Appendix

Appendix Table 1. Climatic data in Son La province 2002

Items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T. mean (t^0C)	15.5	18.7	21.7	24.3	23.6	25.6	25.5	24.7	23.8	22.4	19.1	17.2
T min (t^0C)	11.5	14.7	16.3	20.5	20.4	20.9	22.7	22.3	20.5	18.2	14.8	13.2
T max (t^0C)	21.3	24.7	29.0	30.1	28.6	30.4	30.0	29.7	29.5	28.8	25.3	20.9
Rainfall (mm)	21	16	26	131	254	222	246	354	104	65	16	4
Sunshine (hours)	138	135	195	157	124	140	122	138	182	216	184	173
Humidity (%)	80	71	66	73	81	85	88	62	87	76	79	73
Evaporation (mm)	65	106	155	115	76	64	57	48	56	94	69	91

Appendix Table 2. Area and average maize yield in Son La province in 1990-1999 periods

Years	Area	Average yield
1990	23,700	1.65
1991	28,800	1.87
1992	24,900	1.96
1993	31,100	2.13
1994	25,200	1.81
1995	25,600	1.95
1996	24,400	2.08
1997	29,300	1.73
1998	35,400	2.32
1999	42,500	2.29

Sources. Statistic book 2000

Appendix Table 3. Growth rate of maize production in Vietnam in 1961-2001 periods

Years	Area ('000.ha)	Yield (tons/ha)	Years	Area ('000.ha)	Yield (tons/ha)
1961	260.2	1.12	1982	381.4	1.15
1962	262.0	1.20	1983	378.3	1.24
1963	272.8	0.92	1984	386.5	1.38
1964	257.0	1.24	1985	397.3	1.48
1965	277.4	1.15	1986	400.9	1.42
1966	267.5	0.96	1987	405.6	1.38
1967	230.0	1.10	1988	510.5	1.60
1968	239.0	1.10	1989	509.4	1.64
1969	242.0	1.12	1990	431.8	1.55
1970	233.7	1.10	1991	447.6	1.50
1971	236.1	1.00	1992	478.0	1.56
1972	235.5	1.11	1993	496.5	1.78
1973	240.0	1.25	1994	534.7	2.14
1974	250.0	1.26	1995	556.8	2.20
1975	267.0	1.05	1996	615.2	2.50
1976	336.6	1.15	1997	662.9	2.49
1977	402.9	1.00	1998	649.7	2.51
1978	392.5	1.10	1999	689.9	2.55
1979	374.6	0.99	2000	714.0	2.70
1980	389.6	1.10	2001	723.2	2.90
1981	384.6	1.11	2002	780.0	2.88

Source: FAOSTAT, May 2002

Appendix Table 4. Quantity of maize production and import in periods 1990-2002

Years	Imported maize quantity ('000 ton)	Produced maize quantity ('000 ton)
1990	2.0	671.0
1991	NA	672.0
1992	7.5	747.9
1993	54.0	882.2
1994	5.5	1,143.9
1995	26.0	1,177.2
1996	35.5	1,536.7
1997	19.0	1,650.0
1998	98.0	1,612.0
1999	147.0	1,753.0
2000	197.43	2,005.9
2001	50.0	2,122.8
2002	NA	2,250.0

Source: SATFAO, 2002.

Appendix Table 5. Some main cropping systems in the study sites

Cropping systems	Number of Farmer households practices (n=30)							
	Ang		Ban Hoa		Co Noi		Chieng Ban	
	No.HH	%	No.HH	%	No.HH	%	No.HH	%
Spring rice	30.0	100	30.0	100	26.0	87.0	21.0	70.0
Spring rice -Summer rice	0.0	0.0	10.0	30.3	14.0	46.7	0.0	0.0
Upland rice	12.0	40.0	15.0	50.0	4.0	13.3	26.0	86.7
Maize	28.0	93.3	21.0	70.0	30.0	100	25.0	83.3
Cassava	28.0	93.3	20.0	43.3	14.0	46.6	11.0	36.7
Sugarcane	0.0	0.0	14.0	46.7	17.0	56.7	14.0	46.7
Maize-Soybean intercropping	2.0	6.7	3.0	33.3	0.0	0.0	0.0	0.0
Cassava-soybean intercropping	2.0	20.0	3.0	10.0	0.0	0.0	0.0	0.0
Soybean –Green bean	20.0	66.7	26.0	86.7	9.0	30.0	21.0	70.0
Maize mix soybean	0.0	0.0	6.0	20.0	0.0	0.0	5.0	16.7

Appendix Table 6. Matrix for comparing four yielding constraints in the flatland

Items	Drought	Soil erosion	Shortage & imbalance in fertilizer use	Pest & diseases
Drought	1.00	2.00	4.00	5.00
Soil erosion	0.50	1.00	0.50	3.00
Shortage &low fertilizers	0.25	2.00	1.00	6.00
Pest& diseases	0.20	0.33	0.17	1.00
Total	1.95	5.33	5.67	15.00

Appendix Table 7. Calculating the priority of each yielding constraints in the flatland

Items	Drought	Soil erosion	Shortage &imbalance fertilizer	Pest & diseases	Average weight
Drought	0.51	0.38	0.71	0.33	0.48
Soil erosion	0.26	0.19	0.09	0.20	0.18
Shortage &low fertilizers	0.13	0.38	0.18	0.40	0.27
Pest& diseases	0.10	0.06	0.03	0.07	0.07
Total	1.00	1.00	1.00	1.00	1.00

Appendix Table 8. Determining the λmax, consistency index and consistency ratio

Items	Drought	Soil erosion	Shortage & imbalance fertilizer use	Pest &diseases	Row Total
Drought	0.48	0.37	1.08	0.33	2.25
Soil erosion	0.24	0.18	0.13	0.07	0.62
Shortage &low fertilizers	0.12	0.37	0.27	0.39	1.15
Pest& diseases	0.10	0.06	0.04	0.07	0.27

Row total Weight

$$\begin{pmatrix} 2.25 \\ 0.62 \\ 1.15 \\ 0.27 \end{pmatrix} : \begin{pmatrix} 0.48 \\ 0.18 \\ 0.27 \\ 0.07 \end{pmatrix} = \begin{matrix} 4.68 \\ 3.41 \\ 4.25 \\ 4.10 \end{matrix}$$

Total (λmax) = (4.68 + 3.41+4.25+4.10)/4 = 4.11

Consistency index (C I): CI =(λmax-n)/n-1 = (4.11-4)/3 = 0.0368,

Consistency ratio (CR)= CI/CIR, where CIR consistency index random with n= 4 and then CR =0.0368/0.9 = 0.0409

CR= 0.049 < 0.1, Therefore this result is acceptable for matrix 4x4 in above

Appendix Table 9. Matrix for comparison six yielding constraints in the midland

Items	Drought	Soil erosion	Low soil fertility	Shortage of fertilizer	Weed competition	Pest& diseases
Drought	1.00	0.80	1.25	1.50	3.00	2.50
Soil erosion	1.25	1.00	2.00	1.75	5.00	3.00
Low soil fertility	0.80	0.50	1.00	1.25	1.50	1.75
Shortage of fertilizer	0.67	0.57	0.80	1.00	1.50	1.25
Weed competition	0.33	0.20	0.67	0.67	1.00	0.25
Pest& diseases	0.40	0.33	0.57	0.80	4.00	1.00
Total	4.45	3.40	6.29	6.97	16.00	9.75

Table appendix 10. Calculating the priority (weight) of each yielding constraints in the midland area

Items	Drought	Soil erosion	Low soil fertility	Shortage of fertilizer	Weed competition	Pest& diseases	Average weight
Drought	0.22	0.23	0.20	0.22	0.19	0.26	0.22
Soil erosion	0.28	0.29	0.32	0.25	0.31	0.31	0.29
Low soil fertility	0.18	0.15	0.16	0.18	0.09	0.18	0.16
Shortage of fertilizer	0.15	0.17	0.13	0.14	0.09	0.13	0.14
Weed competition	0.07	0.06	0.11	0.10	0.06	0.03	0.07
Pest& diseases	0.09	0.10	0.09	0.11	0.25	0.10	0.12
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table appendix 11. Determining the λmax, consistency index and consistency ratio

Items	Drought	Soil erosion	Low soil fertility	Shortage of fertilizer	Weed competition	Pest & diseases	Total Row
Drought	0.22	0.24	0.20	0.20	0.21	0.31	1.38
Soil erosion	0.27	0.29	0.31	0.14	0.35	0.37	1.74
Low soil fertility	0.18	0.15	0.16	0.17	0.11	0.22	0.97
Shortage of fertilizer	0.15	0.17	0.13	0.14	0.11	0.16	0.84
Weed competition	0.07	0.01	0.10	0.09	0.07	0.03	0.38
Pest& diseases	0.09	0.10	0.09	0.11	0.28	0.12	0.79

Total row Weight

$$\begin{pmatrix} 1.38 \\ 1.74 \\ 0.97 \\ 0.84 \\ 0.38 \\ 0.79 \end{pmatrix} : \begin{pmatrix} 0.22 \\ 0.29 \\ 0.16 \\ 0.14 \\ 0.07 \\ 0.12 \end{pmatrix} = \begin{matrix} 6.26 \\ 5.93 \\ 6.21 \\ 6.19 \\ 5.43 \\ 6.35 \end{matrix}$$

Total (λmax) = (6.26+5.93+6.21+6.19+5.43+6.35)/6 = 6.06

λ max = 6.06

Consistency index (C I)

CI =(λmax-n)/n-1 = (6.06-6)/5 = 0.0124

Consistency ratio (CR)= CI/CIR where CIR consistency index random with n= 6 and then CR = 0.0124/1.24= 0.001

CR= 0.001 < 0.1, Therefore this result is acceptable for matrix 6x 6 in above

Appendix Table 12. Matrix for comparison five yielding constraints in the steepland

Items	Drought	Soil erosion	Old varieties	Low fertilizer use	Farmers' lack of techniques
Drought	1.00	0.75	3.00	2.00	3.00
Soil erosion	1.33	1.00	3.50	3.00	3.50
Old varieties	0.33	0.29	1.00	3.00	0.50
Low fertilizer use	0.50	0.33	0.33	1.00	3.00
Farmers' lack of techniques	0.33	0.29	2.00	0.33	1.00
Total	3.50	2.65	9.83	9.33	11.00

Appendix Table 13. Calculating the priority (weight) of each yielding constraints in the steepland area

Items	Drought	Soil erosion	Old varieties	Low fertilizer use	Farmers' lack of techniques	Average weight
Drought	0.29	0.28	0.31	0.21	0.27	0.27
Soil erosion	0.38	0.38	0.36	0.32	0.32	0.35
Old varieties	0.10	0.11	0.10	0.32	0.05	0.14
Low fertilizer use	0.14	0.13	0.03	0.11	0.27	0.13
Farmers' lack of techniques	0.10	0.11	0.20	0.04	0.09	0.11
Total	1.00	1.00	1.00	1.00	1.00	1.00

Appendix Table 14. Determining the λmax, consistency index and consistency ratio

Items	**Drought**	**Soil erosion**	**Old varieties**	Low fertilizer use	Farmers' lack of techniques	Total row
Drought	0.27	0.26	0.40	0.27	0.32	1.53
Soil erosion	0.36	0.35	0.47	0.14	0.37	1.69
Old varieties	0.09	0.10	0.13	0.41	0.05	0.79
Low fertilizer use	0.14	0.12	0.04	0.14	0.32	0.75
Farmers' lack of techniques	0.09	0.03	0.27	0.05	0.11	0.54

Total Row Weight

$$\begin{pmatrix} 1.53 \\ 1.69 \\ 0.79 \\ 0.75 \\ 0.54 \end{pmatrix} : \begin{pmatrix} 0.27 \\ 0.35 \\ 0.14 \\ 0.13 \\ 0.11 \end{pmatrix} = \begin{matrix} 5.63 \\ 4.83 \\ 5.64 \\ 5.76 \\ 4.90 \end{matrix}$$

Total (λmax) = (5.63+4.83+5.64+5.76+4.90)/5=5.39

Consistency index (C I); CI =(λmax-5)/n-1 = (5.39-5)/4 = 0.0964

Consistency ratio (CR)= CI/CIR where CIR consistency index random with n= 5 and then CR = 0.0964/1.12=0.0861

CR= 0.0861 < 0.1, Therefore this result is acceptable for matrix 5x5 in above

Appendix Table 15. Test different mean of maize yield between the steepland and midland area

t-Test: Two-Sample Assuming Unequal Variances		
	Midland	*Steepland*
Mean	3.699175439	2.39163043
Variance	1.48100154	0.54712117
Observations	57	46
Hypothesized Mean Difference	0	
df	94	
t Stat	6.71849772	
P(T<=t) one-tail	6.9775E-10	
t Critical one-tail	1.66122618	
P(T<=t) two-tail	1.3955E-09	
t Critical two-tail	1.98552243	

* t-sat = 6.71 > t-critical two tail =1.98. So reject H_0: $M_1 = M_2 = 0$

Accept H_1: M_1 # M_2 # 0

There is different between average of maize yield between steppland and midland area

Appendix Table 16. Test different mean of maize yield in the flatland and steepland

t-Test: Two-Sample Assuming Unequal Variances		
	Flatland	*Steepland*
Mean	4.91768493	2.39163043
Variance	2.97135652	0.54712117
Observations	73	46
Hypothesized Mean Difference	0	
df	106	
t Stat	11.0143877	
P(T<=t) one-tail	1.4451E-19	
t Critical one-tail	1.65935489	
P(T<=t) two-tail	2.8901E-19	
t Critical two-tail	1.98259841	

* t-sat = 11.01 > t-critical two tai = 1.98. So reject H_0: $M_1 = M_2 = 0$
Accept H_1: M_1 # M_2 # 0
There is different between average of maize yield between flatland and steepland area

Appendix Table 17. Test mean of maize yield between the flatland and midland

t-Test: Two-Sample Assuming Unequal Variances		
	Flatland	*Midland*
Mean	4.917685	3.699175
Variance	2.971357	1.481002
Observations	73	57
Hypothesized Mean Difference	0	
df	127	
t Stat	4.718583	
P(T<=t) one-tail	3.08E-06	
t Critical one-tail	1.65694	
P(T<=t) two-tail	6.17E-06	
t Critical two-tail	1.978819	

* t-sat = 4.71 > t-critical two tail = 1.97. So reject H_0: $M_1 = M_2 = 0$
Accept H_1: M_1 # M_2 # 0
There is different between average of maize yield between flatland and midland area

Appendix Table 18. Test different mean of maize yield between hybrid and OPVs

t-Test: Two-Sample Assuming Unequal Variances		
	Hybrid Variable	*OPVs*
Mean	4.377781	2.916
Variance	3.03807	1.224574
Observations	114	62
Hypothesized Mean Difference	0	
df	170	
t Stat	6.786079	
P(T<=t) one-tail	9.18E-11	
t Critical one-tail	1.653866	
P(T<=t) two-tail	1.84E-10	
t Critical two-tail	1.974017	

* t-sat = 6.78 > t-critical two tail = 1.97, So reject $H_0: M_1 = M_2 = 0$

Accept $H_1: M_1 \# M_2 \# 0$

There is different between average of maize yield between hybrid and OPVs varieties

Appendix Table 19. Test different mean of maize yield between OPVs and local varieties

t-Test: Two-Sample Assuming Unequal Variances		
	OPVs	*Local*
Mean	2.916	1.35
Variance	1.224574	0.069255
Observations	62	11
Hypothesized Mean Difference	0	
df	65	
t Stat	9.703136	
P(T<=t) one-tail	1.46E-14	
t Critical one-tail	1.668636	
P(T<=t) two-tail	2.91E-14	
t Critical two-tail	1.997137	

* t-sat = 9.70 > t-critical two tail = 1.99. So reject $H_0: M_1 = M_2 = 0$

Accept $H_1: M_1 \# M_2 \# 0$

There is different between average of maize yield between OPVs and local varieties

Appendix Table 20. Test different mean of maize yield between hybrid and local varieties

t-Test: Two-Sample Assuming Unequal Variances		
	hybrid	*Local*
Mean	4.377781	1.35
Variance	3.03807	0.069255
Observations	114	11
Hypothesized Mean Difference	0	
df	106	
t Stat	16.68113	
P(T<=t) one-tail	1.03E-31	
t Critical one-tail	1.659355	
P(T<=t) two-tail	2.06E-31	
t Critical two-tail	1.982598	

* t-sat = 16.68 > t-critical two tail=1.98. So reject $H_0: M_1 = M_2 = 0$
Accept $H_1: M_1 \# M_2 \# 0$
There is different between average of maize yield between hybrid and local varieties

Appendix Table 21. Correlation matrix of variables in the regression model

	N	P	K	D1	D2	D3	D4	D5	D6
N	1								
P	0.552	1							
K	0.529	0.481	1						
D1	0.321	-0.323	-0.375	1					
D2	-0.479	-0.496	-0.251	0.152	1				
D3	-0.583	-0.471	-0.342	0.061	0.559	1			
D4	-0.385	-0.349	-0.463	0.336	0.322	0.337	1		
D5	-0.097	-0.044	-0.228	0.044	0.126	0.151	0.090	1	
D6	-0.376	-0.335	-0.304	0.156	0.331	0.316	0.288	0.102	1

* The Breusch-Pagan test with 9 degree of freedom is 15.74 (at 5% of significant level) that lower than the critical Chi-Square value is 16.92. It means that have no heteroskedasticity or variance of equation is a constant.

Appendix Table 22. Summary the statistic of inputs use and outputs of maize production in the whole rainfed area

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.928556
R Square	0.862216
Adjusted R Square	0.854746
Standard Error	0.176203
Observations	176

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	32.25155	3.583506	115.4205	1.05E-66
Residual	166	5.153866	0.031047		
Total	175	37.40542			

Appendix Table 23. The coefficients and standard error of regression model

Variables	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	8.15606184	0.0583447	139.791	4.1E-174	8.0409	8.2713	8.0409	8.2713
Ln X_1	0.07913526	0.0130733	6.0532	9.17E-09	0.0533	0.1049	0.0533	0.1049
Ln X_2	0.01296922	0.0166733	0.77784	0.43777	-0.0199	0.0459	-0.0199	0.0459
Ln X_3	0.0343223	0.0132739	2.58571	0.010577	0.0081	0.0605	0.0081	0.0605
D_1	-0.2792804	0.0293968	-9.50036	2.3E-17	-0.3373	-0.2212	-0.3373	-0.2212
D_2	-0.2288577	0.0341315	-6.70518	3.01E-10	-0.2962	-0.1615	-0.2962	-0.1615
D_3	-0.2865578	0.0368345	-7.77961	7.34E-13	-0.3593	-0.2138	-0.3593	-0.2138
D_4	-0.0841391	0.0356867	-2.35772	0.019553	-0.1546	-0.0137	-0.1546	-0.0137
D_5	-0.0587594	0.0286822	-2.04864	0.042072	-0.1154	-0.0021	-0.1154	-0.0021
D_6	-0.0231309	0.030603	-0.75584	0.450818	-0.0836	0.0373	-0.0836	0.0373

Curriculum Vitae

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