Province Name	Code	Province Name
11	D.I. Aceh	32	Jawa Barat	62	Kalimantan Tengah
12	Sumatera Utara	33	Jawa Tengah	63	Kalimantan Selatan
13	Sumatera Barat	34	D.I. Yogyakarta	64	Kalimantan Timur
14	Riau	35	Jawa Timur	71	Sulawesi Utara
15	Jambi	51	Bali	72	Sulawesi Tengah
16	Sumatera Selatan	52	Nusa Tenggara Barat	73	Sulawesi Selatan
17	Bengkulu	53	Nusa Tenggara Timur	74	Sulawesi Tenggara
18	Lampung	54	Timor Timur	81	Maluku
31	D.K.I. Jakarta	61	Kalimantan Barat	82	Irian Jaya

[Intensification Programme] is classified into three category namely ;

- Is : INSUS Programme,
- Im : INMUM Programme and
- N : Non Programme.

[Total Fertilizer] is a total quantity of fertilizers including Urea, TSP, ZPT/PPC etc. This item has values of numeric measurements and not classifications number or character. This item was converted to classification number for further factorial analysis. In this analysis, total amount of fertilizer were classified into following 8 levels at ascending order.

Level	Total amount of fertilizer (kg/ha)	Level	Total amount of fertilizer (kg/ha)
1	0	5	351 ~ 450
2	1 ~ 150	6	451 ~ 550
3	151 ~ 250	7	551 ~ 650
4	251 ~ 350	8	651 ~ 800

Then the data was converted in new column of [Total Fertilizer Level] like as follows. All the data are shown in Table B.1

Province Code	Irrigation Type	Total Fertilizer (kg/ha)	Intensification Program	Yield (ton/ha)	Total Fertilizer Level
12	1	465	Is	5.65	7
31	2	120	Im	4.75	3
52	5	50	N	3.52	2
⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮

Now the data is ready to analysis.

Statistical analysis

Q-1 Which irrigation type contributes to get more yield ?

Calculation of mean yield and variation of yield for each irrigation type may answer this question. Calculation results and plotted all the data are shown below.

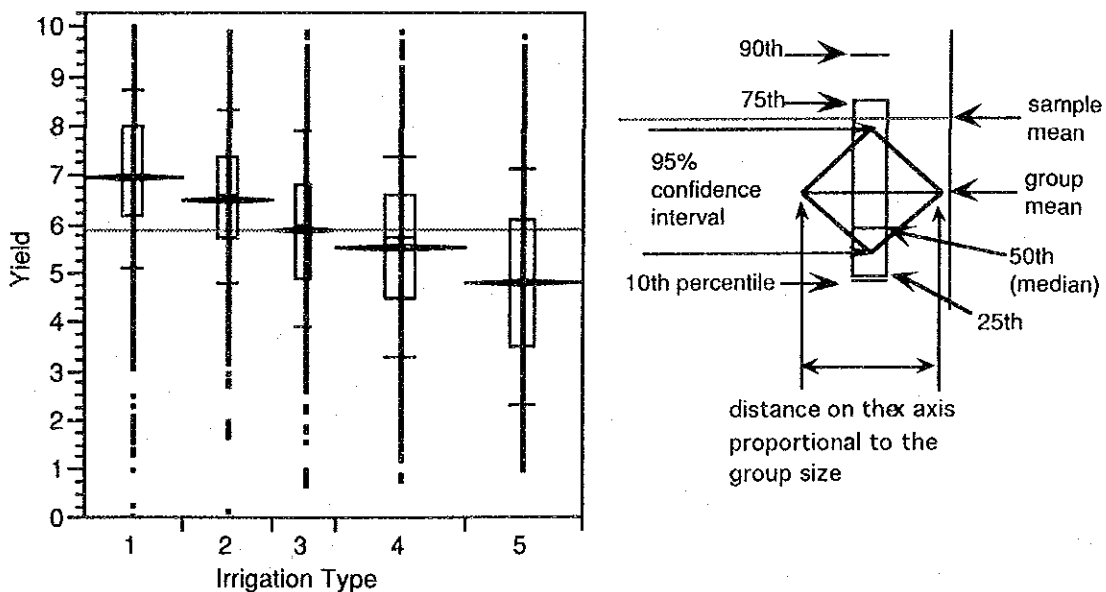


Figure B.1 Yield by Irrigation Type

At a glance, **Type 1** (Technical Irrigation System) provides the highest mean yield, 6.955 ton/ha. The mean yield (ton/ha) of other irrigation type is shown below together with the number of samples.

Type	number	Mean
1	1774	6.95533
2	1673	6.50726
3	1093	5.89790
4	2328	5.50795
5	2113	4.80108

Q-2 Large amount of fertilizer brings more yield?

Same as above, the mean yield under each fertilizer level are calculated and shown below.

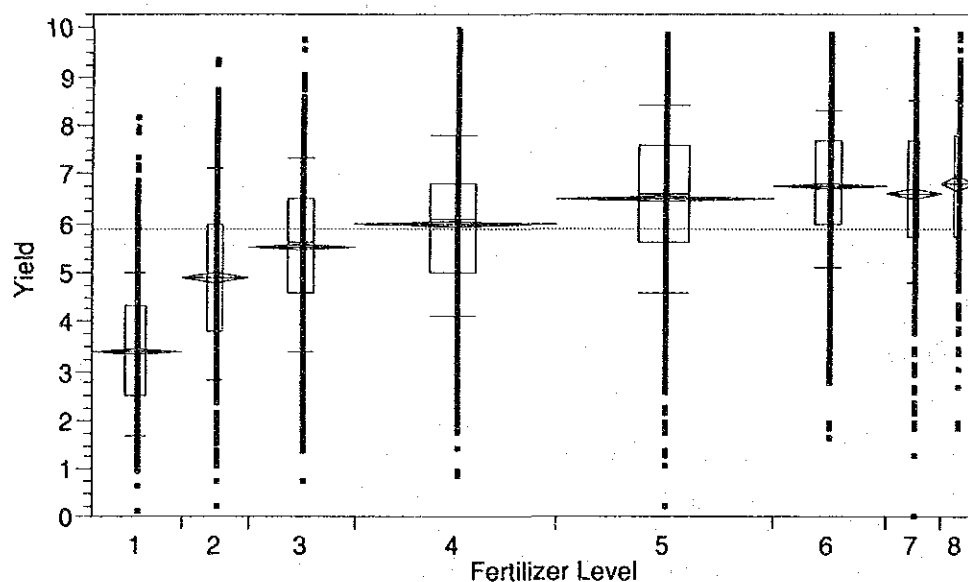


Figure B.2 Yield by Fertilizer Level

Level	number	Mean
1	921	3.41140
2	679	4.89308
3	1091	5.48836
4	2059	5.95585
5	2218	6.52038
6	1127	6.73372
7	563	6.57691
8	323	6.79752

Above figure implies that there is positive correlation-ship between the fertilizer level and yield. Further discussion on the relationship between the fertilizer level and yield will be presented in later Section "Regression Analysis"

At a glance of Figure B.1, the contribution of technical irrigation or semi technical irrigation system to paddy yield is much higher than that of simple or village irrigation system. The amount of fertilizer application in technical or semi-technical irrigation system, however, is much higher than that of other irrigation type, this implication is doubtful because **Q-2** resulted that the more the fertilizer, the more the yield was got. Then next question is

Q-3 Is there a difference in the dosage of fertilizer application among the irrigation type?

Following data plot give an answer to this question. The answer is that the amount of fertilizer application increases with an upgrading of irrigation facility.

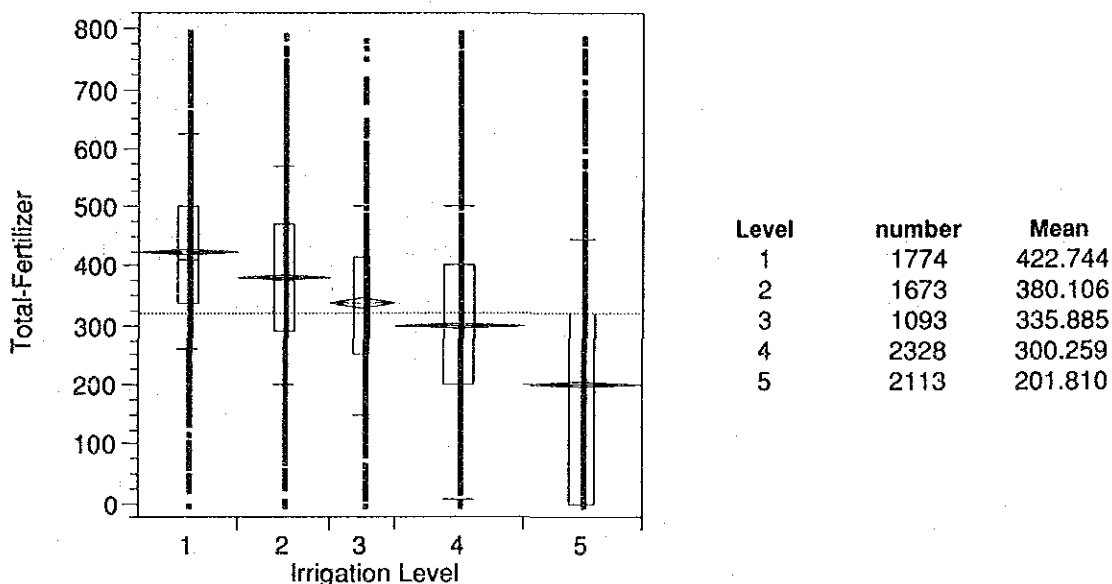


Figure B.3 Total Fertilizer by Irrigation Type

Then, it can be assumed the water (irrigation) may have no contribution to increase the yield of lowland paddy. But this assumption is true or not? Above test can not consider the interaction effect of these two factors, fertilizer and water, on the yield. In Q-1, the effect of fertilizer on the yield was disregarded and in Q-2, the effect of water was also disregarded. To solve this question, a factorial analysis of variance method have been employed as described below.

Q-4 Irrigation and fertilizer contribute to increase paddy yield ?

A factorial analysis of variance is applied under the hypothesis that there is no difference in the yield among the models, and the results of the analysis are shown bellow.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Probability>F
Model	49	10,392.8	212.1	111.0	0.0000
Irrigation level	4	598.3	149.6	78.3	0.0000
Fertilizer level	7	1,693.4	241.9	126.48	0.0000
Irrigation * Fertilizer	28	202.6	7.234	3.782	0.0000
Others	10	7,898.6			
Error	8,931	17,067.8	1.91		
C Total	8,980	27,460.7			

Source: JICA-FIDP team calculation based on the crop cutting data by CBS.

Sum of Squares (SS) quantifies the variation in yield. C total is the corrected total SS. It is divided into the SS for Model and SS for Error.

The SS for Model shows the variation in the yield among the models explained by the analysis of variance and the SS for Error is the remaining or unexplained variation.

A **Mean Square** is a sum of squares divided by its associated degree of freedom (DF).

The **F Ratio** is the model mean square divided by the error mean square.

F Ratio can be used as an index which determine the difference in the yield among the models is resulted from treatment or not, at a definite significant (probability) level.

This result shows that the hypothesis is rejected at the probability of more than 99.99%, because the hypothesis is supported at a probability of less than 0.00%. Therefore, the difference in the paddy yield under the different irrigation type and the different rate of fertilizer application is expected at a probability of more than 99.99%. Thus the irrigation facility and amount of fertilizer affect the paddy yield, significantly.

Q-5 Is there an overall difference in yield between irrigation type?

Factorial analysis of variance on paddy yield provides the following tables which shows the effect of irrigation type on the paddy yield can be made. There is a significant difference in the yield among the irrigation types at probability of more than 99.99%.

Analysis of Variance

Sum of Squares	F Ratio	DF	Prob.>F
381.90426	49.9593	4	0.0000

Least Squares Means

Level	Least Sq Mean	Std Error	Mean
1	6.367311747	0.0861808569	6.95533
2	6.252016963	0.0894919784	6.50726
3	5.908452107	0.1034253661	5.89790
4	5.446003267	0.0554523304	5.50795
5	5.260296204	0.0608479552	4.80108

From above table following matrix of the difference in mean yield is made:

	1	2	3	4	5
1	0.000				
2	-0.115	0.000			
3	-0.459	-0.344	0.000		
4	-0.921	-0.806	-0.162	0.000	
5	-1.107	-0.992	-0.648	-0.186	0.000

Significant level (probability) of the difference in mean yield among different irrigation type is tested by using Fisher's least-significant-difference test and results is shown in following matrix.

	1	2	3	4	5
1	1.000				
2	0.298	1.000			
3	0.001	0.006	1.000		
4	0.000	0.000	0.000	1.000	
5	0.000	0.000	0.000	0.024	1.000

The answer to the question of " Is there an overall difference in yield between irrigation type?" can be made as following matrix with a probability at more than 95%..

	1	2	3	4	5
1	-				
2	No	-			
3	Yes	Yes	-		
4	Yes	Yes	Yes	-	
5	Yes	Yes	Yes	Yes	-

The paddy yield under the different irrigation type is significantly different with a probability at 95%, except between Type 1 and Type 2. In other words, there is a difference in the mean yield among the different irrigation type except between under Technical Irrigation System and Semi- Technical Irrigation System. The paddy yield is the highest under Technical and Semi-Technical irrigation system followed by simple irrigation, village irrigation and non irrigation.

Q-6. Is there an overall difference in yield between fertilizer level?

Following tables show the effect of fertilizer application on the paddy yield. There is also found a difference in the yield among under different amount of fertilizer application at a probability of more than 99.99%.

Analysis of Variance

Sum of Squares	F Ratio	DF	Prob.>F
1693.4336	126.4820	7	0.0000

Least Squares Means

Level	Least Sq Mean	Std Error	Mean
1	4.016900531	0.1255855749	3.41140
2	5.040115724	0.0649774315	4.89308
3	5.667035333	0.0489576054	5.48836
4	6.016195208	0.0312855079	5.95585
5	6.437375330	0.0312275714	6.52038
6	6.564188301	0.0455536923	6.73372
7	6.303772830	0.0666881565	6.57691
8	6.605734236	0.0938296007	6.79752

From above table, following matrix of the difference in the mean yield is produced:

	1	2	3	4	5	6	7	8
1	0.000							
2	1.023	0.000						
3	1.650	0.627	0.000					
4	1.999	0.976	0.349	0.000				
5	2.420	1.397	0.770	0.421	0.000			
6	2.547	1.524	0.897	0.548	0.127	0.000		
7	2.286	1.264	0.637	0.288	-0.134	-0.260	0.000	
8	2.589	1.566	0.939	0.590	0.168	0.042	0.302	0.000

Fisher's least-significant-difference test gives following probabilities.

	1	2	3	4	5	6	7	8
1	1.000							
2	0.000	1.000						
3	0.000	0.000	1.000					
4	0.000	0.000	0.000	1.000				
5	0.000	0.000	0.000	0.000	1.000			
6	0.000	0.000	0.000	0.000	0.022	1.000		
7	0.000	0.000	0.000	0.0001	0.070	0.001	1.000	
8	0.000	0.000	0.000	0.000	0.089	0.690	0.009	1.000

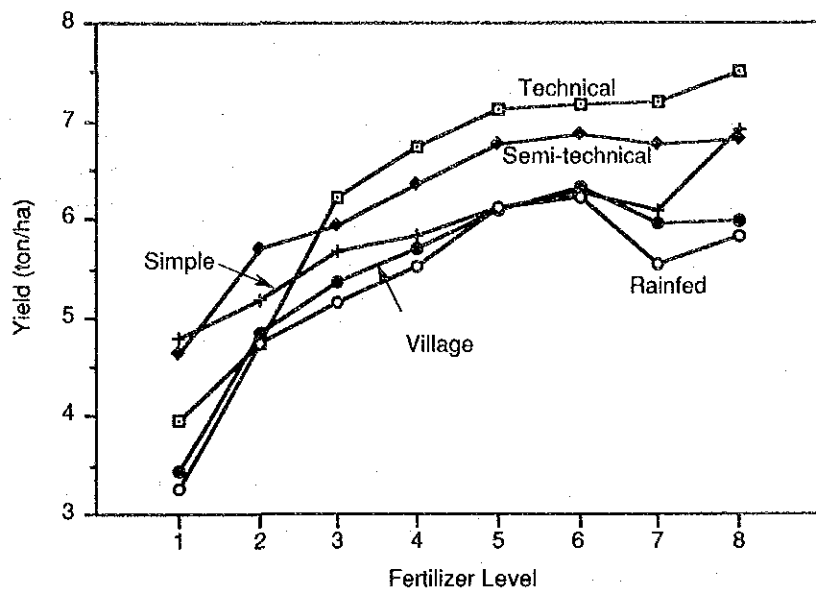
Then the answer to the question of " Is there an overall difference in yield between fertilizer level? " is summarized following matrix:

	1	2	3	4	5	6	7	8
1								
2	Yes							
3	Yes	Yes						
4	Yes	Yes	Yes					
5	Yes	Yes	Yes	Yes				
6	Yes	Yes	Yes	Yes	Yes			
7	Yes	Yes	Yes	Yes	No	Yes		
8	Yes	Yes	Yes	Yes	No	No	Yes	

The hypothesis is rejected by this analysis with a probability at more than 95%. Therefore the more the fertilizer, the more yield is obtained, however, there is no difference in mean yield between level 5 or 6 (350~550 kg/ha) and level 8 (650~800 kg/ha). Which is economical if level 5 or 6 get the same yield as level 8 ?

Q-7 Is there any interaction effect of Irrigation type and Fertilizer level on paddy yield

To check the interaction effect of Irrigation level and Fertilizer level on paddy yield, following figure was made. The yield values used in the figure are obtained by the calculation of the least squares mean of yield



Note: Fertilizer level is shown in page Appendix B-3

Figure B.4 Effect plot Between Fertilizer Level and Irrigation Type

From above graph following implication may withdraw

- 1 In the case of the amount of fertilizer application being less than level 3, there is no definite relationship between irrigation type and paddy yield.
- 2 In the case of the amount of fertilizer application being more than level 3, paddy yield increases with a grade of irrigation facility, however, there is no difference in paddy yield among Simple Irrigation, Village Irrigation and rainfed, in the case of fertilizer application being level 4,5 and 6.
- 3 The yield under Technical and Semi-Technical Irrigation increase in parallel at fertilizer level at more than 3 and the yield is always higher for Technical Irrigation than for semi-technical at the same fertilizer level.
- 4 Fertilizer contributes for increasing yield in fact, but irrigation also contributes to increasing yield. For example, at fertilizer level 5 there is found more than one ton per ha of yield difference between Simple, Village Irrigation or rainfed and Technical Irrigation.
- 5 Technical Irrigation is the most recommendable irrigation type in the case of a large amount of fertilizer being able to apply.

Q-8 Intensification program work well or not ?

Figure B 2.5 shown below may give an answer to this question. INSUS programme has attained more yield than INMUM and non-programme, and INMUM programme provides more yield than non-programme.

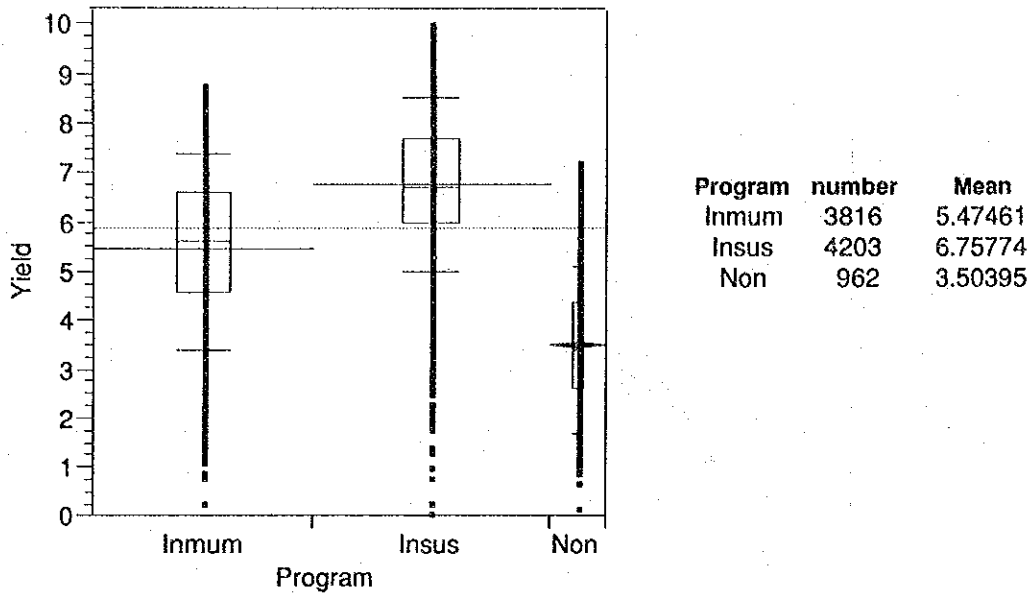


Figure B.5 Yield by Intensification Program

Regression analysis

Simple regression analysis was made to know the relationship between amount of fertilizer and paddy yield. Two regression lines, linear and quadratic, were obtained, and these two regression lines are statistically significant with a probability at more than 99.9%. Following table shows the results of regression analysis. Figure B.6 shows the scatter plot of Paddy Yield of all the samples.

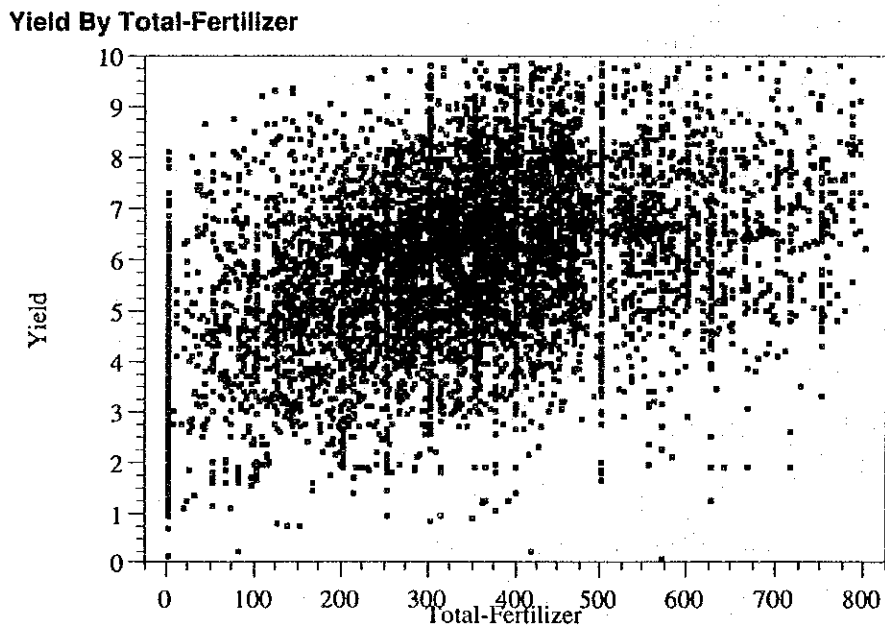


Figure B.6 Scatter plot of Yield by Total Fertilizer

Linear Fit

Summary of Fit

R square	0.263138
Root Mean Square Error	1.501187
Mean of Response	5.861151
Observations (or Sum Wgts)	8981

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	7225.935	7225.93	3206.452
Error	8979	20234.725	2.25	Prob.>F
C Total	8980	27460.660		0.0000

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob.> t
Intercept	4.2535352	0.03251	130.84	0.0000
Total-Fertilizer	0.005016	0.00009	56.63	0.0000

Quadratic curve fit

Summary of Fit

R square	0.315703
Root Mean Square Error	1.446731
Mean of Response	5.861151
Observations (or Sum Wgts)	8981

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	8669.423	4334.71	2071.021
Error	8978	18791.237	2.09	Prob.>F
C Total	8980	27460.660		0.0000

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob.> t
Intercept	3.5910198	0.04023	89.27	0.0000
Total-Fertilizer	0.011124	0.00025	44.90	0.0000
Total-Fertilizer^2	-0.000009615	0	-26.26	0.0000

From above results, paddy yield can be estimated by two formula i.e.

$$Yield = 4.2535352 + 0.005016 \times Total\ Fertilizer$$

or

$$Yield = 3.59102 + 0.011124 \times Total\ Fertilizer - 0.000009615 \times Total\ Fertilizer^2$$

Which line is better to estimates the yield from total fertilizer amount?

"F" values of analysis of variance and "t" values of parametre of these two equations show that these two regression lines are estimated to be significant with a probability at 99.99%, and these equations completely fit to the yield increasing pattern by increasing the amount of

fertilizer application. Looking the value of correlation coefficient (R square) which indicates that lager value shows better fitting, curve fitting has rather bigger value than line fitting.

Table B.1 Crop Cutting Data

Table with 15 columns: SN, Pr, Irr, TF, Y, FL, IP and repeated for 15 different entries. Each entry contains numerical data for various agricultural parameters.

Source : CBS
Note :SN: Serial Number Pr: Province Code Irr: Irrigation Type TF: Total Fertilizer Y: Yield FL: Fertilizer Level IP: Intensification Program

Table B.1 Crop Cutting Data

SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP							
911	12	4	500	608	7	Im	1044	13	4	173	8.24	4	Im	1171	13	4	400	4.1	6	Im	1301	16	2	0	4.8	1	N	1431	16	5	0	3.36	1	N	1561	16	5	300	3.6	5	Im	1691	18	4	153	5.14	4	Im
912	12	5	510	4.98	7	Im	1045	13	4	175	3.76	4	Im	1172	13	4	400	4.82	6	Im	1302	16	2	0	4.8	1	N	1432	16	5	0	3.39	1	N	1562	16	5	300	3.4	5	Im	1692	18	4	153	5.14	4	Im
913	12	4	516	3.92	7	Im	1046	13	4	176	4.32	4	Im	1173	13	4	400	7.68	6	Im	1303	16	2	0	4.83	1	N	1433	16	5	0	3.44	1	N	1563	16	5	300	6.48	5	Im	1693	18	4	160	7.02	4	Im
914	12	4	517	6.51	7	Im	1047	13	4	177	5.98	4	Im	1174	13	4	400	7.68	6	Im	1304	16	2	0	4.83	1	N	1434	16	5	0	3.47	1	N	1564	16	5	300	6.5	5	Im	1694	18	4	160	3.47	4	Im
915	12	5	517	4.34	7	Im	1048	13	4	178	3.4	4	Im	1175	13	4	400	7.68	6	Im	1305	16	2	0	4.86	1	N	1435	16	5	0	3.52	1	N	1565	16	5	300	6.56	5	Im	1695	18	4	160	7.42	4	Im
916	12	4	522	8.34	7	Im	1049	13	4	179	3.4	4	Im	1176	13	4	400	7.12	6	Im	1306	16	3	0	4	1	N	1436	16	5	0	3.52	1	N	1566	16	5	300	6.56	5	Im	1696	18	4	160	5.12	4	Im
917	12	4	525	4.4	7	Im	1050	13	4	180	3.4	4	Im	1177	13	4	400	8	6	Im	1307	16	4	0	3.49	1	N	1437	16	5	0	3.52	1	N	1567	16	5	300	6.72	5	Im	1697	18	4	160	4.4	4	Im
918	12	4	525	4.4	7	Im	1051	13	4	180	3.4	4	Im	1178	13	4	400	6.56	6	Im	1308	16	4	0	3.52	1	N	1438	16	5	0	3.52	1	N	1568	16	5	300	6.72	5	Im	1698	18	4	160	3.44	4	Im
919	12	2	550	6.8	8	Im	1052	13	4	180	3.4	4	Im	1179	13	4	400	6.56	6	Im	1309	16	4	0	3.58	1	N	1439	16	5	0	3.52	1	N	1569	16	4	354	4.66	6	Im	1699	18	4	160	3.44	4	Im
920	12	2	550	6.8	8	Im	1053	13	4	180	3.4	4	Im	1180	13	4	400	7.36	6	Im	1310	16	4	0	3.78	1	N	1440	16	5	0	3.6	1	N	1570	16	5	300	5.6	5	Im	1700	18	5	175	3.89	4	Im
921	12	2	550	6.8	8	Im	1054	13	4	180	3.4	4	Im	1181	13	4	400	7.68	6	Im	1311	16	4	0	4.16	1	N	1441	16	5	0	3.6	1	N	1571	16	5	300	4.5	5	Im	1701	18	4	180	5.04	4	Im
922	12	4	550	4.48	8	Im	1055	13	4	180	3.4	4	Im	1182	13	4	400	5.92	6	Im	1312	16	4	0	4.53	1	N	1442	16	5	0	3.6	1	N	1572	16	5	300	4.8	5	Im	1702	18	4	180	5.04	4	Im
923	12	4	550	4.48	8	Im	1056	13	4	180	3.4	4	Im	1183	13	4	400	7.68	6	Im	1313	16	4	0	4.72	1	N	1443	16	5	0	3.68	1	N	1573	16	5	300	4.8	5	Im	1703	18	4	180	3.44	4	Im
924	12	2	570	7.76	8	Im	1057	13	4	180	3.4	4	Im	1184	13	4	400	5.28	6	Im	1314	16	4	0	4.96	1	N	1444	16	5	0	3.68	1	N	1574	16	5	300	5.22	5	Im	1704	18	4	180	3.44	4	Im
925	12	4	575	5.12	8	Im	1058	13	4	180	3.4	4	Im	1185	13	4	400	5.28	6	Im	1315	16	4	0	4.96	1	N	1445	16	5	0	3.68	1	N	1575	16	5	300	4.44	5	Im	1705	18	4	180	3.72	4	Im
926	12	2	600	7.68	8	Im	1059	13	4	180	3.4	4	Im	1186	13	4	400	4.4	6	Im	1316	16	4	0	5.07	1	N	1446	16	5	0	3.68	1	N	1576	16	5	300	4.61	5	Im	1706	18	4	180	3.72	4	Im
927	12	2	600	8.08	8	Im	1060	13	4	180	3.4	4	Im	1187	13	4	400	5.28	6	Im	1317	16	4	0	5.12	1	N	1447	16	5	0	3.7	1	N	1577	16	5	300	4.62	5	Im	1707	18	4	180	3.64	4	Im
928	12	4	600	5.2	8	Im	1061	13	4	180	3.4	4	Im	1188	13	4	400	7.2	6	Im	1318	16	4	0	5.28	1	N	1448	16	5	0	3.74	1	N	1578	16	5	300	4.74	5	Im	1708	18	4	200	3.54	4	Im
929	12	4	600	5.2	8	Im	1062	13	4	180	3.4	4	Im	1189	13	4	400	5.62	6	Im	1319	16	4	0	5.32	1	N	1449	16	5	0	3.76	1	N	1579	16	5	300	4.78	5	Im	1709	18	4	200	4.74	4	Im
930	12	4	600	6.37	8	Im	1063	13	4	180	3.4	4	Im	1190	13	4	400	6.88	7	Im	1320	16	5	0	1.31	1	N	1450	16	5	0	3.84	1	N	1580	16	5	300	4.84	5	Im	1710	18	4	200	4.74	4	Im
931	12	4	600	6.37	8	Im	1064	13	4	180	3.4	4	Im	1191	13	4	400	5.92	7	Im	1321	16	5	0	1.33	1	N	1451	16	5	0	3.84	1	N	1581	16	5	300	4.94	5	Im	1711	18	4	200	5.04	4	Im
932	12	4	600	6.37	8	Im	1065	13	4	180	3.4	4	Im	1192	13	4	400	5.08	7	Im	1322	16	5	0	1.35	1	N	1452	16	5	0	3.84	1	N	1582	16	5	300	4.94	5	Im	1712	18	4	200	6.16	4	Im
933	12	4	600	6.37	8	Im	1066	13	4	180	3.4	4	Im	1193	13	4	400	5.28	7	Im	1323	16	5	0	1.42	1	N	1453	16	5	0	3.84	1	N	1583	16	5	300	4.94	5	Im	1713	18	4	200	6.74	4	Im
934	12	5	618	4.51	8	Im	1067	13	4	180	3.4	4	Im	1194	13	4	400	7.2	7	Im	1324	16	5	0	1.55	1	N	1454	16	5	0	3.84	1	N	1584	16	5	300	4.94	5	Im	1714	18	5	200	2.92	4	Im
935	12	4	624	5.76	8	Im	1068	13	4	180	3.4	4	Im	1195	13	4	400	3.6	7	Im	1325	16	5	0	1.55	1	N	1455	16	5	0	3.84	1	N	1585	16	5	300	4.94	5	Im	1715	18	5	200	3.44	4	Im
936	12	1	623	1.26	8	Im	1069	13	4	180	3.4	4	Im	1196	13	4	400	6.4	7	Im	1326	16	5	0	1.55	1	N	1456	16	5	0	3.84	1	N	1586	16	5	300	4.94	5	Im	1716	18	4	200	3.28	4	Im
937	12	1	623	1.26	8	Im	1070	13	4	180	3.4	4	Im	1197	13	4	400	5.92	7	Im	1327	16	5	0	1.55	1	N	1457	16	5	0	3.84	1	N	1587	16	5	300	4.94	5	Im	1717	18	4	200	3.54	4	Im
938	12	4	650	4.48	8	Im	1071	13	4	180	3.4	4	Im	1198	13	4	400	6.88	7	Im	1328	16	5	0	1.55	1	N	1458	16	5	0	3.84	1	N	1588	16	5	300	4.94	5	Im	1718	18	4	200	4.32	4	Im
939	12	4	650	4.48	8	Im	1072	13	4	180	3.4	4	Im	1199	13	4	400	6.88	7	Im	1329	16	5	0	1.55	1	N	1459	16	5	0	3.84	1	N	1589	16	5	300	4.94	5	Im	1719	18	4	200	4.74	4	Im
940	12	4	650	4.48	8	Im	1073	13	4	180	3.4	4	Im	1200	13	4	400	3.76	8	Im	1330	16	5	0	1.62	1	N	1460	16	5	0	3.87	1	N	1590	16	5	300	4.94	5	Im	1720	18	4	218	6.45	4	Im
941	12	4	625	4.64	8	Im	1074	13	4	180	3.4	4	Im	1201	13	4	400	7.28	8	Im	1331	16	5	0	1.62	1	N	1461	16	5	0	3.9	1	N	1591	16	5	300	4.94	5	Im	1721	18	4	220	6	4	Im
942	12	5	625	4.32	8	Im	1075	13	4	180	3.4	4	Im	1202	13	4	400	3.92	8	Im	1332	16	5	0	1.62	1	N	1462	16	5	0	3.92	1	N	1592	16	5	300	4.94	5	Im	1722	18	4	220	6.45	4	Im
943	12	5	625	4.32	8	Im	1076	13	4	180	3.4	4	Im	1203	13	4	400	6.28	8	Im	1333	16	5	0	1.63	1	N	1463	16	5	0	3.92	1	N	1593	16	5	300	4.94	5	Im	1723	18	5	225	4.78	4	Im
944	12	2	640	8	8	Im																																										

Table B.1 Crop Cutting Data

SN	Pr	Irr:TF	Y	FL	IP	SN	Pr	Irr:TF	Y	FL	IP	SN	Pr	Irr:TF	Y	FL	IP	SN	Pr	Irr:TF	Y	FL	IP	SN	Pr	Irr:TF	Y	FL	IP	SN	Pr	Irr:TF	Y	FL	IP	SN	Pr	Irr:TF	Y	FL	IP						
1821	18	1	351	7.95	6	Is	1931	32	0	0.64	1	Is	2081	32	3	160	5.6	4	Is	2211	32	4	233	8.64	4	Is	2341	32	4	266	4.53	5	Is	2471	32	4	295	7.1	5	Is	2601	32	4	309	8	5	Is
1822	18	2	360	7.87	6	Is	1932	32	0	0.72	1	Im	2082	32	3	160	6.74	4	Im	2212	32	4	233	6.18	4	Im	2342	32	4	266	6.82	5	Im	2472	32	4	296	6.32	5	Im	2602	32	4	309	6.4	5	Is
1823	18	2	360	8.03	6	Is	1933	32	0	0.67	1	Im	2083	32	3	160	6.8	4	Im	2213	32	4	233	3.15	4	Im	2343	32	4	266	5.79	5	Im	2473	32	4	296	4.14	5	Im	2603	32	4	309	7.2	5	Is
1824	18	4	361	6.4	6	Is	1934	32	4	0.309	1	N	2084	32	4	160	6.7	4	Im	2214	32	4	233	4.5	4	Im	2344	32	4	266	7.36	5	Im	2474	32	4	296	4.88	5	Im	2604	32	4	309	7.36	5	Is
1825	18	1	361	6.6	6	Is	1935	32	4	0.311	N	2085	32	4	160	6.6	4	Im	2215	32	5	233	6.74	4	Im	2345	32	5	267	6.32	5	Is	2475	32	5	296	5.82	5	Im	2605	32	5	309	9.12	5	Is	
1826	18	4	365	6.16	6	Is	1936	32	4	0.331	N	2086	32	2	161	6.05	4	Im	2216	32	4	233	6.74	4	Im	2346	32	2	268	4.82	5	Is	2476	32	4	297	6.94	5	Im	2606	32	5	309	9.12	5	Is	
1827	18	4	366	6.75	6	Is	1937	32	5	0.317	N	2087	32	4	161	6.38	4	Im	2217	32	5	231	6.26	4	Im	2347	32	4	268	4.24	5	Im	2477	32	1	299	5.47	5	Im	2607	32	4	311	6.13	5	Im	
1828	18	4	366	6.8	6	Is	1938	32	5	0.323	N	2088	32	3	162	7.04	4	Im	2218	32	4	235	7.33	4	Is	2348	32	4	268	6.14	5	Im	2478	32	2	299	8.4	5	Im	2608	32	5	311	6.02	5	Im	
1829	18	4	366	6.35	6	Is	1939	32	5	0.35	N	2089	32	5	162	3.92	4	Im	2219	32	4	236	4.94	4	Im	2349	32	4	268	6.19	5	Im	2479	32	2	299	8.99	5	Is	2609	32	4	312	7.6	5	Is	
1830	18	4	369	5.92	6	Is	1940	32	5	0.35	N	2090	32	2	165	5.12	4	Im	2220	32	4	237	6.56	4	Im	2350	32	4	269	3.3	5	Is	2480	32	3	299	3.65	5	Im	2610	32	4	312	4.37	5	Im	
1831	18	1	375	6.98	6	Im	1941	32	5	0.363	N	2091	32	3	165	5.98	4	Im	2221	32	5	237	5.52	4	Im	2351	32	4	269	4.51	5	Im	2481	32	4	299	4.43	5	Im	2611	32	4	312	4.76	5	Im	
1832	18	3	375	8.4	6	Im	1942	32	5	0.363	N	2092	32	4	165	5.9	4	Im	2222	32	4	238	5.7	4	Im	2352	32	4	269	5.52	5	Im	2482	32	4	299	4.47	5	Im	2612	32	4	312	5.47	5	Im	
1833	18	4	335	5.52	6	Im	1943	32	5	0.371	N	2093	32	4	165	6.83	4	Im	2223	32	4	239	5.23	4	Im	2353	32	1	270	6.16	5	Im	2483	32	4	299	8.32	5	Im	2613	32	4	312	6.4	5	Is	
1834	18	5	335	5.12	6	Im	1944	32	5	0.371	N	2094	32	4	165	7.23	4	Im	2224	32	5	239	8.06	4	Im	2354	32	1	270	6.64	5	Im	2484	32	1	300	6.88	5	Im	2614	32	4	312	6.5	5	Im	
1835	18	5	335	5.12	6	Im	1945	32	5	0.371	N	2095	32	5	165	3.81	4	Im	2225	32	2	240	6.14	4	Im	2355	32	1	270	6.8	5	Im	2485	32	1	300	7.07	5	Im	2615	32	4	312	6.74	5	Im	
1836	18	4	381	6.26	6	Is	1946	32	5	0.402	N	2096	32	5	166	4.66	4	Im	2226	32	2	240	7.4	4	Is	2356	32	4	271	4.03	5	Im	2486	32	1	300	7.12	5	Im	2616	32	5	312	5.36	5	Im	
1837	18	4	383	6.8	6	Is	1947	32	5	0.402	N	2097	32	5	166	6.05	4	Is	2227	32	3	240	5.66	4	Is	2357	32	4	271	6.58	5	Im	2487	32	1	300	7.44	5	Im	2617	32	5	312	5.55	5	Im	
1838	18	1	399	7.58	6	Is	1948	32	5	0.403	N	2098	32	2	170	8.88	4	Im	2228	32	4	240	2.82	4	Im	2358	32	5	271	5.17	5	Im	2488	32	1	300	7.47	5	Im	2618	32	2	312	7.2	5	Is	
1839	18	1	400	5.55	6	Im	1949	32	5	0.418	N	2099	32	2	170	8.88	4	Im	2229	32	4	240	4.84	4	Im	2359	32	3	272	5.46	5	Im	2489	32	1	300	7.6	5	Im	2619	32	3	312	7.2	5	Is	
1840	18	3	400	4.14	6	Im	1950	32	5	0.421	N	2100	32	5	170	3.79	4	Im	2230	32	4	240	5.62	4	Im	2360	32	3	272	6.77	5	Im	2490	32	1	300	7.74	5	Im	2620	32	4	313	5.46	5	Im	
1841	18	3	400	5.47	6	Im	1951	32	5	0.43	N	2101	32	5	170	3.79	4	Im	2231	32	4	240	5.62	4	Im	2361	32	4	272	3.44	5	Im	2491	32	1	300	7.76	5	Im	2621	32	4	313	6.69	5	Im	
1842	18	5	400	3.28	6	Im	1952	32	5	0.43	N	2102	32	5	172	3.89	4	Im	2232	32	4	240	7.04	4	Im	2362	32	4	272	4.18	5	Im	2492	32	1	300	7.76	5	Im	2622	32	5	313	6.74	5	Im	
1843	18	5	400	4.11	6	Im	1953	32	5	0.435	N	2103	32	2	174	7.44	4	Is	2233	32	5	240	6.56	4	Is	2363	32	4	272	5.79	5	Im	2493	32	1	300	8.19	5	Im	2623	32	3	314	6.72	5	Im	
1844	18	5	400	4.93	6	Im	1954	32	5	0.44	N	2104	32	3	175	4.38	4	Im	2234	32	4	242	3.45	4	Im	2364	32	5	272	4.32	5	Im	2494	32	1	300	8.19	5	Im	2624	32	4	314	4.58	5	Im	
1845	18	5	400	4.96	6	Im	1955	32	5	0.45	N	2105	32	3	175	4.67	4	Im	2235	32	3	244	6.26	4	Im	2365	32	5	272	5.62	5	Im	2495	32	1	300	8.56	5	Im	2625	32	4	314	6.72	5	Is	
1846	18	1	415	8.48	6	Is	1956	32	5	0.45	N	2106	32	3	175	5.1	4	Im	2236	32	4	245	5.22	4	Im	2366	32	5	272	5.94	5	Im	2496	32	1	300	8.56	5	Im	2626	32	4	314	8	5	Im	
1847	18	1	415	9.44	6	Is	1957	32	5	0.454	N	2107	32	3	175	6.56	4	Im	2237	32	3	247	6.64	4	Im	2367	32	2	273	5.32	5	Im	2497	32	1	300	8.56	5	Im	2627	32	4	314	8	5	Im	
1848	18	1	427	6.75	6	Im	1958	32	5	0.454	N	2108	32	5	175	6.11	4	Im	2238	32	3	247	6.64	4	Im	2368	32	2	273	6.32	5	Im	2498	32	2	300	3.38	5	Im	2628	32	5	314	7.04	5	Im	
1849	18	1	427	7.97	6	Im	1959	32	5	0.462	N	2109	32	3	183	6.22	4	Im	2239	32	2	249	6.73	4	Im	2369	32	2	275	6.48	5	Im	2499	32	2	300	4.88	5	Im	2629	32	3	315	6.29	5	Im	
1850	18	1	427	6.6	6	Im	1960	32	5	0.462	N	2110	32	5	176	6.22	4	Is	2240	32	3	249	6.43	4	Im	2370	32	2	275	6.7	5	Im	2500	32	3	300	5.52	5	Im	2630	32	4	315	9.66	5	Is	
1851	18	1	433	7.84	6	Is	1961	32	5	0.47	N	2111	32	4	178	6.24	4	Im	2241	32	4	249	6.38	4	Im	2371	32	2	275	8.96	5	Im	2501	32	2	300	5.74	5	Im	2631	32	4	315	5.04	5	Is	
1852	18	1	433	7.92	6	Is	1962	32	5	0.47	N	2112	32	5	178	5.23	4	Im	2242	32	4	249	7.6	4	Im	2372	32	4	275	4.93	5	Im	2502	32	2	300	5.87	5	Im	2632	32	4	315	6.4	5	Is	
1853	18	1	433	8.24	6	Is	1963	32	5	0.473	N	2113	32	2	180	4.91	4	Im	2243	32	5	249	6.27	4	Im	2373	32	4	275	4.96	5	Im	2503	32	2	300	6.48	5	Im	2633	32	2	317	7.39	5	Im	
1854	18	4	433	5.12	6	Im	1964	32	5	0.473	N	2114	32	3	180	4.58	4	Im	2244	32	5	249	6.78	4	Im	2374	32	4	275	5.04	5	Im	2504	32	2	300	6.51	5	Im	2634	32	2	318	6.59	5	Im	
1855	18	3	439	3.97	6	Im	1965	32	5	0.473	N	2115	32	4	180	5.38	4	Im	2245	32	2	250	6.16	5	Is	2375	32	4	275	5.04	5	Im	2505	32	2</												

Table B.1 Crop Cutting Data

Table with 40 columns: SN, Pr, Irr, TF, Y, FL, IP, and 32 columns of crop cutting data. Each row represents a specific crop cutting event with its location (SN), province (Pr), irrigation (Irr), fertilizer (TF), yield (Y), fertilizer level (FL), and intensification (IP) level, followed by 32 data points representing different crop cutting stages.

Source: CBS

Note: SN: Serial Number Pr: Province Code Irr: Irrigation Type TF: Total Fertilizer Y: Yield FL: Fertilizer Level IP: Intensification Program

Table B-1 Crop Cutting Data

SN Pr Irr,TF Y FL IP				SN Pr Irr,TF Y FL IP				SN Pr Irr,TF Y FL IP				SN Pr Irr,TF Y FL IP				SN Pr Irr,TF Y FL IP																															
3641	33	181	5.76	4	Im	3771	33	250	8.06	5	Im	3901	33	290	6.9	5	Is	4031	33	421	6.19	5	Is	4161	33	357	6.45	6	Is	4291	33	438	6.88	6	Im	4421	33	1	4.27	6.74	6	Im					
3642	33	183	5.44	4	Im	3772	33	4	250	5.52	5	Is	3902	33	2	290	6.5	5	Is	4032	33	5	321	9.6	5	Im	4162	33	357	5.15	6	Im	4292	33	1	385	8.34	6	Is	4422	33	1	385	8.34	6	Is	
3643	33	183	5.09	4	Im	3773	33	4	250	6.05	5	Is	3903	33	4	290	8.18	5	Is	4033	33	5	321	7.02	5	Im	4163	33	357	5.2	6	Is	4293	33	1	385	7.81	6	Is	4423	33	1	427	6.6	6	Is	
3644	33	183	4.91	4	Im	3774	33	4	250	6.37	5	Im	3904	33	4	290	6.85	5	Is	4034	33	5	321	7.06	5	Im	4164	33	357	5.28	6	Is	4294	33	1	385	5.84	6	Im	4424	33	1	427	6.11	6	Is	
3645	33	184	3.57	4	Im	3775	33	4	250	6.45	5	Im	3905	33	4	290	7.26	5	Im	4035	33	5	321	7.07	5	Im	4165	33	357	6.6	6	Is	4295	33	1	385	5.08	6	Is	4425	33	1	427	6.15	6	Is	
3646	33	185	4.9	4	Im	3776	33	4	250	6.45	5	Im	3906	33	4	290	6.62	5	Im	4036	33	5	322	6.46	5	Im	4166	33	357	6.6	6	Is	4296	33	1	385	6.26	6	Is	4426	33	1	427	6.35	6	Im	
3647	33	185	5.67	4	Im	3777	33	4	250	6.85	5	Im	3907	33	4	290	5.52	5	Is	4037	33	5	322	7.92	5	Im	4167	33	357	9.92	6	Is	4297	33	1	386	7.49	6	Is	4427	33	1	427	7.95	6	Im	
3648	33	185	5.47	4	Im	3778	33	4	250	6.85	5	Im	3908	33	4	290	6.52	5	Im	4038	33	5	322	6.47	5	Im	4168	33	357	6.3	6	Is	4298	33	1	386	7.58	6	Is	4428	33	1	427	8.24	6	Im	
3649	33	187	5.57	4	Im	3779	33	4	250	7.7	5	Is	3909	33	4	291	6.19	5	Im	4039	33	5	323	7.6	5	Is	4169	33	357	4.77	6	Is	4299	33	1	386	7.41	6	Is	4429	33	1	427	5.54	6	Im	
3650	33	187	5.81	4	Im	3780	33	4	250	8.21	5	Im	3910	33	4	291	8.03	5	Im	4040	33	4	324	7.86	5	Is	4170	33	357	5.84	6	Im	4300	33	2	366	7.62	6	Is	4430	33	5	427	6.59	6	Im	
3651	33	188	8.21	4	Im	3781	33	5	250	3.95	5	Im	3911	33	4	291	7.87	5	Im	4041	33	4	325	6.37	5	Is	4171	33	357	5.92	6	Im	4301	33	2	366	9.78	6	Is	4431	33	1	428	7.38	6	Is	
3652	33	188	5.15	4	Im	3782	33	5	250	4.96	5	Im	3912	33	4	291	3.78	5	Im	4042	33	4	325	5.82	5	Is	4172	33	357	5.43	6	Im	4302	33	2	366	8.61	6	Is	4432	33	1	428	7.77	6	Is	
3653	33	190	5.57	4	Im	3783	33	5	250	5.71	5	Im	3913	33	4	291	7.66	5	Is	4043	33	4	325	8	5	Is	4173	33	357	5.57	6	Im	4303	33	2	366	8.38	6	Is	4433	33	1	428	7.84	6	Is	
3654	33	192	6.56	4	Im	3784	33	5	251	7.46	5	Is	3914	33	4	291	6.05	5	Is	4044	33	4	325	7.25	5	Is	4174	33	357	6.19	6	Is	4304	33	3	368	7.38	6	Is	4434	33	1	428	7.84	6	Is	
3655	33	195	5.62	4	Im	3785	33	4	254	5.04	5	Is	3915	33	4	292	5.15	5	Is	4045	33	4	325	6.5	5	Is	4175	33	4	357	5.68	6	Im	4305	33	3	368	8	6	Is	4435	33	1	428	7.7	6	Is
3656	33	195	5.62	4	Im	3786	33	3	255	7.36	5	Is	3916	33	3	293	7.11	5	Is	4046	33	3	325	4.06	5	Is	4176	33	4	357	5.79	6	Im	4306	33	3	368	8.31	6	Is	4436	33	2	428	6.62	6	Im
3657	33	199	4.45	4	Im	3787	33	3	255	6.16	5	Is	3917	33	3	293	8.11	5	Is	4047	33	2	326	5.79	5	Is	4177	33	4	357	6.58	6	Is	4307	33	1	389	7.28	6	Is							
3658	33	199	6.27	4	Im	3788	33	1	256	8.19	5	Is	3918	33	4	293	8.24	5	Im	4048	33	1	327	7.44	5	Im	4178	33	5	357	4.94	6	Im	4308	33	1	391	8	6	Is							
3659	33	199	7.41	4	Im	3789	33	4	256	5.84	5	Is	3919	33	3	294	6.16	5	Im	4049	33	1	327	6.82	5	Im	4179	33	5	357	7.39	6	Im	4309	33	2	391	6.11	6	Is							
3660	33	200	5.2	4	Im	3790	33	4	256	6.53	5	Is	3920	33	3	294	6	5	Im	4050	33	4	327	6.98	5	Is	4180	33	1	358	8.08	6	Is	4310	33	4	391	7.15	6	Is							
3661	33	200	6.06	4	Im	3791	33	4	256	6.56	5	Is	3921	33	4	294	4.61	5	Im	4051	33	4	327	6.57	5	Is	4181	33	1	358	8.34	6	Is	4311	33	3	392	6.16	6	Is							
3662	33	200	7.54	4	Im	3792	33	4	256	7.22	5	Is	3922	33	4	294	6.34	5	Im	4052	33	5	327	5.52	5	Im	4182	33	2	359	6.91	6	Is	4312	33	3	394	6.72	6	Im							
3663	33	200	4.69	4	Im	3793	33	4	257	7.57	5	Is	3923	33	4	294	4.86	5	Im	4053	33	5	328	7.76	5	Im	4183	33	2	359	6.91	6	Is	4313	33	3	394	6.72	6	Im							
3664	33	200	6.77	4	Im	3794	33	4	257	6.24	5	Is	3924	33	4	294	6.34	5	Im	4054	33	2	329	6.91	5	Im	4184	33	1	360	6.08	6	Is	4314	33	3	395	8.4	6	Is							
3665	33	200	4.94	4	Im	3795	33	5	257	6.34	5	Is	3925	33	4	296	8.3	5	Is	4055	33	1	330	6.05	5	Is	4185	33	1	360	6.58	6	Is	4315	33	4	395	8.05	6	Is							
3666	33	200	8.32	4	Im	3796	33	5	258	4.53	5	Im	3926	33	4	299	7.41	5	Is	4056	33	1	330	7.84	5	Is	4186	33	1	360	6.62	6	Is	4316	33	3	398	7.33	6	Is							
3667	33	200	8.32	4	Im	3797	33	5	258	4.88	5	Im	3927	33	4	299	7.46	5	Is	4057	33	2	330	7.17	5	Is	4187	33	1	360	7.68	6	Is	4317	33	3	398	8.37	6	Is							
3668	33	200	4.54	4	Im	3798	33	4	260	5.52	5	Is	3928	33	4	299	6.74	5	Is	4058	33	3	330	6.05	5	Im	4188	33	1	360	4.85	6	Im	4318	33	1	399	8.48	6	Is							
3669	33	200	4.9	4	Im	3799	33	4	260	6.75	5	Im	3929	33	4	299	7.92	5	Im	4059	33	3	332	7.76	5	Im	4189	33	1	360	6.93	6	Im	4319	33	4	399	8	6	Is							
3670	33	200	6.1	4	Im	3800	33	4	260	7.49	5	Im	3930	33	4	299	7.49	5	Im	4060	33	2	332	5.52	5	Im	4190	33	1	360	7.25	6	Im	4320	33	4	399	7.73	6	Is							
3671	33	200	6.27	4	Im	3801	33	4	261	7.77	5	Is	3931	33	4	299	7.23	5	Im	4061	33	2	332	6.18	5	Im	4191	33	2	360	7.31	6	Im	4321	33	5	399	5.28	6	Im							
3672	33	200	6.27	4	Im	3802	33	2	261	7.59	5	Is	3932	33	4	299	7.66	5	Is	4062	33	3	332	7.28	5	Im	4192	33	2	360	7.54	6	Im	4322	33	1	400	5.28	6	Im							
3673	33	200	6.27	4	Im	3803	33	2	261	5.38	5	Is	3933	33	3	299	4.66	5	Im	4063	33	4	332	5.2	5	Im	4193	33	3	360	7.06	6	Im	4323	33	1	400	6	6	Im							
3674	33	200	6.29	4	Im	3804	33	4	261	6.51	5	Is	3934	33	2	300	5.95	5	Im	4064	33	4	332	6.9	5	Is	4194	33	3	360	7.07	6	Im	4324	33	1	400	6.24	6	Im							
3675	33	200	6.46	4	Im	3805	33	5	261	3.87	5	Im	3935	33	2	300	6.67	5	Is	4065	33	4	332	5.12	5	Is	4195	33	4	360	6.37	6	Im	4325	33	1	400	6.34	6	Im							
3676	33	200	6.5	4	Im	3806	33	5	261	4.97	5	Im	3936	33	2	300	6.77	5	Is	4066	33	5	332	4.51	5	Im	4196	33	4	360	7.39	6	Im	4326	33	1	400	6.46	6	Im							
3677	33	200	7.02	4	Im	3807	33	5	261	4.72	5	Im	3937	33	3	300	5.25	5	Im	4067	33	5	332	6.95	5	Is	4197	33	4	360	8.54	6	Im	4327	33	1	400										

Table B.1 Crop Cutting Data

SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP	SN	Pr	Irr	TF	Y	FL	IP							
4551	33	5	458	6.5	7	Is	4681	33	2	500	6.96	7	Is	4811	33	4	580	7.02	8	Im	4941	33	1	722	7.25	9	Is	5071	34	2	300	6.48	5	Is	5201	34	2	380	7.04	6	Is	5331	34	2	450	8.48	7	Is
4552	33	4	459	8.29	7	Is	4682	33	2	500	7.76	7	Is	4812	33	5	580	6.64	8	Im	4942	33	1	723	7.73	9	Is	5072	34	2	300	7.04	5	Is	5202	34	2	380	7.04	6	Is	5332	34	2	450	8.96	7	Is
4553	33	4	459	8.34	7	Is	4683	33	2	500	7.84	7	Im	4813	33	1	582	6.64	8	Is	4943	33	4	723	8.77	9	Is	5073	34	2	300	7.25	5	Im	5203	34	2	380	6.74	6	Is	5333	34	3	450	6.87	7	Im
4554	33	4	460	7.94	7	Is	4684	33	2	500	8.13	7	Is	4814	33	1	583	8.16	8	Is	4944	33	2	726	6.27	9	Is	5074	34	2	300	7.36	5	Is	5204	34	2	380	7.04	6	Is	5334	34	3	450	6.32	7	Im
4555	33	1	460	8.25	7	Is	4685	33	2	500	8.54	7	Is	4815	33	2	583	4.75	8	Is	4945	33	5	727	6.18	9	Is	5075	34	2	300	8.32	5	Is	5205	34	2	380	7.04	6	Is	5335	34	5	450	6.32	7	Im
4556	33	4	460	7.73	7	Im	4686	33	3	500	5.02	7	Im	4816	33	2	583	4.75	8	Is	4946	33	3	728	6.38	9	Is	5076	34	2	300	8.32	5	Is	5206	34	2	380	7.04	6	Is	5336	34	2	450	6.88	7	Im
4557	33	1	461	7.87	7	Is	4687	33	3	500	6.08	7	Im	4817	33	4	583	6.32	8	Is	4947	33	1	735	8.16	9	Is	5077	34	2	300	8.56	5	Im	5207	34	2	383	6.56	6	Is	5337	34	3	453	5.46	7	Im
4558	33	2	461	6.32	7	Im	4688	33	3	500	7.31	7	Im	4818	33	5	583	7.81	8	Im	4948	33	5	743	6.37	9	Is	5078	34	2	384	6.27	5	Im	5208	34	2	384	6.27	6	Is	5338	34	3	454	4.22	7	Im
4559	33	2	461	6.32	7	Im	4689	33	4	500	2.03	7	Im	4819	33	2	584	9.63	8	Is	4949	33	1	749	7.28	9	Is	5079	34	3	300	6.32	5	Is	5209	34	3	385	4.54	6	Is	5339	34	2	453	7.52	7	Im
4560	33	2	462	9.28	7	Im	4690	33	4	500	6.96	7	Im	4820	33	1	585	7.06	8	Is	4950	33	5	749	6.62	9	Is	5080	34	4	300	5.44	5	Is	5210	34	2	387	7.12	6	Is	5340	34	2	456	6.48	7	Im
4561	33	4	462	7.92	7	Im	4691	33	4	500	7.73	7	Im	4821	33	4	586	6	8	Im	4951	33	1	750	6.77	10	Is	5081	34	4	300	6.11	5	Is	5211	34	2	388	6.43	6	Is	5341	34	2	457	8.96	7	Im
4562	33	4	463	7.94	7	Im	4692	33	4	500	5.28	7	Im	4822	33	4	586	7.22	8	Im	4952	33	1	750	6.74	10	Is	5082	34	5	300	3.18	5	Im	5212	34	2	388	6.62	6	Is	5342	34	2	458	7.68	7	Im
4563	33	4	463	8.34	7	Im	4693	33	5	500	6.77	7	Im	4823	33	1	587	9.76	8	Is	4953	33	1	750	7.38	10	Is	5083	34	5	300	4.51	5	Is	5213	34	2	388	6.64	6	Is	5343	34	2	458	7.39	7	Im
4564	33	5	463	5.47	7	Im	4694	33	5	500	7.28	7	Im	4824	33	1	587	8.84	8	Is	4954	33	1	750	7.89	10	Is	5084	34	5	300	5.15	5	Is	5214	34	3	388	4.8	6	Is	5344	34	2	460	7.95	7	Im
4565	33	1	464	8.64	7	Is	4695	33	5	500	7.5	7	Is	4825	33	1	589	7.68	8	Is	4955	33	1	750	7.94	10	Is	5085	34	3	306	7.04	5	Is	5215	34	3	388	5.34	6	Is	5345	34	2	460	8.77	7	Im
4566	33	1	464	6.7	7	Is	4696	33	5	500	7.84	7	Im	4826	33	4	590	7.82	8	Im	4956	33	1	750	8.03	10	Is	5086	34	3	308	5.52	5	Is	5216	34	3	388	7.22	6	Is	5346	34	2	461	6.96	7	Im
4567	33	2	464	6.69	7	Im	4697	33	5	500	9.26	7	Im	4827	33	1	594	7.74	8	Is	4957	33	2	750	5.07	10	Is	5087	34	2	310	6.58	5	Is	5217	34	3	388	5.62	6	Is	5347	34	3	461	7.2	7	Im
4568	33	2	464	6.93	7	Im	4698	33	5	507	5.36	7	Im	4828	33	1	595	8.8	8	Is	4958	33	2	750	5.44	10	Is	5088	34	2	312	6.38	5	Is	5218	34	3	388	7.76	6	Is	5348	34	2	462	7.28	7	Im
4569	33	2	464	6.99	7	Im	4699	33	5	511	6.51	7	Im	4829	33	1	599	7.81	8	Is	4959	33	1	756	7.04	10	Is	5089	34	2	318	6.94	5	Is	5219	34	3	388	4.59	6	Is	5349	34	2	466	8.82	7	Im
4570	33	5	465	6.4	7	Is	4700	33	5	511	6.72	7	Im	4830	33	1	599	5.94	8	Is	4960	33	3	756	8.02	10	Is	5090	34	2	312	7.44	5	Is	5220	34	3	390	4.86	6	Im	5350	34	2	466	7.71	7	Im
4571	33	5	465	6.4	7	Is	4701	33	5	511	6.72	7	Im	4831	33	1	600	6.94	8	Is	4961	33	1	759	6.10	10	Is	5091	34	2	312	7.63	5	Is	5221	34	2	391	5.7	6	Is	5351	34	2	466	7.52	7	Im
4572	33	5	466	6.67	7	Im	4702	33	5	513	8.19	7	Im	4832	33	2	600	6.93	8	Is	4962	33	1	753	5.64	10	Is	5092	34	2	312	7.92	5	Is	5222	34	2	392	7.38	6	Is	5352	34	3	466	5.38	7	Im
4573	33	2	466	7.6	7	Im	4703	33	5	513	8.35	7	Im	4833	33	3	600	8.16	8	Im	4963	33	1	757	6.8	10	Im	5093	34	3	312	7.39	5	Is	5223	34	5	394	6.14	6	Im	5353	34	4	468	6.91	7	Im
4574	33	3	466	7.54	7	Im	4704	33	5	514	6.93	7	Im	4834	33	3	600	8.16	8	Im	4964	33	3	759	6.35	10	Im	5094	34	3	312	5.76	5	Is	5224	34	2	399	6.75	6	Im	5354	34	2	469	6.11	7	Im
4575	33	3	466	5.3	7	Im	4705	33	5	514	9.94	7	Im	4835	33	1	600	8.34	8	Is	4965	33	2	770	8.35	10	Is	5095	34	3	312	6.43	5	Is	5225	34	2	399	6.96	6	Is	5355	34	2	472	7.33	7	Im
4576	33	3	466	5.58	7	Im	4706	33	5	514	9.84	7	Im	4836	33	1	600	9.95	8	Is	4966	33	1	777	7.73	10	Is	5096	34	1	316	9.84	5	Is	5226	34	2	400	5.6	6	Is	5356	34	2	472	7.33	7	Im
4577	33	5	466	5.15	7	Im	4707	33	5	514	6.58	7	Im	4837	33	2	600	6	8	Im	4967	33	1	781	8.16	10	Im	5097	34	2	316	7.68	5	Is	5227	34	2	400	6	6	Is	5357	34	2	475	8.34	7	Im
4578	33	1	468	7.78	7	Im	4708	33	5	514	5.63	7	Im	4838	33	2	600	6.32	8	Im	4968	33	5	782	7.12	10	Im	5098	34	2	317	5.39	5	Is	5228	34	2	400	6.24	6	Is	5358	34	2	475	9.33	7	Im
4579	33	5	468	6.82	7	Im	4709	33	5	515	7.44	7	Im	4839	33	2	600	6.93	8	Is	4969	33	2	784	8.82	10	Im	5099	34	2	317	6.66	5	Is	5229	34	2	400	6.34	6	Is	5359	34	2	475	9.06	7	Im
4580	33	5	468	4.7	7	Im	4710	33	5	517	7.22	7	Im	4840	33	3	600	5.65	8	Im	4970	33	3	784	8.86	10	Im	5100	34	2	318	6.64	5	Im	5230	34	2	400	5.4	6	Is	5360	34	3	475	5.34	7	Im
4581	33	5	468	7.46	7	Im	4711	33	5	517	7.97	7	Im	4841	33	5	600	6.11	8	Im	4971	33	3	785	8.16	10	Im	5101	34	2	320	7.44	5	Is	5231	34	2	400	6.56	6	Is	5361	34	2	476	7.68	7	Im
4582	33	5	468	9.01	7	Im	4712	33	5	518	7.04	7	Im	4842	33	5	600	6.53	8	Im	4972	33	3	785	5.62	10	Im	5102	34	2	321	6.59	5	Is	5232	34	2	400	6.59	6	Is	5362	34	2	480	7.04	7	Im
4583	33	1	469	9.2	7	Im	4713	33	5	518	6.66	7	Im	4843	33	1	605	8.56	8	Is																												

Table B.1 Crop Cutting Data

SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP							
5461	34	2	575	6.66	R	lt	5491	35	5	222	5.17	4	ltm	5721	35	4	285	6.51	5	lt	5851	35	1	327	7.84	5	lt	5981	35	1	357	7.01	6	lt	6111	35	1	382	6.24	6	lt	6241	35	4	400	7.23	6	ltm
5462	34	2	583	6.37	R	lt	5492	35	5	223	5.84	4	ltm	5722	35	1	287	6.48	5	lt	5852	35	2	327	6.18	5	lt	5982	35	1	357	7.44	6	lt	6112	35	1	382	7.22	6	lt	6242	35	5	400	7.53	6	ltm
5463	34	2	580	8.06	R	lt	5493	35	2	225	4	4	ltm	5723	35	2	287	4.26	5	lt	5853	35	1	328	5.23	5	lt	5983	35	1	357	7.54	6	ltm	6113	35	1	382	7.36	6	lt	6243	35	5	400	4.64	6	lt
5464	34	2	582	7.84	R	ltm	5494	35	4	225	6.29	4	ltm	5724	35	2	287	4.35	5	lt	5854	35	1	328	6.56	5	ltm	5984	35	2	357	9.6	6	ltm	6114	35	2	382	7.07	6	lt	6244	35	5	400	4.64	6	lt
5465	34	2	582	8.43	R	lt	5495	35	5	225	5.14	4	ltm	5725	35	3	287	3.73	5	ltm	5855	35	1	330	6.4	5	lt	5985	35	2	357	5.39	6	ltm	6115	35	2	382	5.89	6	lt	6245	35	5	400	5.39	6	ltm
5466	34	2	582	8.13	R	lt	5496	35	5	225	6.29	4	ltm	5726	35	5	287	3.79	5	ltm	5856	35	2	330	4.56	5	lt	5986	35	2	357	3.79	6	ltm	6116	35	2	382	7.3	6	lt	6246	35	5	400	5.39	6	ltm
5467	34	2	583	6.16	R	ltm	5497	35	5	225	6.38	4	ltm	5727	35	2	289	5.46	5	lt	5857	35	2	330	6.78	5	lt	5987	35	2	357	3.82	6	lt	6117	35	5	383	6.22	6	lt	6247	35	5	400	6.37	6	lt
5468	34	2	583	5.46	R	lt	5498	35	5	226	7.14	4	ltm	5728	35	1	290	7.01	5	lt	5858	35	1	332	5.78	5	lt	5988	35	2	357	6.46	6	ltm	6118	35	5	383	7.05	6	lt	6248	35	5	400	6.43	6	lt
5469	34	2	589	7.5	R	lt	5499	35	5	227	7.4	4	ltm	5729	35	1	290	6.54	5	lt	5859	35	1	332	8.4	5	lt	5989	35	2	357	6.16	6	ltm	6119	35	1	384	7.67	6	ltm	6249	35	5	400	7.69	6	lt
5470	34	2	599	6.8	R	lt	5500	35	5	228	5.54	4	ltm	5730	35	5	290	8.89	5	lt	5860	35	1	332	6.4	5	lt	5990	35	4	357	6.18	6	ltm	6120	35	1	384	7.7	6	ltm	6250	35	5	400	7.36	6	lt
5471	34	2	600	2.96	R	ltm	5501	35	5	228	5.98	4	ltm	5731	35	5	291	4.9	5	ltm	5861	35	1	332	6.61	5	ltm	5991	35	4	358	6.59	6	ltm	6121	35	4	384	4.99	6	ltm	6251	35	5	400	7.36	6	lt
5472	34	2	600	8.72	R	lt	5502	35	2	230	5.57	4	ltm	5732	35	2	291	6.14	5	lt	5862	35	1	332	6.1	5	ltm	5992	35	4	357	6.66	6	ltm	6122	35	5	384	6.75	6	ltm	6252	35	5	400	7.36	6	ltm
5473	34	2	600	8.8	R	lt	5503	35	2	230	3.84	4	ltm	5733	35	2	291	6.66	5	ltm	5863	35	1	332	6.43	5	ltm	5993	35	4	357	6.69	6	ltm	6123	35	5	384	7.23	6	ltm	6253	35	3	400	8.45	6	ltm
5474	34	2	624	6.64	R	lt	5504	35	3	232	5.7	4	ltm	5734	35	1	293	6.72	5	lt	5864	35	1	332	7.04	5	lt	5994	35	4	357	7.42	6	lt	6124	35	1	384	6.18	6	lt	6254	35	1	400	8.45	6	ltm
5475	34	2	625	8.88	R	lt	5505	35	1	233	7.36	4	ltm	5735	35	2	294	5.36	5	lt	5865	35	1	332	9.02	5	lt	5995	35	5	357	6.02	6	ltm	6125	35	5	385	6.4	6	ltm	6255	35	4	404	5.84	6	lt
5476	34	3	625	6.56	R	lt	5506	35	1	233	5.18	4	ltm	5736	35	2	294	4.96	5	lt	5866	35	1	332	7.44	5	ltm	5996	35	5	357	5.88	6	ltm	6126	35	5	385	3.92	6	ltm	6256	35	4	404	5.84	6	lt
5477	34	4	625	4.59	R	lt	5507	35	2	233	4.59	4	ltm	5737	35	3	294	4.99	5	lt	5867	35	2	332	8.21	5	ltm	5997	35	5	357	7.87	6	ltm	6127	35	5	385	8.01	6	lt	6257	35	1	405	6.29	6	lt
5478	34	4	625	5.38	R	lt	5508	35	5	233	6.81	4	ltm	5738	35	3	294	3.02	5	ltm	5868	35	2	332	5.81	5	ltm	5998	35	1	358	6.88	6	lt	6128	35	1	387	4.96	6	lt	6258	35	2	405	6.86	6	lt
5479	34	4	625	1.95	R	lt	5509	35	5	233	6.24	4	ltm	5739	35	3	295	6.66	5	ltm	5869	35	2	332	8.16	5	ltm	5999	35	1	359	7.84	6	lt	6129	35	1	387	7.23	6	lt	6259	35	2	405	4.54	6	lt
5480	34	2	628	8.64	R	lt	5510	35	1	234	6.24	4	lt	5740	35	1	296	6.88	5	ltm	5870	35	2	332	4.88	5	ltm	6000	35	1	360	5.52	6	lt	6130	35	5	387	7.39	6	lt	6260	35	3	405	8.27	6	lt
5481	34	4	640	4.96	R	lt	5511	35	2	234	6.56	4	ltm	5741	35	1	296	6.72	5	lt	5871	35	3	332	8.27	5	ltm	6001	35	1	360	6.32	6	lt	6131	35	1	388	8.09	6	lt	6261	35	3	405	8.42	6	lt
5482	34	2	642	7.78	R	ltm	5512	35	4	236	7.41	4	ltm	5742	35	3	296	5.04	5	lt	5872	35	3	332	8.34	5	ltm	6002	35	1	360	6.72	6	lt	6132	35	1	388	7.7	6	ltm	6262	35	3	405	8.54	6	lt
5483	34	4	650	4.42	R	lt	5513	35	3	237	6	4	ltm	5743	35	1	299	7.84	5	lt	5873	35	3	332	8.4	5	ltm	6003	35	1	360	7.52	6	lt	6133	35	1	388	7.44	6	lt	6263	35	3	405	7.92	6	lt
5484	34	4	650	4.8	R	lt	5514	35	2	238	6	4	ltm	5744	35	1	299	7.46	5	lt	5874	35	4	332	4.99	5	ltm	6004	35	1	360	5.92	6	lt	6134	35	1	388	8.18	6	lt	6264	35	3	406	5.44	6	lt
5485	34	2	660	7.44	R	lt	5515	35	2	239	6.42	4	ltm	5745	35	1	299	7.84	5	lt	5875	35	1	332	5.82	5	ltm	6005	35	2	360	5.94	6	lt	6135	35	2	388	6.03	6	lt	6265	35	3	406	7.76	6	lt
5486	34	4	665	4.99	R	lt	5516	35	5	239	6.48	4	ltm	5746	35	1	299	9.25	5	lt	5876	35	5	332	5.97	5	ltm	6006	35	2	360	7.07	6	lt	6136	35	4	388	3.3	6	ltm	6266	35	3	406	8.08	6	lt
5487	34	4	665	4.99	R	lt	5517	35	5	240	6.48	4	ltm	5747	35	1	299	8.02	5	ltm	5877	35	3	332	6.02	5	ltm	6007	35	3	360	6.77	6	lt	6137	35	1	389	1.3	6	ltm	6267	35	3	406	8.27	6	lt
5488	34	4	665	5.2	R	lt	5518	35	1	240	7.76	4	ltm	5748	35	1	300	3.6	5	ltm	5878	35	5	332	4.3	5	ltm	6008	35	3	360	7.23	6	lt	6138	35	1	390	7.02	6	ltm	6268	35	3	406	8.68	6	ltm
5489	34	2	687	5.04	R	lt	5519	35	2	240	6.24	4	ltm	5749	35	1	300	4.75	5	ltm	5879	35	5	332	6.06	5	ltm	6009	35	4	360	6.8	6	ltm	6139	35	1	390	6.19	6	ltm	6269	35	3	407	8.69	6	lt
5490	34	2	690	7.71	R	lt	5520	35	2	240	6.96	4	ltm	5750	35	1	300	4.85	5	ltm	5880	35	5	332	6.14	5	ltm	6010	35	4	360	6.64	6	ltm	6140	35	1	391	6.59	6	ltm	6270	35	1	408	6.56	6	ltm
5491	34	3	708	4.21	R	lt	5521	35	3	241	7.36	4	ltm	5751	35	1	300	5.15	5	ltm	5881	35	5	332	6.19	5	ltm	6011	35	5	360	6.38	6	ltm	6141	35	2	391	6.5	6	ltm	6271	35	2	408	6.24	6	ltm
5492	34	3	714	8	R	lt	5522	35	4	242	6.32	4	lt	5752	35	1	300	6.42	5	lt	5882	35	5	332	4.88	5	ltm	6012	35	5	360	6.56	6	ltm	6142	35	2	391	4.5	6	ltm	6272	35	3	408	6.04	6	ltm
5493	34	2	749	7.68	R	lt	5523	35	5	243	2.59	4	ltm	5753	3																																	

Table B.1 Crop Cutting Data

SN	Pr	Inr.	TF	Y	FL	IP	SN	Pr	Inr.	TF	Y	FL	IP	SN	Pr	Inr.	TF	Y	FL	IP	SN	Pr	Inr.	TF	Y	FL	IP	SN	Pr	Inr.	TF	Y	FL	IP							
6371	35	1 428	6.82	6	Is	6501	35	2 455	6.48	7	Im	6631	35	2 499	6.32	7	Im	6761	35	1 548	8.18	7	Is	6891	35	1 605	7.62	8	Is	7021	35	1 714	7.49	9	Is	7151	51	2 350	3.71	6	Is
6372	35	2 428	6.8	6	Im	6502	35	1 457	7.94	7	Is	6632	35	2 499	6.7	7	Is	6762	35	1 550	7.31	8	Is	6892	35	1 605	7.68	8	Im	7022	35	1 714	8.18	9	Is	7152	51	2 350	3.78	6	Is
6373	35	2 428	4.77	6	Im	6503	35	1 457	8.29	7	Is	6633	35	2 499	6.58	7	Is	6763	35	1 550	8.18	8	Is	6893	35	1 606	7.62	8	Is	7023	35	1 714	5.47	9	Is	7153	51	2 350	6.53	6	Is
6374	35	2 428	6.56	6	Im	6504	35	1 457	9.52	7	Is	6634	35	2 499	7.97	7	Is	6764	35	1 550	8.18	8	Is	6894	35	2 606	6.4	8	Is	7024	35	2 714	5.34	9	Im	7154	51	2 350	7.41	6	Is
6375	35	2 428	6.84	6	Im	6505	35	2 457	5.71	7	Im	6635	35	2 499	7.7	7	Im	6765	35	1 550	8.22	8	Is	6895	35	2 606	6.31	8	Is	7025	35	2 714	6.22	9	Im	7155	51	2 350	7.73	6	Is
6376	35	2 428	9.77	6	Im	6506	35	1 457	7.86	7	Im	6636	35	2 499	6.78	7	Is	6766	35	1 550	7.36	8	Im	6896	35	1 606	8.56	8	Is	7026	35	2 714	5.04	9	Im	7156	51	2 350	3.50	6	Is
6377	35	2 428	6.51	6	Is	6507	35	2 458	6.73	7	Is	6637	35	2 499	6.37	7	Is	6767	35	1 550	8.44	8	Is	6897	35	4 606	6.99	8	Is	7027	35	3 714	7.7	9	Is	7157	51	2 350	8.4	6	Is
6378	35	2 428	5.09	6	Is	6508	35	2 458	6.91	7	Is	6638	35	2 499	6.57	7	Im	6768	35	1 550	9.52	8	Is	6898	35	4 606	7.07	8	Is	7028	35	3 714	8.16	9	Is	7158	51	2 350	8.64	6	Is
6379	35	1 430	6.24	6	Is	6509	35	1 459	6.72	7	Is	6639	35	3 499	6.47	7	Is	6769	35	2 550	6.56	8	Is	6899	35	1 607	8.59	8	Is	7029	35	1 716	6.24	9	Im	7159	51	2 350	9.2	6	Is
6380	35	4 430	5.76	6	Is	6510	35	2 459	6.34	7	Im	6640	35	5 499	7.52	7	Im	6770	35	2 550	6.62	8	Im	6900	35	1 607	9.09	8	Is	7030	35	2 720	7.78	9	Is	7160	51	2 350	8.4	6	Is
6381	35	1 431	6.58	6	Is	6511	35	4 439	6.1	7	Is	6641	35	1 500	5.66	7	Im	6771	35	2 550	6.64	8	Is	6901	35	1 607	9.12	8	Is	7031	35	1 729	5.78	9	Im	7161	51	2 350	8.78	6	Is
6382	35	1 431	5.22	6	Is	6512	35	1 460	7.65	7	Is	6642	35	1 500	5.84	7	Im	6772	35	2 550	7.57	8	Im	6902	35	1 607	9.31	8	Is	7032	35	1 734	6.3	9	Is	7162	51	2 350	4.96	6	Is
6383	35	2 431	6.56	6	Im	6513	35	1 460	5.63	7	Im	6643	35	1 500	6.94	7	Is	6773	35	2 550	8.37	8	Im	6903	35	1 607	9.07	8	Is	7033	35	1 735	9.76	9	Is	7163	51	2 350	6.98	6	Is
6384	35	1 432	7.36	6	Im	6514	35	1 460	4.9	7	Is	6644	35	1 500	5.98	7	Is	6774	35	3 499	6.8	8	Im	6904	35	1 607	6.56	8	Is	7034	35	1 735	7.47	9	Is	7164	51	2 350	6.3	6	Is
6385	35	1 432	8.08	6	Is	6515	35	2 460	6.72	7	Is	6645	35	1 500	6.1	7	Is	6775	35	3 499	7.7	8	Im	6905	35	1 608	7.38	8	Is	7035	35	1 735	7.55	9	Is	7165	51	2 350	8.05	6	Is
6386	35	1 432	5.58	6	Im	6516	35	2 460	6.87	7	Is	6646	35	1 500	6.24	7	Im	6776	35	4 550	6.66	8	Im	6906	35	2 610	8.32	8	Is	7036	35	1 735	7.57	9	Is	7166	51	2 350	7.85	6	Is
6387	35	2 432	6.59	6	Im	6517	35	2 460	6.77	7	Im	6647	35	1 500	6.27	7	Im	6777	35	2 551	6.51	8	Is	6907	35	2 610	8.85	8	Is	7037	35	1 735	7.6	9	Is	7167	51	2 350	8.86	6	Is
6388	35	2 432	8.19	6	Im	6518	35	2 460	6.45	7	Is	6648	35	1 500	6.32	7	Im	6778	35	5 551	7.2	8	Is	6908	35	2 610	6.53	8	Is	7038	35	1 737	9.3	9	Is	7168	51	2 350	7.66	6	Is
6389	35	4 432	6.4	6	Is	6519	35	2 460	6.88	7	Is	6649	35	1 500	6.59	7	Im	6779	35	1 551	8.21	8	Is	6909	35	2 610	6.74	8	Is	7039	35	1 737	9.31	9	Is	7169	51	2 350	7.92	6	Is
6390	35	1 433	7.74	6	Im	6520	35	2 460	5.54	7	Is	6650	35	1 500	6.72	7	Is	6780	35	4 551	6.02	8	Is	6910	35	1 612	6.8	8	Is	7040	35	1 738	7.92	9	Is	7170	51	2 350	6.64	6	Is
6391	35	2 433	4.93	6	Im	6521	35	1 462	6.05	7	Im	6651	35	1 500	6.88	7	Is	6781	35	4 552	7.07	8	Is	6911	35	1 612	6.88	8	Is	7041	35	1 738	8.29	9	Im	7171	51	2 350	8.26	6	Is
6392	35	2 433	6.22	6	Im	6522	35	1 462	6.27	7	Im	6652	35	1 500	6.88	7	Is	6782	35	1 551	7.36	8	Is	6912	35	1 612	6.97	8	Is	7042	35	1 738	9.04	9	Im	7172	51	2 350	7.86	6	Is
6393	35	2 433	6.72	6	Im	6523	35	1 462	6.88	7	Im	6653	35	1 500	7.14	7	Im	6783	35	1 551	7.79	8	Is	6913	35	1 614	9.01	8	Is	7043	35	1 746	9.12	9	Is	7173	51	2 350	5.76	6	Is
6394	35	3 433	5.55	6	Im	6524	35	2 462	4.67	7	Im	6654	35	1 500	7.25	7	Im	6784	35	1 551	8.71	8	Is	6914	35	1 614	7.76	8	Is	7044	35	1 749	6.94	9	Is	7174	51	2 372	7.47	6	Is
6395	35	3 433	6.24	6	Im	6525	35	2 462	4.97	7	Im	6655	35	1 500	7.38	7	Im	6785	35	1 551	8.42	8	Is	6915	35	5 616	7.68	8	Im	7045	35	1 749	9.25	9	Is	7175	51	2 374	7.79	6	Is
6396	35	2 434	7.47	6	Im	6526	35	2 462	6.91	7	Im	6656	35	1 500	7.39	7	Im	6786	35	1 551	8.43	8	Is	6916	35	1 617	6.05	8	Is	7046	35	1 749	9.28	9	Is	7176	51	2 374	7.39	6	Is
6397	35	1 435	8.08	6	Is	6527	35	1 463	6.69	7	Im	6657	35	1 500	7.44	7	Im	6787	35	1 551	8.56	8	Is	6917	35	2 618	4.66	8	Im	7047	35	1 749	6.33	9	Is	7177	51	2 374	7.42	6	Is
6398	35	1 437	7.2	6	Is	6528	35	1 463	7.6	7	Im	6658	35	1 500	7.6	7	Is	6788	35	1 551	8.62	8	Is	6918	35	2 620	7.2	8	Im	7048	35	1 750	5.12	9	Im	7178	51	2 375	6.64	6	Is
6399	35	2 437	5.92	6	Im	6529	35	1 463	5.12	7	Is	6659	35	1 500	7.82	7	Is	6789	35	1 551	8.68	8	Is	6919	35	1 621	6.82	8	Is	7049	35	1 750	5.87	9	Im	7179	51	2 375	8.26	6	Is
6400	35	2 437	6.24	6	Im	6530	35	1 463	6.27	7	Im	6660	35	1 500	8.03	7	Im	6790	35	1 551	8.18	8	Is	6920	35	1 621	6.86	8	Im	7050	35	1 750	6.85	9	Im	7180	51	2 382	8.05	6	Is
6401	35	2 437	6.32	6	Im	6531	35	2 463	6.76	7	Im	6661	35	1 500	8.21	7	Im	6791	35	1 551	8.36	8	Is	6921	35	1 624	7.94	8	Is	7051	35	1 750	4.96	10	Im	7181	51	2 385	6.45	6	Is
6402	35	4 437	3.02	6	Im	6532	35	5 463	4.96	7	Im	6662	35	1 500	8.24	7	Im	6792	35	1 551	9.49	8	Im	6922	35	2 624	8.32	8	Is	7052	35	2 750	6.4	10	Im	7182	51	2 386	8.67	6	Is
6403	35	4 437	5.49	6	Im	6533	35	1 464	8.03	7	Im	6663	35	1 500	8.37	7	Im	6793	35	2 551	9.44	8	Im	6923	35	2 624	8.96	8	Is	7053	35	2 750	7.95	10	Im	7183	51	2 388	9.14	6	Is
6404	35	1 440	8.02	6	Im	6534	35	1 464	7.34	7	Is	6664	35	1 500	8.34	7	Im	6794	35	2 551	5.71	8	Is	6924	35	2 624	9.28	8	Is	7054	35	1 756	7.76	10	Im	7184	51	2 388	9.44	6	Is
6405	35	1 440	7.68	6	Im	6535	35	1 464	8.35	7	Is	6665	35	1 500	8.35	7	Is	6795	35	2 551	7.04	8	Is	6925	35	2 624	9.6	8	Is	7055	35	1 759	7.12	10	Im	7185	51	2 393	6.21	6	Is
6406	35	1 440	9.44	6	Im	6536	35	2 464	4.82	7																															

Table B.1 Crop Cutting Data

SN	Pr	Ir	TF	Y	FL	IP	SN	Pr	Ir	TF	Y	FL	IP	SN	Pr	Ir	TF	Y	FL	IP	SN	Pr	Ir	TF	Y	FL	IP	SN	Pr	Ir	TF	Y	FL	IP	SN	Pr	Ir	TF	Y	FL	IP									
7281	52	2	240	7.23	4	Is	7411	52	2	499	6.74	7	Im	7541	61	5	0	3.54	1	N	7671	62	5	0	3.44	1	N	7801	63	5	0	3.78	1	N	7931	63	5	187	6.42	4	Im	8061	63	5	402	3.87	6	Im		
7282	52	4	242	6.18	4	Im	7412	52	1	509	5.84	7	Is	7542	61	5	0	3.68	1	N	7672	62	5	0	3.44	1	N	7802	63	5	0	3.79	1	N	7932	63	5	187	7.2	4	Im	8062	63	5	410	4.35	6	Im		
7283	52	1	250	5.41	4	Im	7413	52	2	500	5.76	7	Is	7543	61	5	0	3.68	1	N	7673	62	5	0	3.44	1	N	7803	63	5	0	3.79	1	N	7933	63	5	187	7.2	4	Im	8063	63	5	416	6.16	6	Im		
7284	52	4	249	6.29	4	Im	7414	52	2	500	7.01	7	Is	7544	61	5	0	3.7	1	N	7674	62	5	0	3.44	1	N	7804	63	5	0	3.84	1	N	7934	63	5	189	4.07	4	Im	8064	63	4	424	5.33	6	Im		
7285	52	3	249	7.04	4	Is	7415	52	2	500	7.44	7	Is	7545	61	5	0	3.84	1	N	7675	62	5	0	3.44	1	N	7805	63	5	0	3.84	1	N	7935	63	5	190	4.24	4	Im	8065	63	4	424	5.38	6	Im		
7286	52	3	249	6.72	4	Is	7416	52	2	500	8.19	7	Is	7546	61	5	0	3.84	1	N	7676	62	5	0	3.52	1	N	7806	63	5	0	4.03	1	N	7936	63	5	192	5.2	4	Im	8066	63	4	424	5.42	6	Im		
7287	52	1	250	6.56	5	Im	7417	52	3	500	5.73	7	Im	7547	61	5	0	3.86	1	N	7677	62	5	0	3.52	1	N	7807	63	5	0	4.03	1	N	7937	63	5	194	6.91	4	Im	8067	63	5	424	2.32	6	Im		
7288	52	2	250	4.19	5	Im	7418	52	4	500	8.16	7	Im	7548	61	5	0	3.89	1	N	7678	62	5	0	3.52	1	N	7808	63	5	0	4.16	1	N	7938	63	5	199	4.66	4	Im	8068	63	5	428	4.99	6	Im		
7289	52	2	250	6.83	5	Im	7419	52	2	504	6.56	7	Im	7549	61	5	0	3.92	1	N	7679	62	5	0	3.68	1	N	7809	63	5	0	4.42	1	N	7939	63	5	199	2.24	4	Is	8069	63	5	429	4.3	6	Im		
7290	52	2	250	7.9	5	Im	7420	52	1	528	4.32	7	Im	7550	61	5	0	3.97	1	N	7680	62	5	0	3.76	1	N	7810	63	5	0	4.48	1	N	7940	63	5	199	2.85	4	Is	8070	63	5	433	6.16	6	Im		
7291	52	2	250	8.19	5	Im	7421	52	2	540	6.48	7	Is	7551	61	5	0	4.05	1	N	7681	62	5	0	3.76	1	N	7811	63	5	0	4.49	1	N	7941	63	5	200	5.28	4	Im	8071	63	5	440	2.66	6	Im		
7292	52	5	250	3.73	5	Im	7422	52	2	540	6.64	7	Is	7552	61	5	0	4.1	1	N	7682	62	5	0	3.92	1	N	7812	63	5	0	4.72	1	N	7942	63	5	200	2.13	4	Im	8072	63	5	441	3.2	6	Im		
7293	52	5	250	4.35	5	Im	7423	52	2	543	7.12	7	Is	7553	61	5	0	19.114	2	Im	7683	62	5	0	3.95	1	N	7813	63	5	0	4.74	1	N	7943	63	5	200	2.45	4	Im	8073	63	5	442	3.84	6	Im		
7294	52	5	250	4.48	5	Im	7424	52	2	550	3.12	8	Is	7554	61	5	0	20.126	2	Im	7684	62	5	0	4	1	N	7814	63	5	0	4.93	1	Im	7944	63	5	200	4.54	4	Im	8074	63	5	451	3.26	7	Im		
7295	52	3	255	5.46	5	Is	7425	52	2	550	3.65	8	Is	7555	61	5	0	30.138	2	Im	7685	62	5	0	4	1	N	7815	63	5	0	5.02	1	Im	7945	63	5	202	5.04	4	Im	8075	63	5	453	3.1	7	Im		
7296	52	4	255	6.8	5	Im	7426	52	1	562	6.72	8	Is	7556	61	5	0	40.269	2	Im	7686	62	5	0	4.1	1	N	7816	63	5	0	5.12	1	Im	7946	63	4	204	3.25	4	Im	8076	63	5	462	5.76	7	Im		
7297	52	4	256	6.35	5	Im	7427	52	2	571	6.62	8	Is	7557	61	5	0	50.117	3	Im	7687	62	5	0	4.4	1	N	7817	63	5	0	5.12	1	Im	7947	63	5	204	6.18	4	Im	8077	63	5	472	4.7	7	Im		
7298	52	3	258	5.92	5	Im	7428	52	2	583	5.79	8	Im	7558	61	5	0	50.304	3	Im	7688	62	5	0	4.56	1	N	7818	63	5	0	5.14	1	Im	7948	63	4	206	3.55	4	Im	8078	63	5	491	3.36	7	Im		
7299	52	2	260	5.96	5	Im	7429	52	2	595	6.64	8	Im	7559	61	5	0	70.112	3	Im	7689	62	5	0	4.56	1	N	7819	63	5	0	5.39	1	Im	7949	63	5	207	7.09	4	Im	8079	63	5	499	3.62	7	Im		
7300	52	2	260	5.6	5	Im	7430	52	2	599	6	8	Im	7560	61	4	83	2.56	3	Im	7690	62	5	0	4.56	1	N	7820	63	5	0	5.68	1	N	7950	63	5	208	3.09	4	Im	8080	63	5	499	3.49	7	Im		
7301	52	2	260	6.48	5	Im	7431	52	2	610	5.55	8	Im	7561	61	5	0	90.328	3	Im	7691	62	5	0	5.04	1	N	7821	63	5	0	5.71	1	N	7951	63	4	210	3.23	4	Is	8081	63	5	500	6.24	7	Im		
7302	52	2	262	7.98	5	Is	7432	52	2	625	4.4	8	Im	7562	61	4	93	2.72	3	Im	7692	62	5	0	5.04	1	N	7822	63	5	0	5.89	1	N	7952	63	4	210	2.54	4	Is	8082	63	5	516	5.12	7	Im		
7303	52	3	265	7.07	5	Is	7433	52	2	625	2.56	8	Im	7563	61	4	93	2.72	3	Im	7693	62	5	0	5.4	2	Im	7823	63	5	0	5.28	1	Im	7953	63	5	210	4.8	4	Im	8083	63	5	516	4.96	7	Im		
7304	52	1	266	8.16	5	Is	7434	52	2	640	6.88	8	Im	7564	61	5	0	94.174	3	Im	7694	62	5	0	5.4	2	Im	7824	63	2	9	4.8	2	Is	7954	63	4	213	2.56	4	Im	8084	63	5	525	5.09	7	Im		
7305	52	2	266	4.59	5	Im	7435	52	2	666	6.4	9	Is	7565	61	5	0	95.24	3	Im	7695	62	4	99	3.92	2	Im	7825	63	2	25	4.05	2	Im	7955	63	5	213	4.08	4	Im	8085	63	5	525	5.09	7	Im		
7306	52	3	269	6	5	Is	7436	52	2	666	6.56	9	Is	7566	61	5	0	97	2	3	Im	7696	62	5	0	5.3	4.88	3	Im	7826	63	5	31	3.44	2	Im	7956	63	5	213	4.94	4	Im	8086	63	5	525	6.16	7	Im
7307	52	2	271	5.2	5	Im	7437	52	2	671	6.56	9	Im	7567	61	5	0	98	2.48	3	Im	7697	62	5	0	5.7	4.64	3	Im	7827	63	5	33	3.95	2	Im	7957	63	5	213	5.04	4	Im	8087	63	5	530	2.16	8	Im
7308	52	2	276	5.68	5	Is	7438	52	2	677	6.44	9	Im	7568	61	4	99	2.4	3	Im	7698	62	5	0	6.4	1.6	3	Im	7828	63	5	37	4.19	2	Im	7958	63	4	214	4.44	4	Im	8088	63	5	537	5.8	8	Im	
7309	52	2	278	5.44	5	Im	7439	52	2	681	5.34	9	Im	7569	61	4	106	2.56	3	Im	7699	62	5	0	6.6	4.64	3	Im	7829	63	5	39	6.56	2	Im	7959	63	5	214	7.4	4	Im	8089	63	5	542	4.98	8	Im	
7310	52	4	277	7.84	5	Im	7440	52	2	681	5.66	9	Im	7570	61	5	0	106	2	3	Im	7700	62	5	0	80	4.16	3	Im	7830	63	2	41	3.36	2	Im	7960	63	5	215	1.95	4	Im	8090	63	5	542	5.6	8	Im
7311	52	4	278	7.22	5	Im	7441	52	2	703	7.76	9	Is	7571	61	5	0	112	2	3	Im	7701	62	5	0	80	4.32	3	Im	7831	63	5	41	3.2	2	Im	7961	63	5	218	5.06	4	Im	8091	63	5	542	7.8	8	Im
7312	52	1	279	7.02	5	Is	7442	52	2	729	7.04	9	Is	7572	61	4	133	2.93	3	Im	7702	62	5	0	80	4.32	3	Im	7832	63	5	43	6.64	2	Im	7962	63	5	220	5.62	4	Im	8092	63	5	577	3.84	9	Im	
7313	52	2	280	5.82	5	Is	7443	52	2	740	6.4	9	Im	7573	61	5	0	133	4.06	3	Im	7703	62	5	0	80	4.48	3	Im	7833	63	5	43	6.92	2	Im	7963	63	5	220	6.27	4	Im	8093	63	5	600	4.16	9	Im
7314	52	2	280	5.82	5	Is	7444	53	4	0	3.2	1	N	7574	61	4	140	2.9	3	Im	7704	62	5	0	80	4.56	3	Im	7834	63	5	44	2.88	2	Im															

Table B.1 Crop Cutting Data

SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP	SN	Pr	Irr.	TF	Y	FL	IP									
8191	71		3	142	5.35	3	8321	71		5	312	6.72	5	8451	72		4	2	2.4	1	N	8581	73		4	88	6.86	3	8711	73		4	238	4.99	4	8841	73		4	350	5.01	6	N
8192	71		4	143	6.73	3	8322	71		5	312	6.91	5	8452	72		4	0	3.31	N		8582	73		4	90	4.34	3	8712	73		5	238	5.34	4	8842	73		5	328	6.05	6	N
8193	71		5	143	9.41	3	8323	71		5	312	7.41	5	8453	72		4	0	3.39	N		8583	73		2	94	4.66	3	8713	73		5	238	4.69	4	8843	73		5	350	6.61	6	N
8194	71		5	144	8.02	3	8324	71		5	320	6.18	5	8454	72		4	0	3.62	N		8584	73		4	99	8.03	3	8714	73		5	240	6.13	4	8844	73		5	352	6.69	6	N
8195	71		2	149	5.47	3	8325	71		5	320	7.02	5	8455	72		4	0	4.02	N		8585	73		2	100	6.26	3	8715	73		5	242	8.22	4	8845	73		4	356	7.25	6	N
8196	71		4	150	4.29	4	8326	71		4	326	6.64	5	8456	72		4	0	4.67	N		8586	73		5	100	5.23	3	8716	73		5	244	7.2	4	8846	73		4	356	7.3	6	N
8197	71		5	150	6.86	4	8327	71		3	327	6.16	5	8457	72		5	0	1.15	N		8587	73		5	100	5.62	3	8717	73		5	245	3.07	4	8847	73		5	356	6.9	6	N
8198	71		5	150	7.36	4	8328	71		5	327	6.19	5	8458	72		5	0	1.22	N		8588	73		5	100	5.9	3	8718	73		5	249	6.64	4	8848	73		5	356	6.9	6	N
8199	71		5	151	6.38	4	8329	71		1	332	5.18	5	8459	72		5	0	2.24	N		8589	73		4	140	3.3	3	8719	73		5	249	6.33	4	8849	73		5	357	7.86	6	N
8200	71		5	153	4.59	4	8330	71		1	332	8.16	5	8460	72		5	0	2.37	N		8590	73		2	111	4.14	3	8720	73		5	249	6.12	4	8850	73		5	357	7.12	6	N
8201	71		4	160	6.61	4	8331	71		1	332	5.28	5	8461	72		5	0	2.34	N		8591	73		5	111	4.46	3	8721	73		5	249	6.48	4	8851	73		5	357	5.89	6	N
8202	71		2	162	5.3	4	8332	71		2	333	8.61	5	8462	72		5	0	2.4	N		8592	73		5	117	7.82	3	8722	73		1	250	6.56	5	8852	73		5	357	6.46	6	N
8203	71		2	162	8.93	4	8333	71		5	333	7.06	5	8463	72		5	0	2.42	N		8593	73		3	121	8.74	3	8723	73		1	250	6.64	5	8853	73		5	357	6.68	6	N
8204	71		4	162	8.38	4	8334	71		5	333	7.02	5	8464	72		5	0	3.09	N		8594	73		4	125	7.68	3	8724	73		4	250	3.1	5	8854	73		3	366	4.74	6	N
8205	71		2	163	5.94	4	8335	71		5	337	4.85	5	8465	72		5	0	3.2	N		8595	73		5	125	6.69	3	8725	73		4	250	3.14	5	8855	73		3	366	4.8	6	N
8206	71		2	163	5.7	4	8336	71		5	337	8.42	5	8466	72		5	0	3.2	N		8596	73		5	126	6.83	3	8726	73		4	250	5.07	5	8856	73		3	366	5.02	6	N
8207	71		5	163	7.41	4	8337	71		5	340	7.92	5	8467	72		5	0	3.48	N		8597	73		2	133	6.75	3	8727	73		5	250	1.89	5	8857	73		5	369	7.33	6	N
8208	71		5	163	8	4	8338	71		4	340	6.67	5	8468	72		5	0	4.5	N		8598	73		5	133	3.73	3	8728	73		5	250	1.95	5	8858	73		4	370	4.93	6	N
8209	71		3	165	5.31	4	8339	71		5	348	7.46	5	8469	72		5	0	4.64	N		8599	73		5	138	6	3	8729	73		5	250	2.03	5	8859	73		5	370	5.6	6	N
8210	71		3	166	5.33	4	8340	71		1	350	6.21	6	8470	72		5	0	4.96	N		8600	73		2	141	4.29	3	8730	73		5	250	3.9	5	8860	73		5	374	5.6	6	N
8211	71		5	166	5.94	4	8341	71		1	350	8.35	6	8471	72		5	0	5.6	N		8601	73		1	142	6.29	3	8731	73		5	250	4.32	5	8861	73		1	375	6.42	6	N
8212	71		5	166	6.34	4	8342	71		1	350	8.8	6	8472	72		5	0	5.92	N		8602	73		3	142	5.01	3	8732	73		5	250	4.69	5	8862	73		1	375	6.61	6	N
8213	71		5	166	5.86	4	8343	71		5	350	6.8	6	8473	72		1	48	3.87	2		8603	73		4	142	3.02	3	8733	73		5	250	4.98	5	8863	73		2	375	4.75	6	N
8214	71		4	170	5.98	4	8344	71		5	350	7.12	6	8474	72		1	52	4.5	3		8604	73		4	142	8.18	3	8734	73		5	250	5.44	5	8864	73		2	375	6.48	6	N
8215	71		4	171	6.27	4	8345	71		4	356	3.47	6	8475	72		1	64	3.82	3		8605	73		5	143	8.78	3	8735	73		5	250	5.46	5	8865	73		3	375	5.47	6	N
8216	71		5	174	8.77	4	8346	71		4	356	7.82	6	8476	72		1	66	4.96	3		8606	73		5	144	7.49	3	8736	73		5	250	5.48	5	8866	73		3	375	6.06	6	N
8217	71		5	175	6.19	4	8347	71		4	356	7.39	6	8477	72		1	66	5.32	3		8607	73		5	145	4.58	3	8737	73		5	253	3.81	5	8867	73		4	375	5.89	6	N
8218	71		2	178	6.69	4	8348	71		2	357	8.42	6	8478	72		2	70	5.15	3		8608	73		2	149	5.1	3	8738	73		3	256	7.7	5	8868	73		5	375	4.74	6	N
8219	71		5	178	7.81	4	8349	71		2	357	5.49	6	8479	72		1	100	4.72	3		8609	73		4	150	4	4	8739	73		5	257	8.13	5	8869	73		2	378	7.86	6	N
8220	71		4	180	8.48	4	8350	71		5	357	8.14	6	8480	72		1	100	4.88	3		8610	73		5	150	6.4	4	8740	73		4	258	2.8	5	8870	73		4	380	3.86	6	N
8221	71		5	180	5.46	4	8351	71		5	357	6.3	6	8481	72		1	100	5.04	3		8611	73		5	150	6.86	4	8741	73		5	258	1.82	5	8871	73		1	380	6.56	6	N
8222	71		2	181	3.87	4	8352	71		5	357	6.93	6	8482	72		1	117	3.41	3		8612	73		5	151	5.95	4	8742	73		4	259	6.22	5	8872	73		5	382	5.97	6	N
8223	71		1	187	6.58	4	8353	71		2	366	8.22	6	8483	72		5	135	3.23	3		8613	73		5	153	4.29	4	8743	73		2	260	7.79	5	8873	73		5	384	6.75	6	N
8224	71		2	188	4.9	4	8354	71		3	366	3.07	6	8484	72		1	144	3.24	3		8614	73		5	154	5.04	4	8744	73		5	260	3.93	5	8874	73		5	384	7.47	6	N
8225	71		2	189	8.21	4	8355	71		3	366	8.16	6	8485	72		1	150	4.05	4		8615	73		4	160	4.93	4	8745	73		1	261	6.74	5	8875	73		1	390	6.66	6	N
8226	71		5	194	7.28	4	8356	71		3	366	5.38	6	8486	72		1	158	4.21	4		8616	73		4	160	6.16	4	8746	73		2	262	7.17	5	8876	73		4	390	6.3	6	N
8227	71		5	196	7.87	4	8357	71		5	369	6.99	6	8487	72		4	180	4.96	4		8617	73		2	162	4.94	4	8747	73		5	262	4.43	5	8877	73		3	394	5.66	6	N
8228	71		4	199	4.66	4	8358	71		4	370	5.28	6	8488	72		4	187	4.99	4		8618	73		2	162	8.34	4	8748	73		5	262	4.88	5	8878	73		5	394	7.44	6	N
8229	71		3	200	4.78	4	8359	71		5	370	6	6	8489	72		2	199	4.67	4		8619	73		4	162	7.82	4	8749	73		1	266	6.1	5	8879	73		1	399	5.07	6	N
8230	71		4	2																																							

Annex C

Land Resources Assessment

ANNEX C

LAND RESOURCES ASSESSMENT

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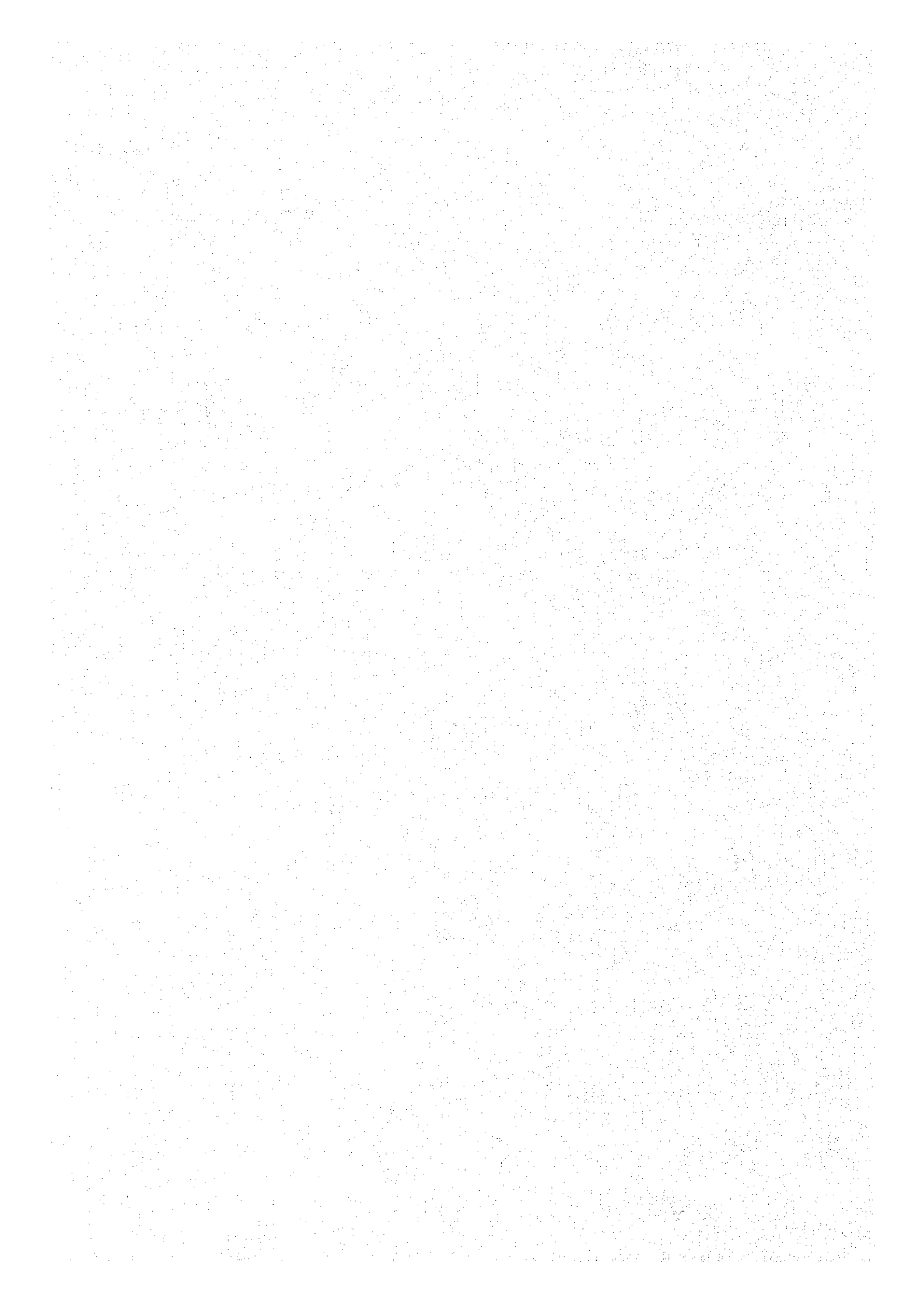
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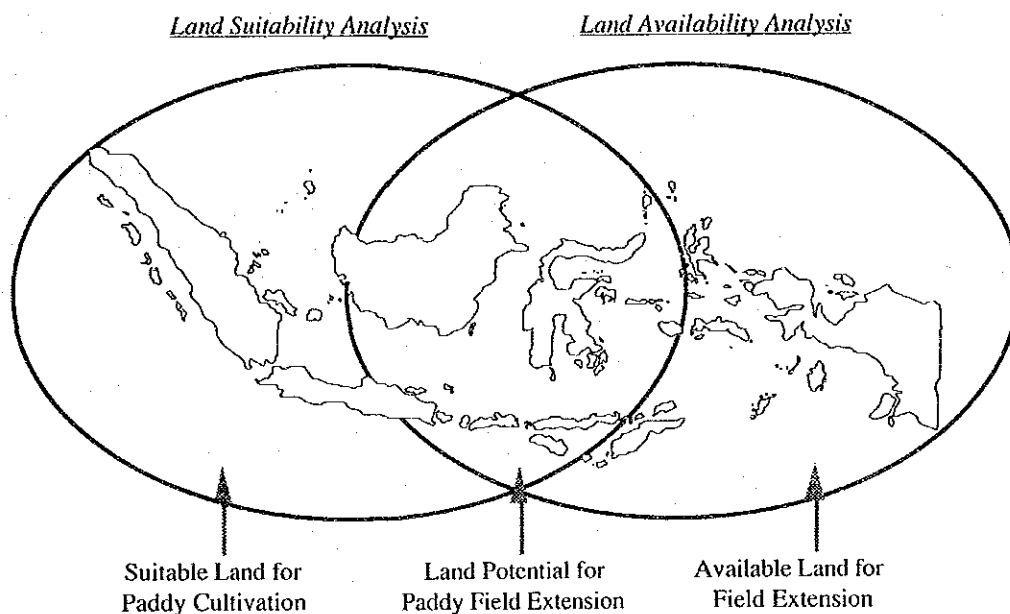


1. Introduction

This technical report of Land Resources Assessment presents physical land potential for wet paddy field development and irrigation development in Indonesia. The results of the analyses offer extension potential of irrigated paddy field to raise rice production capacity in future.

As for land potential assessment, land suitability analysis is carried out primarily for whole land of Indonesia. Then, land availability is analyzed on the basis of present land use and land status. The combination of these results provides further potential of wetland agriculture development from viewpoint of physical land conditions. Generally, land which is suitable for paddy cultivation and available for field extension is considered as potential land for paddy field extension, as explained in the following figure.

General Concept of Land Potential Assessment



To assess irrigation development potential, river basin approach from both aspects of water and land potential is adopted. Water availability is another crucial factor that limits extensive irrigation development, but this report does not describe about its analysis in detail (another technical note issue that).

Land resources for wetland cultivation will be assessed in a viewpoint of irrigation development potential in Indonesia. Land potential assessment will couple with water resources potential, because both of them are critical limiting factors of irrigation development.

For assessment of national land potential, Regional Physical Planning Project for Transmigration (RePPPProT) study by Ministry of Transmigration is considered to provide the most relevant and fundamental data. This is the only nationwide land evaluation by an integrated land unit approach, not only soil type, in Indonesia. In the RePPPProT study, 414 Land Systems are defined in whole national area, then those qualities are evaluated with the requirement of the planned crop or land use type. Following to the land suitability assessment, land availability to be developed is secondly assessed by present land use and land status. Finally, the RePPPProT study defines 760 Recommended Development Areas for transmigration by settlement type.

The land resources assessment starts from review of the RePPPProT results by the above reason. The classification criteria on the Land Systems and the evaluation criteria on land suitability are re-examined in terms of paddy cultivation with irrigation. Through the process, the land potential of land development is evaluated by integrated criteria consisted of topography, geology, soils, climate, hydrology and so on. At the next step, the potential areas are examined upon another limiting factor of irrigation water availability in each river basin area. The assessment process is to clarify physical potential area of irrigation development in the country.

A similar study of land resources assessment was carried out by Delft Hydraulics/Euroconsult (Project BTA-155). The study also used RePPPProT land assessment data, and distinguished land development potential area in the whole Indonesia. The FIDP study carries out the analyses of land development potential in more detail. Further, the FIDP study analyses nationwide irrigation development potential.

2. General Descriptions of Land Resources

2.1 Outline of the Integrated Land Unit Approach

The land resources assessment of the FIDP study is carried out on the basis of land system evaluation data by Regional Physical Planning Program for Transmigration (RePPPProT) study, because there are not any other systematic maps or descriptions of land characters of

the whole Indonesia. The RePPPProT study applied the integrated land unit approach to evaluate land potential for transmigration. This method is more efficient to evaluate the environment in terms of a whole range of attributes, including landform, soils, land cover and climate. Land evaluation then becomes essentially a process of matching the characteristics of the land units defined during the land resources survey with the requirements of defined kinds of land use.

The integrated land unit approach of the RePPPProT requires many kinds and large amounts of information concerning to nationwide land resources. Initially airphotographies, satellite imageries and also existing many kinds of topographic maps are collected for physiographic, geographic and vegetation information in the whole Indonesia. For climate and hydrology, long term records at a lot of rainfall measuring stations and river discharge gauging station are applied. For soil characteristics, applicable soil data are collected mainly at Research Center of Soil and Agroclimate, under Ministry of Agriculture. Forestry and environmental issues are also considered using existing forest categories, authorized by Ministry of Forest. Those all data are organized well as examination factors of the national land resources in textbooks and maps, with following processes.

The RePPPProT study completed land resources assessment of the eight major regions of Indonesia during 1984 to 1989, and prepared Regional Reviews and three kinds of maps at 1:250,000. Those reports and maps offer a number of data and descriptions about land resources by region.

- 8 Regional Reviews
(Sumatera, 1988; Jawa and Bali, 1989; Kalimantan Barat, 1987; Kalimantan Tengah, 1985; Kalimantan Timur and Selatan, 1987; Sulawesi, 1988; Maluku and Nusa Tenggara, 1989; Irian Jaya, 1986)
- 237 Land System Maps at 1:250,000
(414 land systems with lithology, topography, climate, hydrology, soil and vegetation)
- 237 Present Land Use Maps at 1:250,000
(76 categories of forest and land use types)
- 213 Land Status Maps at 1:250,000
(Existing and firmly planned developments; gazetted, proposed nature reserves)

The great heap of data and findings about land resources is concluded in National Overview and Atlas in 1990.

- National Overview, 1990
- Atlas at 1:2,500,000

(1. Geology; 2. Mineral and energy resources; 3. Rainfall; 4. Agro-climate; 5. Groundwater; 6. Physiographic type; 7. Land unit and land use planning; 8. Soil; 9. Land cover; 10. Land use/forest; 11. Environmental hazards; 12. Transmigration site/Replita IV; 13. Population distribution; 14. Regional development)

The methodology and original data sources of RePPPProT integrated land unit approach are briefly summarized in the following table.

Methodology and Original Data Source of RePPProT Land Evaluation Approach

Item	Methodology/Source
Approach	Integrated Land Unit Approach ... FAO, (1981) The Land Unit Approach to Land Resources Surveys for Land Use Planning, with Particular Reference to the Sekampung watershed, Lampung Province, Sumatra, Indonesia.
Identification unit of Land Systems	Average: more than 400,000 ha. Minimum: about 50 ha, based on 1/250,000 maps.
Number of Land Systems	414 Land Systems in Indonesia
Land System areas	Measured on 1/250,000 maps and summarized by map sheet and province.
Land Suitability Criteria	FAO (1976) Framework for land evaluation ... A standard set of principles and concepts on land evaluation system.
Geology	Existing maps at 1/100,000 - 1/1,000,000 by Geological Research and Development Center (up to 1984). RePPProT photogeological land system maps at 1/1,000,000. Other survey results.
Climate	Climatic records by Agency for Meteorology and Geophysics.
Hydrology	River gauging and hydrological records by Center for Research and Development of Water Resources.
Physiography	Airphotography (Jawa & Bali, much of Sulawesi and Kalimantan, 1981-82; most of the rest, 1976-79; significant part of West Kalimantan, 1969) for basic information; Recent Landsat, SPOT and radar imagery to fill in gaps.
Soils (Source/ Classification)	Landforms on imagery. USDA Soil Taxonomy (1985) ... One of world standard soil classification system.
Land Cover (Land Use)	Airphotography (Jawa & Bali, much of Sulawesi and Kalimantan, 1981-82; most of the rest, 1976-79; significant part of West Kalimantan, 1969) for basic information; Recent Landsat, SPOT and radar imagery to fill in gaps and to update forest boundary.
Forest Category	Consensus Forest Land Use Plan (Tata Guna Hutan Kcepakatan, TGHK) in 1982. The areas of categories were revised on the RePPProT maps.
Swamp (Inland)	Adopted by suitability criteria for <u>wetland arable</u> . Total area and suitability can be identified by Land System descriptions, but availability can not be identified.
Swamp (Tidal)	Adopted by suitability criteria for <u>tidal irrigation</u> . Total area and suitability can be identified by Land System descriptions, but availability can not be identified.

There is a similar study of land resources assessment as a part of the project BTA-155 (Technical note 3, 1991). The BTA-155 also assessed nationwide land potential for wetland agriculture development. As the FIDP study started after the study, some modifications of methods and further irrigation development potentials could be made by the FIDP. Differences between the FIDP study and the BTA-155 are summarized as follows:

Comparison with FIDP Study and BTA-155 Study

Item	FIDP	BTA-155
<i>General</i>		
Objectives	Land resources assessment for Wetland Development and Irrigation Development	Land resources assessment for Wetland Development
Data source	RePPPProT	RePPPProT
<i>Land suitability</i>		
Land suitability criteria	Unified criteria as described on RePPPProT National Overview	Slight modification on RePPPProT Regional Reviews
Land suitability class	4 classes; fully suitable, conditionally suitable, marginally suitable, unsuitable	3 classes; fully suitable, conditionally suitable, unsuitable
<i>Land Availability</i>		
Present land use and land status	Based on RePPPProT Regional Reviews; estimation of each land use area in all land systems	Based on RePPPProT Regional Reviews
Forest criteria	Revised TGHK by RePPPProT Regional Reviews; estimation of each TGHK area in all land systems	Revised TGHK by RePPPProT Regional Reviews; concerned as forest convertability for only selected suitable area
Facet reduction factor	Not concerned; unsuitable facets should be removed by identification efficiency index	Unsuitable facets are excluded by facet reduction factor; derived from the descriptions in Regional Reviews
Identification efficiency index	0.36; from RePPPProT Regional Review of Central Kalimantan	0.36; from RePPPProT Regional Review of Central Kalimantan
<i>Land Potential</i>		
Wetland development	Assessed by province and by river basin	Assessed by province
Irrigation development	Assessed by combined with irrigation water availability by river basins	No assessment

2.2 Agroclimatic Zones

Climatic conditions, such as rainfall, temperature and sunshine, vary significantly in Indonesia. This variation affects moisture regime in relationship soils and plants. These different soil moisture regimes create distinctive soil types, which help to define land systems. Moisture regime also determines the types of plants that can survive in an area under natural conditions, and to hence the area's agricultural potential. USDA Soil Taxonomy Manual, a systematic treatment of soil moisture is applied to define geographic limits for the resulting agro-climatic zones.

Monthly rainfall conditions determine four agroclimatic zones; aridic, ustic, udic and perhumid, and also temperature conditions affected by altitude divide these zones into two groups. The brief descriptions of them and some recommendations for development plans are

Aridic or permanently dry zone:

The severest limitations to plant growth are imposed by the climatic conditions of a semi-permanent dry season which create the aridic soil type; this is designated the aridic or permanently dry zone, and is defined as having nine or more months with an average rainfall of less than 100 mm. It occupies 0.34 million ha or 0.2 % of Indonesia, and occurs on the coasts of north and northwest Timor, northeast and southeast Sumba the Palu area of Sulawesi Tengah and smaller coastal patches of east and northwest Wetar, north Lombok, north Flores and east Sumbawa.

Ustic or seasonally dry zone:

Less severe but still difficult conditions are found in the ustic or seasonally dry zone, defined as having five to eight months with an average rainfall of less than 100 mm. It occupies 14.3 million ha or 7.5% of the country, and covers much of the north and east coast and the Solo and Brantas river basins of Jawa, a large area of southeast Irian Jaya, and substantial areas of north and south Bali, northeast Lombok, Sumbawa, Sumba, Flores, Adonara, Pantar, Alor, Wetar, north and west Timor and west Yamdena. It also covers small areas of north Ambon, coastal Sulawesi Tenggara and Sulawesi Selatan, and the Palu valley and Balantak Peninsula of Sulawesi Tengah.

Udic or seasonally wet zone:

Most of Indonesia lies within the udic or seasonally dry zone, defined as having up to four months with an average rainfall of less than 100 mm. This zone occupies

134.0 million ha or 70.1 % of Indonesia. It covers most of Sumatera, Kalimantan and Maluku; about half of Jawa, Sulawesi, Timor and Irian Jaya; and small parts of the other islands. Rainfall agriculture is possible in much of this zone, but yields are higher and multiple cropping is possible where the effort has been made to provide supplementary irrigation water.

Perhumid or permanently wet zone:

Perhumid or permanently wet zone is defined as having 12 wet months (mean monthly rainfall exceeding 200 mm), and covers 20.6 million ha or 10.8 % of Indonesia. The zone includes extensive areas of the central mountains and bird's head of Irian Jaya, the inland mountains of Kalimantan, small areas of Balisan Mountains and central west coast of Sumatera, two small areas in the mountains of Jawa Barat and Jawa Tengah. This zone is particularly suitable for such trees as oil palm and sago, but is too wet for most other crops.

Highland or permanently cool zone:

This cool zone is defined in terms of altitude and includes all land above the 1,000 m contour. It therefore overlaps with wet, moist and dry zones (though not with the aridic zone) to give sub-zones with distinctive combinations of characteristics. These cover 21.9 million ha or 11.5% of the country. Highland agriculture as practiced in most areas involves such crops as maize, wheat, sorghum, soybean, groundnut, banana, arabica coffee and a range of temperate latitude vegetables and market garden produce particularly near the major cities of Jawa and Sumatera. This form of agriculture is found in the submontane subzone, between 1,000 and 2,000 m.

The agroclimatic zones recognized by the RePPPProT consists of aridic, ustic, udic, perhumid and highland units, respectively termed the permanently dry, seasonally dry, seasonally wet, permanently wet and permanently cool or highland zones. Within the cool/highland zone, sub-montane and montane and alpine sub-zones are recognizable. The areas of Indonesia found in the respective zones are give in following table.

Areas of Agroclimatic Zones by Region

(million ha)

Region	Hot				Cool		
	Wet	Moist	Dry	Arid	Wet	Moist	Dry
Sumatera	0.82	41.70	0.16	0.00	0.21	4.64	0.00
Jawa & Bali	0.10	6.10	5.27	0.00	0.09	2.02	0.24
Kalimantan	10.51	41.01	0.02	0.00	1.26	0.78	0.00
Sulawesi	0.00	13.90	0.90	0.02	0.00	3.78	0.02
Maluku & NT	0.00	8.93	5.86	0.31	0.00	0.64	0.12
Irian Jaya	9.12	22.25	2.04	0.00	5.99	2.08	0.00
Indonesia	20.55	133.89	14.26	0.34	7.55	13.94	0.38

Source: RePPProT National Overview

2.3 Physiography

The major physiographic types in Indonesia shown on Atlas Map 6 are a selection of specific and general landforms, chosen mainly for their importance for land planning considerations. Thus, the lowland types are quite detailed while the hills and mountains are not differentiated. The map at a scale 1:2,500,000 has been simplified from land system map series at 1:250,000. Brief descriptions of the 414 land systems are grouped by physiographic types, and the legend to the land system maps in the Regional Reviews is similarly subdivided.

The distribution of these more useful physiographic types within the country is not uniform. The following table shows the distribution of physiographic types by Regional Review area. When grouped into physiographic types each land system can occur in one category only. In the second grouping of land systems into physiographic regions a land system may be found in several categories.

Physiographic Types by Region

(million ha)

Physiography	Sumatera	Jawa/Bali	Kalimantan	Sulawesi	Maluku/NT	Irian Jaya	Total
Beach	0.42	0.10	0.14	0.16	0.19	0.20	1.21
Tidal swamp	0.86	0.17	1.09	0.22	0.24	1.43	4.01
Peat swamp, marsh	6.21	0.00	5.11	0.22	0.00	5.36	16.90
Meander belt	0.83	0.00	0.00	0.07	0.10	0.60	2.08
Seasonal swamp	0.00	0.00	2.57	0.00	0.00	2.11	2.11
Alluvial plain	4.28	1.83	0.41	1.00	0.67	1.18	11.53
Alluvial valley	0.40	0.18	0.00	0.13	0.15	1.76	3.02
Alluvial fan, lahar	0.77	1.01	3.23	0.76	0.37	0.79	3.70
Terraces	1.46	0.47	18.88	0.03	1.03	1.72	7.95
Plain (non-alluvial)	16.00	5.77	7.92	2.14	2.31	6.84	51.86
Hill	4.85	1.95	13.35	2.51	3.53	2.76	23.52
Mountain	10.18	2.19	0.50	11.20	7.17	16.41	60.50

Source: RePPProT National Overview.

The physiographic types may be divided into two broad groups for planning purpose; those with potential for a wide range of agricultural development activities and those with no potential or a limited potential for a much narrower range of developments. The beaches, all three types of swamps, most of terraces and hills, and the mountain physiographic types all have very limited development potential. The tidal swamps have potential only for brackish water fisheries development and the beaches, terraces, hills and mountains have potential only for a limited range of tree-crop and forest plantation developments. Many of these areas have greater significance for mining, tourism or conservation, for example, than for agriculture.

The physiographic types with potential for a wide range of development activities are the alluvial plains, meander belts, alluvial valleys, fans and lahars, and a wide range of non-alluvial plains. With varying levels of inputs, wetland rice cultivation, dryland arable farming and a wide range of tree-crop developments are all possible in these physiographic types. Overall, about 38 % or 722,000 km² of Indonesia consists of the physiographic types with potential for a wide range of development activities, although peat swamps and marshes with an area of 8.9 % are considered to be suitable for wetland rice cultivation using low-input technology. The Jawa and Bali region has the greatest proportion of better quality land (64 % or 8.8 million ha), and Sulawesi (22 % or 4.1 million ha), Maluku and Nusa Tenggara (23 % or 3.6 million ha) and Irian Jaya (27 % or 11.2 million ha) the smallest.

2.4 Soils

The soil identification in Indonesia is carried out in the RePPPProT Regional Reviews, in line with USDA Soil Taxonomy (1985) methods and criteria. The recognized eight soil Orders in Indonesia are Histosols, Entisols, Inceptisols, Aridisols, Mollisols, Vertisols, Alfisols, Utisols, Spodosols and Oxisols. The major 34 soil Great Groups within the Orders are identified and mapped, as listed in the following table. General features and distributions of the Great Groups are explained in Table 2.1.

Major Soil Orders, Suborders and Great Groups in Indonesia

Order	Suborder	Great Group
Histosols	Hemists	Tropohemists
Entisols	Aquepts	Tropaquepts, Fluvauents, Hydraquepts
	Orthents	Troporthents, Ustorthents
	Psamments	Tropopsamments, Ustipsamments
	Fluvents	Tropofluvents, Ustifluvents
Inceptisols	Aquepts	Tropaquepts
	Andepts	Dystrandeps, Eutrandeps, Vitrandeps
	Tropepts	Dystropepts, Eutropepts, Ustropepts, Humitropepts
Mollisols	Ustolls	Calciustolls
	Rendosols	
Vertisols	Usterts	Pellusterts
Aridisols	Orthids	Calciorthids
Alfisols	Udalfs	Tropudalfs, Paleudalfs
	Ustalfs	Rhodustalfs, Haplustalfs
Ultisols	Udults	Paleudults, Tropudults
	Ustalfs	Rhodustalfs, Haplustalfs
Spodosols	Aquods	Placaquods, Tropaquods
Oxisols	Orthox	Haplorthox
	Ustox	Haplustox

Source: RePPProT National Overview.

Indonesian soils range from highly fertile to virtually sterile, with a wide range of intermediate condition. Those which have least limitations for non-irrigated cultivation and which are already used intensively are deep, well drained soils of moderately fine texture and with as well balanced nutrient status. Such soils occur on young intermediate or basaltic volcanic of the volcanic arc as Eutrandeps, Eutropepts or Ustropepts. On calcareous parent materials of the outer arc and in parts of Kalimantan and Irian Jaya, Alfisols, Vertisols, Hapludosols and Haplustolls also fulfill these conditions but have a more restricted distribution. Young riverine and estuarine plains on all the major islands also support intensive irrigated agriculture on poorly drained but relatively fertile Tropauepts.

The most difficult soils to deal with are the very strongly weathered and leached, waterlogged Placaquods and sterile Quartzipsamments of Kalimantan and east Sumatera quartz-sand terraces, the deep peats of Sumatera and Kalimantan and Irian Jaya, the toxic Haplorthox on ultrabasic rocks of Sulawesi, Maluku and Nusa Tenggara, and the shallow Troporthents, Rendolls and Calciustolls of limestone karst and mountains. Together, these