APPENDICES

Appedix A Layout of the experiment

S P 1	S P 4	S P 3	S P 5
P S 8	P S 6	P S 2	P S 7

Rep.1

S P 6	S P 7	S P 5	S P 8
P S 2	P S 3	P S 4	P S 1

Rep.2

S P 5	S P 2	S P 7	S P 4
P S 1	P S 3	P S 8	P S 6

Rep.3

Note: 1- PoLoNo 5- PoLoN1 S- Soybean
2- P1LoNo 6- P1LoN1 P- Peanut
3- PoL1No 7- PoL1N1
4- P1L1No 8- P1L1N1

Appedix B Analysis of variance (ANOVA)

Appendix B.1 ANOVA of plant height

Source ofvariation		V4.5 (30 DAS)		R4.5 (50 DAS)		R6.5 (72 DAS)		Harvest	
	DF	MS	P	MS	P	MS	P	MS	P
N (A)	1	69.84	0.002	194.41	0.000	189.61	0.000	198.86	0.000
Rep. (B)	2	9.99	0.051	21.32	0.000	20.70	0.001	32.85	0.002
P (C)	1	216.33	0.000	652.69	0.000	1032.3	0.000	1106.9	0.000
L (D)	1	9.99	0.075	38.88	0.000	2.34	0.269	4.75	0.264
A*C	1	0.25	0.924	9.18	0.037	26.10	0.001	27.75	0.013
A*D	1	5.53	0.174	3.41	0.182	10.26	0.030	6.38	0.199
C*D	1	1.80	0.427	0.83	0.829	6.60	0.074	6.97	0.180
A*C*D	1	1.17	0.520	8.53	0.494	12.60	0.018	3.91	0.309
Error	14	2.70		1.73		1.71		3.51	
Species (E)	1	886.60	0.000	528.01	0.000	149.81	0.000	24.79	0.073
A*C*D*E	7	8.00	0.267	8.70	0.365	8.32	0.433	9.54	0.267
Error	16	5.67		7.35		7.88		8.76	

Appendix B.2 ANOVA of LAI

Source of variation		V4.5 (30 DAS)		R4.5 (50 DAS)		R6.5 (72 DAS)	
	DF	MS	P	MS	P	MS	P
N (A)	1	1.55E-01	0.001	7.379	0.000	5.678	0.000
Rep. (B)	2	1.39E-03	0.862	3.09E-02	0.702	0.241	0.118
P (C)	1	7.52E-01	0.000	16.685	0.000	24.533	0.000
L (D)	1	2.55E-03	0.608	2.358	0.000	1.751	0.000
A*C	1	7.52E-04	0.780	2.13E-01	0.136	1.767	0.000
A*D	1	7.25E-03	0.391	6.75E-04	0.930	0.328	0.086
C*D	1	2.55E-03	0.608	4.29E-01	0.041	0.047	0.495
A*C*D	1	5.85E-03	0.440	2.25E-02	0.615	0.949	0.007
Error	14	9.28E-03		8.53E-02		0.096	
Species (E)	1	6.82E-02	0.015	2.35E-01	0.140	0.101	0.297
A*C*D*E	7	1.96E-02	0.102	3.13E-01	0.025	0.021	0.067
Error	16	9.31E-03		9.76E-02		0.087	

Appendix B.3 ANOVA of nodule number

Source of variation		V4.5 (30 DAS)		R4.5 (50 DAS)		R6.5 (72 DAS)	
	DF	MS	P	MS	P	MS	P
N (A)	1	69.120	0.003	398.48	0.000	787.32	0.000
Rep. (B)	2	6.623	0.330	7.564	0.324	5.559	0.633
P (C)	1	1125.20	0.000	3108.9	0.000	4965.4	0.000
L (D)	1	808.520	0.000	1710.0	0.000	2394.2	0.000
A*C	1	1.203	0.647	22.550	0.077	32.341	0.120
A*D	1	7.520	0.262	2.566	0.530	20.541	0.208
C*D	1	0.907	0.691	86.135	0.002	56.333	0.046
A*C*D	1	0.007	0.971	20.150	0.093	4.563	0.544
Error	14	5.518		6.202		11.802	
Species (E)	1	9.013	0.269	149.46	0.000	607.760	0.000
A*C*D*E	7	13.971	0.114	21.354	0.052	21.730	0.124
Error	16	6.878		8.167		11.061	

Appendix B.4 ANOVA of nodule dry weight

Source of variation		V4.5 (30 DAS)		R4.5 (50 DAS)		R6.5 (72 DAS)	
	DF	MS	P	MS	P	MS	P
N (A)	1	1.68E-04	0.130	1.06E-02	0.001	2.21E-02	0.000
Rep. (B)	2	8.65E-05	0.297	9.70E-04	0.294	1.89E-04	0.729
P (C)	1	9.63E-03	0.000	7.51E-02	0.000	2.04E-01	0.000
L (D)	1	1.97E-03	0.000	5.70E-02	0.000	6.97E-02	0.000
A*C	1	5.33E-06	0.779	6.30E-05	0.772	3.16E-03	0.358
A*D	1	1.63E-05	0.624	8.92E-04	0.286	1.68E-04	0.600
C*D	1	1.40E-05	0.649	5.96E-03	0.012	3.16E-03	0.035
A*C*D	1	1.00E-05	0.700	1.37E-03	0.190	1.51E-03	0.130
Error	14	6.53E-05		7.25E-04		5.87E-04	
Species (E)	1	1.65E-03	0.171	4.55E-02	0.000	5.13E-02	0.000
A*C*D*E	7	3.72E-04	0.847	1.95E-03	0.127	2.58E-03	0.002
Error	16	8.06E-04		1.00E-03		4.70E-04	

Appendix B.5 ANOVA of dry matter yield

Source of variation		V4.5 (30 DAS)		R4.5 (50 DAS)		R6.5 (72 DAS)	
	DF	MS	P	MS	P	MS	P
N (A)	1	2.29E+05	0.000	3.73E+06	0.000	1.18E+07	0.000
Rep. (B)	2	526.02	0.900	258.40	0.962	8421.4	0.489
P (C)	1	8.39E+05	0.000	1.27E+07	0.000	4.92E+07	0.000
L (D)	1	6.34E+04	0.003	1.59E+06	0.000	4.04E+06	0.000
A*C	1	2394.20	0.499	3.30E+05	0.000	3.77E+05	0.000
A*D	1	910.02	0.675	3.89E+04	0.030	4.00E+05	0.000
C*D	1	1.28E+04	0.131	3.44E+05	0.000	1.30E+05	0.004
A*C*D	1	31.68	0.937	1463.0	0.648	4.91E+05	0.000
Error	14	4989.70		6749.1		1.12E+04	
Species (E)	1	1.58E+05	0.000	2067.2	0.657	4.57E+06	0.000
A*C*D*E	7	2.03E+04	0.025	1.71E+05	0.000	2.46E+05	0.000
Error	16	6362.50		1.01E+04		1.10E+04	

Appendix B.6 ANOVA of nitrogen content in the plant

Source of variation		V4.5 (30 DAS)		R4.5 (50 DAS)		R6.5 (72 DAS)	
	DF	MS	P	MS	P	MS	P
N (A)	1	2.88E-01	0.000	3.68E-02	0.009	1.76E-01	0.000
Rep. (B)	2	7.96E-03	0.438	3.94E-03	0.401	1.41E-02	0.216
P (C)	1	3.10E-01	0.000	5.18E-01	0.000	5.96E-01	0.000
L (D)	1	7.50E-03	0.379	1.35E-01	0.000	9.63E-02	0.004
A*C	1	8.50E-02	0.008	5.95E-02	0.001	2.95E-02	0.080
A*D	1	1.28E-01	0.002	1.96E-02	0.045	1.35E-01	0.001
C*D	1	1.87E-03	0.657	1.71E-01	0.000	1.11E-01	0.002
A*C*D	1	1.75E-01	0.000	3.52E-04	0.772	5.85E-03	0.415
Error	14	9.11E-03		4.05E-03		8.29E-03	
Species (E)	1	3.20E-01	0.000	1.059	0.000	2.21E-02	0.028
A*C*D*E	7	1.58E-01	0.000	7.37E-02	0.000	7.78E-02	0.000
Error	16	3.99E-03		7.91E-03		3.80E-03	

Appendix B.7 ANOVA of nitrogen yields

Source of variation		V4.5 (30 DAS)		R4.5 (50 DAS)		R6.5 (72 DAS)	
	DF	MS	P	MS	P	MS	P
N (A)	1	396.18	0.000	4237.50	0.000	1.31E+0	0.000
Rep. (B)	2	2.38E-01	0.963	1.97	0.809	44.27	0.251
P (C)	1	1290.70	0.000	1.54E+0	0.000	5.27E+0	0.000
L (D)	1	91.57	0.002	1991.80	0.000	4296.00	0.000
A*C	1	3.57	0.468	243.90	0.000	362.45	0.003
A*D	1	3.52E-02	0.942	22.14	0.143	58.74	0.176
C*D	1	20.15	0.098	215.05	0.000	16.68	0.461
A*C*D	1	2.12	0.575	6.75E-02	0.932	178.26	0.026
Error	14	6.45		9.19		29.04	
Species (E)	1	3336.55	0.000	482.60	0.000	5382.70	0.000
A*C*D*E	7	56.89	0.000	178.84	0.000	419.68	0.000
Error	16	7.92		10.37		21.23	

Appendix B.8 ANOVA of yield components

Source of variation		pods plant^{-1}		filled pods plant^{-1}		100 seed weight	
	DF	MS	P	MS	P	MS	P
N (A)	1	592.91	0.000	435.01	0.000	10.92	0.000
Rep. (B)	2	3.81	0.334	8.31E-01	0.685	3.77E-02	0.482
P (C)	1	893.55	0.000	703.04	0.000	65.56	0.000
L (D)	1	231.00	0.000	209.59	0.000	7.60	0.000
A*C	1	39.78	0.003	10.36	0.045	2.55E-01	0.038
A*D	1	2.85E-01	0.770	4.21E-01	0.663	2.12	0.000
C*D	1	2.85E-01	0.770	2.75	0.275	1.87E-03	0.847
A*C*D	1	3.16E-01	0.758	9.45	0.054	2.26E-01	0.049
Error	14	3.22		2.14		4.91E-02	
Species (E)	1	2100.10	0.000	1674.40	0.000	1.82E+0	0.000
A*C*D*E	7	13.26	0.002	27.01	0.000	3.44	0.000
Error	16	2.37		2.19		5.10E-02	

Appendix B.9 ANOVA of yield

Source of variation		Yield	
	DF	MS	P
N (A)	1	1.48E+06	0.000
Rep.(B)	2	1.01E+04	0.096
P (C)	1	2.43E+06	0.000
L (D)	1	5.69E+05	0.000
A*C	1	1.21E+05	0.000
A*D	1	667.52	0.675
C*D	1	1621.70	0.515
A*C*D	1	5.62E+04	0.001
Error	14	5650.90	
Spicies (E)	1	1.67E+06	0.000
A*C*D*E	7	1.44E+04	0.013
Error	16	3841.40	

Appendix B 10. ANOVA for gross return and net return

Source of variation	DF	Gross return		Net return	
		MS	P	MS	P
N (A)	1	2.74E+07	0.000	3.64E+06	0.000
Rep. (B)	2	1.87E+05	0.094	1.86E+05	0.093
P (C)	1	4.39E+07	0.000	6.07E+06	0.000
L (D)	1	1.04E+07	0.000	7.30E+06	0.000
A*C	1	2.09E+06	0.000	2.08E+06	0.000
A*D	1	2.47E+04	0.551	2.47E+04	0.551
C*D	1	2.60E+04	0.540	2.61E+04	0.540
A*C*D	1	1.03E+06	0.001	1.03E+06	0.001
A*B*C*D	14	6.63E+04		6.63E+04	
V (E)	1	5.34E+07	0.000	5.34E+07	0.000
A*C*D*E	7	3.81E+05	0.002	3.81E+05	0.002
A*B*C*D*E	16	7.09E+04		7.09E+04	

Appendix C: Data of field experiment

Table 1. Effect of N, P, lime on plant height (cm) of soybean and peanut at different growth stages

a. V4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	15.2	9.5	20.1	10.6	18.2	12.2	17.8	10.7
P1LoNo	20.3	14.8	27.0	13.2	23.6	16.3	23.6	14.4
PoL1No	15.8	15.0	17.8	12.8	19.7	10.3	17.7	12.7
P!L1No	20.7	14.7	25.2	16.1	22.5	13.2	22.8	14.7
PoLoN1	22.2	11.3	17.8	12.5	20.0	14.0	20.0	12.6
P1LoN1	22.0	15.7	28.5	17.1	26.2	14.5	25.8	15.8
PoL1N1	20.4	14.2	25.5	11.8	22.3	13.6	22.7	13.2
P1L1N1	26.0	17.1	28.7	14.3	31.2	15.8	28.6	15.7

b. R4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	22.7	17.8	24.6	20.0	25.8	15.6	24.3	17.8
P1LoNo	33.2	24.7	34.8	27.2	28.0	26.0	32.0	25.9
PoL1No	23.6	17.3	28.1	20.2	24.0	18.8	25.2	18.8
P!L1No	32.4	26.6	39.2	25.3	35.8	24.3	35.8	25.3
PoLoN1	24.8	25.0	30.0	21.1	27.3	22.9	27.4	22.9
P1LoN1	32.7	26.3	39.2	28.8	36.8	27.4	36.2	27.4
PoL1N1	26.9	27.8	31.1	24.7	29.2	26.5	28.7	26.5
P1L1N1	34.1	32.6	41.6	27.8	38.0	30.0	37.9	30.0

c. R6.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	30.1	22.7	29.4	24.2	27.1	25.8	28.8	24.4
P1LoNo	34.1	28.3	38.2	30.8	33.0	31.1	35.1	30.0
PoL1No	25.3	21.2	29.6	23.5	26.8	19.4	27.2	21.3
P!L1No	34.3	30.4	40.8	28.3	36.2	33.2	37.1	30.3
PoLoN1	25.9	27.3	31.6	24.2	27.6	26.0	28.3	25.8
P1LoN1	34.9	38.5	41.8	40.2	37.0	36.4	38.0	38.4
PoL1N1	27.1	29.8	32.7	25.7	30.1	27.1	29.9	27.5
P1L1N1	37.0	41.1	43.3	37.5	40.0	36.4	40.0	38.3

d. Harvesting

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	30.2	23.6	29.5	26.1	27.5	27.7	29.0	25.8
P1LoNo	34.3	30.2	39.7	35.7	33.4	31.8	35.6	32.6
PoL1No	25.5	22.3	30.6	26.2	27.2	24.2	27.8	24.2
P!L1No	35.1	32.3	41.2	31.3	36.5	36.1	37.6	33.2
PoLoN1	26.0	30.1	32.1	26.6	28.4	28.9	28.9	28.5
P1LoN1	35.1	40.2	42.3	44.3	37.5	38.3	38.3	40.9
PoL1N1	27.6	31.1	32.2	27.6	30.5	30.1	30.1	29.6
P1L1N1	37.5	44.2	43.7	40.9	40.7	40.0	40.8	41.7

Table 2. Effect of N, P, lime on nodule number of soybean and peanut at dtfferent growth stages

a. V4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	2.0	0.0	3.6	0.0	1.9	0.0	2.5	0.0
P1LoNo	9.6	6.9	15.0	10.3	13.3	7.1	12.6	8.1
PoL1No	8.7	14.5	11.2	8.8	6.5	10.3	8.8	11.2
P!L1No	20.8	15.7	17.7	20.3	24.3	18.9	20.4	18.3
PoLoN1	2.6	6.2	4.2	3.7	3.2	5.0	3.3	5.0
P1LoN1	17.7	13.7	11.2	16.2	13.7	10.6	14.2	13.5
PoL1N1	7.8	9.5	12.3	16.0	8.5	13.5	9.5	13.0
P1L1N1	19.6	22.3	25.9	19.6	25.3	16.7	23.6	19.5

b. R4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	6.5	8.7	10.3	13.6	9.7	9.3	8.4	10.5
P1LoNo	25.6	29.3	22.7	23.7	28.2	25.1	25.5	25.7
PoL1No	20.1	17.7	24.3	20.2	18.6	23.3	21.0	20.4
P!L1No	36.3	42.1	40.1	38.6	34.9	45.3	37.1	42.0
PoLoN1	6.4	10.5	3.8	6.3	6.0	9.2	5.4	8.7
P1LoN1	15.0	22.5	12.7	17.6	18.2	20.8	15.3	20.3
PoL1N1	11.2	15.5	16.7	12.7	12.9	18.3	13.6	15.5
P1L1N1	27.3	35.8	24.8	42.0	30.4	39.2	27.5	39.0

c. R6.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	12.7	21.4	7.8	16.7	11.5	14.8	10.7	17.6
P1LoNo	26.8	33.4	32.5	41.2	30.4	35.8	29.9	36.8
PoL1No	28.2	25.8	24.5	28.1	20.8	33.4	24.5	29.1
P!L1No	49.2	56.8	43.7	52.8	45.6	61.3	46.1	56.9
PoLoN1	5.7	13.3	8.2	6.8	6.6	9.8	6.8	9.9
P1LoN1	20.2	35.2	18.5	26.8	23.7	28.7	20.8	30.2
PoL1N1	15.8	17.8	20.4	23.6	19.6	20.7	18.6	20.7
P1L1N1	29.7	50.1	33.6	42.8	36.9	46.3	33.4	46.4

Table 3. Effect of N, P, lime on nodule dry weight (gr/plant) of soybean and peanut at different stages

a. V4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	0.007	0.000	0.009	0.000	0.007	0.000	0.008	0.000
P1LoNo	0.050	0.009	0.070	0.010	0.060	0.010	0.060	0.010
PoL1No	0.020	0.015	0.030	0.010	0.020	0.012	0.020	0.012
P!L1No	0.070	0.019	0.050	0.020	0.090	0.020	0.070	0.020
PoLoN1	0.009	0.009	0.010	0.005	0.010	0.007	0.010	0.007
P1LoN1	0.070	0.015	0.050	0.020	0.060	0.010	0.060	0.015
PoL1N1	0.020	0.010	0.040	0.020	0.030	0.015	0.030	0.015
P1L1N1	0.060	0.025	0.090	0.023	0.090	0.020	0.080	0.022

b. R4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	0.030	0.010	0.040	0.016	0.040	0.010	0.040	0.012
P1LoNo	0.190	0.059	0.180	0.050	0.200	0.057	0.190	0.055
PoL1No	0.150	0.024	0.190	0.028	0.120	0.030	0.150	0.027
P!L1No	0.220	0.140	0.250	0.120	0.210	0.160	0.230	0.140
PoLoN1	0.028	0.015	0.018	0.006	0.020	0.010	0.023	0.010
P1LoN1	0.090	0.032	0.060	0.028	0.120	0.030	0.090	0.030
PoL1N1	0.050	0.020	0.090	0.015	0.060	0.026	0.070	0.020
P1L1N1	0.190	0.110	0.160	0.140	0.200	0.120	0.180	0.120

c. R6.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	0.060	0.030	0.040	0.020	0.050	0.018	0.050	0.022
P1LoNo	0.200	0.100	0.270	0.140	0.240	0.120	0.240	0.120
PoL1No	0.200	0.050	0.160	0.060	0.130	0.070	0.160	0.060
P!L1No	0.340	0.190	0.300	0.200	0.320	0.230	0.320	0.210
PoLoN1	0.030	0.020	0.040	0.010	0.030	0.018	0.030	0.018
P1LoN1	0.120	0.130	0.100	0.070	0.150	0.100	0.120	0.100
PoL1N1	0.080	0.030	0.120	0.050	0.100	0.040	0.100	0.040
P1L1N1	0.200	0.200	0.250	0.160	0.280	0.180	0.240	0.180

Table 4. Effect of N, P, lime on leaf area index of soybean and peanut at different growth stages

a. V4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	0.47	0.58	0.58	0.45	0.40	0.56	0.48	0.53
P1LoNo	0.70	0.60	0.86	0.87	0.76	0.58	0.77	0.68
PoL1No	0.29	0.58	0.38	0.52	0.30	0.69	0.32	0.58
P!L1No	0.76	0.76	0.73	0.60	0.82	0.86	0.77	0.74
PoLoN1	0.46	0.72	0.52	0.52	0.67	0.60	0.55	0.61
P1LoN1	0.88	0.80	0.70	0.95	0.80	0.86	0.79	0.87
PoL1N1	0.46	0.80	0.60	0.65	0.54	0.72	0.53	0.72
P1L1N1	0.88	1.03	0.74	0.87	0.86	0.80	0.82	0.90

b. R4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	1.03	1.08	1.71	0.80	1.10	0.95	1.28	0.94
P1LoNo	1.96	1.56	2.08	2.13	2.60	1.74	2.21	1.81
PoL1No	1.74	1.13	1.22	1.76	1.31	1.25	1.42	1.38
P!L1No	3.12	2.59	2.58	1.98	2.83	2.46	2.84	2.34
PoLoN1	1.84	2.05	1.22	2.32	1.58	1.78	1.54	2.05
P1LoN1	2.67	3.14	3.12	2.47	2.98	2.89	2.92	2.83
PoL1N1	1.48	1.98	2.15	2.64	1.66	2.19	1.76	2.27
P1L1N1	4.12	2.96	3.85	3.52	3.85	3.07	3.87	3.18

c. R6.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	1.36	1.98	1.82	1.36	1.57	1.64	1.58	1.66
P1LoNo	2.95	2.62	3.46	3.24	2.60	2.45	2.97	2.77
PoL1No	2.36	1.96	1.82	2.39	2.12	1.65	2.11	2.00
P!L1No	3.30	2.96	2.87	2.37	3.20	2.61	3.12	2.64
PoLoN1	1.87	1.93	2.41	2.44	1.42	2.18	1.90	2.18
P1LoN1	4.02	3.52	3.84	3.28	3.47	2.94	3.80	3.24
PoL1N1	1.56	2.96	2.18	2.35	2.16	2.26	1.96	2.52
P1L1N1	4.50	4.27	4.54	4.36	4.62	4.13	4.55	4.20

Table 5. Effect of N, P, lime on dry matter yield of soybean and peanut at different growth stages

a. V4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	284	367	397	243	242	314	307	308
P1LoNo	417	552	558	658	472	486	482	565
PoL1No	301	324	397	278	330	395	342	332
P!L1No	564	665	518	607	637	742	573	671
PoLoN1	314	528	378	392	470	448	387	456
P1LoN1	636	715	467	866	562	769	548	783
PoL1N1	335	598	501	461	412	525	415	528
P1L1N1	692	1031	518	927	627	887	612	951

b. R4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	823	938	1017	800	896	873	911	870
P1LoNo	1695	1331	1742	1518	1876	1412	1794	1420
PoL1No	1015	1076	843	1249	934	1126	944	1149
P!L1No	2327	1961	2141	1803	2235	1905	2234	1889
PoLoN1	1068	1494	875	1586	976	1423	976	1500
P1LoN1	2202	2343	2326	2110	2285	2243	2270	2234
PoL1N1	1192	1605	1378	1775	1266	1653	1272	1677
P1L1N1	3064	2635	2903	2826	2993	2702	2984	2720

c. R6.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	1696	2379	1898	2175	1774	2315	1788	2289
P1LoNo	3755	4151	3916	4316	3682	4090	3783	4185
PoL1No	2405	2714	2232	2886	2315	2661	2317	2753
P!L1No	4237	4515	4061	4342	4158	4398	4151	4418
PoLoN1	2178	3457	2315	3659	2093	3558	2195	3544
P1LoN1	4779	4978	4584	4756	4674	4863	4678	4865
PoL1N1	2695	3977	2902	3760	2844	3821	2813	3852
P1L1N1	5498	6187	5364	6332	5549	6125	5470	6214

Table 6. Effect of N, P, lime on nitrogen content in the plant of soybean and peanut at different stages (% of dry matter)

a. V4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	3.05	3.15	3.22	3.47	3.16	3.32	3.14	3.31
P1LoNo	3.72	3.57	3.74	3.60	3.56	3.45	3.67	3.54
PoL1No	3.52	3.45	3.49	3.56	3.54	3.38	3.51	3.46
P!L1No	3.53	3.83	3.44	3.68	3.39	3.74	3.45	3.75
PoLoN1	3.85	3.47	3.80	3.61	3.92	3.50	3.85	3.52
P1LoN1	3.54	3.93	3.41	3.87	3.43	3.78	3.46	3.86
PoL1N1	3.41	3.62	3.36	3.58	3.34	3.72	3.37	3.64
P1L1N1	3.40	3.95	3.35	4.10	3.29	4.05	3.34	4.03

b. R4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	2.76	3.07	2.93	3.04	2.89	2.93	2.86	3.01
P1LoNo	3.38	3.29	3.31	3.43	3.27	3.36	3.32	3.61
PoL1No	3.18	3.31	3.28	3.22	3.10	3.16	3.18	3.23
P!L1No	3.20	3.44	3.13	3.54	3.28	3.59	3.20	3.52
PoLoN1	3.04	3.21	2.91	3.28	2.87	3.34	2.94	3.28
P1LoN1	3.09	3.55	3.11	3.67	3.23	3.51	3.15	3.58
PoL1N1	3.13	3.37	3.18	3.52	3.05	3.48	3.12	3.45
P1L1N1	2.90	3.77	2.94	3.64	3.03	3.59	2.96	3.67

c. R6.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	2.72	2.56	2.61	2.40	2.54	2.47	2.62	2.48
P1LoNo	2.96	2.75	3.01	2.86	2.89	2.91	2.95	2.84
PoL1No	3.05	2.68	2.89	2.74	2.96	2.60	2.97	2.67
P!L1No	3.07	3.12	3.03	2.96	2.92	3.01	3.00	3.03
PoLoN1	2.68	2.79	2.86	2.95	2.72	2.83	2.75	2.86
P1LoN1	3.01	3.23	3.07	3.27	2.86	3.14	2.98	3.21
PoL1N1	2.85	3.05	2.92	2.90	2.78	2.94	2.85	2.96
P1L1N1	2.67	3.10	2.76	3.24	2.82	3.18	2.75	3.17

Table 7. Effect of N, P, lime on nitrogen yield (kg/ha) of soybean and peanut at different stages

a. V4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	8.7	11.6	12.8	8.4	7.6	10.4	9.7	10.1
P1LoNo	15.5	19.7	20.8	23.7	16.8	16.7	17.6	20.0
PoL1No	10.6	11.2	13.8	9.9	11.7	13.3	12.0	11.4
P!L1No	19.9	25.4	17.8	22.3	21.6	27.7	19.7	25.1
PoLoN1	12.0	18.3	14.4	14.1	18.4	15.7	4.9	16.0
P1LoN1	22.5	28.0	15.9	33.5	19.2	29.0	19.2	30.2
PoL1N1	11.4	21.6	16.8	16.5	13.7	19.5	13.9	19.2
P1L1N1	23.5	40.0	17.3	38.0	20.6	35.9	20.4	38.3

b. R4.5

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	22.7	28.8	29.8	24.3	25.9	25.5	26.1	26.2
P1LoNo	57.2	43.8	57.6	52.0	61.3	47.4	58.7	47.7
PoL1No	32.3	35.6	27.6	40.2	29.0	35.6	29.6	37.1
P!L1No	74.4	67.4	67.0	63.8	73.3	68.4	71.5	66.5
PoLoN1	32.5	47.9	25.5	52.0	28.7	47.5	28.9	49.1
P1LoN1	68.0	83.1	72.3	77.4	71.9	78.8	70.7	79.8
PoL1N1	37.3	54.0	43.8	62.5	39.5	57.5	40.2	58.0
P1L1N1	88.8	99.3	85.3	102.8	88.6	97.0	87.5	99.7

c. R6.5-

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	46.1	60.9	49.5	52.2	45.0	57.2	46.8	56.7
P1LoNo	111.1	114.1	117.8	123.4	106.4	119.0	111.7	118.8
PoL1No	73.3	72.7	64.5	79.0	68.5	69.2	68.7	73.6
P!L1No	130.0	140.8	123.0	128.5	121.4	132.3	124.8	133.8
PoLoN1	58.3	96.4	66.2	107.9	56.9	100.7	60.4	101.6
P1LoN1	143.8	60.7	140.7	155.5	133.6	152.7	139.3	156.3
PoL1N1	76.8	121.2	84.7	109.0	79.0	112.3	80.1	114.1
P1L1N1	146.8	191.8	149.1	205.1	156.5	194.7	150.8	197.2

Table 8. Effect of N, P, lime on yield and its components of soybean and peanut

a. Pods/plant

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	14.0	7.5	17.6	5.6	16.4	7.0	16.0	6.7
P1LoNo	24.4	11.2	27.5	12.8	23.2	9.8	25.0	11.2
PoL1No	23.0	11.1	19.2	12.3	20.7	9.0	20.9	10.8
P!L1No	32.2	15.9	28.6	13.2	30.8	15.5	30.5	14.8
PoLoN1	22.3	11.0	23.7	12.5	19.4	10.4	21.8	11.3
P1LoN1	37.8	20.3	33.7	17.6	36.1	18.4	35.8	18.8
PoL1N1	26.7	16.0	29.5	13.1	26.9	14.4	27.7	14.5
P1L1N1	39.5	23.2	37.5	24.7	40.9	21.6	39.3	23.1

b. Filled pods/plant

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	9.7	5.3	12.8	3.9	11.7	4.8	11.4	4.6
P1LoNo	19.2	8.9	21.3	10.2	18.4	8.1	19.6	9.0
PoL1No	17.1	7.4	14.5	8.5	15.7	6.5	15.7	7.5
P!L1No	26.4	11.5	26.8	8.9	28.1	10.8	27.1	10.4
PoLoN1	15.8	8.2	16.9	9.6	14.0	7.8	15.5	8.5
P1LoN1	32.3	15.3	28.4	12.2	30.1	13.7	29.9	13.7
PoL1N1	23.1	12.8	24.2	9.7	25.2	11.7	24.8	11.4
P1L1N1	33.5	16.8	30.6	19.3	34.7	15.1	32.9	17.1

c. % of filled pod

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	69.6	70.6	72.6	69.5	71.5	68.5	71.2	69.5
P1LoNo	78.6	79.4	77.5	79.6	79.2	82.6	78.4	80.5
PoL1No	74.5	66.6	75.6	69.1	75.8	72.2	75.3	69.3
P!L1No	81.9	72.3	84.8	67.4	80.7	69.6	82.4	69.7
PoLoN1	70.8	74.5	70.8	76.8	72.1	75.0	71.2	75.4
P1LoN1	85.4	75.3	84.3	69.3	80.6	74.5	83.4	73.0
PoL1N1	86.5	80.0	88.7	74.0	93.6	81.2	88.9	78.4
P1L1N1	84.8	72.4	81.6	78.1	84.4	70.0	83.7	73.5

d. Weight of 100 seeds (gr)

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	8.0	45.3	8.2	46.0	8.3	45.7	8.2	45.6
P1LoNo	9.3	48.5	9.6	48.2	9.5	48.8	9.4	48.5
PoL1No	8.4	46.1	8.2	45.8	8.3	46.2	8.3	46.0
P!L1No	9.1	50.1	9.3	49.6	9.3	49.5	9.2	49.7
PoLoN1	8.5	45.5	8.5	46.0	8.7	45.8	8.6	45.7
P1LoN1	9.8	50.0	9.7	79.8	9.7	49.8	9.7	49.8
PoL1N1	9.0	48.0	9.1	47.6	9.2	48.3	9.7	48.6
P1L1N1	10.0	51.6	10.2	51.8	10.4	51.2	10.2	51.5

e. Yield (kg/ha)

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	391	696	488	598	433	653	433	652
P1LoNo	833	1116	885	1165	796	1043	838	1108
PoL1No	719	1021	634	1096	670	951	674	1022
P!L1No	1015	1397	924	1248	789	1336	909	1327
PoLoN1	611	1128	654	1197	548	1086	605	1137
P1LoN1	1225	1634	1105	1476	1165	1582	1165	1564
PoL1N1	770	1295	874	1172	802	1232	815	1233
P1L1N1	1443	1828	1387	1897	1483	1752	1438	1829

Table 9. Gross return *

Treat.	Rep1		Rep2		Rep3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	1560	3132	1952	2691	1732	2938	1732	2934
P1LoNo	3332	5022	3540	5242	3184	4693	3352	4986
PoL1No	2876	4594	2536	4932	2680	4279	2696	4599
P!L1No	4060	6286	3696	5616	3156	6012	3636	5971
PoLoN1	2444	5076	2616	5386	2192	4887	2420	5116
P1LoN1	4900	7352	4420	6642	4660	7119	4660	7038
PoL1N1	3080	5827	3496	5274	3208	5544	3260	5548
P1L1N1	5772	8226	5532	8536	5932	7884	5752	8230

* Price of soybean: 4000 d kg^{-1}, peanut: 4500 d kg^{-1}

Table 10. Total variable costs for both soybean and peanut (1000 d) *

Treat	Variable costs					
	N	P	L	Pest control	Labour	Total
PoLoNo	0	0	0	100	600	700
P1LoNo	0	1200	0	100	600	1900
PoL1No	0	0	150	100	600	850
P1L1No	0	1200	150	100	600	2050
PoLoN1	960	0	0	100	600	1660
P1LoN1	960	1200	0	100	600	2860
PoL1N1	960	0	150	100	600	1810
P1L1N1	960	1200	150	100	600	3010

Note: Price of N urea: 3000 d/kg; Superphotphate: 1300 d./kg;
CaO: 200 d./kg; Labor: 10000 d./manday

Table 11. Net return (1000 d)

Treat.	Rep1		Rep 2		Rep 3		Mean	
	S	P	S	P	S	P	S	P
PoLoNo	860	2432	1252	1991	1032	2238	1032	2234
P1LoNo	1432	3122	1640	3342	1284	2793	1452	3086
PoL1No	2026	3744	1686	4082	1830	3429	1846	3741
P1L1No	2010	4236	1646	3566	1106	3962	1586	3921
PoLoN1	784	3416	956	3726	532	3227	760	3456
P1LoN1	2040	4493	1560	3782	1800	4259	1800	4178
PoL1N1	1270	4017	1686	3464	1398	3734	1450	3738
P1L1N1	2762	5216	2522	5526	2921	4874	2742	5220

Table 12. Soil chemical properties after experiment

Treat.	pH(KCl)		N(%)		P(ppm)		K(ppm)	
	S	P	S	P	S	P	S	P
				Rep 1				
PoLoNo	4.6	4.5	0.10	0.12	2.4	2.8	61	57
P1LoNo	4.8	4.9	0.13	0.11	12.1	10.9	60	59
PoL1No	5.5	5.3	0.12	0.13	3.1	3.5	66	53
P1L1N1	5.8	5.9	0.11	0.13	13.6	13.2	59	60
PoLoN1	4.5	4.8	0.10	0.12	3.2	2.6	63	59
P1LoN1	4.8	4.9	0.09	0.10	11.8	12.5	59	60
PoL1N1	5.6	5.2	0.11	0.12	3.5	3.5	61	59
P1L1N1	5.6	5.5	0.14	0.12	13.2	12.7	58	57
				Rep2				
PoLoNo	4.8	4.8	0.12	0.13	2.6	3.1	65	62
P1LoNo	4.9	4.6	0.14	0.12	11.7	13.2	56	64
PoL1No	5.8	5.4	0.11	0.11	3.4	3.9	64	56
P1L1No	5.9	5.6	0.09	0.13	14.3	12.7	60	57
PoLoN1	4.7	4.5	0.12	0.13	2.8	3.1	66	63
P1LoN1	4.8	4.7	0.09	0.11	13.4	13.4	55	55
PoL1N1	5.7	5.7	0.13	0.14	4.2	4.0	58	55
P1L1N1	5.2	5.8	0.13	0.13	12.7	13.6	54	53
				Rep3				
PoLoNo	4.7	4.7	0.11	0.11	2.7	2.3	60	61
P1LoNo	4.8	4.6	0.10	0.10	10.6	11.0	58	63
PoL1No	5.7	5.6	0.12	0.12	3.2	3.7	62	55
P1L1No	5.9	5.3	0.10	0.12	13.4	13.0	84	59
PoLoN1	4.4	4.7	0.11	0.11	2.3	2.8	65	61
P1LoN1	4.7	4.8	0.12	0.12	12.0	12.3	57	59
PoL1N1	5.5	5.3	0.12	0.13	3.7	3.8	61	60
P1L1N1	5.9	5.5	0.12	0.11	13.1	12.0	56	55
				Mean				
PoLoNo	4.7	4.7	0.11	0.11	2.7	2.3	60	61
P1LoNo	4.8	4.6	0.10	0.10	10.6	11.0	58	63
PoL1No	5.7	5.6	0.12	0.12	3.2	3.7	62	55
P1L1No	5.9	5.3	0.10	0.12	13.4	13.0	64	59
PoLoN1	4.4	4.7	0.11	0.11	2.3	2.8	65	61
P1LoN1	4.7	4.8	0.12	0.12	12.0	12.3	57	59
PoL1N1	5.5	5.3	0.12	0.13	3.7	3.8	61	60
P1L1N1	5.9	5.5	0.12	0.11	13.1	12.0	56	55

Appendix D Climate characteristics in three surveyed provinces

Appendix D.1 Bac thai province

Indicators	1	2	3	4	5	6	7	8	9	10	11	12
Temp (^{O}C)	15	16	19	23	27	28	28	27	26	24	20	17
Rainfall (mm)	22	35	55	117	234	354	392	390	237	118	45	23
Atm. humidity (%)	80	82	85	86	82	83	83	86	83	81	79	78
Suny hours	73	48	48	80	176	167	196	181	189	179	152	122

Appedix D.2 Cao bang province

Indicators	1	2	3	4	5	6	7	8	9	10	11	12
Temp (^{O}C)	14	14	19	22	26	27	27	26	25	22	18	15
Rainfall (mm)	16	27	39	88	184	250	264	264	156	86	44	19
Atm. humidity (%)	79	79	80	80	79	82	84	86	83	81	81	80
Suny hours	62	53	78	121	170	162	202	186	171	138	110	110

Appedix D.3 Lang son province

Indicators	1	2	3	4	5	6	7	8	9	10	11	12
Temp (^{O}C)	13	14	18	22	25	27	27	26	25	22	18	15
Rainfall (mm)	24	41	53	96	164	199	257	255	164	78	34	23
Atm. humidity (%)	78	81	84	83	81	82	84	85	84	80	78	78
Suny hours	81	57	61	94	187	161	191	167	181	157	135	116

Appedix E. Soil chemical properties in three surveyed villages

Appedix E.1 Um village, Phuc ha community, Dong hi district, Bac thai province

Sample	pH (KCl)	N (%)	P (ppm)	K (ppm)
1	5.2	0.12	4.3	52
2	4.8	0.13	2.8	58
3	4.5	0.09	3.5	47
4	4.7	0.15	3.1	61
5	5.0	0.07	4.2	55
6	4.7	0.14	3.6	53
7	4.8	0.21	2.9	45
8	4.6	0.11	5.3	57
9	4.3	0.15	3.3	60
10	4.7	0.12	4.1	54

Appedix E.2 Lung rieng village, Quoc phong community, Quang hoa district, Cao bang province

Sample	pH (KCl)	N (%)	P (ppm)	K (ppm)
1	6.3	0.15	6.1	56
2	5.8	0.14	3.5	67
3	5.0	0.12	6.3	49
4	4.7	0.10	4.7	55
5	5.3	0.09	5.4	62
6	5.8	0.13	6.6	58
7	4.8	0.11	3.8	60
8	4.6	0.18	4.2	53
9	5.1	0.21	5.7	65

Appendix E.3 Parang village, Hoa binh community, Chi lang district, Lang son province

Sample	pH (KCl)	N (%)	P (ppm)	K (ppm)
1	4.6	0.10	4.7	53
2	4.6	0.17	5.6	61
3	4.1	0.15	3.7	57
4	4.7	0.21	5.0	58
5	4.3	0.14	4.1	71
6	5.1	0.16	6.2	66
7	4.8	0.09	5.4	58
8	4.5	0.17	4.3	55
9	4.7	0.12	3.9	67

Appendix G. Determination of P applied rate

Relationship between amount of superphosphate added and P concentration in the soil solution

Superphosphate added (ppm)	P concentration in soil solution (ppm)
0	0.00
60	0.002
120	0.008
180	0.020
240	0.054
380	0.107
360	0.205
420	0.325

Appedix H. Survey questionaire

Name of interviewer:
Date of interview:

I. Socio-economic profile

Q.1. Name of respondent: ( ) Sex: M ( ) F ( )
Age: ( ) Schooling years: ( )

Q.2. Ethenic group:

Q.3. Family members: M ( ) F ( ) Children ( ) total ( ) persons

Q.4. Coud you please enumerate all the family members in relation to the following informations:

Member's relation to household	Age	Occupation	Level of education	farming member
.....				
.....				
.....				

Q.5. Farm size: 1. Landholding

- Arable area for food legume production: ( ) In which: Soybean ( ) peanut ( )
- Arable area for food crop production: ( )

2. Family labors: of which:

- In-aged labors: ( ) Full-time farming: ( ) Part-time farming: ( )
- Over-aged labors: ( ) Working in farm ( ) Working outside farm ( )
- Under-aged labors: ( ) Working in farm ( ) Not working yet ( )

II. Production profile

Q.6. Could you please describe your cropping pattern (crop calendar) in this agricultural year?

Q.7. How many food legume crops in your farming and what are their cropping calendar?

Q.8. What legume varieties do you use?

Q. 9. Food legume production:

Iterms	1st crop	2nd crop	3rd crop
Total area			
A. Material cost (Amount and cost)			
- Seed			
- N			
- P			
- K			
- Lime			
- Manure			
- Pesticides			
- Bullock labor			
- Irrigation			
- Other materials			
B. Labor cost			
- Soil preparation			
- Sowing			
- Weeding			
-Harvesting			
Total (A+B)			
Total production			
Yield (kg ha^{-1})			

III. Processing and consumption:

Q.10. Types of processing products of food legumes?

Q.11. Could you please describe the processing facilities and their technological conditions?

Q.12. Do you have any difficulties in processing your food legumes? If do, what are?

Q.13. How many kg of food legumes your family consum per year? In which: soybean ( ) peanuts ( ) pulses ( )

Q.14. What are types, quantity, and prices of marketed food legume products?

Q.15. Where can you sell your food legumes? and do you have any difficulties in selling your products?

Q.16. Do you use food legumes for animal feed? If do, how many kg do you use per year?

Q.17. What do you think about the importance of food legumes in animal feed?

IV. Farmer's opinion about the ecological role of food legumes:

Q.18. What do you think about the following roles of food legumes to soil fertility (please enumerate evidence for your answer)?

- Increase
- Decrease
- No change

Q.18. Do you think there are effects of food legumes on soil erosion? (Please enumerate evidence). If any, the erosion are

- Increased
- Decreased

Q.19. Do you think there are impacts of food legumes to pests in subsequent crops? If any, the pests are

- Increased
- Decreased

V. Farmer's opinion about economic valuations of food legumes

Q.20. How much the food legumes contribute to your annual income per year?

Q.21. What is your opinion about input requirement of food legumes in comparison to nonlegume crops in your farm?

- Lower
- Higher
- The same

Q.22. What do you think about economic efficiency (benefit) of food legumes compared with other crops? Higher? Lower? The same?

Q.23. What do you think about labor use in your family when food legumes are grown?

- Better
- Worse
- no change

VI. Farmer's opinion about the role of food legumes in human and animal nutrition

Q.24. What do you think about the role of food legumes in your daily meals and animal feed?

- Very important
- Important
- Not important

Q.25. How many percent of your daily meals you use food legumes as the foods?

VII. Farmer's opinion about constraints in their food legume production

Q.26. According to you what are constraints on your food legume production with respect to the following physical conditions? What is the most serious? Please mark in the bracket.

- Soil condition: Acidity ( ) Infertile ( )
- Variety: Not relevent ( ) lack of good seed ( )
- Climate conditions: Low or high temperature ( ) Drought ( ) Other ( )

Q.27. What do you think about socio-economic constraints to your food legume production? What is the most serious? Please mark in the bracket

- Lack of capital
- Lack of know-how in production
- Market accessibility
- Low prices
- Poor processing facilities
- Government policies incentives
- Other

CURRICULUM VITAE

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