TABLE OF CONTENTS

	Page
ACKNOWLEDGMENT	iii
ABSTRACT	iv
THAI ABSTRACT	vii
LIST OF TABLE	vii Xii
LIST OF ILLUSTRATIONS	xiv
	ΥİΑ
CHAPTER I INTRODUCTION	1
CHAPTER II LITERATURE REVIEW	
2.1 Climatic Effect on Red Kidney Bean	4
2.2 Nitrogen Response in Red Kidney Bean	5
2.3 Nitrogen Fixation by Red Kidney Bean	8
2.4 Other Essential Element Necessary for N-Fixation	13
2.5 Contribution of Rhizobium to Yield Increment	14
CHAPTER III MATERIALS AND METHODS	
3.1 Preliminary Farmer Survey	19
3.1.1 Crop cutting	19
3.1.2 Farmer survey	19
3.2 Field Experiment	20
3.2.1 Data collection	21
3.2.1.1 Climatic data	21
3.2.1.2 Phenology	21
3.2.1.3 Crop management data	22
3.2.1.4 Soil analysis	22
3.2.1.5 Dry matter	22
3.2.1.6 Total plant nitrogen	22
3.2.1.7 Nitrogen fixation	22
3.2.1.8 Yield and yield components	24
3.2.2 Data analysis	24
3.3 Assessing of Farmer Production Systems	25
3.3.1 Formal survey method	25
3.3.1.1 Pre-diagnosis	25

3.3.1.2 Formal survey	25
3.3.2 Data collection	26
3.3.3 Data analysis	26
CHAPTED IN COUNTY ADDA AND TO BE ADDA	
CHAPTER IV STUDY AREA AND FARMER PRODUCTION SYSTEM	
OF RED KIDNEY BEAN	
4.1 Description of Study Area	27
4.1.1 The community	29
4.1.2 Land ownership	30
4.2 Agronomic Management of Red Kidney Bean Production	31
4.2.1 Land preparation	31
4.2.2 Planting	31
4.2.3 Weed control	31
4.2.4 Harvesting	32
4.3 Farmer Yield	32
4.3.1 Yield variation and distribution	32
4.3.2 Plant height and yield components	34
4.4 Material Inputs Used in Red Kidney Bean Production	34
4.5 Labor Utilization	36
4.6 Cost and Return in Red Kidney Bean Production	37
4.7 Production Constraints and Opportunities for Improvement	41
	• •
CHAPTER V RESULT OF FIELD EXPERIMENTS	
5.1 Dry Matter	43
5.2 Total Nitrogen Uptake	49
5.3 Nitrogen Fixation	53
5.4 Yield and Yield components	54
5.4.1 Seed yield	55
5.4.2 Biomass	56
5.4.3 Plant height	56
5.4.4 Number of pod per plant	57
5.4.5 Number of seed per pod	58
5.4.6 One hundred seeds weight	58
5.4.7 Pecent of seed damage	
5.5 Red Kidney Bean Phenology	59
5.6 Crop Management	60
5.7 Cost Benefit Analysis	60
· ····································	61

CHAPTER VI DISCUSSION	
6.1 Significance of Red Kidney Bean to Household Economy	63
6.2 Production System and Its Limitation	63
6.3 Opportunity for Improving Farming Practice Through	
Enhancing Soil Fertility	65
6.3.1 Chemical fertilizer	65
6.3.2 Rhizobium inoculation	66
6.3.3 Field experiment	66
6.3.4 Effect of nitrogen fertilizer	68
6.3.5 Economic benefit	70
CHAPTER VII CONCLUSION AND RECOMMENDATION	72
REFERENCES	74
APPENDICES	82
CURRICULUM VITAE	103

LIST OF TABLES

Table		Page
2.1	Example of estimates of nitrogen fixed by some legumes	10
2.2	Comparisons of the N ₂ -fixation capacities of different species	
	of food legumes	13
2.3	Response of soybean to N fertilizer as urea on inoculation with	
	rhizobium in acid sulphate soils (pH 4.5-5.0) of the Mekong Delta	15
3.1	Experimental treatment combinations consisting of two factors of	
	rhizobium and nitrogen management	21
4.1	Population in Kae Noi areas, 1992	29
4.2	Red kidney bean farm size, Ban Kae Noi	30
4.3	Farmer yield (kg/ha) of red kidney bean in early and late rainy	
	season planting, 1994	33
4.4	Average yield (kg/ha) distribution from early and late rainy	
	season planting, 1994	33
4.5	Yield components of farmers field (kg/ha) in early and late rainy	
	season planting, 1994	34
4.6	Material input of red kidney bean cultivation for no fertilizer	
_ <	and fertilizer application	35
4.7	Material input of red kidney bean in early and late rainy	
J.	season planting	35
4.8	Labor use in red kidney bean production (man-day rai ⁻¹)	36
4.9	Labor use in red kidney bean production in early and late	
4.10	rainy season planting (man-day rai ⁻¹)	37
4.10	Variable cost of no fertilizer application in red kidney bean (baht rai ⁻¹)	
4.11	Variable cost of fertilizer application in red kidney bean (baht rai ⁻¹)	38
4.12	Variable cost of red kidney bean in early rainy season plnating	
4.10	(baht rai ⁻¹)	39
4.13	Variable cost of red kidney bean in late rainy season planting	
4 1 4	(baht rai ⁻¹)	40
4.14	Return of red kidney bean production of no fertilizer and fertilizer	
4.15	application	40
4.15	Return of red kidney bean production in early and late rainy season	
116	planting	41
4.16	The pattern of nitrogen management and rhizobium factor	42

5.1	Summary analysis of variance (ANOVA) of shoot dry weight	
<i>-</i> 0	at different growth stages in May planting	44
5.2	Summary analysis of variance (ANOVA) of shoot dry weight	
<i>c</i> 2	at different growth stages in September planting	45
5.3	Summary analysis of variance (ANOVA) of N uptake	
~ .	at different growth stages in May planting	50
5.4	Summary analysis of variance (ANOVA) of N uptake	
	at different growth stages in September planting	50
5.5	Effects of N management on N uptake (kg N/ha) at R ₅ in	
	May planting	51
5.6	Effects of N management on N uptake (kg N/ha) at R ₇ in	
	May planting	52
5.7	Effects of N management on N uptake (kg N/ha) at R ₁ in	
	September planting	52
5.8	Effects of N management on N uptake (kg N/ha) at R7 in	
	September planting	53
5.9	Effects of N and rhizobium management on relative ureide-	
	nitrogen (%) in September planting	54
5.10	Plant density of red kidney bean at harvest for both seasons, 1994	55
5.11	Effects of N fertilizer on seed yield (kg/ha) of red kidney bean	
	grown in May and September, 1994	55
5.12	Effects of N fertilizer on biomass (kg/ha) of red kidney bean	
	grown in May and September, 1994	56
5.13	Effects of N fertilizer on plant height (cm) of red kidney bean	•
	grown in May and September, 1994	57
5.14	Effects of N fertilizer on pod/plant of red kidney bean	-
	grown in May and September, 1994	57
5.15	Effects of N fertilizer on seed/pod of red kidney bean	٠,
	grown in May and September, 1994	58
5.16	Effects of N fertilizer on 100 seeds weight (g) of red kidney	
	bean grown in May and September, 1994	59
5.17	Effects of N fertilizer on seed damage (%) of red kidney bean	.
	grown in May and September, 1994	59
5.18	Red kidney bean phenology in May and September planting, 1994	60
5.19	Red kidney bean management in May and September planting, 1994	60
5.20	Cost and benefit of red kidney bean planted in May planting	61
5.21	Cost and benefit of red kidney bean planted in September planting	62
6.1	Net return (baht/household) at Ban Kae Noi, 1995	71
		/ I

LIST OF ILLUSTRATIONS

Figure		Page
3.1	Flow chart percent of nitrogen fixation estimation	24
4.1	Maximum and minimum temperature (°C) May-Dec, 1994	28
4.2	Rainfall (mm) and solar radiation (Mj m ⁻² d ⁻¹) during	20
C 1	May-Dec, 1994	28
5.1	Effects of N management on total shoot dry matter weight (kg/ha)	
5.2	at different growth stages in May planting	44
5.2	Effects of N management on total shoot dry matter weight (kg/ha)	
<i>5</i> 2	at different growth stages in September planting	45
5.3	Crop Growth Rate (CGR) as measured by rate of change of dry	
	matter accumulation of F ₀ , F ₁ , F ₂ (A) CGR in May planting	
	(B) CGR in September planting	46
5.4	Crop Growth Rate (CGR) as measured by rate of change of dry	
	matter accumulation in May planting (A) CGR of F ₀ (B) CGR	
	of F ₁ (C) CGR of F ₂ (D) CGR of F ₃	47
5.5	Crop Growth Rate (CGR) as measured by rate of change of dry	
	matter accumulation in September planting (A) CGR of F ₀	
	(B) CGR of F ₁ (C) CGR of F ₂ (D) CGR of F ₃	48
5.6	Effects of N management on total N uptake (kgN/ha) at different	70
	growth stage in May planting	50
5.7	Effects of N management on total N uptake (kgN/ha) at	50
	different growth stage in September planting	<i>5</i> 1
	b. s. a. suge in September planning	51