



UNIVERSITI PUTRA MALAYSIA

**NITROGEN CONTRIBUTION OF PARASERIANTHES FALCATARIA
TREE BIOMASS TO CORN (ZEA MAYS. L) PRODUCTION**

RICHARD CHINTU

FP 2002 1

**NITROGEN CONTRIBUTION OF *PARASERLIANTHES FALCATARIA* TREE
BIOMASS TO CORN (*ZEA MAYS. L*) PRODUCTION**

By

RICHARD CHINTU

**Thesis Submitted in Fulfilment of the Requirement for the
Degree of Master of Agriculture Science in the Faculty of Agriculture
Universiti Putra Malaysia**

January 2002



DEDICATION

This thesis is dedicated to the entire human existence now, and time to come



Abstract of the thesis presented to the Senate of the Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Agriculture Science

NITROGEN CONTRIBUTION OF *PARASERLIANTHES FALCATARIA* TREE BIOMASS TO CORN (*ZEAMAYS. L*) PRODUCTION

By
RICHARD CHINTU

January 2002

Chairperson: Professor Dr. Zaharah Abdul Rahman

Faculty: Agriculture

Tree legumes can be an important nitrogen (N) source for cereals in developing countries where little or no fertilizer is used due to prohibitive costs. *P. falcataria* biomass as a source of nitrogen for corn, was studied in a series of field and controlled experiments using ¹⁵N labeling techniques. The aim of the study was to characterize the effect of biomass quality on nitrogen mineralization, and on N recovery from *P. falcataria* residues by corn.

It was hypothesized that mixing of residues of varying quality would alter residue (litter) quality and nitrogen mineralization. *P. falcataria* leaves were mixed with *P. falcataria* roots (*P. falcataria* mixture). Residue quality assessment was based on the index; (Polyphenol + Lignin)-to-N content. Litter quality was in the order of; *P. falcataria* leaves > *P. falcataria* mixture > *P. falcataria* roots, nitrogen and carbon (C) mineralization also followed the same sequence (P <0.05), indicating that the potential of residues to increase soil inorganic N depends on their quality.

P. falcataria leaves including mixture treatments significantly ($P < 0.05$) mitigated soil acidity while *P. falcataria* roots alone did not. Thus, there is a potential benefit of residues as 'lime' in cropping systems.

Leaves under humid tropical conditions decomposed rapidly causing an initial transitory increase in soil inorganic N, then substantial $\text{NO}_3\text{-N}$ leaching from 30 to 60 days after application. Significant amounts of Ca^{++} , Mg^{++} , and K^+ were leached beyond the top 20 cm soil profile only after 60 days.

There is need to strategically mix residues of contrasting quality, to regulate N release and reduce leaching while increasing soil inorganic N under field conditions.

The potential of the ^{15}N indirect and direct labeling methods to estimate N- cycling from tree residues was similar ($P < 0.05$). Corn recovered more N from *P. falcataria* roots than from *P. falcataria* leaves.

Data on corn produced under field conditions indicated that, the use of residues in combination with an inorganic N source, as opposed to the sole use of either of them, seems a more effective management strategy for improving N use efficiency, including mitigating soil acidity.



Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia sebagai memenuhi keperluan untuk penganugerahan ijazah Master Sains Pertanian

**SUMBANGAN NITROGEN DARIPADA BIOJISIM POKOK
PARASERIANTHES FALCATARIA KEPADA PENGELUARAN JAGUNG
(ZEA MAYS .L)**

By
RICHARD CHINTU

January 2002

Pengerusi: Profesor Dr. Zaharah Abdul Rahman

Fakulti: Pertanian

Pokok kekacang boleh menjadi sumber nitrogen yang penting kepada bijirin di negara-negara membangun di mana tiada atau kurang penggunaan baja kerana kos yang tinggi.

Biojisim *P. falcataria* sebagai sumber N untuk jagung telah dikaji dalam beberapa siri kajian ladang dan terkawal menggunakan teknik penglabelan ^{15}N . Tujuan kajian ialah untuk mencirikan kesan kualiti biojisim ke atas pemineralan N dan pengambilan N dari sisa *P. falcataria* oleh jagung.

Ini berdasarkan hipotesis bahawa campuran sisa-sisa pelbagai kualiti akan mengubah kualiti sisa dan pemineralan N. Daun-daun *P. falcataria* dicampur dengan akar (campuran *P. falcataria*). Kualiti sisa dinilai berdasarkan indeks nisbah kandungan polifenol+lignin kepada N. Kualiti sisa adalah mengikut turutan daun *P. falcataria*>campuran *P. falcataria*>akar *P. falcataria*, dan pemineralan nitrogen dan carbon juga mengikut turutan yang sama ($P<0.05$), menunjukkan potensi sisa untuk meningkatkan mineral N tanah bergantung kepada kualitinya. Rawatan daun *P.*

falcataria dan campuran *P. falcataria* mengurangkan keasidan tanah dengan bererti ($P < 0.05$) manakala akar *P. falcataria* sahaja tidak. Ini menunjukkan potensi sisa sebagai ‘bahan kapur’ dalam sistem pertanian.

Di kawasan tropika lembap daun akan mereput dengan cepat dan menyebabkan peningkatan sementara N tak organik dalam pada, diikuti dengan larutlesap N yang banyak pada hari ke 30 hingga 60 selepas rawatan. Penglarutlesapan Ca^{++} , Mg^{++} , dan K^+ yang bererti melampaui paras 20 cm profil tanah hanya berlaku selepas 60 hari.

Strategi pencampuran sisa berbeza kualiti adalah perlu untuk mengawalatur pembebasan N dan mengurangkan proses larutlesap sambil meningkatkan mineral N tanah di lapangan. Potensi kaedah penglabelan ^{15}N secara langsung dan tidak langsung untuk menganggarkan kitaran N dari sisa pokok adalah sama ($P < 0.05$). Jagung mendapat lebih N dari akar *P. falcataria* berbanding daun *P. falcataria*.

Data pengeluaran jagung di bawah keadaan lapangan menunjukkan bahawa penggunaan gabungan sisa dan sumber N tak organik, berbanding dengan penggunaan hanya sisa atau N tak organik sahaja, merupakan satu strategi pengurusan yang lebih berkesan untuk meningkatkan kecekapan penggunaan N, termasuklah mengurangkan keasidan tanah.

ACKNOWLEDGMENTS

As a preamble to this report, I quote the African proverb ‘umweo wa bantu walala mu matwi’ which literally translated reads; ‘human life lies in the ears’ but the moral or broader meaning of it as taught to me by my late grand mother is that ‘the potential of human beings to survive depends on their ability to listen and learn’.

My mentors, my sponsors and I, will only feel repaid for this work if, either the scientific facts or ignorance highlighted in this report, in a minute or major way, contribute to the advancement of knowledge for the benefit of the present and future generations world-over.

I am grossly and personally indebted to the chairperson (Prof. A.R. Zaharah) and members of my supervisory committee (Dr. Anuar B. Abdul Rahim, Dr. Halimi Mohd Saud, Dr. Wan Rasidah W.A. Kadir) for the un-failing professional support and guidance they offered me throughout my research program. From them, I learnt more than just science.

I thank Ms. Zabedah Bt Tumirin and Dr. A. R. Bah for their unmatched technical back-stopping in terms of laboratory procedures and analysis. I also thank Dr. Gamini and all staff at both the IAEA Seibersdorf laboratory, Austria and the Malaysian Institute of Nuclear Technology (MINT) for facilitating ^{15}N analyses of my numerous soil and plant samples.

My sincere and larger share of appreciations go to my boss at Zambia-ICRAF, Dr. P. L. Mafongoya, for subtly and scientifically provoking, encouraging and shaping my seminal or virgin ideas about plant residue mixtures in agroforestry systems (he himself being a guru in that area), but more so I thank him for making it possible for me to actualize my scientific dreams in South East Asia by pledging me a to-and-fro



airfare in lieu of (forfeiting) his two official but pleasurable trips to attend Soil Science Society of America annual meetings, in Wisconsin, USA. ‘Asante sana PLM!!’; Thank you so much PLM!! This is indeed a challenging sign of true and selfless leadership, alien to most institutions.

I owe most of my unwavering professional maturity and courage to Dr. F. R. Kwesiga, who baptized me with ‘fire’ during my early career days as a novice administrator at Chalimbana, and has always set me mountains of professional challenges and standards to scale and I promise to live up to that and to rise to every occasion of duty with sincere and professional dedication.

The good efforts of Mr. T. S. Chirwa, Mr. M. Mwale and others to take care of my field experiments at Chipata during my studies abroad can not be ignored.

I have tremendously searched my English vocabulary, but all in vain, for the most suitable words to use to acknowledge the tremendous support and assistance rendered to me and to my family by my work mates and friends, individually or collectively, during my long absence from home.

To my loving and beloved family that missed my much needed presence at home for a whole period of two years, I say that, I know very well that home is the best place to be, but at times we have to get away if only to better our selves professionally so as to contribute more meaningfully to the extremely needy economy of our mother land, Africa.



I certify that an Examination Committee met on 8th January 2002 to conduct the final examination of Richard Chintu on his Master of Agriculture Science thesis entitled “Nitrogen Contribution of *Paraserianthes falcataria* Tree Biomass to Corn (*Zea mays*. L) Production” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

AZIZAH HASHIM, Ph.D.

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairperson)

ZAHARAH ABD. RAHMAN, Ph.D.

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

ANUAR B. ABDUL RAHIM, Ph.D.

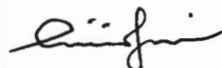
Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

HALIMI MOHD SAUD, Ph.D.

Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

WAN RASIDAH W.A. KADIR, Ph.D.

Researcher
Forestry Research Institute of Malaysia (FRIM)
(Member)



AINI IDERIS, Ph.D.

Professor/Dean of Graduate School
Universiti Putra Malaysia

Date: **21 JAN 2002**

This thesis submitted to the senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Agriculture Science.



AINI IDERIS, Ph.D.
Professor/ Dean of Graduate School
Universiti Putra Malaysia

Date: **14** MAR 2002

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



RICHARD CHINTU

Date: 8th January 2002

TABLE OF CONTENTS

	Page
DEDICATION	2
ABSTRACT	3
ABSTRAK	5
ACKNOWLEDGMENTS	7
APPROVAL	9
DECLARATION	11
LIST OF TABLES	16
LIST OF FIGURES	17
 CHAPTER	
I	
INTRODUCTION	19
Back-ground	19
Justification	20
Hypotheses	22
General Objective	23
Specific Objectives	23
Why the <i>P. falcataria</i> Option?	24
II	
GENERAL REVIEW OF LITERATURE	26
Nitrogen Cycling from Plant Organic Inputs with Specific Reference to Leaf and Root Biomass of Tree Legumes	26
Biochemical Factors Affecting N Cycling from Plant Residues	28
Total N Content and its Release	29
C: N Ratio	29
Lignin	30
Polyphenols	31
(L + PP): N Ratio	31
Rational Approach to N Cycling from Organic Residues	32
III	
EXPERIMENT 1: NITROGEN MINERALIZATION AND CO ₂ -C EVOLUTION FROM <i>P. FALCATARIA</i> RESIDUES UNDER CONTROLLED CONDITIONS	33
Introduction	33
Hypothesis:	35
Objectives:	35
Materials and methods	35
¹⁵ N Solution Preparation for Labeling of Experimental Units	37
Experimental Set-up, Design and Sampling for Lab Analysis	38
Extraction And Distillation for inorganic N (NH ₄ -N and NO ₃ -N) and ¹⁵ N Analysis	39
Monitoring of CO ₂ -C Release	40
Soil pH Dynamics	40
Statistical Analysis	41



Results	41	
Residue Quality	41	
Soil Inorganic N Dynamics	42	
Percent Ammonium and Nitrate-Ndfr	44	
Carbon dioxide-C Evolution	47	
Soil pH Dynamics	50	
Discussion	51	
Residue Quality	51	
Soil Inorganic N Dynamics Relations to Litter Quality	52	
Percentage of N Derived from Residues (%Ndfr)	55	
Carbon dioxide-Carbon Dynamics and Residue Quality	56	
Soil pH Dynamics and Residue Quality	59	
Conclusions	63	
IV	EXPERIMENT 2: NITROGEN UPTAKE BY CORN (<i>ZEA MAYS</i> . L) INTEGRATED WITH <i>P. FALCATARIA</i> TREES AS ASSESSED BY USING ¹⁵ N ISOTOPE STEM INJECTION LABELING TECHNIQUE: SPECIAL EMPHASIS ON ROOT BIOMASS N CONTRIBUTION	65
	Introduction	65
	Hypothesis:	67
	Objectives:	68
	Materials and Methods	68
	Site	68
	Direct ¹⁵ N Isotope Labeling of Trees by Injection	68
	Design and Plot Description	71
	Plot Management	72
	Treatment application	73
	Corn Harvest and Tissue Analysis	75
	Expression of Results	75
	Results	76
	Tree Biomass, N Content and ¹⁵ N Enrichment	76
	Maize Yield	77
	N Content and ¹⁵ N Enrichment of Corn	78
	N Yield of Corn Components	79
	Percent N Derived from Plant Residues (%Ndfr)	80
	Ndfr (g per pot)	82
	Residue N Use Efficiency (rNE)	82
	¹⁵ N Isotope Injection vs Indirect Labeling	83
	Soil Inorganic N and pH Dynamics	83
	Discussion	84
	Conclusion	90
V	EXPERIMENT 3: FIELD EVALUATION OF <i>PARASERIANTHES FALCATARIA</i> AS A SOURCE OF N FOR CORN (<i>ZEA MAYS</i> . L) GROWN ON AN ACIDIC ULTISOL UNDER HUMID TROPICAL CONDITIONS	93
	Introduction	93
	Materials and Methods	96



Study Area	96
Hypothesis:	96
Objective:	96
Treatments (Land-use Systems)	97
Plot Size and Plant Population	98
Field Management	98
Soil Sampling and Analysis	99
Harvesting	100
Chemical Analysis	100
Data Calculations and Analysis	100
Results	101
Dry Matter Yield	101
N Concentration (g kg ⁻¹)	102
Nitrogen Yield	103
¹⁵ N Enrichment	104
Percentage of Nitrogen Derived from Treatment by Corn (%Ndfrt)	105
Nitrogen Derived from Treatment (NdfrT in Kg N ha ⁻¹) and N Use efficiency (%rNE)	106
Soil Inorganic N Economy And Soil pH Dynamics	109
Discussion	110
N Recovery from <i>P. falcataria</i> Leaf Mulch	110
N Recovery from Treatments Integrated with <i>P. falcataria</i> Hedgerows	111
Integrating N Sources to Mitigate Soil N Deficiencies and Acidity	113
Conclusion	114
VI	
EXPERIMENT 4: DECOMPOSITION AND N MINERALIZATION OF <i>P. FALCATARIA</i> LEAVES UNDER FIELD CONDITIONS	116
Introduction	116
Hypothesis:	118
Objectives:	118
Materials and Methods	118
Site	118
Weather	118
Materials	120
PVC Tube Installation and Sampling	120
Chemical Analysis of Soil	121
Chemical Analysis of Resin Trapped Minerals	121
Calculations of Results	122
Results	123
Soil pH	123
Topsoil:	123
Subsoil:	124
Inorganic N	125
Topsoil:	125
Subsoil:	126
¹⁵ N enrichment	127



Resin-Trapped inorganic N	128
Leached Ca ⁺⁺ , Mg ⁺⁺ and K ⁺ in the Resins	129
Discussion	130
Soil pH	130
Inorganic N Release, Leaching and Retention or Immobilization	132
¹⁵ N Enrichment	133
Leaching of Bases	134
Conclusion	134
VII GENERAL SUMMARY	135
VIII GENERAL CONCLUSION	137
REFERENCES	140
BIODATA OF THE AUTHOR	150



LIST OF TABLES

Table		Page
1	Specific characteristics of soil used in the study.....	37
2	Quality of <i>P. falcata</i> residues.....	42
3	CO ₂ - evolution at every time interval C [mg CO ₂ -C mg kg ⁻¹ of soil]	49
4	Initial characteristics of soil used for experiments.....	72
5	Average tree yield, % N and ¹⁵ N enrichment of <i>P. falcata</i>	77
6	Yield of maize components per pot 89 days after planting.....	78
7	Total N and ¹⁵ N enrichment of maize components.....	79
8	Nitrogen yield of the maize components per pot 89 days after planting.....	80
9	N derived from treatment by maize components.....	82
10	Soil inorganic N and pH status at cropping and harvest time.....	84
11	Maize yield for two seasons at Puchong.....	101
12	N concentration in maize components (g kg ⁻¹).....	102
13	Nitrogen yield of maize components (kg ha ⁻¹).....	103
14	Percent ¹⁵ N enrichment of maize components.....	104
15	Nitrogen derived from treatments (NdfrT) by maize components.....	107
16	Soil inorganic N status and soil pH dynamics at the beginning and end of crop 2 season.....	109
17	Inorganic topsoil N and ¹⁵ N enrichment after application of labeled leaves.....	128



LIST OF FIGURES

Figure		Page
1	Inorganic N dynamics over time in an Ultisol amended with <i>P. falcataria</i> plant residues.....	44
2	Nitrate N dynamics as affected with treatment and time.....	45
3	Percentage of soil inorganic ammonium-N derived from fresh <i>P. falcataria</i> residues with time.....	46
4	Soil inorganic ammonium N derived from fresh <i>P. falcataria</i> residues after 70 days of incubation in an Ultisol.....	46
5	CO ₂ -C evolution with time in an Ultisol amended with <i>P. falcataria</i> residues.....	48
6	Daily rate of CO ₂ -C evolution from <i>P. falcataria</i> per time interval of incubation.....	49
7	Soil pH dynamics in an Ultisol amended with <i>P. falcataria</i> residues.....	50
8	Percent N in maize components derived from <i>P. falcataria</i> residues.....	81
9	Overall N contribution to maize production by <i>P. falcataria</i> treatments and soil.....	81
10	Overall percent N derived from treatment (%NdfT) by corn grown on an acidic Ultisol.....	106
11	Percent N recovery (%rNE) by corn grown in various treatments	108
12	Rainfall at Puchong during the <i>P. falcataria</i> field incubation study (May 15 - July 23, 2001).....	119
13	Top soil pH dynamics of an Ultisol amended with <i>P. falcataria</i> leaves.....	123
14	Subsoil pH dynamics of an Ultisol amended with <i>P. falcataria</i> leaves.....	124
15	Soil pH dynamics of an Ultisol amended with <i>P. falcataria</i> leaves	125
16	Dynamics of leached inorganic N from the surface applied <i>P. falcataria</i> leaf in the topsoil of an acidic Ultisol.....	126



17	Dynamics of leached inorganic N from the surface applied leaves in the subsoil of an acidic Ultisol.....	127
18	Dynamics of soil inorganic N leached past the top 20 cm soil following leaf <i>P. falcataria</i> application.....	129
19	Ca ⁺⁺ , Mg ⁺⁺ and K ⁺ leached from the applied fresh <i>P. falcataria</i> leaves through the top 20 cm of an acidic Ultisol.....	130



CHAPTER I

INTRODUCTION

Back-ground

Most farmers in the tropics face the critical problem of ever declining crop yields due to nutrient mining arising from continuous cropping without adequate replenishment of the depleted nutrients. In most cases inorganic fertilizers are either insufficiently used or not used at all because of financial constraints and distribution problems. Nitrogen is known to be the most limiting nutrient to crop production in the tropics. However, organic inputs such as green manures and litter from legumes have shown some potential in mitigating soil N deficiency, though for various reasons, N use efficiency remains low in most cases.

In agroforestry land-use systems, organic inputs in terms of above ground (fresh leaves, twigs and dry litter) and below ground (dead and live root) biomass from N rich tree legumes play a significant role in the supply of N to crops. While literature on most agroforestry cropping systems has dealt much on N contribution of tree above ground biomass to crop, little documentations are available on tree below ground biomass N contribution to crop productivity. One of the basic reasons for poor documentation of the role of roots in agroforestry systems is that, quantitative root studies in the field are notoriously difficult and cumbersome, especially when time and labour aspects are fully taken into account (Schroth, 1999).

In this study, less laborious methods of direct and indirect ^{15}N isotope labeling of plants and plant residues were used in an attempt to quantitatively separate the below- and above-ground biomass N contribution of *P. falcataria* to corn grain crop in agroforestry cropping systems.

The study was aimed at providing some insights into appropriate strategies for modifying the existing agroforestry practices and systems in order to optimize their productivity as well as their overall economic viability. For instance, it was assumed that, if N contributed by roots alone, can meet crop N requirement, then above-ground biomass would be spared for a range of other optional uses or technologies such as biomass transfer for either fodder or soil fertility improvement.

Justification

Nitrogen plays a key role in plant nutrition. It is the mineral required in greatest quantity by cereal crops and is the nutrient that is most often deficient in tropical soils. As a result of its critical role and low supply, N resource management is an extremely important aspect in crop production (Novoa *et al.*, 1981). Fertilizer use in many small holder, resource poor tropical agricultural systems remain insufficient to meet crop N demand as well as to sustain soil fertility due to critical financial constraints (Buresh *et al.*, 1998). Researchers (Kwesiga and Coe, 1994; Kwesiga *et al.*, 1999) suggested deliberate inclusion of N_2 -fixing tree legumes in the tropical production systems in order to increase N availability to crops. The potential soil fertility benefits from the use of leaves of such tree legumes as *G. sepium* and *S. sesban* in agroforestry cropping systems has been well acknowledged by various authors (Wade *et al.*, 1983; Zaharah *et al.*, 1996; Buresh *et al.* 1997; Kwesiga *et al.*,

1999). Mafongoya *et al.* (1997a and 1998a) and also Buresh (pers. comm.) attributed the increase in maize grain yield under improved fallow management to increase in soil inorganic N due to decomposition of the incorporated leaves and twigs.

Periodic pruning of above ground biomass (shoots) is a common management practice in agroforestry systems such as alley cropping, biomass transfer and improved fallow systems that integrate coppicing legume tree species. The practice does not only promote leaf biomass production and recycling of N from the leaves, but it also induces root N turn over (i. e. some amount of fine roots die, decompose and eventually mineralize and enhance soil inorganic N availability). Lehmann *et al.* (1998) concluded from a review of literature that the ratio of live-to-dead roots decreased when the trees were pruned, suggesting root biomass shedding. Bashir *et al.* (1998) reported that, about 20 to 50% of root residues from trees and shrubs in a tropical self regenerating fallow is converted to soil humus while only 10 to 20 % of above ground litter is converted into soil humus.

According to Palm (1995) and Giller *et al.* (1995) crop nitrogen recovery from the incorporated prunings range between 10 to 20%. However, there is an indication that root N contribution to crop in agroforestry systems can be substantial since, below ground biomass accumulation by tree roots could be considerably high, in the order of 3 to 6 Mg ha⁻¹ year⁻¹ (Sanchez, 1995). Mineralization rate of organic matter is one of the major factors that influence N availability to crops. Synchrony or asynchrony of N demand by the crop, with N supply from an organic source also depends on the rate of mineralization and timing of application of the organic source. A green house study by Mafongoya *et al.* (1997a) highlighted three important factors that influence



mineralization of organic residues: Chemical composition (i.e. residue quality), cultural practices (i.e. method, timing and rate of application) and soil properties. However, the environmental or microclimatic conditions (temperature and moisture) may override all the above factors. When physical and environmental factors are not limiting, residue quality plays an important role in regulating decomposition rate (Buresh *et al.*, 1998).

This study attempted to address the following issues which were identified as crucial knowledge gaps with regards to the use of *P. falcataria* above and below ground biomass as a source of N for crop production.

- Residue quality i.e. N, polyphenol and lignin content of the above- and below-ground biomass.
- N mineralization rates from tree leaf and root components, individually and in mixture.
- Above- and below-ground biomass production of *P. falcataria* tree
- N recovery from *P. falcataria* residues by the crop (corn).
- Soil inorganic N and soil pH dynamics as affected by the tree or its components once integrated in the cropping system.

Hypotheses

The hypotheses for this study were as follows:

- Once *P. falcataria* above ground biomass is harvested, the corresponding unexcavated below ground biomass will have a nutrient release pattern in close synchrony with the nutrient demand of the associated corn, leading to a

relatively higher N use efficiency in agroforestry cropping systems.

- N mineralization from fresh *P. falcataria* leaves decomposing under humid tropical field conditions would be high, with potential risks of rapid N loss by leaching.
- Combining residues of varying or contrasting qualities alters or regulates rate of mineralization.
- Sustainable, cost effective soil fertility management options, leading to high and stable soil N status and recovery rates, will result from land-use strategies that integrate minimal inorganic farm inputs with readily available organic resources.

General Objective:

The general objective was as follows:

- To show the effects of above and below ground biomass of *P. falcataria* on soil inorganic N availability to crop.

Specific Objectives

The specific objectives were:

- (1) To determine the quality of *P. falcataria* leaves and roots separately and when mixed;
- (2) To characterize N and C mineralization of *P. falcataria* leaves and roots

incubated individually and in mixture under controlled or uncontrolled conditions in an acidic Ultisol;

- (3) To determine the soil inorganic N and soil pH dynamics as affected by *P. falcataria* integrated in cropping systems;
- (4) To assess crop recovery rates of the N mineralized from the above- and below-ground biomass components of *P. falcataria*;
- (5) To compare the ¹⁵N direct and the indirect labeling techniques as tools of estimating N cycling from leaf residues of trees in agroforestry cropping systems.

Why the *P. falcataria* Option?

P. falcataria is a tree legume which belongs to the genus *Albizia*. It is indigenous to Indian subcontinent, Southeast Asia and monsoon areas of Australia (Lowry, 1989). It also adapts well to most areas of the wet tropics and it is a species of major importance due to its wide range of uses (Lowry, 1989). The well known attributes of the *P. falcataria* include:

- Provision of fodder
- Bearing of edible fruits
- Provision of wood for timber and fuel (can accumulate as much as 5m³ of wood biomass ha⁻¹ yr⁻¹ - Pradhan and Dayal, 1981)
- Potential source of leaf litter for manuring (can shed 5 tons of leaf biomass ha⁻¹ yr⁻¹ -Pradhan and Dayal, 1981)
- Provides an array of traditional medicines (Dastur, 1951).