CHAPTER 6

RISK ANALYSIS

Stochastic dominance analysis was used to evaluate decision about farm management strategies (FMS). The rice farm management strategies considered in this study were the choice of choosing rice variety and fertilizer management levels on selected soil series and growing season. The first degree stochastic dominance criterion was first applied to eliminate a large number of options as being risk-inefficient. The second degree stochastic dominance analysis was then used to derive risk-efficient strategy when first order was failure. The stochastic dominance analysis of yield draw efficient farm management strategies for self sufficiency farmers while such analysis of net margin derived proper farm management strategies for farmers who optimize their rice farm income.

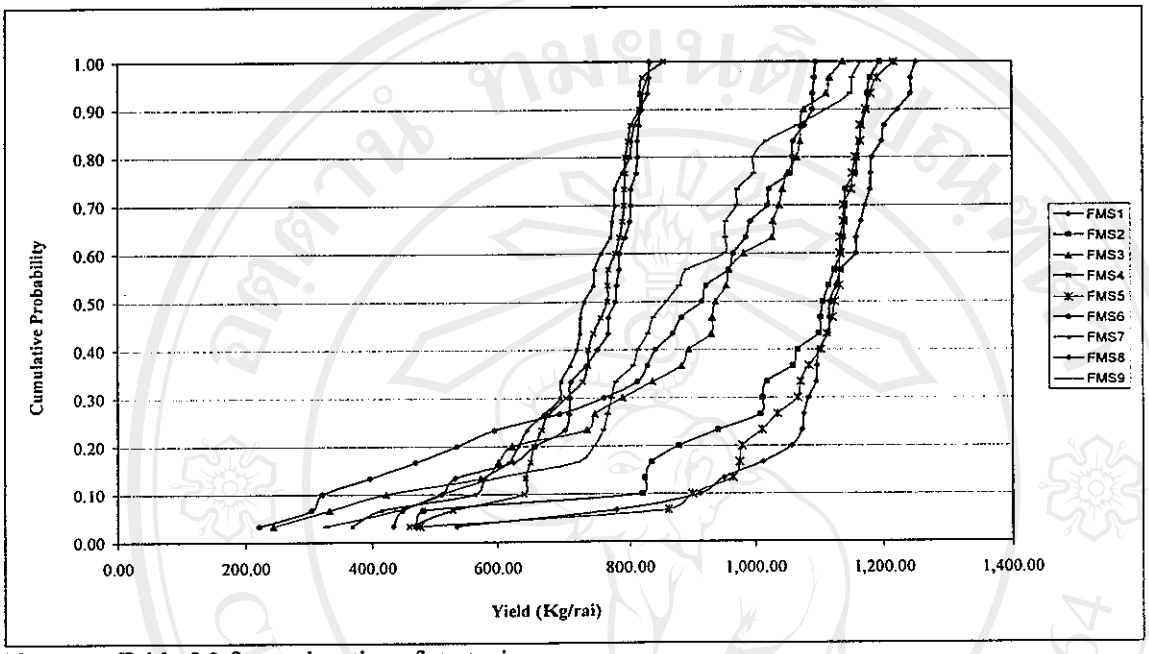
6.1 Stochastic Dominance Analysis of Yield

Stochastic dominance analysis is a tool for comparing alternative risky choice of rice farm management strategies. Comparison of rice grain yield in 36 scenarios was done for rice farmers who are rice self sufficiency. The analysis assumed that they aimed to maximize rice grain yield to secure food consumption.

The management scenarios of choosing rice variety and fertilizer management levels were analyzed under selected soil series and growing season. The following sections present the results from stochastic dominance analysis.

Hang Dong soil series in rainy season

The cumulative probability distribution of rice farm management strategies were constructed for comparison in each farm management strategy (Figure 6.1).



Note: see Table 5.3 for explanation of strategies

Figure 6.1 The cumulative probability distribution of rice yield for different farm management strategies at Hang Dong soil series in rainy season

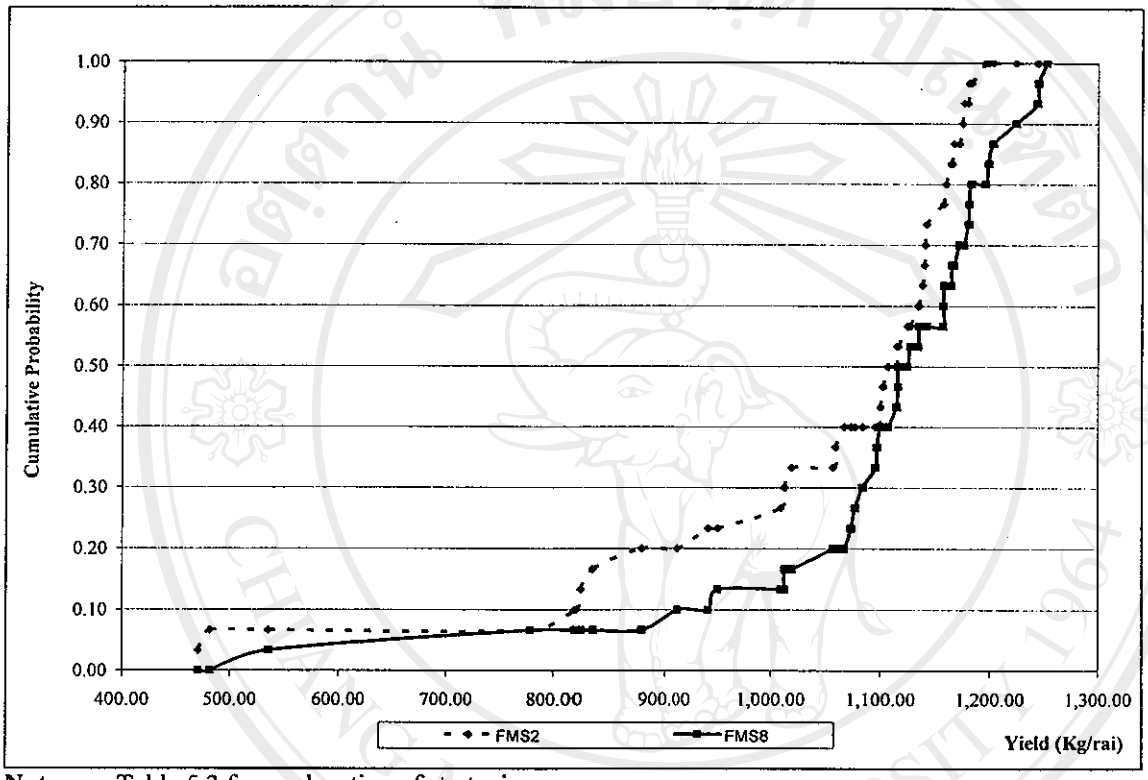
The fist degree stochastic dominance rule (FSD) eliminated a number of farm management strategies as being risk-inefficient. For example, the comparison of FMS2 and FMS8 by using FSD was shown in Table 6.1 and Figure 6.2 that FMS8 dominates FMS2 because all CDF FMS8 are less than or equal to CDF FMS2. The remaining as risk efficient strategies as evaluated by FSD are FMS5 and FMS8. This result demonstrates the potential usefulness of FSD in rapidly screening inefficient choices. The risk-efficient set identified by the FSD criterion was subjected to the second degree stochastic dominance analysis (SSD). Theoretically, more options would be eliminated as being unacceptable to risk-averse farmers.

Table 6.1 The comparison of FMS2 and FMS8 by using the first degree of stochastic dominance analysis (FSD)

Yield(kg)	Freq FMS2	Freq FMS8	Pdf FMS2	Pdf FMS8	CDF FMS2	CDF FMS8
470.08	1		0.03	0.00	0.03	0.00
481.12	1		0.03	0.00	0.07	0.00
535.52		1	0.00	0.03	0.07	0.03
778.56		1	0.00	0.03	0.07	0.07
818.72	1		0.03	0.00	0.10	0.07
822.88	1		0.03	0.00	0.13	0.07
834.40	1		0.03	0.00	0.17	0.07
878.40	1		0.03	0.00	0.20	0.07
912.16		1	0.00	0.03	0.20	0.10
941.60	1		0.03	0.00	0.23	0.10
950.56		1	0.00	0.03	0.23	0.13
1,008.96	1		0.03	0.00	0.27	0.13
1,012.16	1		0.03	0.00	0.30	0.13
1,012.80		1	0.00	0.03	0.30	0.17
1,019.20	1		0.03	0.00	0.33	0.17
1,057.44		1	0.00	0.03	0.33	0.20
1,059.20	1		0.03	0.00	0.37	0.20
1,067.20	1		0.03	0.00	0.40	0.20
1,073.44		1	0.00	0.03	0.40	0.23
1,076.96		1	0.00	0.03	0.40	0.27
1,083.84		1	0.00	0.03	0.40	0.30
1,095.36		1	0.00	0.03	0.40	0.33
1,096.80		1	0.00	0.03	0.40	0.37
1,099.36		1	0.00	0.03	0.40	0.40
1,099.84	1		0.03	0.00	0.43	0.40
1,102.24	1		0.03	0.00	0.47	0.40
1,106.56	1		0.03	0.00	0.50	0.40
1,114.56		1	0.00	0.03	0.50	0.43
1,114.88	1		0.03	0.00	0.53	0.43
1,115.52		1	0.00	0.03	0.53	0.47
1,116.16		1	0.00	0.03	0.53	0.50
1,124.16	1		0.03	0.00	0.57	0.50
1,126.88		1	0.00	0.03	0.57	0.53
1,133.92	1		0.03	0.00	0.60	0.53
1,134.72		1	0.00	0.03	0.60	0.57
1,137.92	1		0.03	0.00	0.63	0.57
1,140.00	1		0.03	0.00	0.67	0.57
1,140.80	1		0.03	0.00	0.70	0.57
1,141.92	1		0.03	0.00	0.73	0.57
1,156.96	1		0.03	0.00	0.77	0.57
1,157.12		1	0.00	0.03	0.77	0.60
1,157.60		1	0.00	0.03	0.77	0.63
1,159.84	1		0.03	0.00	0.80	0.63
1,164.16	1		0.03	0.00	0.83	0.63
1,165.28		1	0.00	0.03	0.83	0.67
1,167.04	1		0.03	0.00	0.87	0.67
1,171.68		1	0.00	0.03	0.87	0.70
1,174.88	1		0.03	0.00	0.90	0.70
1,176.48	1		0.03	0.00	0.93	0.70
1,180.00		1	0.00	0.03	0.93	0.73
1,180.96	1		0.03	0.00	0.97	0.73
1,181.12		1	0.00	0.03	0.97	0.77
1,183.04		1	0.00	0.03	0.97	0.80
1,195.84	1		0.03	0.00	1.00	0.80
1,198.56		1	0.00	0.03	1.00	0.83
1,203.04		1	0.00	0.03	1.00	0.87
1,223.68		1	0.00	0.03	1.00	0.90
1,243.20		1	0.00	0.03	1.00	0.93
1,244.00		1	0.00	0.03	1.00	0.97
1,252.00		1	0.00	0.03	1.00	1.00
	30	30	1.00	1.00		

Note : Pdf = probability distribution function
CDF= cumulative probability distribution function

For illustrative purposes of the first degree stochastic dominance analysis, the cumulative probability of distribution of FMS8 always lies on or to the right of the cumulative probability distribution of FMS2 (Figure 6.2).

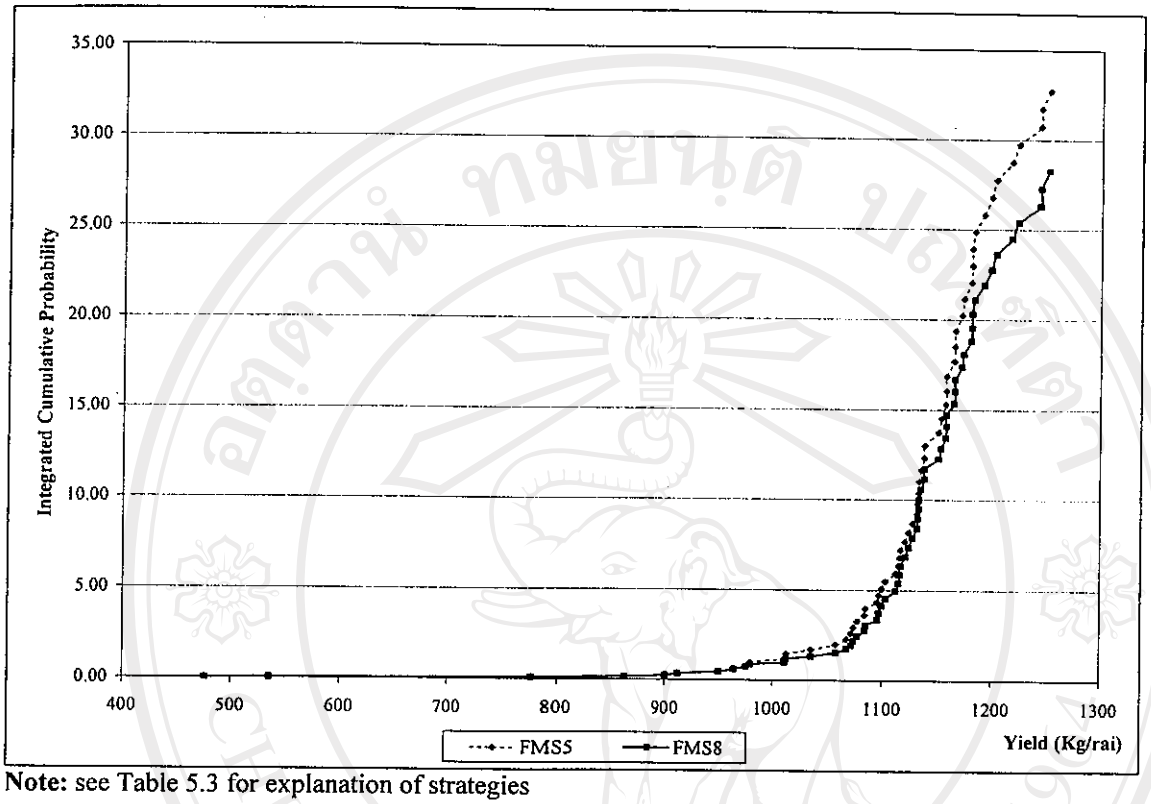


Note: see Table 5.3 for explanation of strategies

Figure 6.2 The comparison of risk-efficient management strategies between FMS2 and FMS8 of yield for Hang Dong soil series in rainy season resulted from FSD analysis

The high fertilizer management level of NSPT (FMS5) and the high fertilizer management level of RD6 (FMS8) were found to be risk-efficient by FSD for Hang Dong soil series. They are subjected for SSD analysis. For illustrative purposes, the integrated cumulative probability distribution functions for two selected FSD risk-efficient sets for Hang Dong series in rainy season were present in Figure 6.3. The

integrated cumulative probability of distribution of FMS8 always lies on or to the right of the integrated cumulative probability distribution of FMS5 (Figure 6.3).



Note: see Table 5.3 for explanation of strategies

Figure 6.3 Comparison of risk-efficient management strategies of yield for Hang Dong soil series in rainy season resulted from SSD analysis

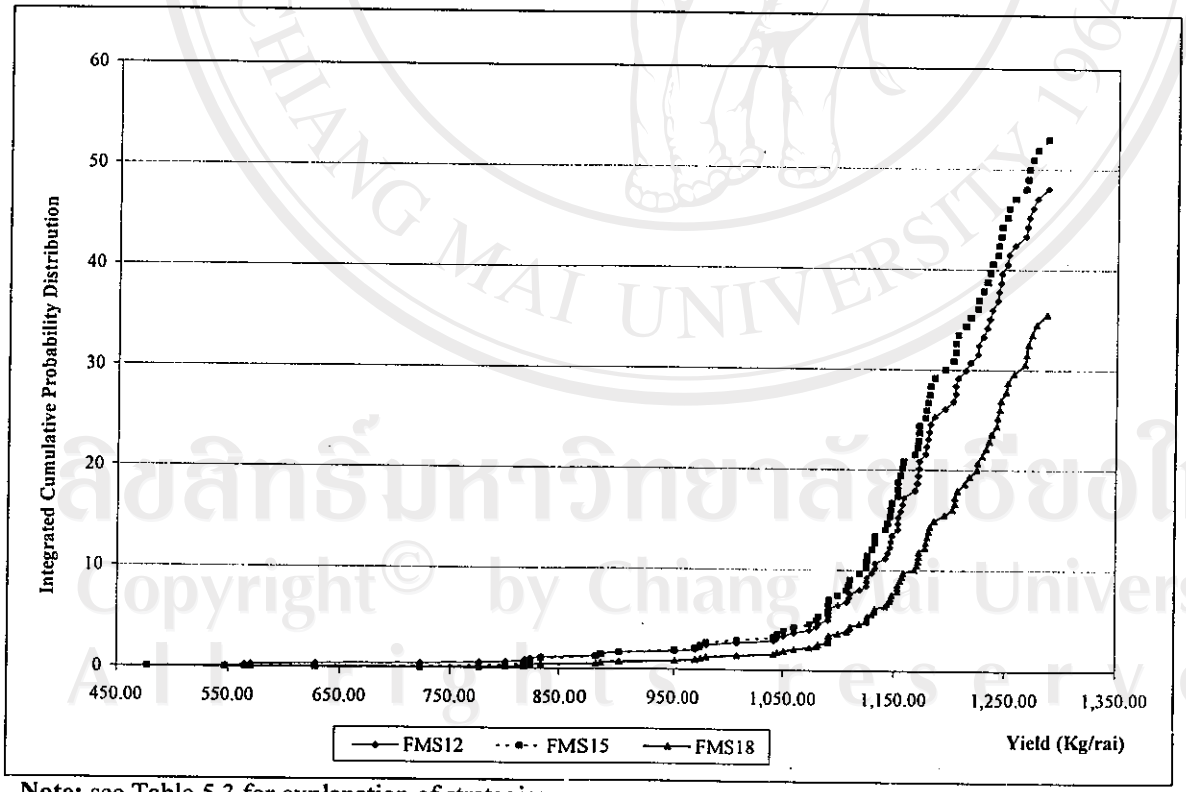
On the second degree stochastic dominance analysis of FMS8 and FMS5, the analysis formed the integrated cumulative probability of FMS8 and FMS5 shown as Int CDF FMS8 and Int CDF FMS5 in Table 6.2. The FMS8 dominates FMS5 because all Int CDF FMS8 are less than or equal to Int CDF FMS5. Based on the stochastic dominance analysis, one could summarize that RD6 at high level of fertilizer management (FMS8) was more preferred in Hang Dong soil series for risk-averse farmer. The average yield of RD6 at the high level of fertilizer management would be approximately 1,098 kg./rai and the standard deviation would be 147 kg./rai. The range of yield using FMS8 management strategy would be 535.52 – 1,252 kg./rai.

Table 6.2 The comparison of FMS8 and FMS5 by using the second degree of stochastic dominance analysis

Yield(kg)	Freq FMS8	Freq FMS5	Pdf FMS8	Pdf FMS5	CDF FMS8	CDF FMS5	Int CDF FMS8	Int CDF FMS5
476.16		1	0.00	0.03	0.00	0.03	0.00	0.03
535.52	1		0.03	0.00	0.03	0.03	0.03	0.07
778.56	1		0.03	0.00	0.07	0.03	0.10	0.10
861.44		1	0.00	0.03	0.07	0.07	0.17	0.17
900.48		1	0.00	0.03	0.07	0.10	0.23	0.27
912.16	1		0.03	0.00	0.10	0.10	0.33	0.37
950.56	1		0.03	0.00	0.13	0.10	0.47	0.47
964.64		1	0.00	0.03	0.13	0.13	0.60	0.60
975.68		1	0.00	0.03	0.13	0.17	0.73	0.77
979.68		1	0.00	0.03	0.13	0.20	0.87	0.97
1,011.36		1	0.00	0.03	0.13	0.23	1.00	1.20
1,012.80	1		0.03	0.00	0.17	0.23	1.17	1.43
1,035.36		1	0.00	0.03	0.17	0.27	1.33	1.70
1,057.44	1		0.03	0.00	0.20	0.27	1.53	1.97
1,067.20		1	0.00	0.03	0.20	0.30	1.73	2.27
1,071.52		1	0.00	0.03	0.20	0.33	1.93	2.60
1,073.44	1		0.03	0.00	0.23	0.33	2.17	2.93
1,076.96	1		0.03	0.00	0.27	0.33	2.43	3.27
1,083.84	1		0.03	0.00	0.30	0.33	2.73	3.60
1,084.32		1	0.00	0.03	0.30	0.37	3.03	3.97
1,095.36	1		0.03	0.00	0.33	0.37	3.37	4.33
1,096.80	1		0.03	0.00	0.37	0.37	3.73	4.70
1,099.36	1		0.03	0.00	0.40	0.37	4.13	5.07
1,102.40		1	0.00	0.03	0.40	0.40	4.53	5.47
1,111.84		1	0.00	0.03	0.40	0.43	4.93	5.90
1,114.56	1		0.03	0.00	0.43	0.43	5.37	6.33
1,115.52	1		0.03	0.00	0.47	0.43	5.83	6.77
1,116.16	1		0.03	0.00	0.50	0.43	6.33	7.20
1,120.48		1	0.00	0.03	0.50	0.47	6.83	7.67
1,123.84		1	0.00	0.03	0.50	0.50	7.33	8.17
1,126.88	1		0.03	0.00	0.53	0.50	7.87	8.67
1,131.36		1	0.00	0.03	0.53	0.53	8.40	9.20
1,131.68		1	0.00	0.03	0.53	0.57	8.93	9.77
1,132.80		1	0.00	0.03	0.53	0.60	9.47	10.37
1,132.96		1	0.00	0.03	0.53	0.63	10.00	11.00
1,134.72	1		0.03	0.00	0.57	0.63	10.57	11.63
1,137.76		1	0.00	0.03	0.57	0.67	11.13	12.30
1,138.24		1	0.00	0.03	0.57	0.70	11.70	13.00
1,150.40		1	0.00	0.03	0.57	0.73	12.27	13.73
1,152.96		1	0.00	0.03	0.57	0.77	12.83	14.50
1,157.12	1		0.03	0.00	0.60	0.77	13.43	15.27
1,157.60	1		0.03	0.00	0.63	0.77	14.07	16.03
1,157.60		1	0.00	0.03	0.63	0.80	14.70	16.83
1,164.48		1	0.00	0.03	0.63	0.83	15.33	17.67
1,165.28	1		0.03	0.00	0.67	0.83	16.00	18.50
1,165.44		1	0.00	0.03	0.67	0.87	16.67	19.37
1,171.68	1		0.03	0.00	0.70	0.87	17.37	20.23
1,173.28		1	0.00	0.03	0.70	0.90	18.07	21.13
1,180.00	1		0.03	0.00	0.73	0.90	18.80	22.03
1,180.96		1	0.00	0.03	0.73	0.93	19.53	22.97
1,181.12	1		0.03	0.00	0.77	0.93	20.30	23.90
1,183.04	1		0.03	0.00	0.80	0.93	21.10	24.83
1,191.52		1	0.00	0.03	0.80	0.97	21.90	25.80
1,198.56	1		0.03	0.00	0.83	0.97	22.73	26.77
1,203.04	1		0.03	0.00	0.87	0.97	23.60	27.73
1,217.28		1	0.00	0.03	0.87	1.00	24.47	28.73
1,223.68	1		0.03	0.00	0.90	1.00	25.37	29.73
1,243.20	1		0.03	0.00	0.93	1.00	26.30	30.73
1,244.00	1		0.03	0.00	0.97	1.00	27.27	31.73
1,252.00	1		0.03	0.00	1.00	1.00	28.27	32.73
	30	30	1.00	1.00				

San Sai soil series in rainy season

It found that FMS12, FMS15 and FMS18 were selected for FSD analysis as they were obvious dominant strategies for San Sai soil series in rainy season. These farm management strategies were the intensive fertilizer management of KDML105, NSPT and RD6. The second degree of stochastic dominance was applied for evaluating of the FMS12, FMS15 and FMS18 (Figure 6.4). As clearly seen, the FMS18 dominated FMS12 and FMS15. The yield outcomes of FMS18 were 628.16 – 1,286.56 kg./rai. The mean yield and standard deviation were 1,140 kg./rai and 139 kg./rai, respectively. Therefore, the intensive fertilizer level of RD6 (FMS18) was the most preferable farm management strategy under risk and uncertainty as justified by using the second degree stochastic dominance analysis.

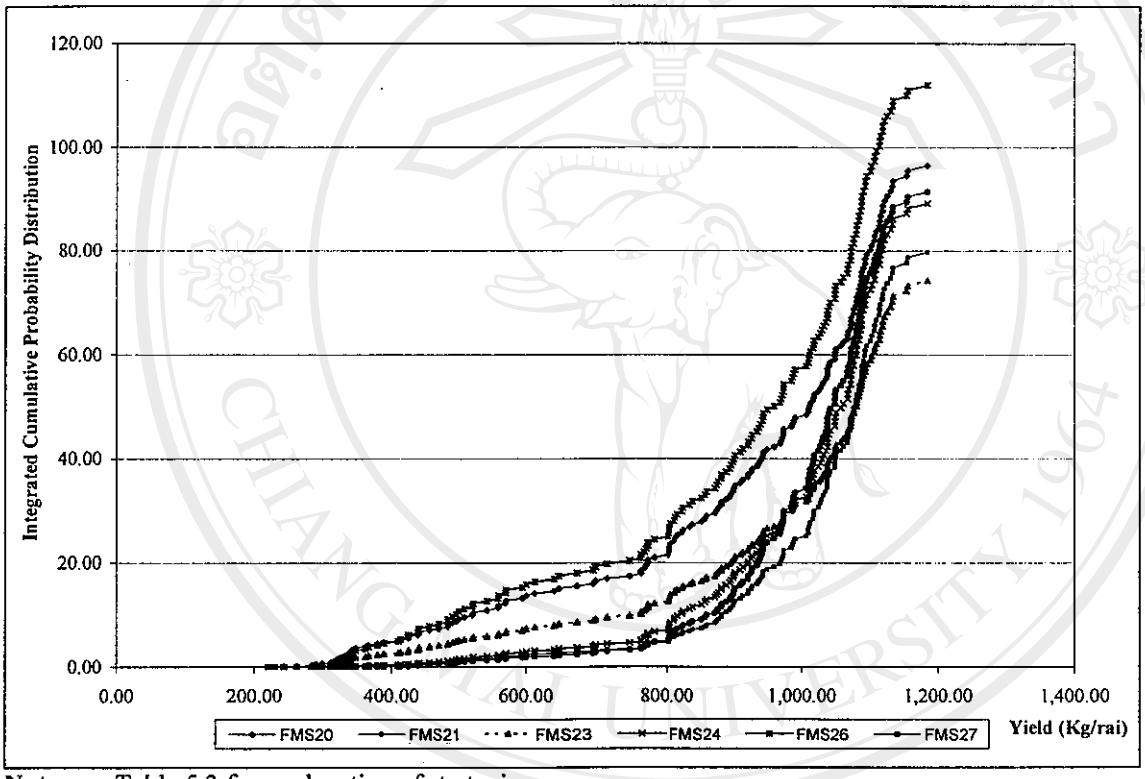


Note: see Table 5.3 for explanation of strategies

Figure 6.4 Comparison of risk-efficient management strategies of yield for San Sai soil series in rainy season resulted from SSD analysis

San Pa Thong soil series in rainy season

Passing through the first degree of stochastic dominance analysis, the risk-efficient set of rice farm management strategies on San Pa Thong soil series in rainy season were FMS20, FMS21, FMS23, FMS24, FMS26 and FMS27 (Figure 6.4). When SSD criterion was applied to these strategies, the risk-efficient farm management strategies were FMS21, FMS23, FMS24 and FMS27.



Note: see Table 5.3 for explanation of strategies

Figure 6.5 Comparison of risk-efficient management strategies of yield for San Pa Thong soil series in rainy season resulted from SSD analysis

Based on the simulated rice yield (Table 6.3), growing KDML105 with intensive level of fertilizer management (FMS21) could produce 895.74 kg./rai of average yield and 200.63 kg./rai of standard deviation. A rice farm producing NSPT with high level of fertilizer management (FMS23) would get 852.82 kg./rai and standard deviation was 313.86 kg./rai. NSPT at intensive level of fertilizer

management (FMS24) yielded 844.95 kg./rai of average yield and 219.47 kg./rai of standard deviation. RD6 at intensive fertilizer management (FMS27), yielded the lowest outcomes of 388.96 kg./rai. This is still higher than the lowest outcomes of other farm management strategies. The average yield of FMS27 was 851.01 kg./rai and standard deviation was 186.80 kg./rai.

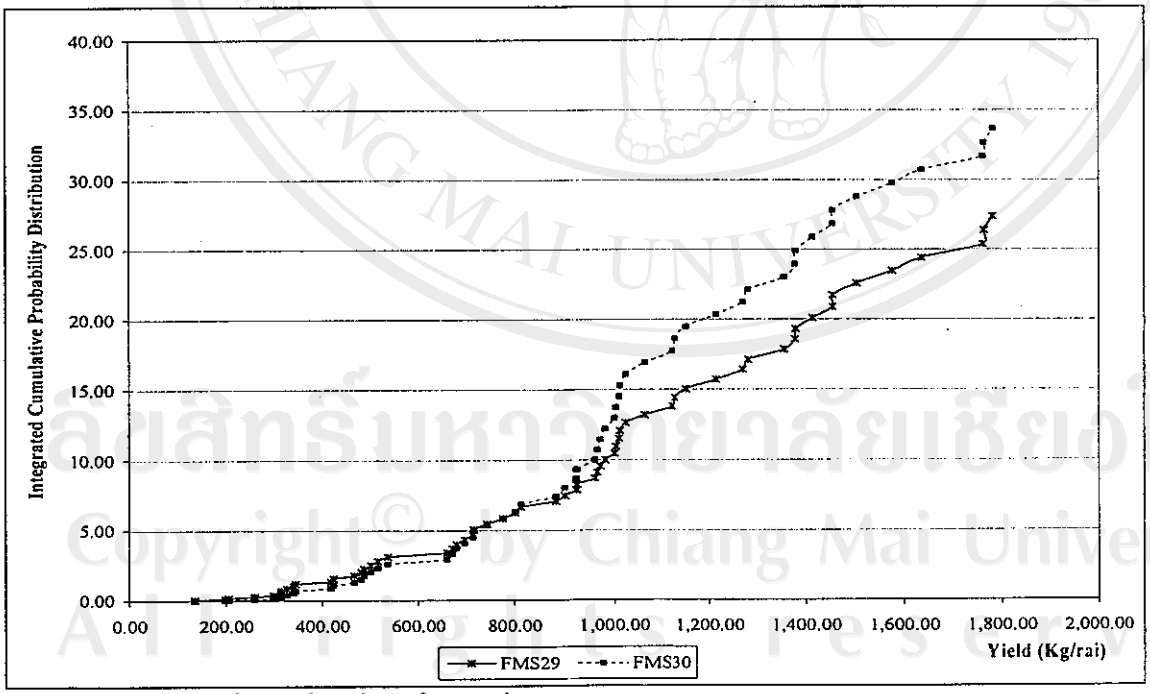
Table 6.3 Performance in terms of yield of selected management options for San Pa Thong soil series in rainy season

Rep	Yield (kg./rai)			
	FMS21	**FMS23**	**FMS24**	**FMS27**
1	1,102.56	1,118.24	1,068.80	838.56
2	966.88	440.32	612.96	693.92
3	1,072.00	1,124.80	1,037.92	933.60
4	822.08	938.24	804.32	810.72
5	881.60	1,067.52	1,129.76	641.60
6	985.92	712.80	812.00	968.64
7	1,018.24	989.60	496.48	958.56
8	1,086.40	1,038.08	696.80	940.96
9	1,006.56	560.16	803.36	834.08
10	324.00	594.72	761.44	972.64
11	1,072.48	1,100.64	1,048.80	881.76
12	1,048.96	229.12	942.56	908.96
13	972.48	1,113.76	1,076.32	925.44
14	569.92	912.48	852.16	1,154.88
15	1,010.08	1,092.80	920.64	899.84
16	815.36	1,029.92	340.96	771.20
17	872.00	1,095.36	771.36	780.80
18	856.96	1,035.68	570.72	1,118.40
19	877.12	1,120.80	1,057.60	500.96
20	761.76	874.56	409.76	926.72
21	438.40	1,114.24	983.84	1,184.16
22	803.52	600.32	1,009.92	888.32
23	1,087.84	1,132.32	1,050.72	424.00
24	859.68	1,049.28	766.08	801.12
25	901.44	1,080.80	1,011.52	893.28
26	1,017.60	379.84	942.08	388.96
27	520.80	261.28	456.00	948.32
28	1,090.56	341.12	987.52	972.32
29	1,012.64	1,115.20	898.56	672.32
30	1,016.32	320.64	1,027.52	895.36
Average yield (kg./rai)	**895.74**	**852.82**	**844.95**	**851.01**
Standard deviation of yield(kg./rai)	*200.63*	*313.86*	*219.47*	*186.80*

Note: see Table 5.3 for explanation of strategies

Hang Dong soil series in dry season

From the first degree stochastic dominance analysis, SPT1 at high fertilizer management (FMS29) and SPT1 at intensive level of fertilizer management (FMS30) were found as risk efficient set. They are subject to second degree stochastic dominance analysis. When the second degree stochastic dominance analysis was applied, FMS29 and FMS30 were also found as risk-efficient strategies on Hang Dong soil series in dry season (Figure 6.6). The average simulated yield of FMS29 produced 964.76 kg./rai with standard deviation of 498.50 kg./rai while FMS30 produced 805.01 kg./rai of mean yield and 369.27 kg./rai of standard deviation. The average yield of FMS29 was greater than the mean yield of FMS30 but the standard deviation was larger than FMS29.

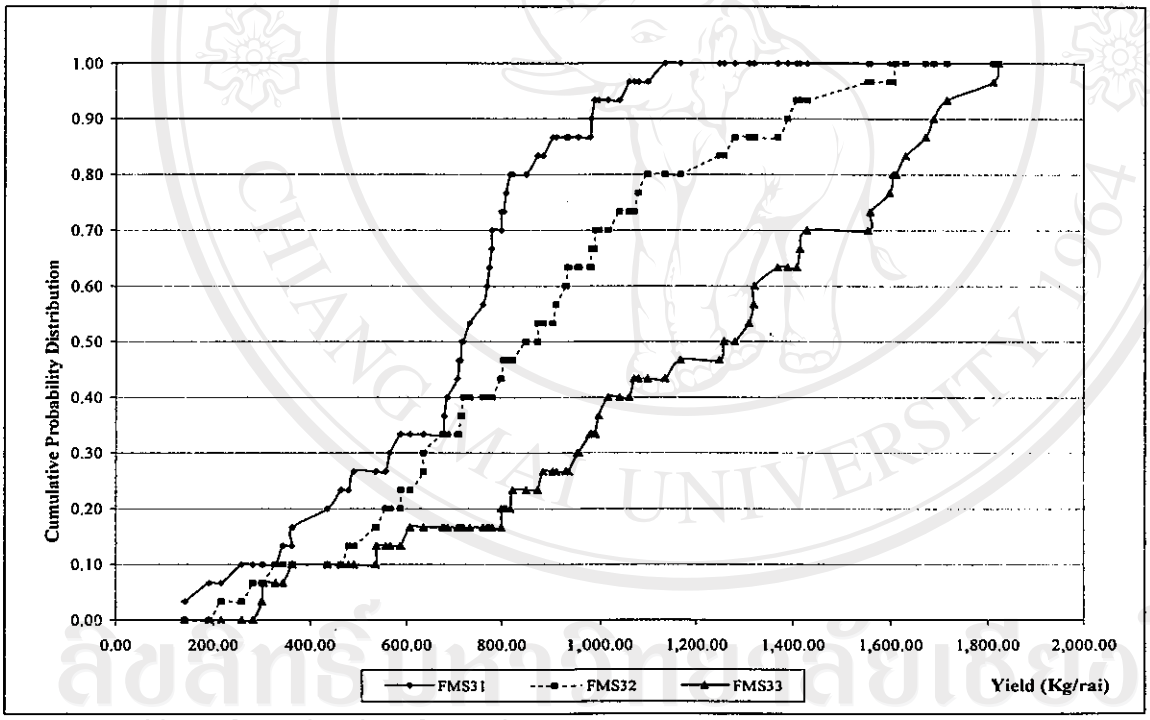


Note: see Table 5.3 for explanation of strategies

Figure 6.6 Comparison of risk-efficient management strategies of yield for Hang Dong soil series in dry season resulted from SSD analysis

San Sai soil series in dry season

The first degree stochastic dominance criterion terminated the risk-inefficient farm management strategies in this case (Figure 6.7). Since cumulative probability distribution function of SPT1 with intensive fertilizer management level (FMS33) was lower or equal to SPT1 with low fertilizer management level (FMS31) and SPT1 with high fertilizer management level (FMS32) the risk-efficient farm management strategy was FMS33 for San Sai soil series in dry. The average simulated grain yield of FMS33 was 1,177.45 kg./rai and standard deviation was 454.18 kg./rai.

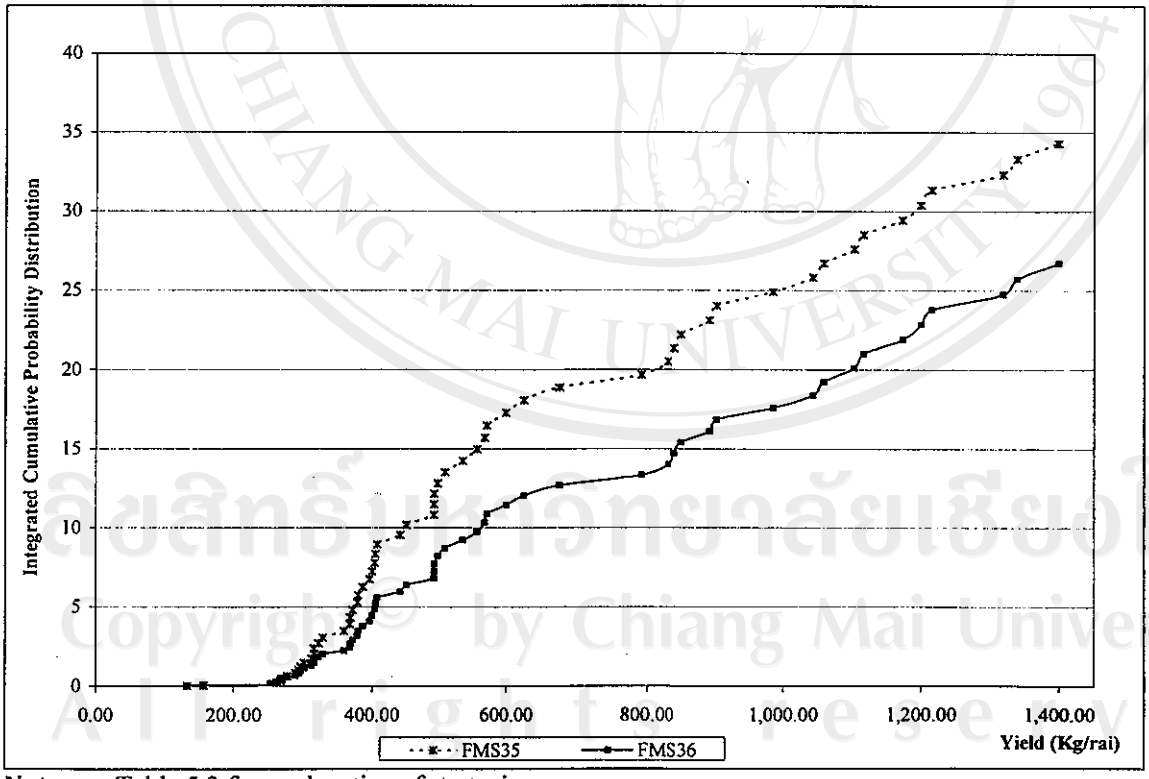


Note: see Table 5.3 for explanation of strategies

Figure 6.7 Cumulative probability of farm management strategies of yield for San Sai soil series in dry season

San Pa Thong soil series in dry season

Based on FSD, the farm management strategies evaluated as risk efficient were SPT1 with high level of fertilizer management (FMS35) and SPT1 at intensive fertilizer management level (FMS36). When the second degree stochastic dominance analysis was applied, the integrated cumulative probability distribution function (CDF) of the FMS36 was not all lower or equal to that of FMS35 (Figure 6.8). These FMS35 and FMS36 were found as risk-efficient strategies on San Pa Thong series in dry season. FMS35 produced 508.07 kg./rai of mean yield and 306.18 kg./rai of standard deviation while the average yield of FMS36 produced 653.11 kg./rai with standard deviation of 357.55 kg./rai.



Note: see Table 5.3 for explanation of strategies

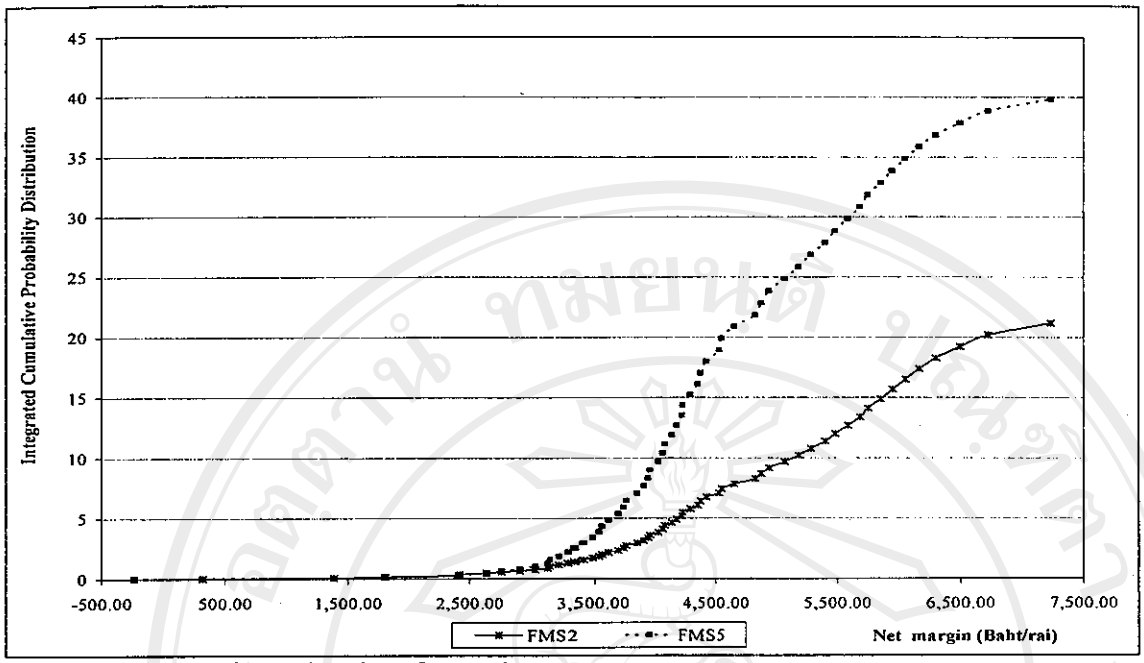
Figure 6.8 Comparison of risk-efficient management strategies of yield for San Pa Thong soil series in dry season resulted from SSD analysis

6.2 Stochastic Dominance Analysis of Net Margin

In term of economic, net margin was evaluated by using stochastic dominance analysis for rice farmer who optimize their rice farm income. There were initially 600 values of net margin in each farm management strategies. They were reduced to 30 values by percentile technique. The simulated net margin of rice farm management strategies were sorted to use in the formation of cumulative probability distribution for stochastic dominance analysis.

Hang Dong soil series in rainy season

From the first degree stochastic dominance analysis, the farm management strategies evaluated as risk efficient were KDML105 with high fertilizer management level (FMS2), NSPT with high fertilizer management level (FMS5) and RD6 with high fertilizer management level (FMS8). They were further analyzed by second degree stochastic dominance analysis. When the SSD was applied, the above farm management strategies were the risk efficient set for Hang Dong soil series in rainy season. For illustrative purpose, the cumulative distribution function for selected SSD risk-efficient sets was demonstrated in Figure 6.9. The average net margin of FMS2 produced 4,810 baht/rai and standard deviation of 1,380.07 baht/rai while FMS5 produced 3,499.86 baht/rai of mean net margin and 831.57 baht/rai of standard deviation.



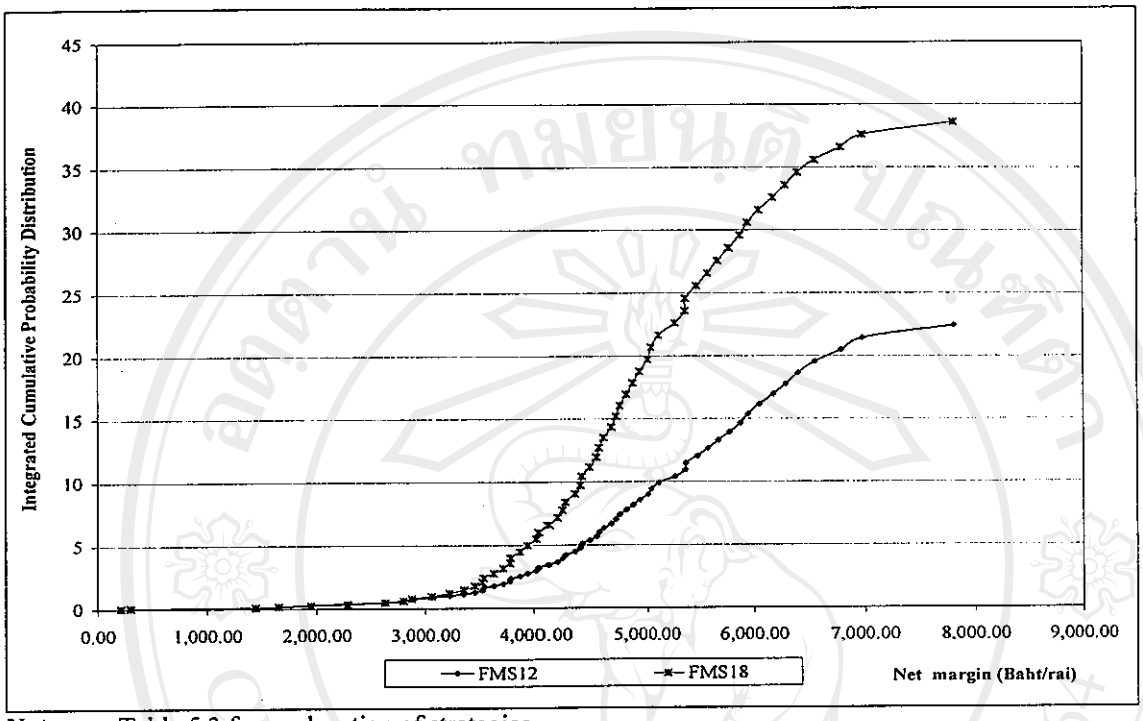
Note: see Table 5.3 for explanation of strategies

Figure 6.9 Comparison of risk-efficient management strategies of net margin for Hang Dong soil series in rainy season resulted from SSD analysis

San Sai soil series in rainy season

From the first degree stochastic dominance analysis, the two strategies were found as risk efficient set. The farm management strategies evaluated as risk efficient were KDML105 at intensive level of fertilizer management (FMS12) and RD6 at intensive fertilizer management level (FMS18). They are subjected to second degree stochastic dominance analysis. When the second degree of stochastic dominance analysis was applied, non strategies was eliminated as risk inefficient one. Therefore, KDML105 at intensive level of fertilizer management (FMS12) and RD6 at intensive fertilizer management level (FMS18) were also the risk-efficient farm management strategies set on San Sai soil series in rainy season (Figure 6.8). The average net margin of FMS12 was 4,949.84 baht/rai and standard deviation was 1,506 baht/rai

while average net margin of FMS18 was 3,812.73 baht/rai and standard deviation was 923.43 baht/rai.



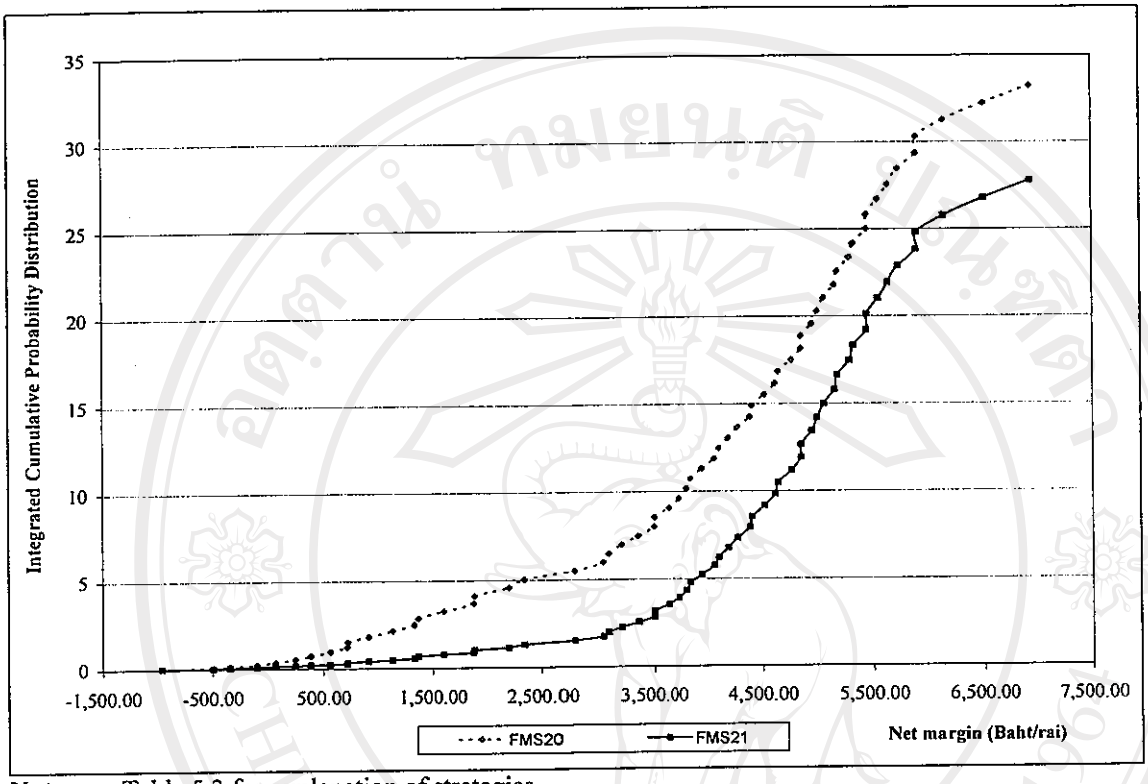
Note: see Table 5.3 for explanation of strategies

Figure 6.10 Comparison of risk-efficient management strategies of net margin for San Sai soil series in rainy season resulted from SSD analysis

San Pa Thong soil series in rainy season

KDML105 at high level of fertilizer application (FMS20) and KDML105 at intensive fertilizer rate (FMS21) were a set of risk-efficient by using FSD. For SSD, the integrated cumulative probability distribution functions for two selected FSD risk-efficient sets for San Pa Thong soil series in rainy season were considered. Farm management strategies FMS21 had lower or equal integrated cumulative probability distribution functions (Figure 6.11). The result implied that the KDML105 at intensive level of fertilizer application (FMS21) dominated the FMS20. The

dominated rice farm management strategies produced the average net margin of 3,879 baht/rai with standard deviation of 1,406 baht/rai.

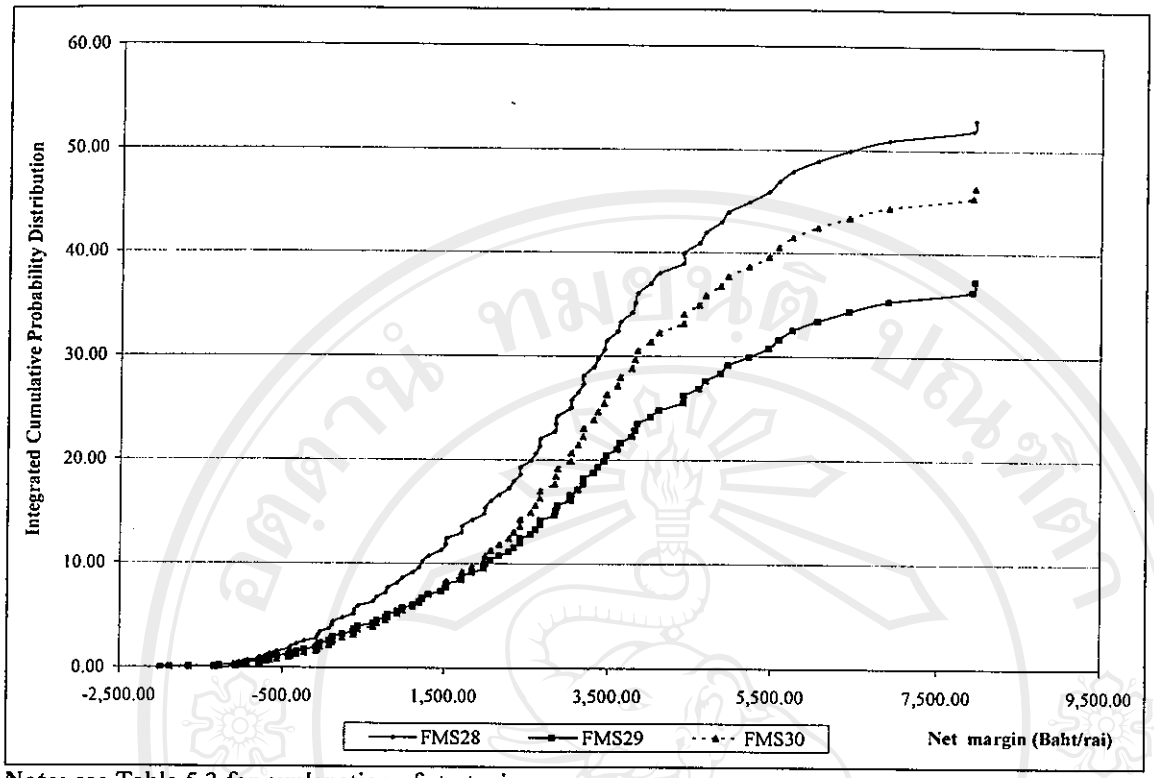


Note: see Table 5.3 for explanation of strategies

Figure 6.11 Comparison of risk-efficient management strategies of net margin for San Pa Thong soil series in rainy season resulted from SSD analysis

Hang Dong soil series in dry season

From the first degree stochastic dominance analysis, the three strategies were found as risk efficient set. They are subject to second degree stochastic dominance analysis. For SSD, the SPT1 at high level of fertilizer management (FMS29) and SPT1 at intensive management level (FMS30) were risk-efficient farm management strategies on Hang Dong soil series in dry season (Figure 6.12). The average net margin of FMS29 produced 2,740.07 baht/rai with standard deviation of 2,507.04 baht/rai while the FMS30 yielded 1,868 baht/rai of average net margin and 1,875.29 baht/rai of standard deviation.

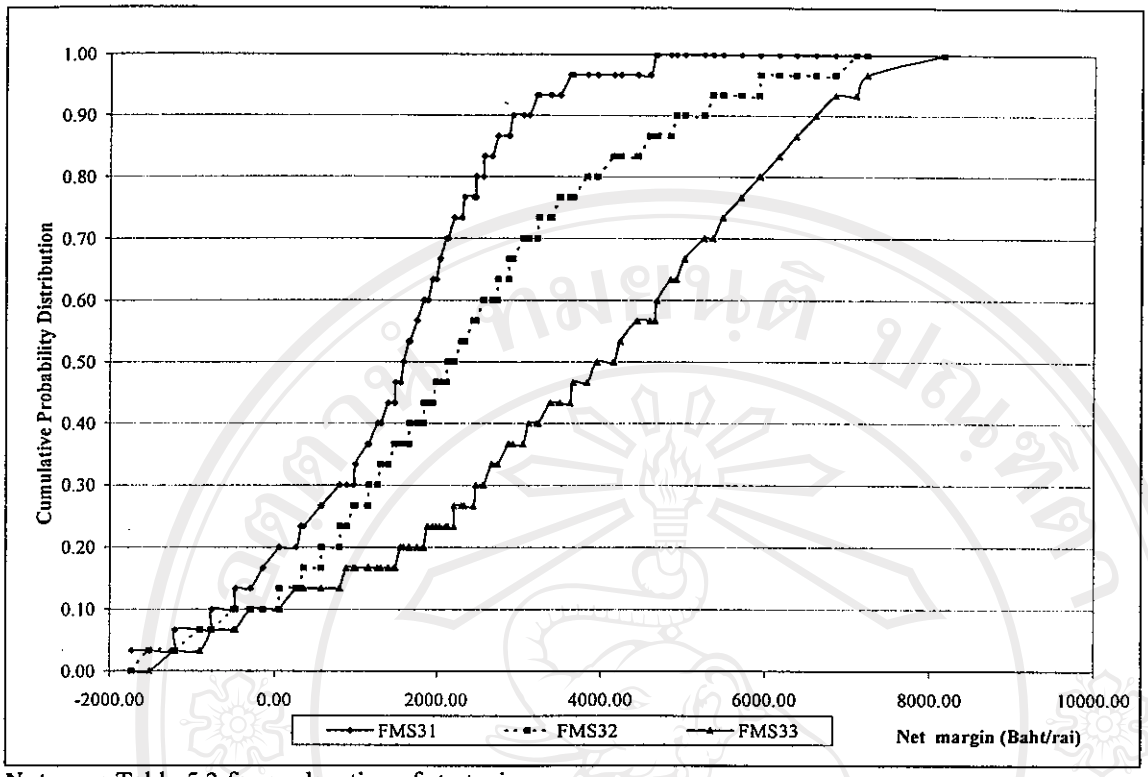


Note: see Table 5.3 for explanation of strategies

Figure 6.12 Comparison of risk-efficient management strategies of net margin for Hang Dong soil series in dry season resulted from SSD analysis

San Sai soil series in dry season

FSD could eliminate the risk-inefficient strategy as being unacceptable to risk-averse farmers. For Figure 6.13 obviously showed that SPT1 at intensive level of fertilizer application (FMS33) was the risk-efficient strategy for rice growing on San Sai series in dry season. The range of outcomes for this dominated strategy was -1,217 to 8,162 baht/rai while the mean was 3,734 baht/rai and standard deviation was 2,303 baht/rai.



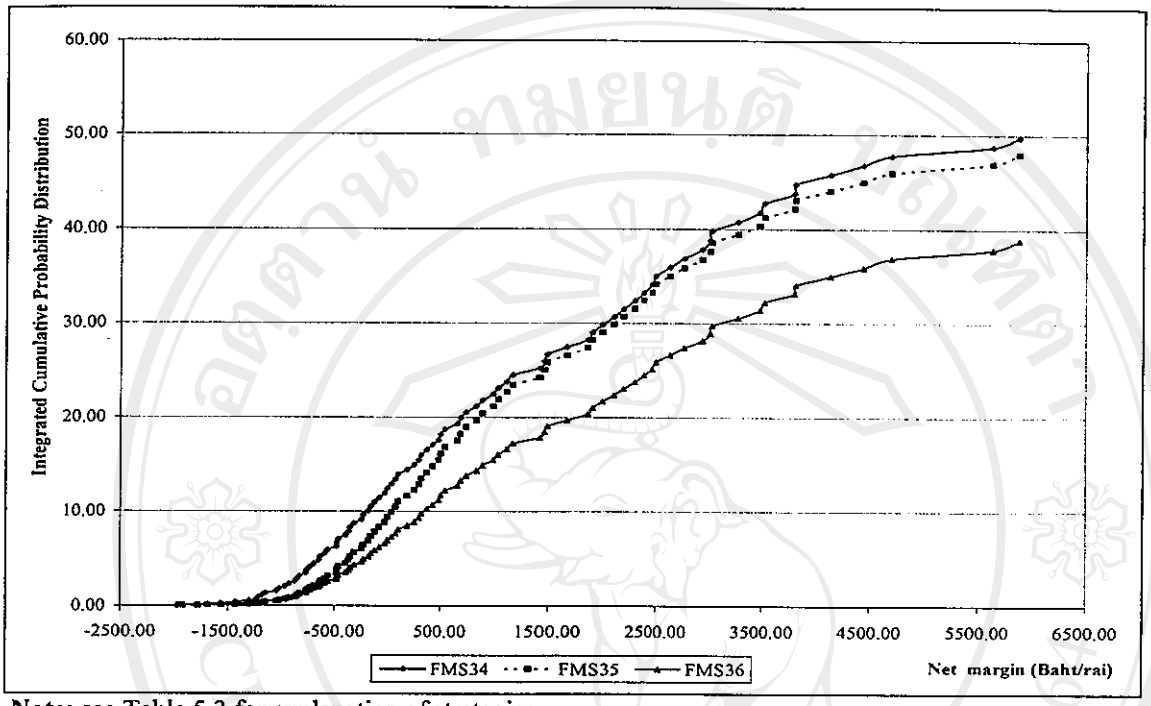
Note: see Table 5.3 for explanation of strategies

Figure 6.13 The cumulative probability of farm management strategies for San Sai soil series in dry season

San Pa Thong soil series in dry season

The FSD criterion could not screen the risk-inefficient farm management strategies of San Pa Thong soil series in dry season. All of strategies were found to be risk-efficient of FSD for this biophysical condition. Subsequently, the second degree of stochastic was used to evaluate the preferred farm management strategies. Figure 6.14 showed that SPT1 at high level of fertilizer management (FMS35) and SPT1 at intensive level of fertilizer management level (FMS36) were the risk-efficient farm management strategies evaluated by SSD. The average net margin of FMS35 produced 451.42 baht/rai with standard deviation of 1,560 baht/rai while FMS36

produced 1,106 baht/rai of mean net margin and 1,812.55 baht/rai of standard deviation.



Note: see Table 5.3 for explanation of strategies

Figure 6.14 Comparison of risk-efficient management strategies of net margin for San Pa Thong soil series in dry season resulted from SSD analysis

6.3 Summary of the Findings and Discussion

The preferred farm management for self-sufficiency farm was presented in table 6.4. Base on data, RD6 of high fertilizer management level (FMS8) was risk-efficient for Hang Dong soil series in rainy season while RD6 of intensive fertilizer management level (FMS18) was preferred strategies for San Sai soil series in rainy season. For San Pa Thong soil series in rainy season, the risk-efficient farm management strategies were KDML105 at intensive level of fertilizer management (FMS21), NSPT at high level (FMS23), NSPT at intensive fertilizer management level (FMS24) and RD6 at intensive fertilizer management level (FMS27). In dry

season, SPT1 at high fertilizer management level (FMS29) and intensive level (FMS30) were the risk-efficient farm management strategies in Hang Dong soil series while SPT1 at intensive fertilizer management level (FMS33) was only risk-efficient farm management strategy in San Sai soil series. For San Pa Thong soil series in dry season, SPT1 at high fertilizer management level (FMS35) and SPT1 at intensive level of fertilizer management were risk-efficient farm management strategies of SSD.

The risk-efficient farm management strategies for optimize income farm were presented in Table 6.5. KDML105 at high level of fertilizer management (FMS2) and NSPT at high level of fertilizer management (FMS5) were the preferred farm management strategies for Hang Dong soil series in rainy season while KDML105 at intensive level of fertilizer management (FMS12) and RD6 at intensive level of fertilizer management (FMS18) were the risk-efficient farm management strategies for San Sai soil series in rainy season. For San Pa Thong soil series in rainy season, only KDML105 at intensive level was the risk-efficient farm management strategy. For dry season, SPT1 at high level (FMS29) and intensive level (FMS30) were the risk-efficient farm management in Hang Dong soil series while SPT1 at intensive level of fertilizer management was the preferred farm management strategy in San Sai soil series. For San Pa Thong soil series in dry season, SPT1 at high level of fertilizer management (FMS35) and SPT1 at intensive fertilizer management level (FMS36) were the risk-efficient farm management strategies.

Table 6.4 The risk-efficient farm management strategies derived from stochastic dominance analysis for self-sufficiency farm classified by biophysical conditions

Biophysical conditions		Preferred strategies for self-sufficiency farm
Season	**Soil series**	
Rainy season	Hang Dong	RD6 with high level of fertilizer management (FMS8)
	San Sai	RD6 with intensive level of fertilizer management (FMS18)
	San Pa Thong	KDML105 with intensive level of fertilizer management (FMS21), NSPT with high level of fertilizer management (FMS23), NSPT with intensive level of fertilizer management (FMS24) and RD6 with intensive level of fertilizer management (FMS27)
Dry season	Hang Dong	SPT1 with high level of fertilizer management (FMS29) and SPT1 with intensive level of fertilizer management (FMS30)
	San Sai	SPT1 with intensive level of fertilizer management (FMS33)
	San Pa Thong	SPT1 with high level of fertilizer management (FMS35) and SPT1 with intensive level of fertilizer management (FMS36)

Note: see Table 5.3 for explanation of strategies

Table 6.5 The risk-efficient farm management strategies derived from stochastic dominance analysis for farm targeted at optimize income classified by biophysical conditions

Biophysical conditions		Preferred strategies for optimal income farm
Season	**Soil series**	
Rainy season	Hang Dong	KDML 105 with high level of fertilizer management (FMS2) and NSPT with high level of fertilizer management (FMS5)
	San Sai	KDML 105 with intensive level of fertilizer management (FMS12) and RD6 with intensive level of fertilizer management (FMS18)
	San Pa Thong	KDML 105 with intensive level of fertilizer management (FMS21)
Dry season	Hang Dong	SPT1 with high level of fertilizer management (FMS29) and SPT1 with intensive level of fertilizer management (FMS30)
	San Sai	SPT1 with intensive level of fertilizer management (FMS33)
	San Pa Thong	SPT1 with high level of fertilizer management (FMS35) and SPT1 with intensive level of fertilizer management (FMS36)

Note: see Table 5.3 for explanation of strategies

The above findings demonstrated the prospect of crop growth simulation models with stochastic dominance tools for evaluating farm management strategies (FMS). This study considered only rice varieties and level of fertilizer management as farm strategies of irrigated rice production in each biophysical condition. The risk-efficient farm management strategies were different depending on the biophysical condition and farmer's objective. RD6 with high or intensive level of fertilizer management usually was the risk-efficient farm management strategies for self-sufficient farm. On the other hand, KDML105 rice variety with high of intensive level of fertilizer management was the preferred farm management strategies for optimal income (commercial) farm. The findings were confirmed by the (fact from) filed survey in San Sai district, Chiang Mai province (2002) that farmers cultivated RD6 for home consumption. On the contrary, farmers planted KDML105 for selling because it could sell at higher price than other varieties.